Anatomy Seminar

Shoulder & Arm
Surgical Approach

명지병원 정형외과
R3 이규환

Contents

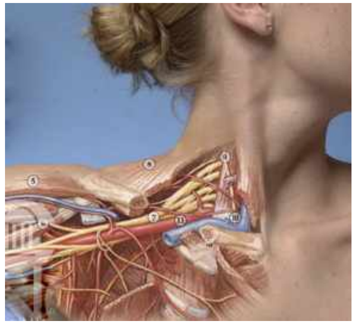
- Approach to Clavicle : anterior
- Approach to Shoulder : anterior, anterolateral, lateral, posterior
- Approach to Humerus : anterior, posterior

Ant. Approach to the clavicle

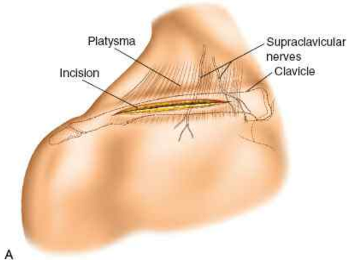
1. Open reduction and internal fixation of fractures
2. Reconstruction of the sternoclavicular and the acromioclavicular joints in case of dislocation or subluxation
3. Drainage of sepsis
4. Biopsy and excision of tumors
5. Osteotomy for malunion

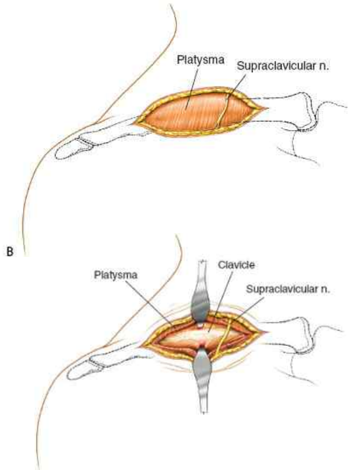
Clavicle

- The neurovascular structure
  - Brachial plexus
  - Subclavian A. & V.



Incision: 8 ~ 10cm From Sternal notch To A-C joint





Superficial surgical dissection

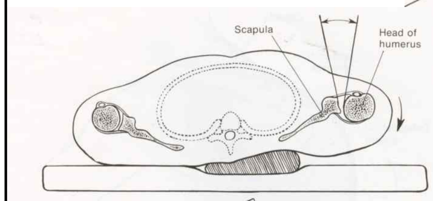
: Platysma

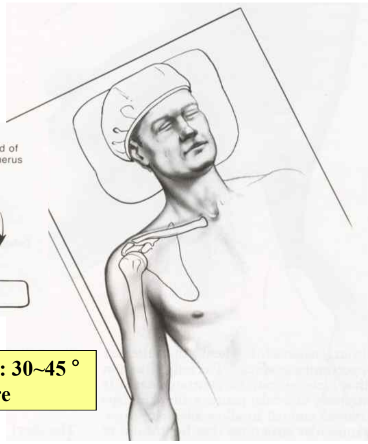
Clavipectoral fascia

Ant. Approach to shoulder joint
(ant. axillary app., utility app.)

1. Reconstruction of recurrent dislocation
2. Drainage of sepsis
3. Ex. & Bx. of tumors
4. Repair or stabilization of the tendon of long head of the biceps
5. Shoulder arthroplasties, which usually are inserted through modified ant. incision
6. Fixation of proximal humerus Fx.

Supine position

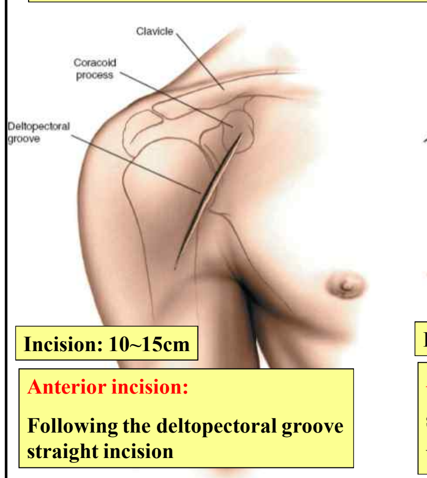




Elevate the head of table : 30~45 °
➔ reduce venous pressure

Land mark :

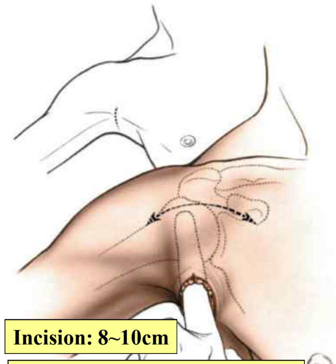
coracoid process-deltopectoral groove



Incision: 10~15cm

Anterior incision:

Following the deltopectoral groove straight incision



Incision: 8~10cm

Axillary incision:

shoulder ; abduct 90, ER

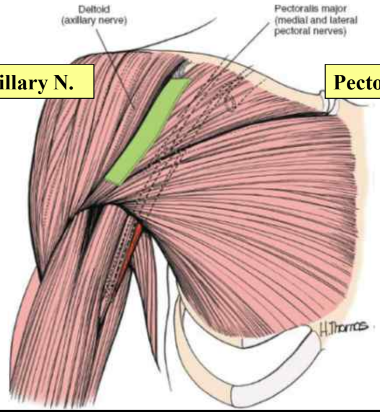
Vertical incision in the axilla

Internervous plane ;

Between deltoid m. and pectoralis major m.

Axillary N.

Pectoral N.



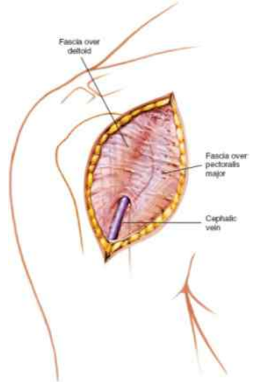
Superficial surgical dissection

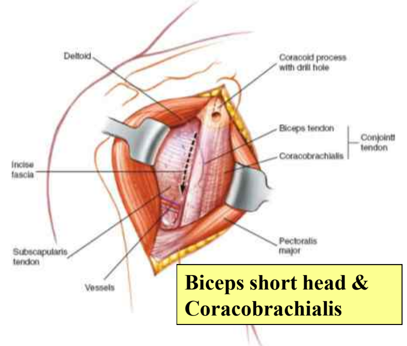
Deltopectoral groove with cephalic vein

Pectoralis major medially,

Deltoid & cephalic vein laterally

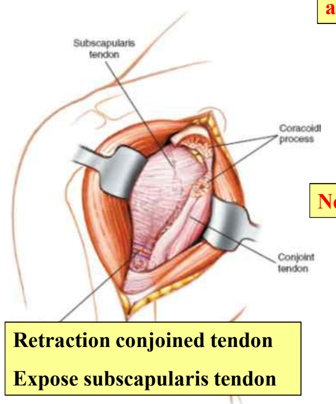
Expose the conjoined tendon





Biceps short head & Coracobrachialis

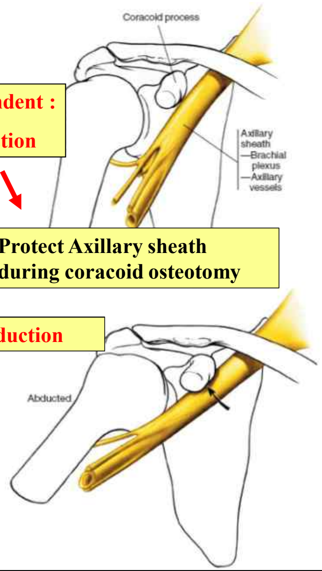
Deep surgical dissection



Retraction conjoined tendon

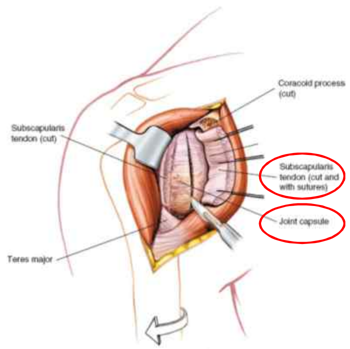
Expose subscapularis tendon

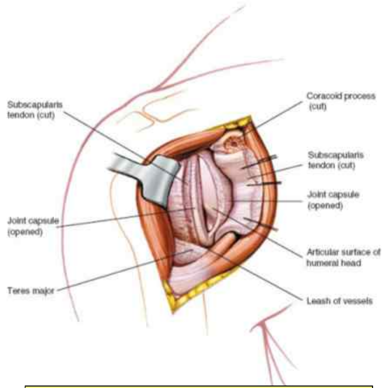
Dependent : adduction



Protect Axillary sheath during coracoid osteotomy

No Abduction



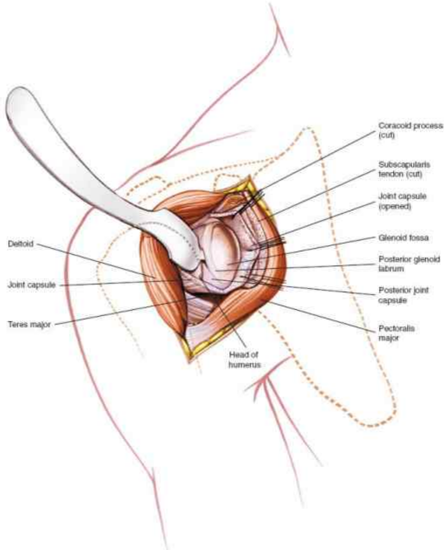


Stay suture - subscapularis tendon

Incise joint capsule longitudinally

expose the humeral head and glenoid cavity

Retract humeral head
→ Expose the glenoid cavity & labrum

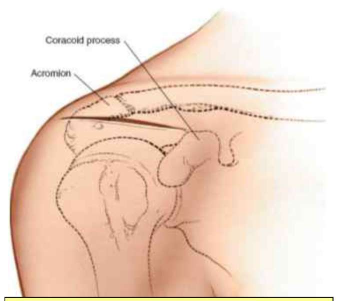


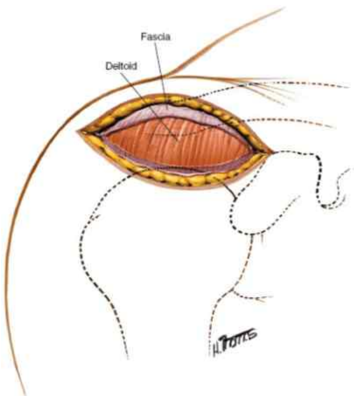
Anterolateral Approach

1. Ant. decompression of the shoulder
2. Repair of the rotator cuff
3. Repair or stabilization of the long head of a biceps tendon
4. Ex. of osteophytes from the A-C joint

Subacromial structure
(Rotator cuff)

Incise deep fascia



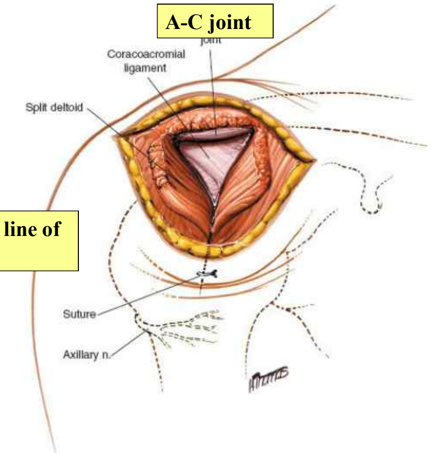


Landmark

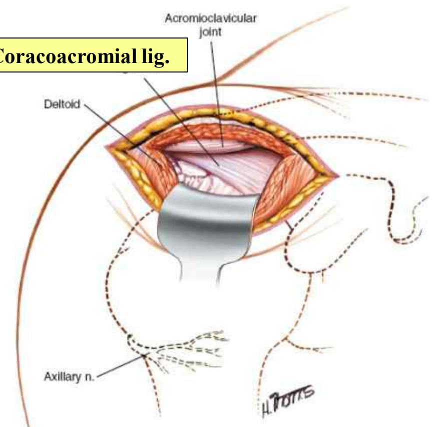
Anterolat. corner of the acromion

- Just lat. to the coracoid process

A-C joint

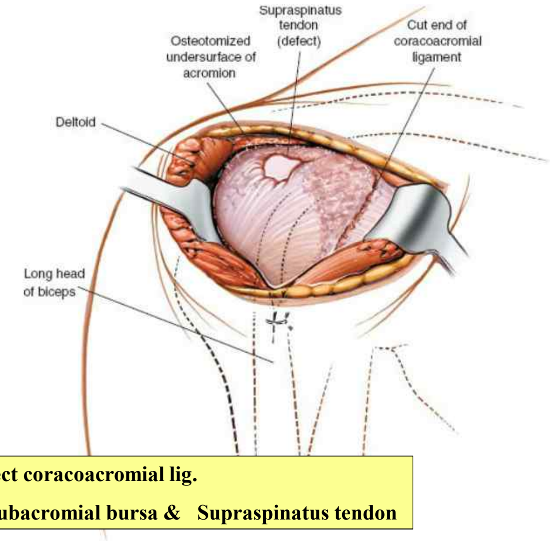


Split deltoid m. in the line of its fibers for 5 cm



Coracoacromial lig.

Detach deltoid m. from acromion

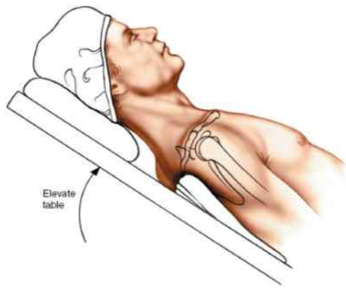


Resect coracoacromial lig.

→ Subacromial bursa & Supraspinatus tendon

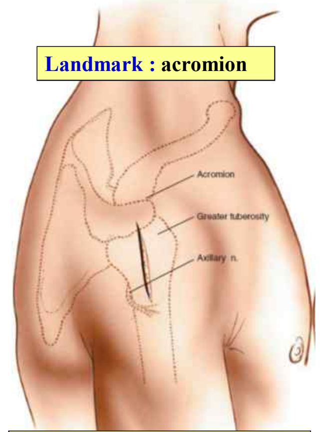
Lat. Approach (Deltoid splitting app.)

1. OR & IF of displaced Fx. of the greater tuberosity of the humerus
2. OR & IF of humeral neck Fx.
3. Insertion of IM rods in the humerus
4. Removal of calcific deposits from the subacromial bursa
5. Repair of the supraspinatus tendon & rotator cuff



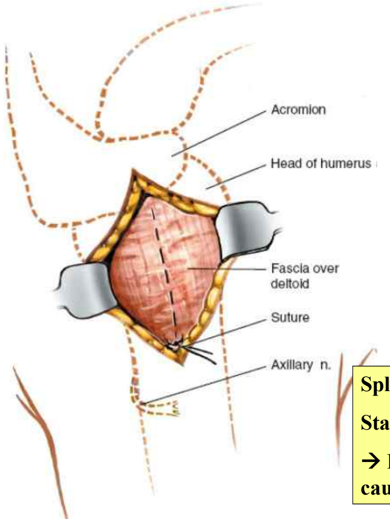
Supine position,

Table elevation 45 °



Landmark : acromion

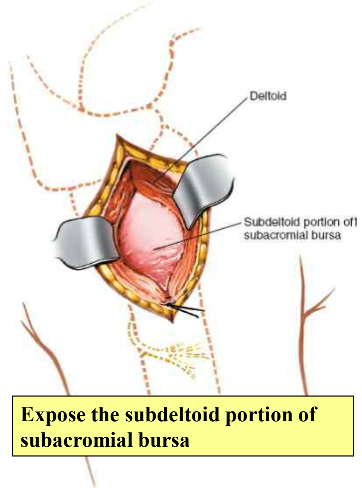
5 cm from acromial tip down the lateral aspect of arm



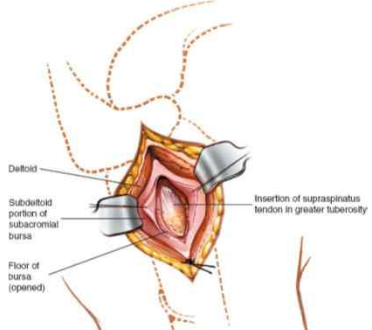
Split deltoid m

Stay suture

→ Prevent extended incision causing axillary n. injury



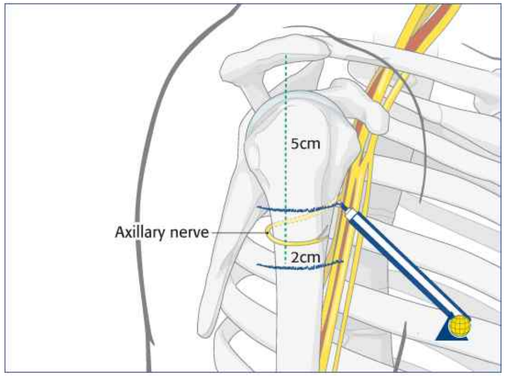
Expose the subdeltoid portion of subacromial bursa



Axillary n.

Incise subacromial bursa

→Reveal the insertion of the supraspinatus into GT



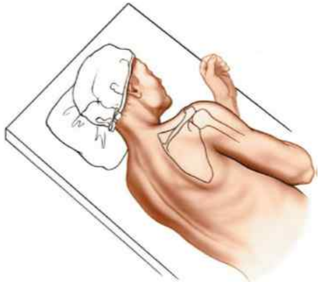
Danger zone (axillary n.)

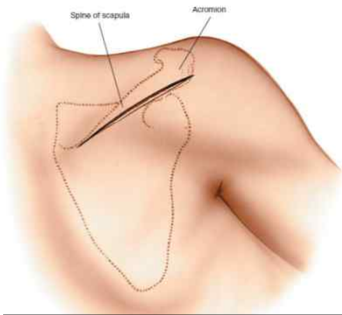
The nerve enters the deltoid muscle posteriorly from its deep surface, about 5 to 7 cm below the tip of the acromion.

Post. Approach - Rare

1. **Repairs in cases of recurrent post. dislocation or subluxation of the shoulder**
2. **Treatment of posterior fracture dislocations of the proximal humerus**
3. **Glenoid osteotomy**
4. **Bx. & Ex. of tumors**
5. **Removal of loose bodies in the post. recess of the shoulder**
6. **Drainage of sepsis**

Recurrent post. D/L





Lateral position

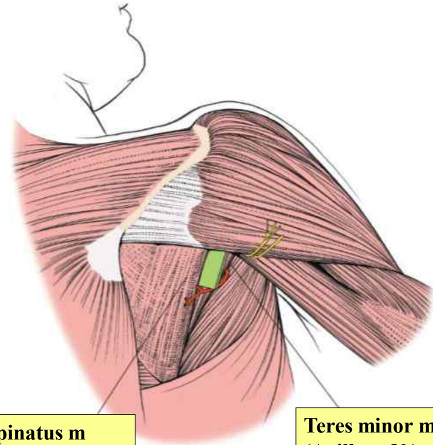
Landmark;

Post. corner of Acromion

--> Scapular spine

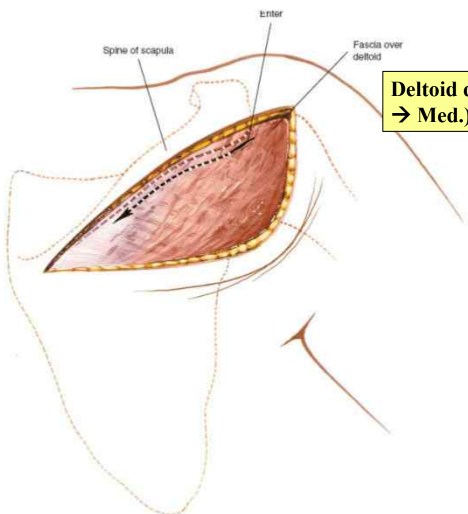
Incision over entire length of spine

Internervous plane



Infraspinatus m (Suprascapular N.)

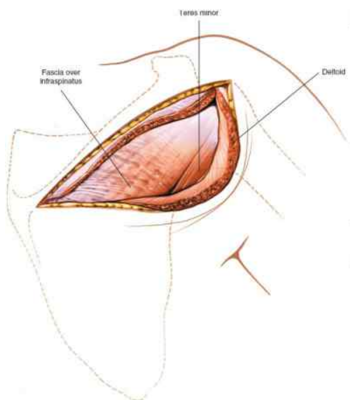
Teres minor m (Axillary N.)

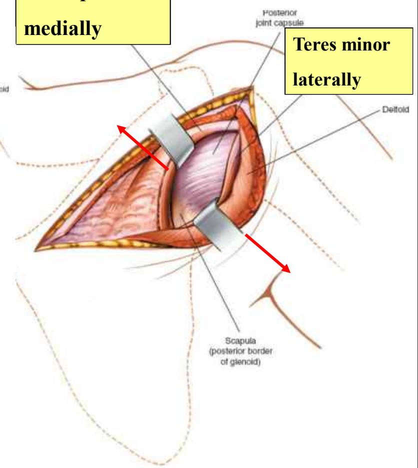


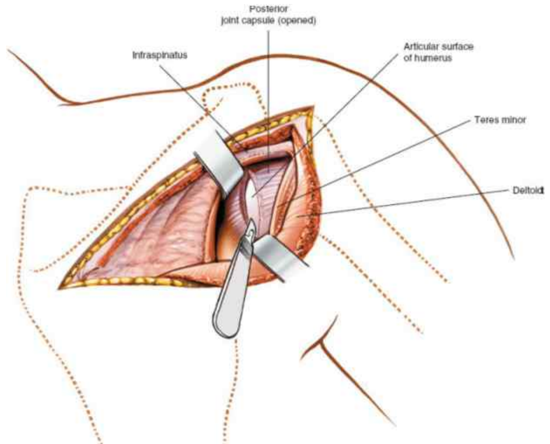
Deltoid detach (Lat. → Med.)

Infraspinatus medially

Teres minor laterally

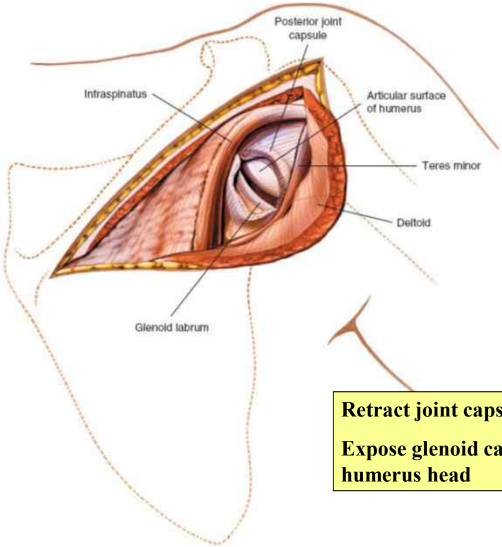






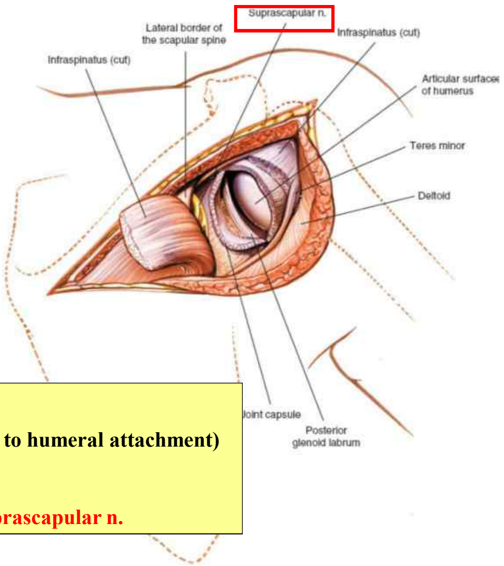
Retract infraspinatus and teres minor

Incise joint capsule close to the glenoid cavity



Retract joint capsule ;

Expose glenoid cavity, scapular neck, humerus head



To greater exposure

Infrasupinatus cut (close to humeral attachment)

Be careful to retract m

➔ to avoid stretching suprascapular n.

Upper arm

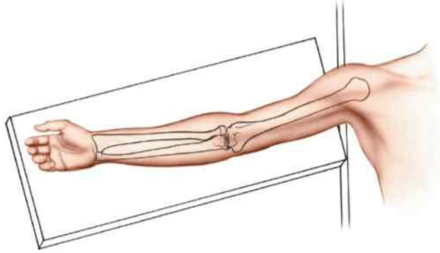
1. **Ant. Approach**
2. **Post. Approach**

Ant. Approach
(brachialis splitting ant. Approach)

1. Internal fixaion of Fx. of the humerus
2. Osteotomy of the humerus
3. Bx. & resection of bone tumors
4. Tx. of Osteomyelitis

Supine position

Arm abduction : 60°



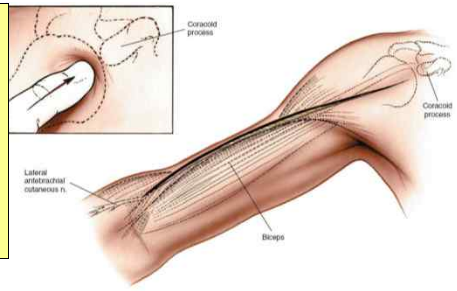
Landmark :

Coracoid process

Deltopectoral groove

Along lat. aspect of humerus

5 cm above elbow flexion crease



Two different internervous plane

Deltoid m (Axillary N.)

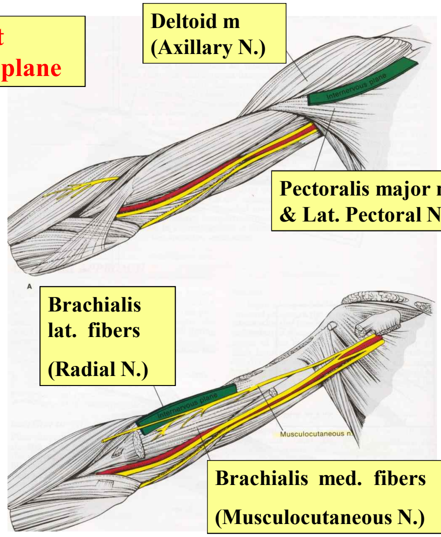
Pectoralis major m (Med. & Lat. Pectoral N.)

Brachialis lat. fibers

(Radial N.)

Brachialis med. fibers

(Musculocutaneous N.)

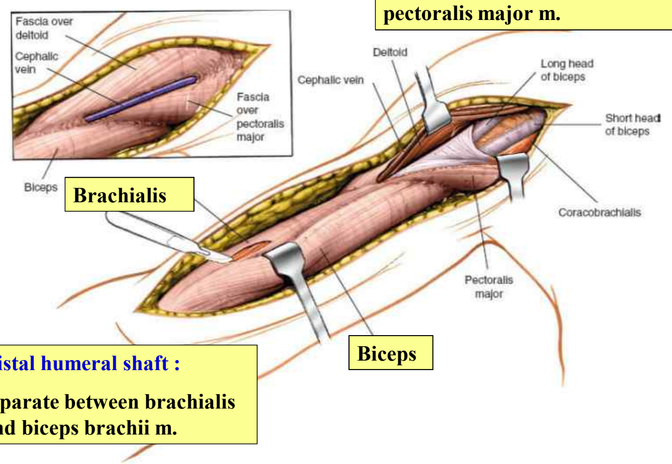


Superficial surgical dissection

Proximal humeral shaft :

Guide : cephalic vein

separate between deltoid and pectoralis major m.



Brachialis

Biceps

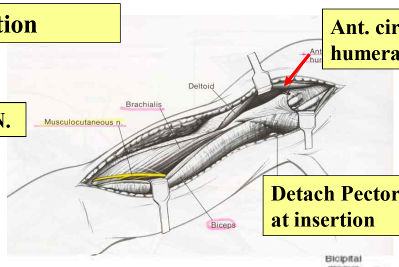
Distal humeral shaft :

separate between brachialis and biceps brachii m.

Deep surgical dissection

Ant. circumflex humeral A.

Musculocutaneous N.



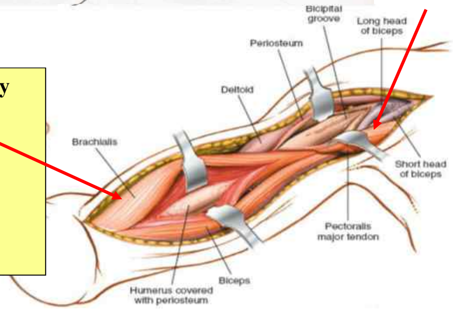
Detach Pectoralis major at insertion

Split brachialis longitudinally along midline

Elbow flexion

→Brachialis release

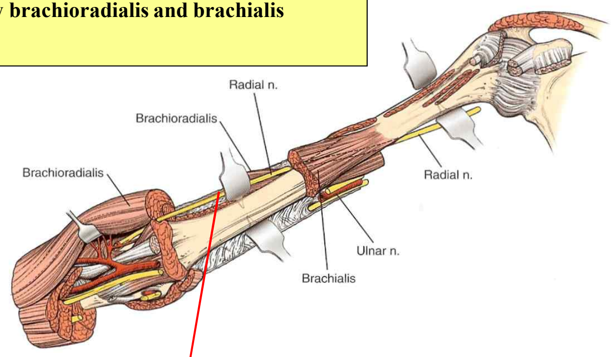
→Exposure easier



Danger : Radial nerve

1. Spiral groove

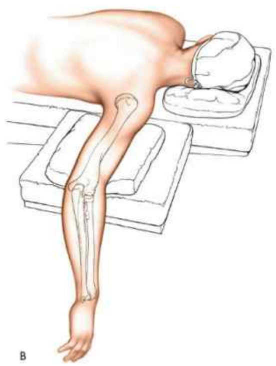
2. Pierces the lat. intermuscular septum to run btw brachioradialis and brachialis



Lateral portion of Brichialis serves as a cushion

Post. Approach

1. OR / IF of Fx. of the humerus
2. Tx. of Osteomyelitis
3. Bx. & Ex. of tumors
4. Tx. of nonunion of Fx.
5. Exploration of the radial N. in spiral groove



Prone position

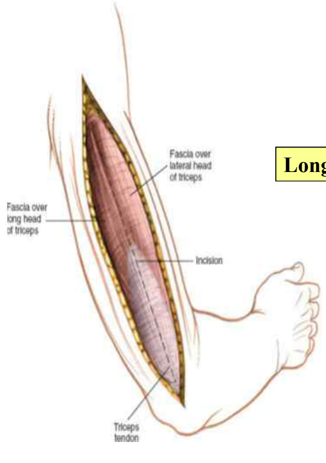
Arm abducted 90°

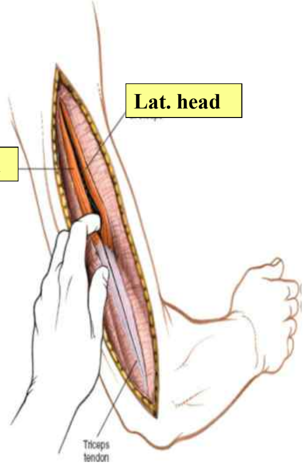
Incision :

in the midline of post aspect of arm

8 cm below the acromion ~ olecranon fossa

Identify the gap btw lateral head and long head of triceps m.





Lat. head

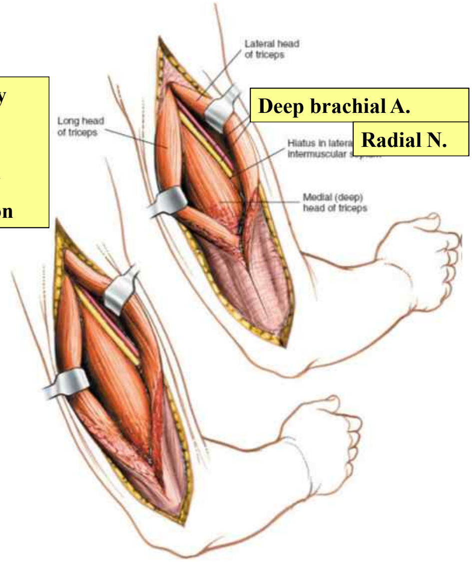
Long head

Long head: medailly

Lat head : laterally

Expose medial head

Split common tendon

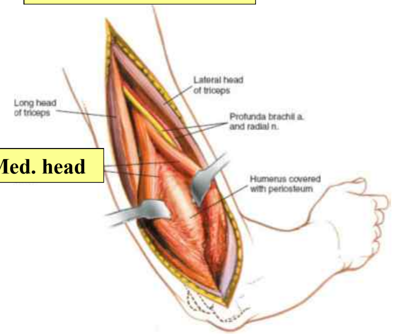


Deep brachial A.

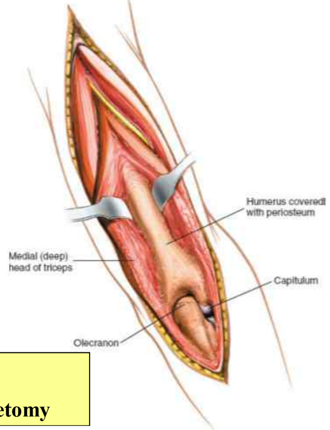
Radial N.

Incise medial head

Radial nerve preserved



Med. head



Incision extended distally :

Elbow joint, Olecranon ostetomy

Thank You for Your Attention!!

Complication- associated THA

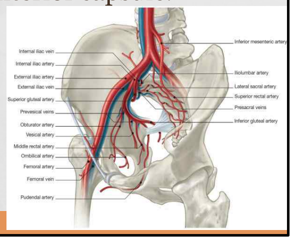
명지병원
2023.03.22
R4. 이인엘

Introduction

- Hematoma
- HO(heterotopic ossification)
- Thromboembolism
- Nerve injury

Hematoma formation

- Branches of the obturator vessles.
- 1st perforating br. of the profunda femoris deep to the gluteus maximus insertion
- Br. of the femoral vessles near the anterior capsule.
- Br. of the inf. & sup. Gluteal vessles.
- Iliac vessles.



- Late bleeding(1wks or more post op~)

-false aneurysm or from iliopsoas impingement 에서 발생.
- CT, MRI, Angiography 필요.(for identification)

CT scan shows fluid within the iliopsoas muscle sheath consistent with hematoma secondary to impingement from acetabular component. (From Bartelt RB, Sierra RJ: Recurrent hematomas within the iliopsoas muscle caused by impingement after total hip arthroplasty. J Arthroplasty 26:665, 2011.)

- Treatment (almost observation)

-discontinuation of anticoagulants.
-treatment of coagulopathy & close observation.

- OP indication

-wound dehiscence
-marginal necrosis
-associated nerve palsy
-infected hematoma

Heterotopic ossification

- X-ray . 주로 abductor , iliopsoas 부위에서 발생.

- Risk factor

-hypertropic OA male, history of HO, post traumatic OA with HO

-Ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis, paget Dz, unilateral HO.

-Anterior & Anterolateral approaches, cementless fixation.

- 보통 수술후 3~4주에서 x-ray상 calcification관찰됨

- 증상

-painless(대부분)에서 marked LOM까지 다양.
-LOM, bony ankylosis: uncommon
-significant 기능 소실 있는 경우는 10 %

- Prophylaxis

-routine is not recommended. But high risk->

Method: low dose RT(500cGy)
NSAID for 6weeks.

- Operation
- 보통 증상 없고 수술이 어렵고 해도 재발되기에 거의 안한다.
- Bone scan상 decreased technetium시 성숙된 Heterotropic bone이기에 안전, excision시행하는 경우 있음.

(수술 후 이득이 있을 경우 시행. ROM은 호전가능하나 통증의 경우는 호전 안될 수도 있음)

case M/65 404229

Thromboembolism

- Pelvis, thigh, calf의 혈관에서 발생
- 수술한 쪽 다리에서 발생
- DVT peak incidence: 4~17days after surgery.
- RF. -→

표 4-9 Risk Factors for Venous Thromboembolic Disease

CLINICAL RISK FACTORS	HEMOSTATIC ABNORMALITIES (HYPERCOAGULABLE STATES)
Advanced age	Antithrombin III deficiency
Fracture of pelvis, hip, femur, or tibia	Protein C deficiency
Paralysis or prolonged immobility	Protein S deficiency
Prior venous thromboembolic disease	Dysfibrinogenemia
Operation involving abdomen, pelvis, or lower extremities	Lupus anticoagulant and antiphospholipid antibodies
Obesity	Myeloproliferative disorder
Congestive heart failure	Heparin-induced thrombocytopenia
Myocardial infarction	Disorders of plasminogen and plasminogen activation
Stroke	

- Dx.

-pain & tenderness in calf or thigh.
-Homan's sign
-low-grade fever
-rapid pulse
-unilateral swelling & erythema of leg
(-50% 정도에서는 임상 진단 명확x)

Homan's sign

- (DVT sign.)
- Passive, supine.
- Dorsiflexion the foot and squeezing the calf.->
- (+) pain at the post. leg of calf

- Dx. 이어서

-venography
  -most sensitive & specific test in calf & thigh.

  -pelvic vein thrombosis 를 detection못함
  -비용이 비싸고 불편, invasive.
  -조영제에 대한 allergic reaction가능성.
  -thrombosis 유발위험.

-duplex Doppler Ultrasonography
  -DVT screening test 로 사용
  -not invasive, easily repeated.
  -femoral detection은 정확, calf, pelvic 은 부정확.

- PTE.

-Sx: chest pain.
-EKG, chest x-ray, ABGA.
-HRCT: 확진
-radionuclide perfusion lung scanning
-pulmonary angiography.

- Prophylaxis of TE.

-early mobilization, actice exercise of both lower extremities. (venous stasis, thrombus formation 감소)
-mechanical : pneumotic compression., pump.
-pharmacological : 와파린, LMWH, aspirin등

표 4-10 AAOS Clinical Practice Guideline for Deep Vein Thrombosis Prophylaxis

RISK	AGENT
Standard risk of pulmonary embolism and major bleeding	Aspirin, LMWH, pentasaccharide, warfarin (INR ≤ 2)
Elevated risk of pulmonary embolism; standard risk of bleeding	LMWH, pentasaccharide, warfarin (INR ≤ 2)
Standard risk of pulmonary embolism; elevated risk of bleeding	Aspirin, warfarin (INR ≤ 2), no prophylaxis
Elevated risk of pulmonary embolism and bleeding	Aspirin, warfarin (INR ≤ 2), no prophylaxis

INH, international normalized ratio; LMWH, low-molecular weight heparin.

Nerve injury.

- RF

-hip dysplasia
-post traumatic arthritis
-posterior approach
-cementless fixation
-revision surgery
-female gender
-significant lengthening of the extremity

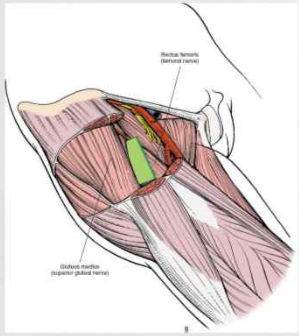
- Sciatic, femoral, obturator, sup. gluteal nerve. (m/c injury.)

- Cause

-direct surgical trauma
-traction
-pressure from retractors
-ext. positioning
-limb lengthening
-thermal of pressure injury from cement

- Sciatic nerve injury
- Femoral nerve injury
- Obturator nerve injury
- Superior gluteal nerve injury

-most susceptible to injury with anterolateral approaches that splint gluteus medius m.
-abductor weakness with Trendelenburg gait may result from this.



Sartorius (femoral n.)
Tensor fasciae latae (sup. gluteal n.)

Xray conference

Case presentation

명지병원 정형외과

R4. 이 인 엘

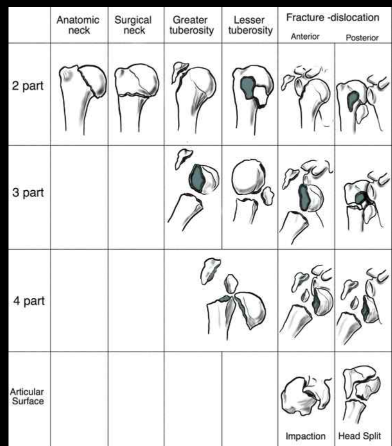
2023.03.22

이진관 M/69 01271840

- C.C) Lt. shoulder
- P.I) 69세 남자환자 내원 직전 보행하다 차량과 부딪히며 수상 후 발생한 Lt. shoulder를 주소로 응급실 경유 입원

- Hx.) n-s

Proximal humerus fracture neer classification



- Most commonly used classification system for prox. Humeral fracture

- Based on :
  - Anatomical relationship of 4' 'part'
  - Articular surface component
  - Greater tuberosity
  - Lesser tuberosity
  - Humeral shaft (surgical neck)

- 1cm 이상의 displaced

Operative treatment

1) 2-part GT fx. : 1cm 이상 displacement 시에 ORIF
   old age : 비흡수성 봉합사
   young age : 나사못 고정
2) 2-part surgical neck fx.
   (1) not comminuted : C/R & pinning
   (2) comminuted : lock – plate fixation
3) 2-part anatomical neck fx.
   (1) young age : ORIF 시도 권장
   (2) old age : TSA

4) 3 part fx.
   (1) TOC : ORIF c plate
   (2) old age : TSA

수술일자 2023-03-10

수술 전 진단명

수술 전 진단명
Fx. distal 1/3, shaft, tibiofibula, leg, Rt.
Fx. prox. humerus, shoulder, Lt.

수술 후 진단명

수술 후 진단명
Fx. distal 1/3, shaft, tibiofibula, leg, Rt.
Fx. prox. humerus, shoulder, Lt.

수술명

수술명
rTSA, Lt.

집도의1 김철환 보조의1 경태현
보조의2 이규환

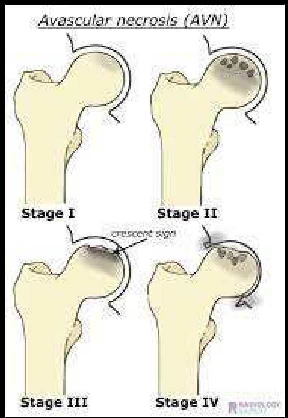
마취방법 ●General ○Epidural ○Spinal ○Caudal ○BPB ○Local

수술관찰소견

Neer classification : 2-part
(골절된지 약 4주정도 지난 subacute phase이기에 reduction 가능성 낮아 rTSA로 진행함

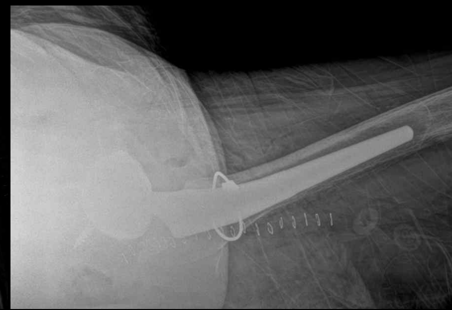
윤경자 F/81 360927

- C.C) Lt. hip pain
- P.I) 81세 여자환자 3개월 전부터 특이 외상력 없이 발생한 Lt. hip pain을 주소로 외래 경유하여 입원함.
- Hx.) DM, HTN, both TKR



Stage	Features
0	Normal radiographs (silent hip)
I	Inconspicious abnormality orminor osteopenia changes
II	Sclerotic or cystic lesions
	II a. Focal radiological changes
	II b. Crescent sign without flattening of the femoral head
III	Flattening of the femoral head or femoral head collapse, joint space normal
IV	Femoral head collapse and osteoarthritis of the hip (joint spacecollapse, acetabular changes)

Ficat and Arlet classification system.



2023 Anatomy Seminar

ELBOW & FOREARM

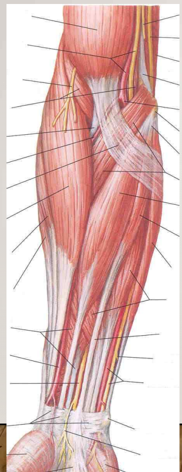
ANGIOLOGY & NEUROLOGY

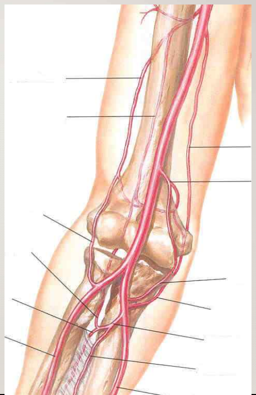
2023.03.24

R2 김 수 영

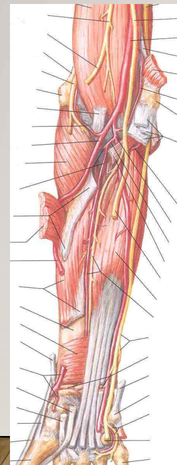
Angiology

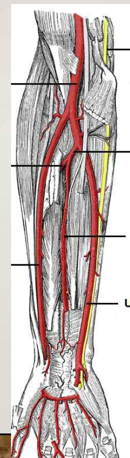
Ulnar artery

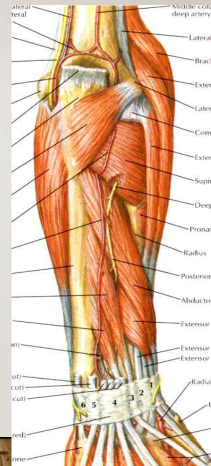




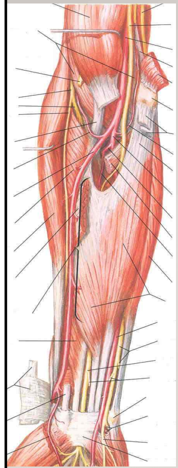
Ulnar artery

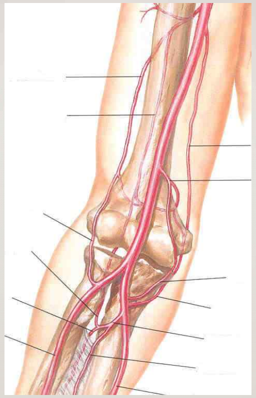


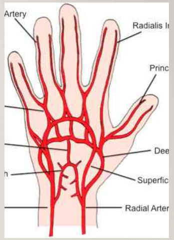




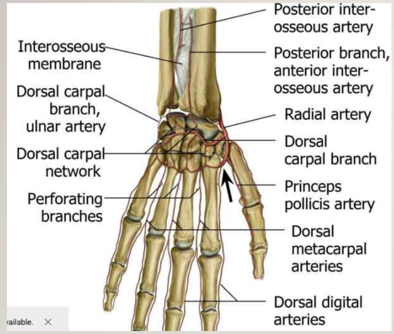
Radial artery

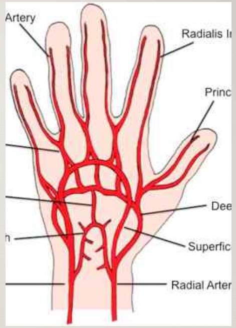






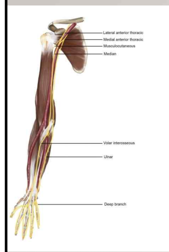
Radial artery

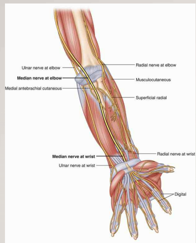


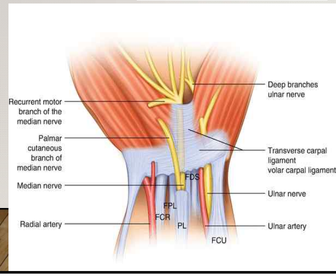


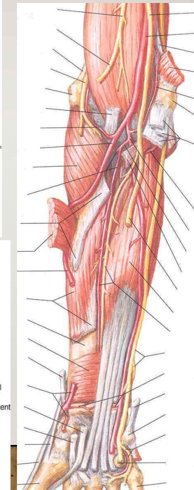
Neurology

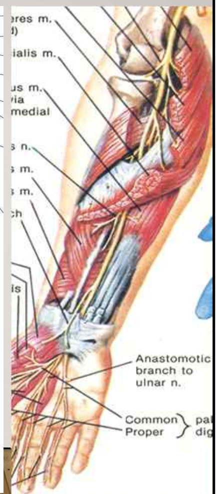
Median nerve



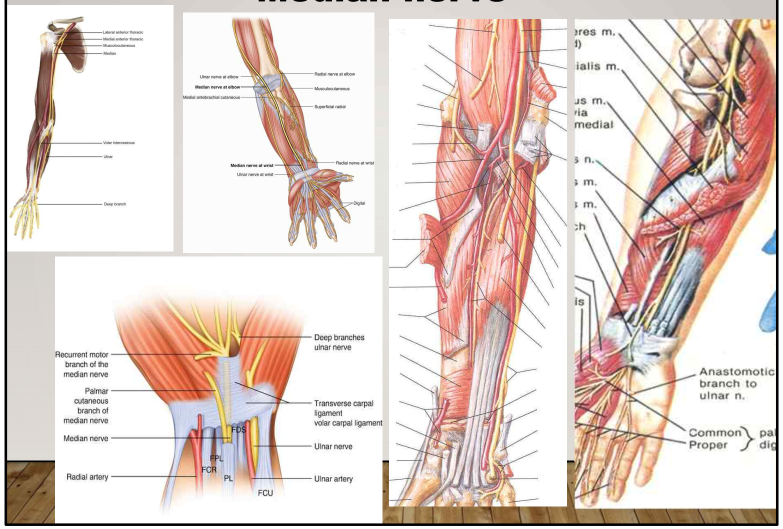




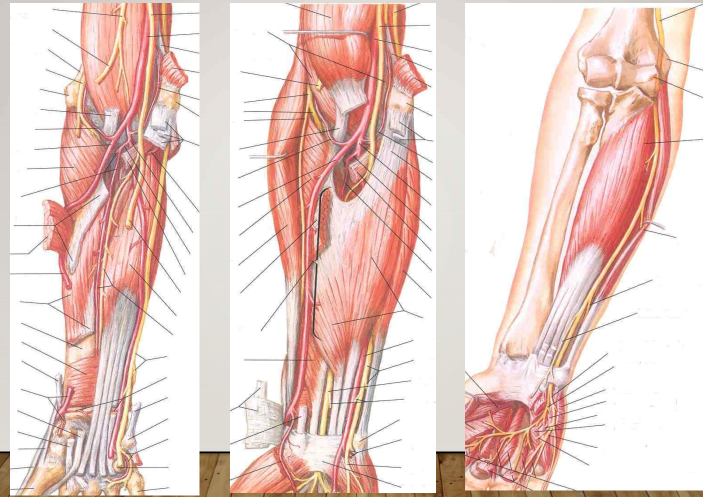




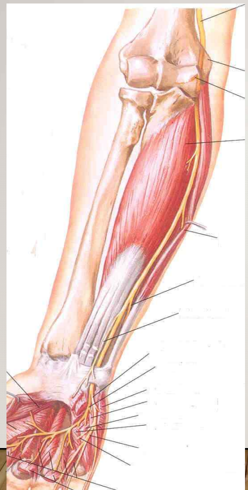
Median nerve

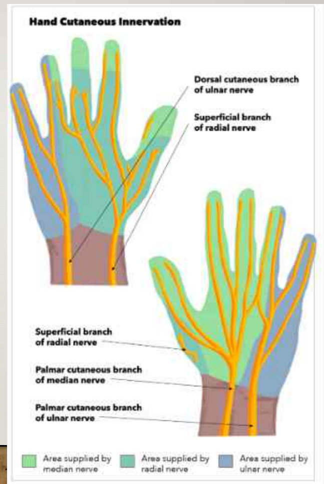


Ulnar nerve

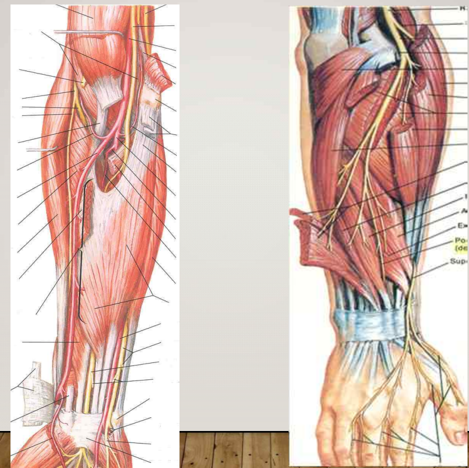


Ulnar nerve





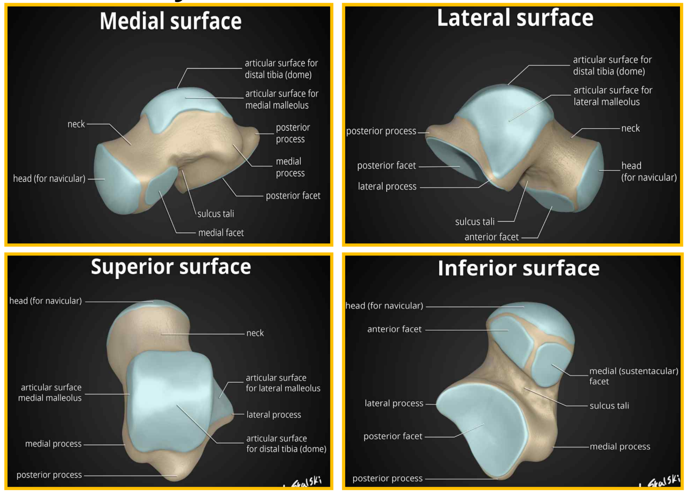
Radial nerve



Osteochondral lesion of talus

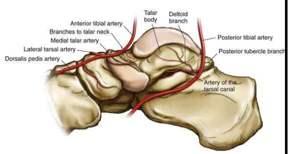
2023.03.24
R2. 우창우

Anatomy

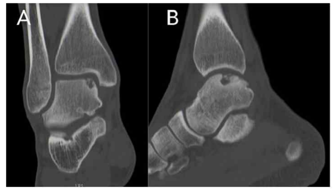


Anatomy

- Cartilage
  - Covers 70% of talus
  - Among the thickest in the body
  (Implications for osteochondral autografting)
  - Maintains tensile strength longer than femoral head with aging process
- Blood supply
  - Relies on extra-osseous blood supply
  - Deltoid artery supplies majority of talar body and dome



Epidemiology

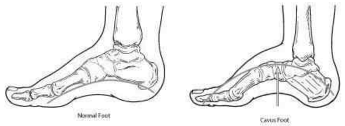


- Incidence
  - 69% of ankle fractures
  - 70% of ankle sprains
  - 10% are bilateral
  - medial talar dome lesions more common
- Anatomic location
  - Medial talar dome
    - usually no history of trauma
    - more posterior
    - larger and deeper than lateral lesions
  - Lateral talar dome
    - usually have a traumatic history
    - more superficial and smaller
    - more central or anterior
    - lower incidence of spontaneous healing
    - more often displaced and symptomatic

Pathophysiology

- Mechanism of injury
  Lateral OLT
  - Ankle inversion / dorsiflexion during axial load

  Medial OLT
  - Ankle inversion / external rotation / plantar-flexion during axial load creates
- Pathophysiology
  - Possible repetitive microtrauma creates ischemic environment and loss of integrity of subchondral bone
  - Leads to softening and disruption of overlying cartilage
- Associated conditions
  - Cavus hindfoot alignment



Epidemiology

- Medial lesion vs Lateral lesion

	Medial (more common)	Lateral
Injury mechanism	Inversion / PF	Inversion / DF
Trauma Hx	Less	Common
Location	Mid to post	Ant
Shape	Deep cup shape	Shallow, horizontal
Displacement	Less	Common
Degenerative arthritis	Rare	Frequent
Sx.	Mild and late onset	Svere and early onset
Cystic lesion	Frequent	Rare
Tx.	OP : stave IV	OP : stage III, IV

Symptoms

- History
  - Inversion ankle sprain
- Symptoms
  - Pain centered over ankle joint line
  - Joint effusion
  - Mechanical symptoms such as giving way or locking
- Physical exam
  - Inspection
    - Joint effusion
    - Palpation rarely reproduces pain
    - Cavus hindfoot alignment
  - Motion
    - Often limited secondary to pain or effusion

Imaging

- Radiographs
  - Recommended views
    - Standard weightbearing ankle series
  - Findings
    - Often normal
    - Subtle lucency or bone fragmentation
- Bone scan
- CT
- MRI

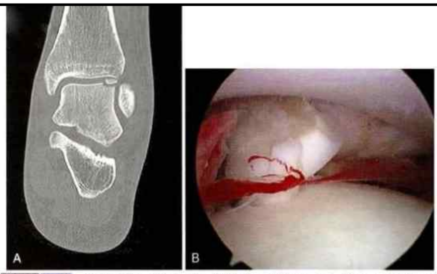


FIGURE 90.40 A, CT of stage IV osteochondral lesion of talus; note that fragment is flipped, with articular cartilage adjacent to subchondral bone. B, Stage IV osteochondral lesion as seen arthroscopically.

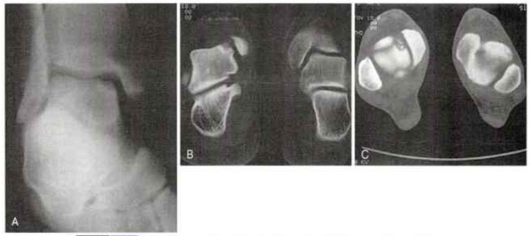


FIGURE 90.45 A, Anteroposterior radiograph shows stage III lesion of medial talus. B, CT scan reveals extent and depth of lesion. C, Scan cut in coronal plane shows location of lesion anteriorly.

Classification

- Berndt and Harty classification

- Stage 1
  - Small area of subchondral compression
- Stage 2
  - Partial fragment detachment
- Stage 3
  - Complete fragment detachment but not displaced
- Stage 4
  - Displaced fragment

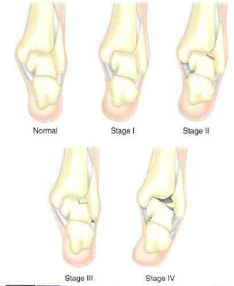
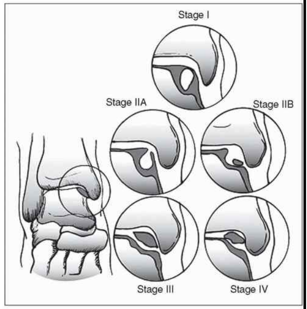


FIGURE 90.39 Four stages of osteochondritis dissecans of talus. Lateral lesions characteristically appear shallow and horizontal and frequently are elevated or detached. Medial lesions are characteristically deeper; and although they may appear to be detached, most frequently they sit in their crater.

Classification

- Ferkel and Sgaglione CT Staging System

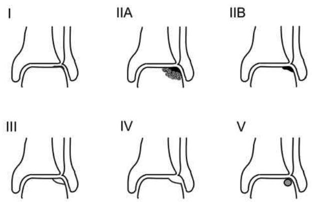
- Stage 1
  - Cystic lesion within dome of talus with an intact roof on all view
- Stage 2a
  - Cystic lesion communication to talar dome surface
- Stage 2b
  - Open articular surface lesion with the overlying nondisplaced fragment
- Stage 3
  - Nondisplaced lesion with lucency
- Stage 4
  - Displace fragment



Classification

- Hepple MRI Staging System

- Stage 1
  - Articular cartilage edema
- Stage 2a
  - Cartilage injury with underlying fracture and surrounding bony edema
- Stage 2b
  - Stage 2a without surrounding bone edema
- Stage 3
  - Detached but nodisplaced fragment
- Stage 4
  - Displaced fragment
- Stage 5
  - Subchondral cyst formation



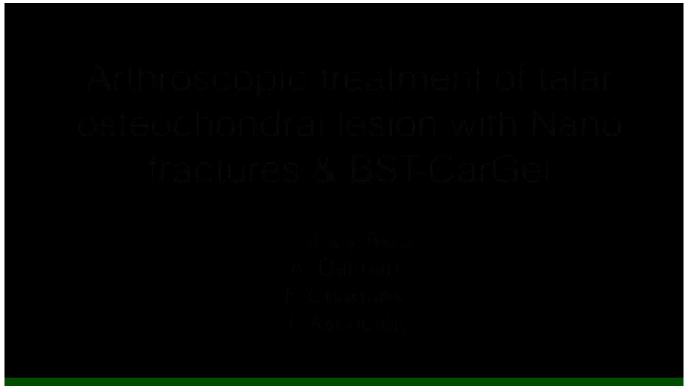
Treatment

- Nonoperative
  - **Immobilization and non-weight bearing**
  - indications
    - acute injury
    - nondisplaced fragment with incomplete fracture

Treatment

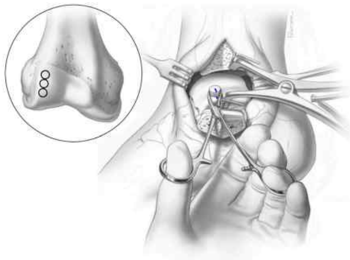
- Operative
- **Arthroscopy with removal of the loose fragment, debridement and marrow stimulation**
  - Indications
    - chronic lesions
    - size < 1 cm
    - displaced smaller fragment with minimal bone on the osteochondral fragment (poor healing potential)
- **Retrograde drilling and/or bone grafting**
  - Indications
    - size > 1 cm with intact cartilage cap
- **Osteochondral grafting (osteochondral autograft transplantation, autologous chondrocyte implantation, bulk allograft)**
  - Indications
    - Size > 1 cm and displaced lesions, shoulder lesions
    - Salvage for failed marrow stimulation or drilling
- **Autologous chondrocyte implantation**

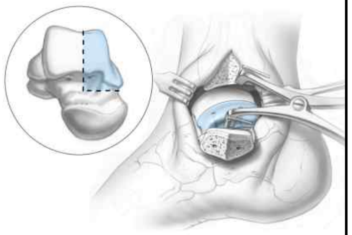
Arthroscopic bone marrow stimulation



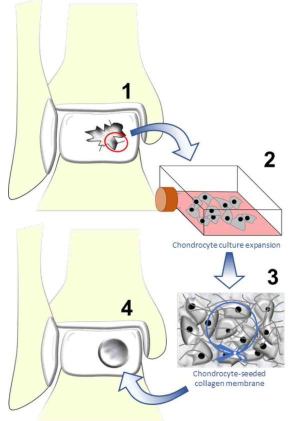
Retrograde drilling

Osteochondral grafting

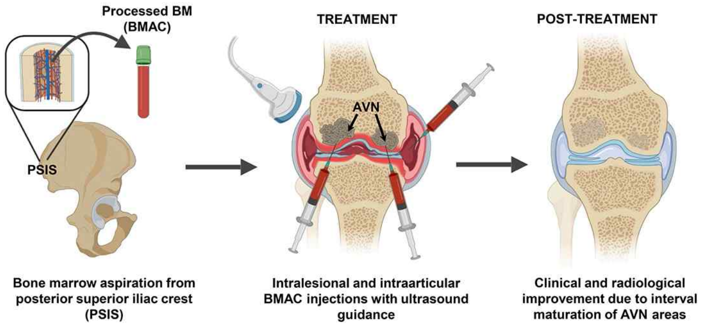




Autologous chondrocyte implantation



BMAC



1. 2개월전 외상 후 내원한 44세 여자의 CT 사진이다. Brendt & Harty classification과 치료로 적절한 조합은? 08B2

㉮ stage II - 관찰
㉯ stage II - 약물 및 물리치료
㉰ stage III - 6주간 단하지 석고붕대 고정
㉱ stage IV - 관혈적 정복 및 내고정술
㉲ stage IV - 관절경하 변연절제 및 천공술

답 : 마

Reference

Current concept review : osteochondral lesions of the talus
Foot ankle Int 2010. McGahan PJ

Fluoroscopy-guided retrograde core drilling and cancellous bone grafting in osteochondral defects of the talus.
Int Orthop 2012. Anders S

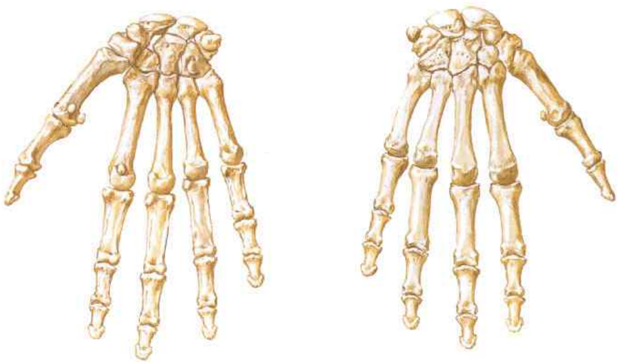
Osteochondral lesion of talus
JBJS 1980 Canale ST

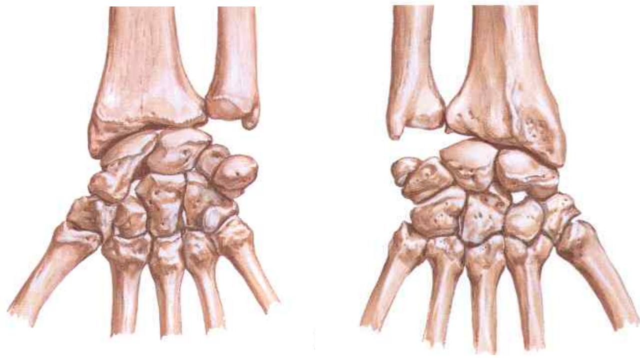
Anatomy Seminar

Wrist & Hand

2023.03.27
명지병원 정형외과
R1 정승호

Osteology





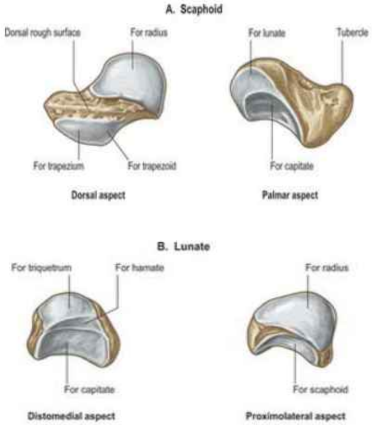
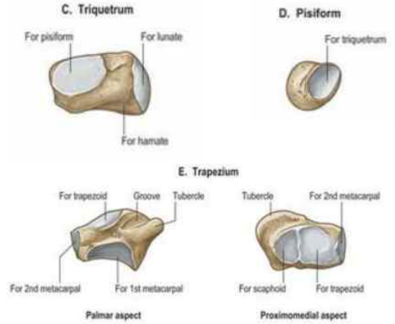
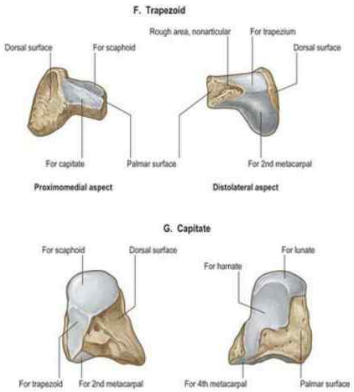
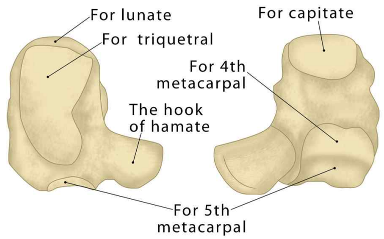


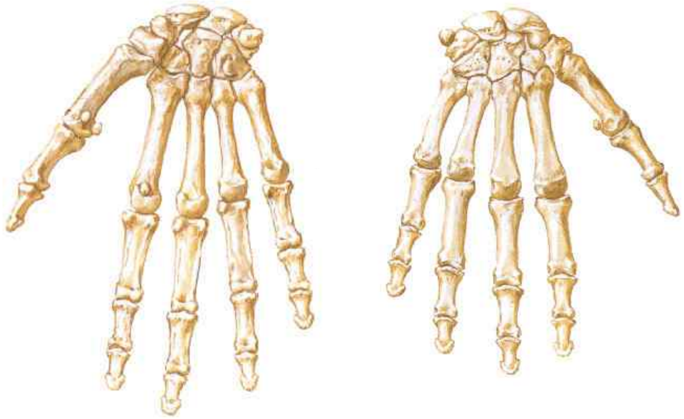
Table 1. Lichtman Classification for the Stages of the Kienbock's Disease

Stages	Definition
1	Plain radiographs are normal MRI shows diffuse t1 signal decrease positive scintigraphy
2	Sclerosis of lunate with no collapse of bone
3A	Lunate collapse with carpal height preserved
3B	Lunate collapse with hyper flexed scaphoid
4	Carpal arthritis

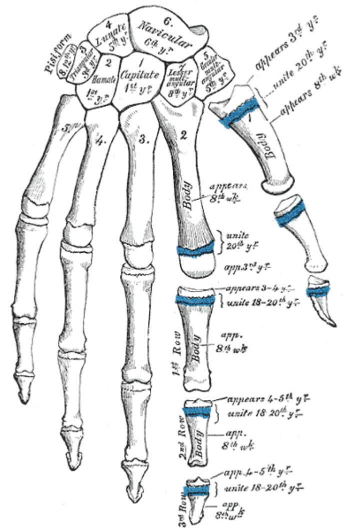








Ossification



Arthrology

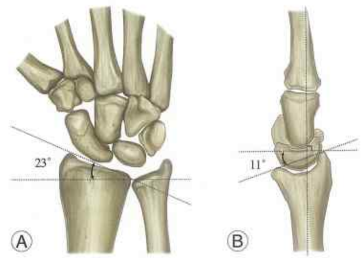


그림 VI-2, (A) 척측 경사, (B) 수장 경사.

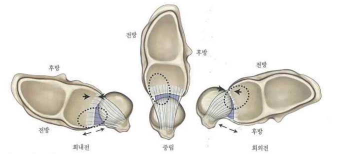
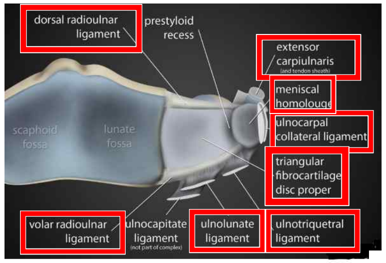


그림 II-25. 원위 요척관절(DRUJ)의 운동은 요골의 S형 절흔(Sigmoid notch)과 척골 골두의 반경이 서로 다르기 때문에 회내전 운동을 할 때에는 원위 요골에 대해 척골 골두가 후방으로 전위되고 회외전 운동을 할 때에는 전방 전위가 일어난다.



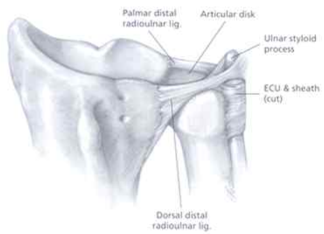
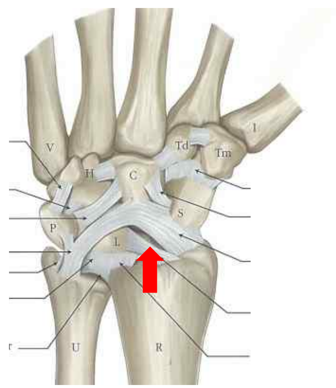
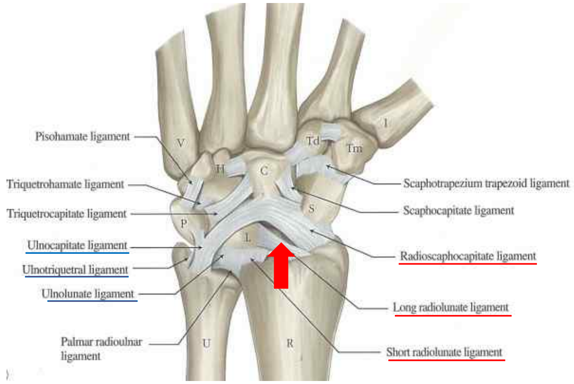


그림 II-5. 삼각 섬유연골 복합체(triangular fibrocartilaginous complex, TFCC). 원위요척인대(DRUL, distal radioulnar ligament).





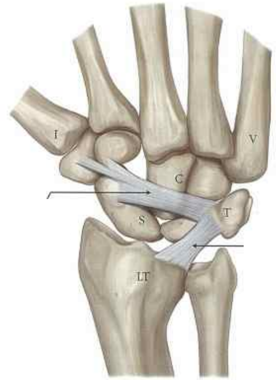


그림 VI-7. 후방 수근골인대(dorsal carpal ligament). LT: Lister's tubercle.

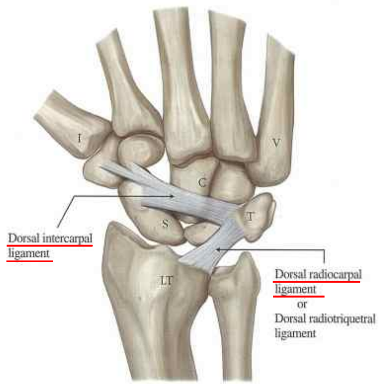
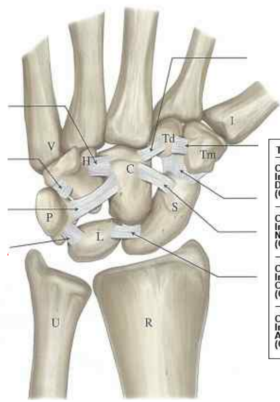
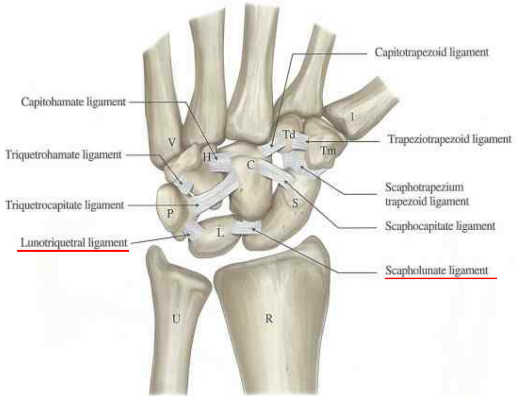
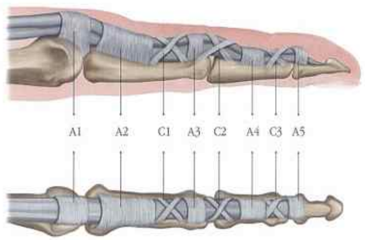


그림 VI-7. 후방 수근골인대(dorsal carpal ligament). LT: Lister's tubercle.



Type	Pattern of Instability
Carpal Instability Dissociative (CID)	Derangement within or between bones of the same carpal row
Carpal Instability Non-dissociative (CIND)	Derangement between the radius and bones of the proximal carpal row or between the proximal and distal carpal rows
Carpal Instability Complex (CIC)	Features of both CID and CIND
Carpal Instability Adaptive (CIA)	Origin of instability is proximal or distal to the wrist





그림II- 42. 수지 활차 구성.

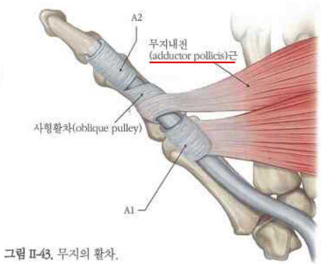


그림 II-43. 무지의 활차.

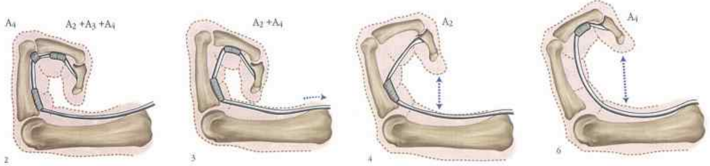


그림 II-27. 효과적인 힘의 전달을 위해 건은 두꺼워진 활액막으로 싸여 있는데 이것을 활차(pulley)라고 한다. 이 중 A2 및 A4 활차는 수지 굴곡에 필수적이므로 수술시 꼭 보존해야 하며 만일 손상된 경우 활시위 현상 (bowstring)이 일어나 수지를 완전히 굴곡시킬 수 없게 되므로 복원이나 재건을 해야 한다.

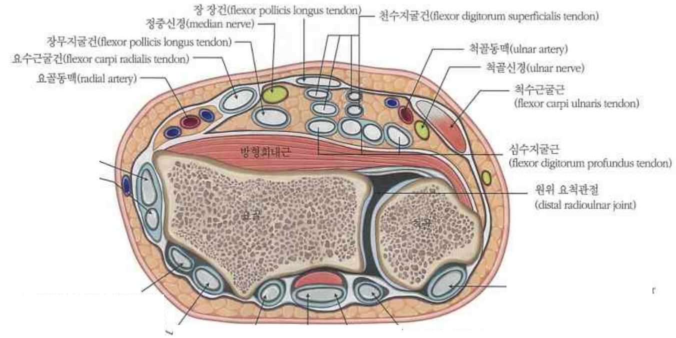


그림 II-

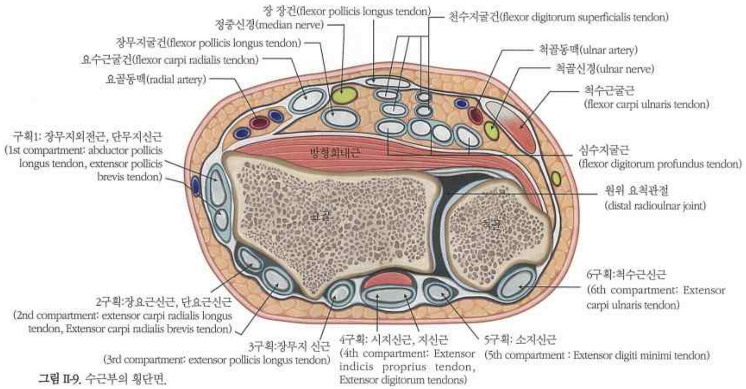


그림 II-9. 수근부의 횡단면.

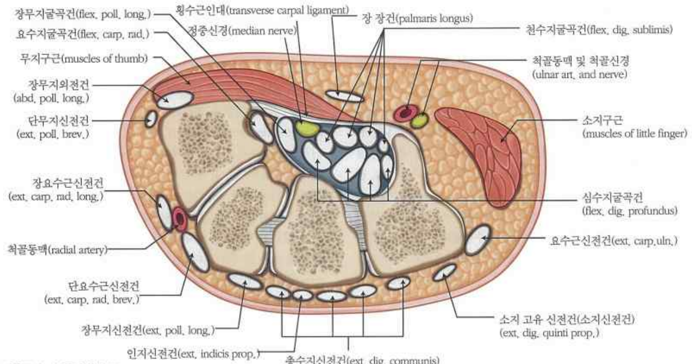
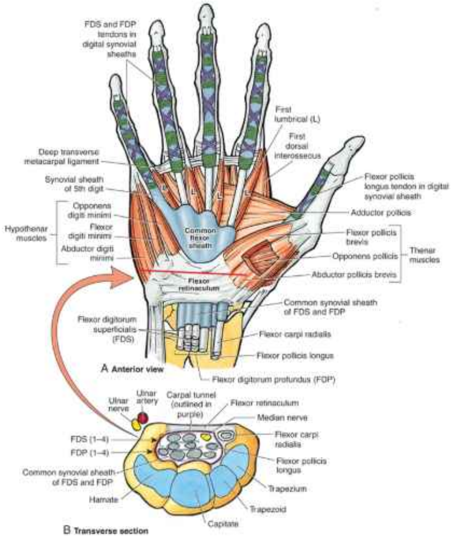


그림 II-19. 수근관의 구조.

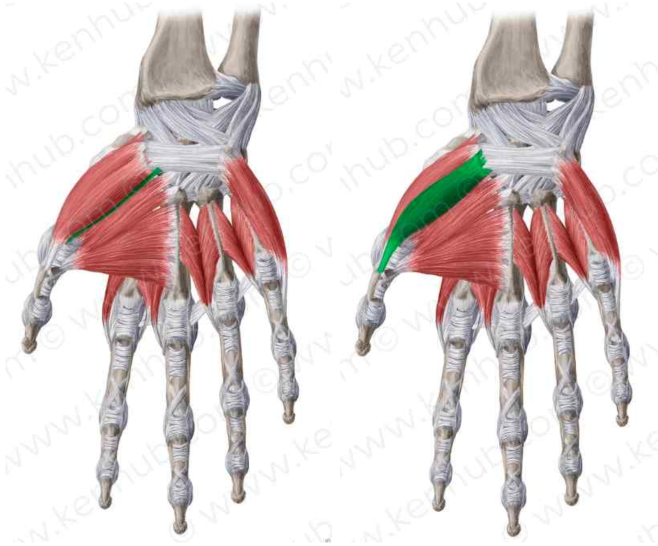


Hand muscle

Hand	Lateral volar	Thenar (Abductor pollicis brevis, Flexor pollicis brevis, Opponens pollicis) Adductor pollicis	
	Medial volar	Hypothenar (Abductor digiti minimi, Flexor digiti minimi, Oppenens digiti minimi)	
	Intermediate	Lumbrical / Interossei (Dorsal, Palmar)	
	Fascia	Posterior	Extensor retinaculum / Extensor expansion
		Anterior	Flexor retinaculum / Palmar aponeurosis

Thenar muscle

Hand	Lateral volar	Thenar (Abductor pollicis brevis, Flexor pollicis brevis, Opponens pollicis) Adductor pollicis	
	Medial volar	Hypothenar (Abductor digiti minimi, Flexor digiti minimi, Oppenens digiti minimi)	
	Intermediate	Lumbrical / Interossei (Dorsal, Palmar)	
	Fascia	Posterior	Extensor retinaculum / Extensor expansion
		Anterior	Flexor retinaculum / Palmar aponeurosis



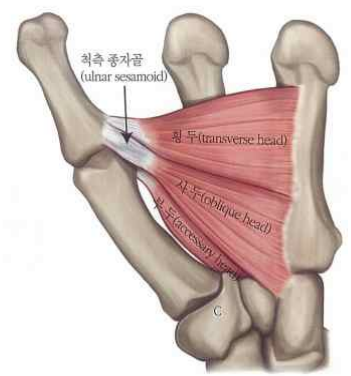
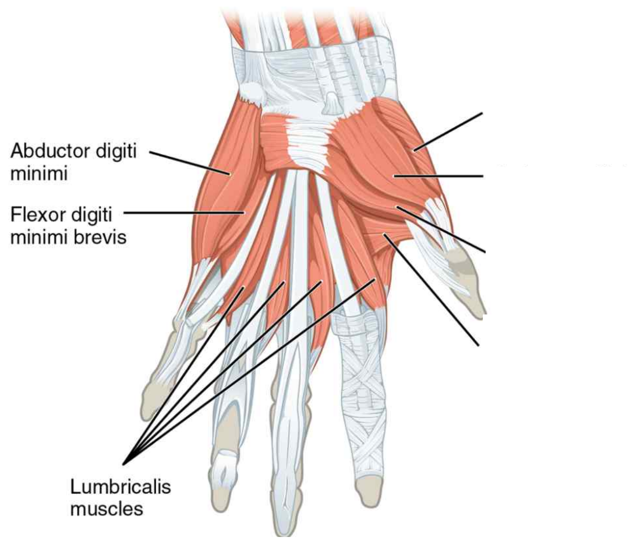
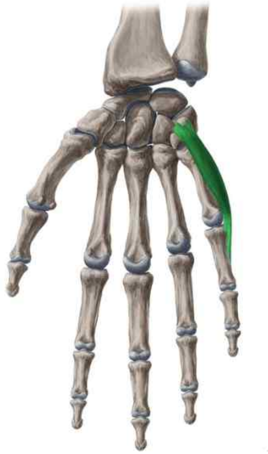


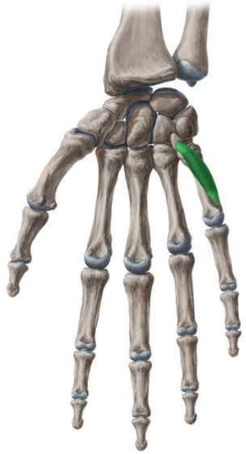
그림 II-12. 무지내전근(adductor pollicis muscle).



Hypothenar muscle

Hand	**Lateral volar**	Thenar (Abductor pollicis brevis, Flexor pollicis brevis, Opponens pollicis) Adductor pollicis	
	Medial volar	Hypothenar (Abductor digiti minimi, Flexor digiti minimi, Oppenens digiti minimi)	
	Intermediate	Lumbrical / Interossei (Dorsal, Palmar)	
	Fascia	Posterior	Extensor retinaculum / Extensor expansion
		Anterior	Flexor retinaculum / Palmar aponeurosis





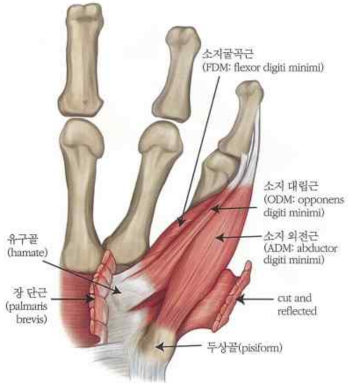
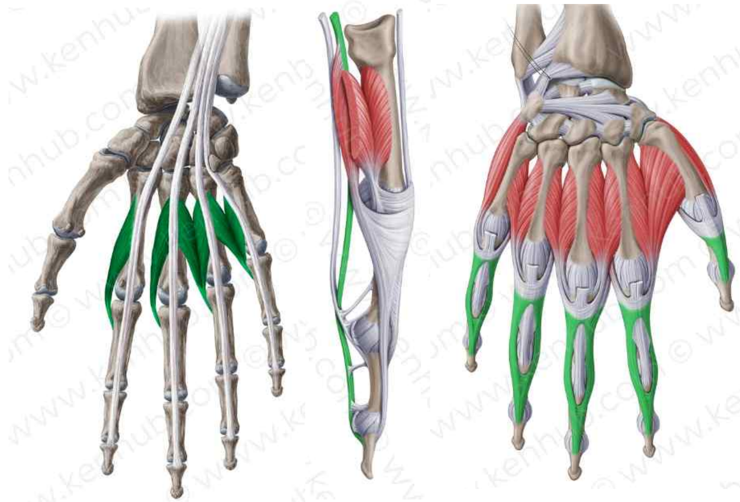
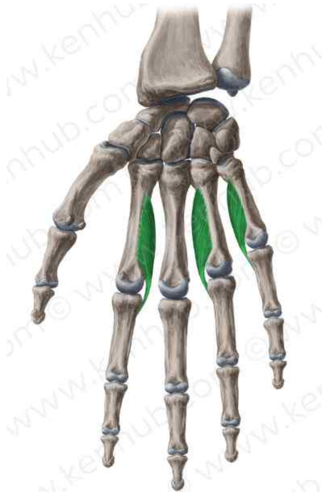


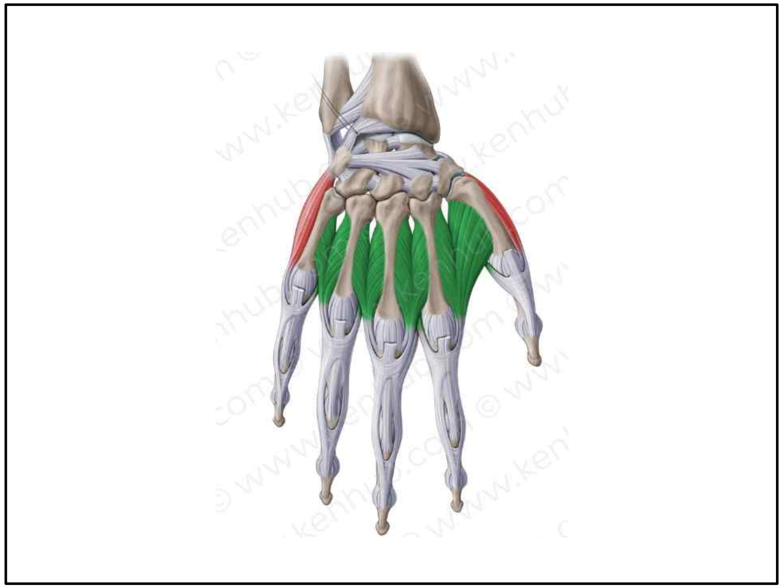
그림 II-13. 소지구근: 소지굴곡근(flexor digiti minimi), 소지외전근(abductor digiti minimi), 소지대립근(opponens digiti minimi).

Lumbricals, interossei

Hand	**Lateral volar**	Thenar (Abductor pollicis brevis, Flexor pollicis brevis, Opponens pollicis) Adductor pollicis	
	Medial volar	Hypothenar (Abductor digiti minimi, Flexor digiti minimi, Oppenens digiti minimi)	
	Intermediate	Lumbrical / Interossei (Dorsal, Palmar)	
	Fascia	Posterior	Extensor retinaculum / Extensor expansion
		Anterior	Flexor retinaculum / Palmar aponeurosis





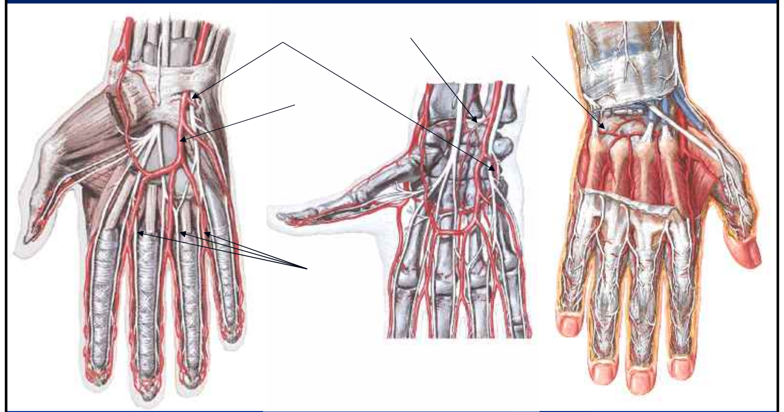


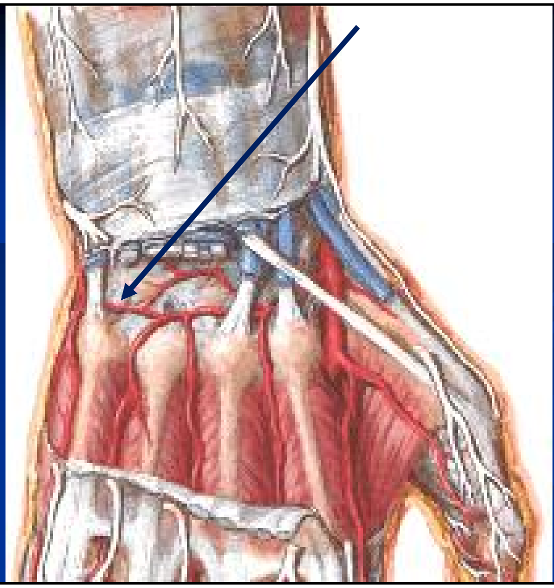
Neurovascular Anatomy of the Wrist and Hand

2023.03.27

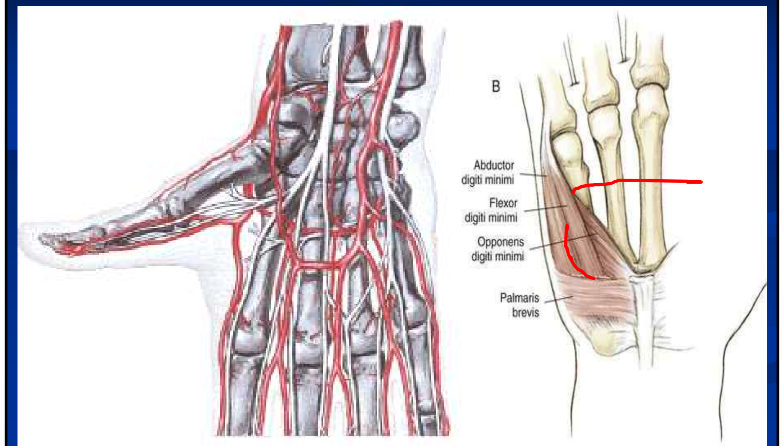
R2 우창우

Ulna artery

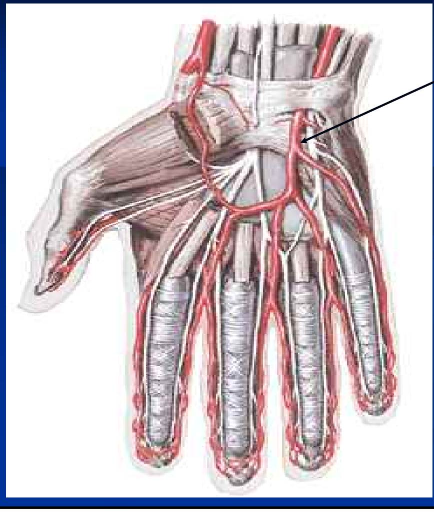




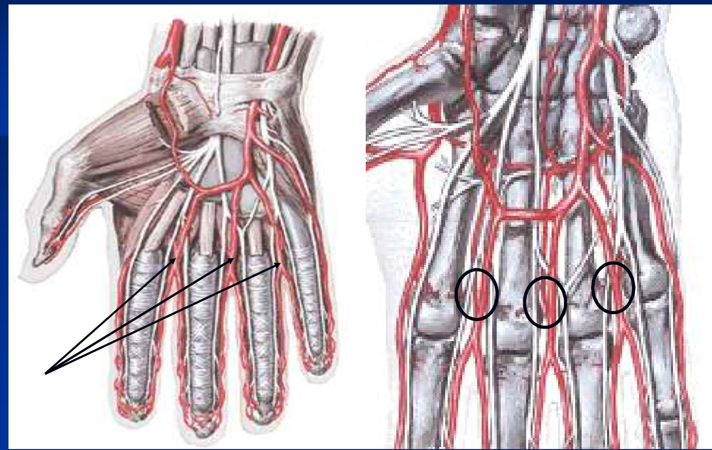
Ulna artery



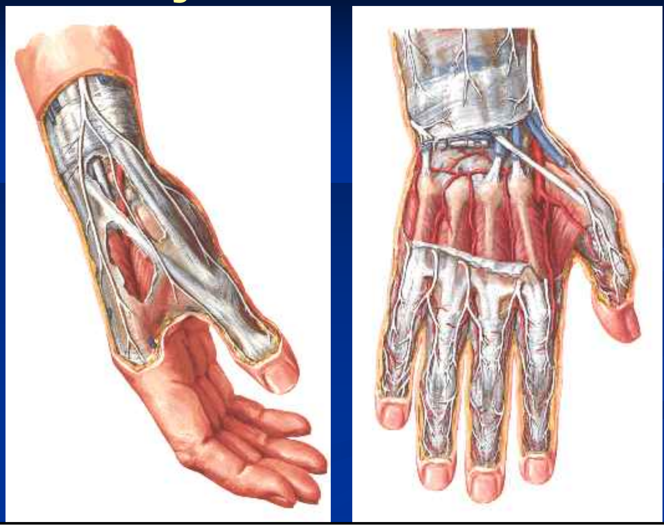
Ulna artery

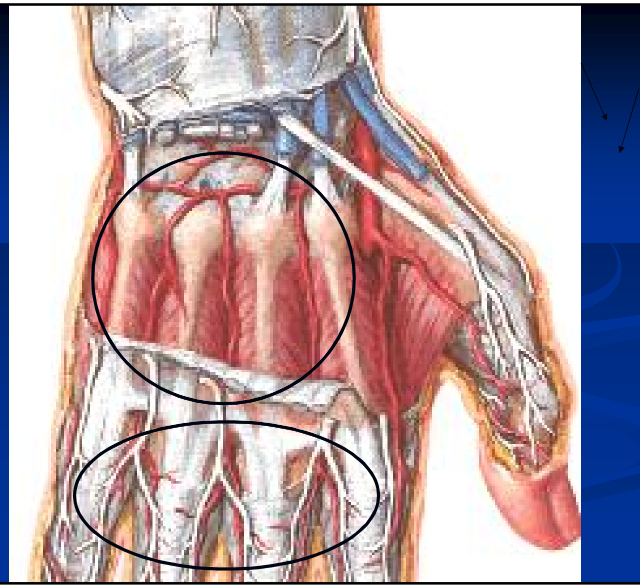


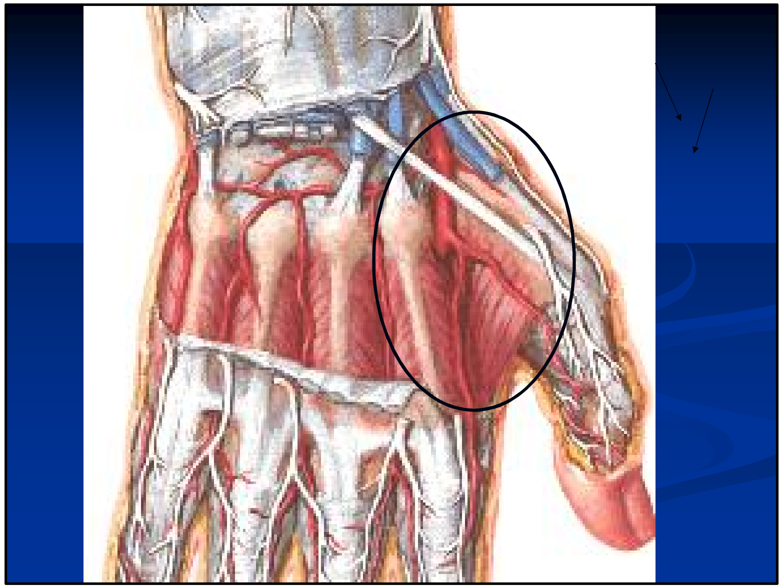
Ulna artery

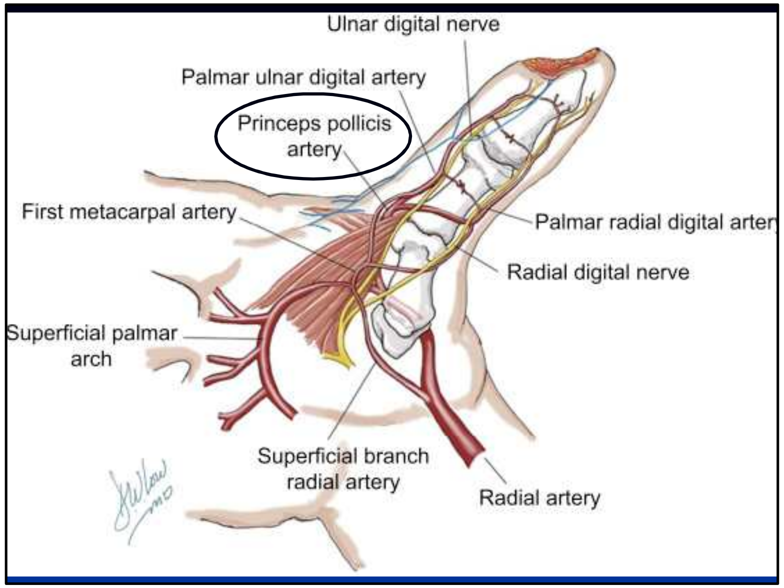


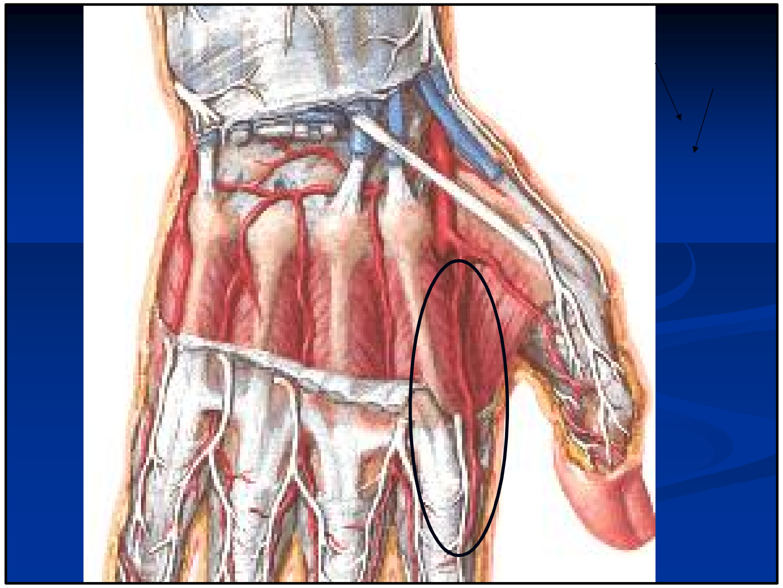
Radial artery

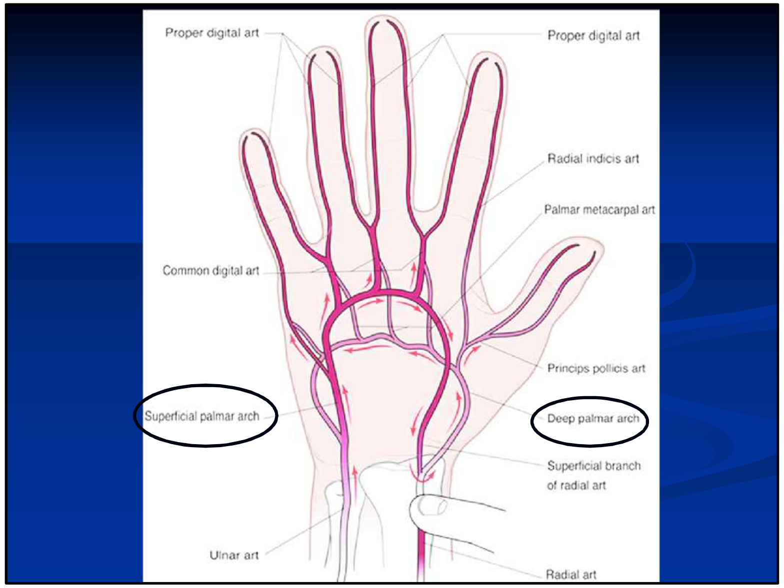




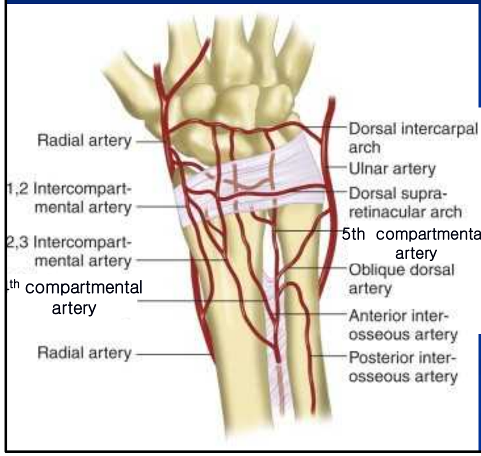


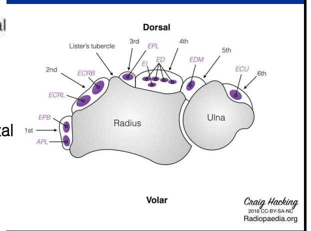

Ulnar digital nerve
Palmar ulnar digital artery
Princeps pollicis artery
First metacarpal artery
Palmar radial digital arter
Radial digital nerve
Superficial palmar arch
Superficial branch radial artery
Radial artery




Proper digital art
Proper digital art
Radial indicis art
Palmar metacarpal art
Common digital art
Princips pollicis art
Superficial palmar arch
Deep palmar arch
Superficial branch of radial art
Ulnar art
Radial art

Dorsal radiocarpal arch



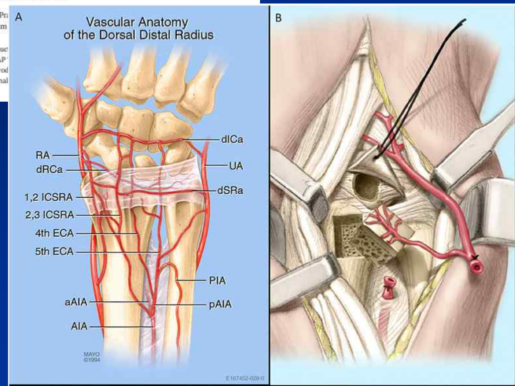


ICSRA

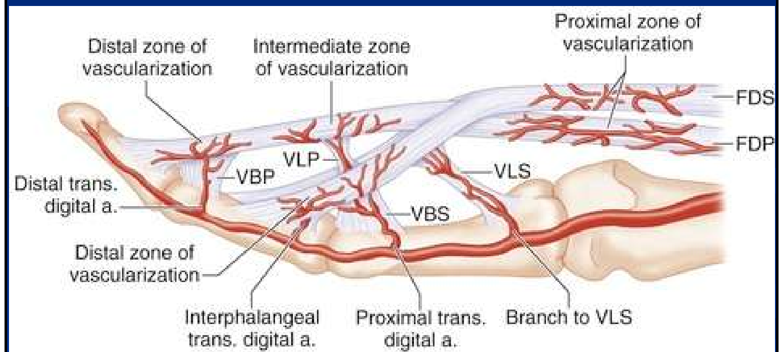
1,2 Intercompartmental Supraretinacular Artery-Based Vascularized Graft for Scaphoid Nonunion With Avascular Necrosis

Terrence Jose Jerome [1], Ramesh Pr
Bhuvaneswari Shanmugasundaram

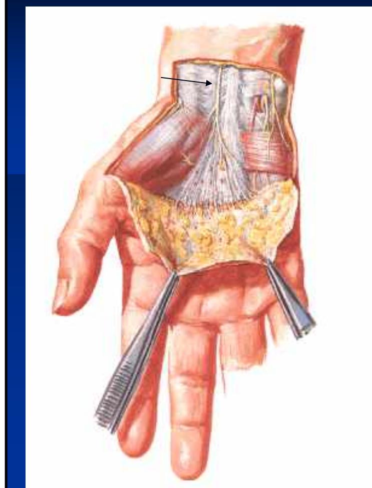
1. Orthopaedics, Hand and Reconstruc
Orthopaedics and Traumatology, KAP
(MGM) Hospital, Trichy, IND 3. Reprod
Centre, Trichy, IND 4. Urology, Dhanal
Medical College, Perambalur, IND

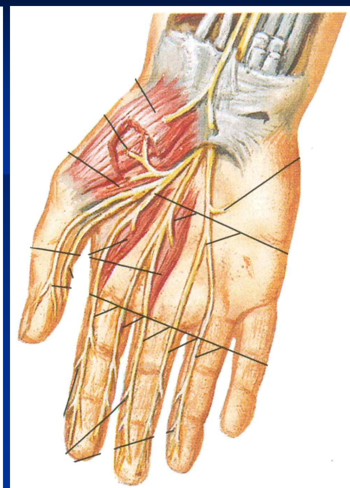


Vascular supply to flexor tendon of finger

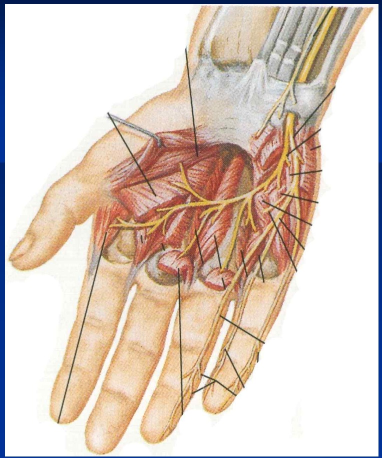


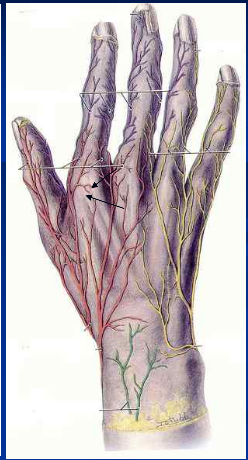
Median nerve



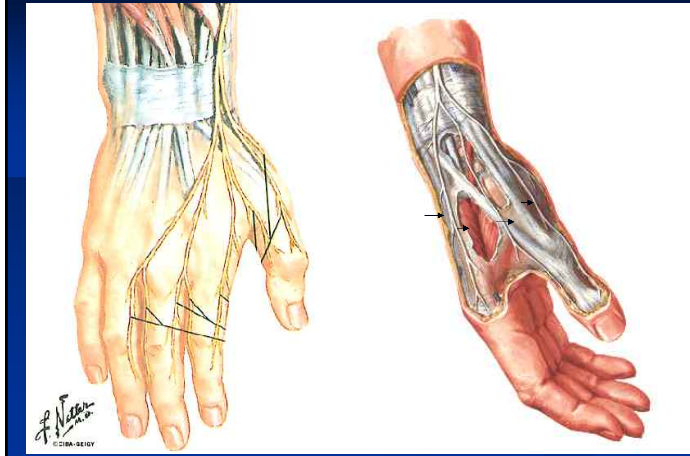


Ulnar nerve





Radial nerve



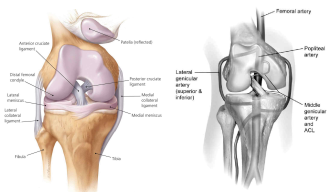
ACL (1) : Functional Anatomy & Biomechanics

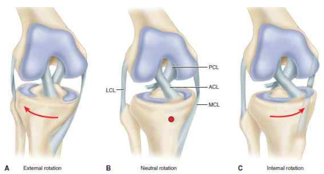
명지병원 정형외과
R1. 정승호

ACL Functional Anatomy

Anatomy

- The cruciate ligaments : Intraarticular extrasynovial structure
  - 관절의 안전성에 매우 중요한 역할
- A highly organized collagen matrix
  - Type I collagen (90%) + Type III collagen (10%)
  - multiple fiber bundles (20 μm)
  - Water constitutes 60%
- Origin : Posteromedial aspect of the lateral femoral condyle
- Insertion : Anteromedial aspect of the tibia between the condyles
- Blood supply : branches of the middle genicular artery
- Nerve : posterior articular nerve branched from posterior tibial N
- PCL과 서로 십자모양으로 배열
  - 경골을 외회전하면 풀리고 내회전하면 꼬임



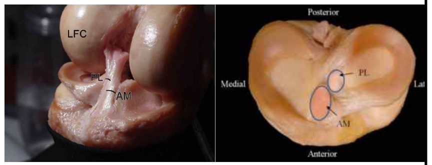


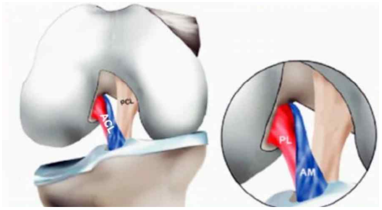
Function

1. Primary restraint to anterior tibial displacement (AM)
2. Secondary restraint on tibial rotation and varus-valgus angulation at full extension (PL)
3. Proprioceptive function evidenced by the presence of mechanoreceptors in the ligament.
4. Free nerve ending reacts to the intra-articular inflammation and pain

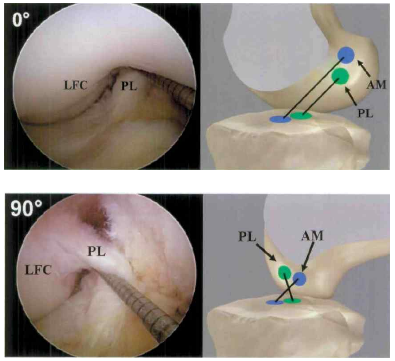
Two functional bundles

- defined by their respective tibial insertion
- The AM bundle
  - 37.7 mm in length, 8.5mm in width
  - originates in the proximal part of the femoral origin
  - inserts in the anteromedial portion of the tibial insertion
  - 슬관절 굴곡시 긴장
  - 보다 수직으로 위치하여 경골 전방 전위에 대해 main resistant
- The PL bundle
  - 20.7 mm in length, 7.7mm in width (PL bundle)
  - originates distally in the femoral origin
  - inserts in the posterolateral aspect of the tibial insertion.
  - 슬관절 신장시 긴장
  - Principal resistance for hyperextension
  - important role in resisting internal and external rotation
  - 보다 수평으로 위치하여 경골 회전을 조절하는 역할





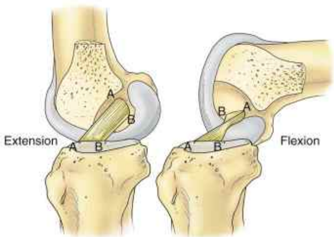
Two functional bundles



- ROM : Not isometric
- The distinct functional bundles of the ACL have different roles at different stages of knee motion
- In extension
  - the bundles are parallel
  - PL bundle becomes tight
- In flexion
  - the femoral origin of the PL bundle moves anteriorly, and the bundles cross.
  - AM bundle becomes tight

Two functional bundles

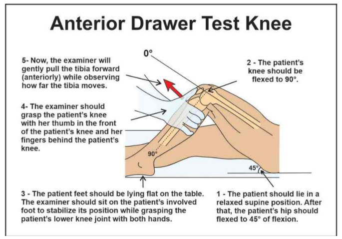
- Isolated rupture of the AM bundle
  - Anterior draw test (performed at 90 degrees of flexion)
- Failure of the PL bundle
  - Lachman test (performed at 30 degrees of flexion).

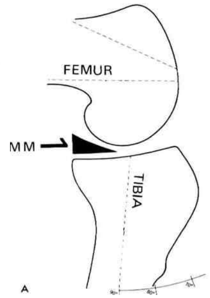


Physical examination

- Anterior Drawer test
  - Supine, hip 45 and knee 90 degrees of flexion
  - Both hands are placed behind the knee to feel for relaxation of the hamstring muscles
  - Proximal part of the leg is pulled and pushed anteriorly and posteriorly
  - False negative : Door-stop effect of MM
  - False positive : PCL tear give posterior subluxation of the tibia

Grade	전방전위
Grade 1	3~5mm
Grade 2	6~10mm
Grade 3	11mm ~





Physical examination

- Lachmann test
  - Excluding door-stop effect
  - Slight external rotation + 15 (20~30) degrees of flexion
  - Hip muscles, quadriceps, hamstring muscles relaxed
  - One hand stabilize femur, other hand grips the proximal tibia anteriorly

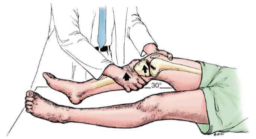


FIG 3.18 The Lachman test is performed in 30 degrees of flexion with anterior force exerted on the proximal end of the tibia. (From Tria AJ Jr, Klein KS: *An illustrated guide to the knee,* New York, 1992, Churchill Livingstone.)

FIGURE 45-54 Lachman test for anterior cruciate instability.

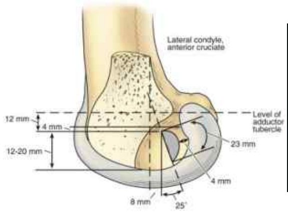
Rotational instability

- When the flexion angle of the ACL bundles increases,
  - the axial rotation ("twisting") increases as well.
- At full extension
  - the ACL is internally twisted by approximately 10 degrees.
- At 90 degrees of flexion
  - the internal twist increases to approximately 40 degrees

Ref) Li G, Defrate LE, Rubash HE, Gill TJ.
In vivo kinematics of the ACL during weight-bearing knee flexion. J Orthop Res. 2005;23(2):340–344

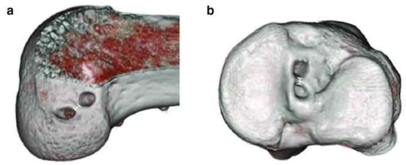
Femoral attachment site

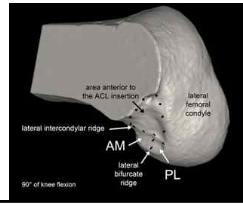
- The ACL originates from the medial surface of the lateral femoral condyle , posteriorly in the intercondylar notch
  - anterior side of the attachment is almost straight
  - posterior side convex.
- The ligament courses anteriorly, distally, and medially toward the tibia
- Over the length of its course, the fibers of the ligament undergo slight external rotation.

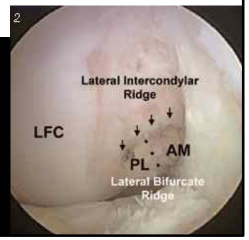


Femoral attachment site

- Two ridges outline the insertion of the ACL to the bone.
- **lateral intercondylar ridge** (resident's ridge)
  - borders the top of the ACL
  - runs from proximal to distal with the knee straight, and no cruciate fibers insert anterior to this point
- **lateral bifurcate ridge**
  - forms the border between the AM and PL bundles

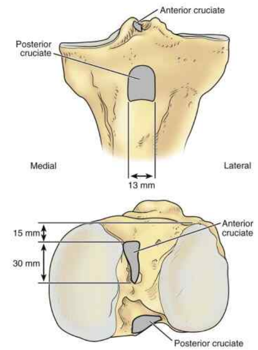






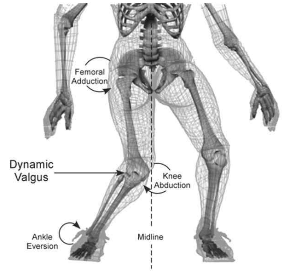
Tibial attachment site

- Wide, depressed area anterior and lateral to the medial tibial tubercle in the intercondylar fossa
- Medial to the insertion of the anterior horn of LM
- Larger and more secure than the femoral site.



ACL Injury Mechanism

Injury mechanism



① Rotation maneuver
② Sudden deceleration
③ Hyperextension jump
④ Pivoting position

- Common in sports , such as football or skiing

- External forces (valgus stress) applied to the knee.
- The patient often describes hyperextended or popping out of joint and then reducing.
- Pop is frequently heard or felt.
- Fallen to the ground and is not immediately able to get up.
- Resumption of activity usually is not possible, and walking is often difficult.

- Within a few hours, the knee swells, and aspiration of the joint reveals hemarthrosis
  → in this scenario, the likelihood of an ACL injury is greater than 70%.

Injury mechanism

Injury mechanism

- 4 mechanisms
  - Abd, flex, IR of the femur on the tibia
    - M/C
    - Medial supporting structures are the initial structures injured (MCL and medial capsular ligament)
  - Add, flex, ER of the femur on the tibia
    - LCL usually is disrupted initially
  - Hyperextension
    - During jumping or high kick maneuvers with or without varus force
    - Stretching and disruption of the posterior capsule and PCL if the force is severe
  - AP displacement
    - Tibia striking a car dashboard
    - Either ACL or PCL depending on the direction of the tibial displacement

- Unhappy triad of O'Donoghue
  - When lateral force impacts the knee while the foot is fixed to the ground
    → ACL & MCL & MM tear

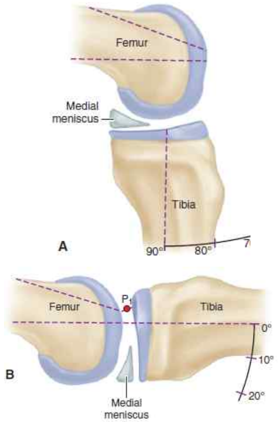
Combined injury

- Approximately 50 ~70% of ACL injuries occur in combination with damage to the meniscus, articular cartilage, or other ligaments(MCL).

- Secondary damage may occur in patients who have repeated episodes of instability due to ACL injury.
  - With chronic instability, up to 90 % of patients will have meniscus damage when reassessed 10 or more years after the initial injury.
  - The LM is more commonly injured with the initial incident.
  - Most late meniscal tears occur in the MM because of its firm attachment to the capsule.

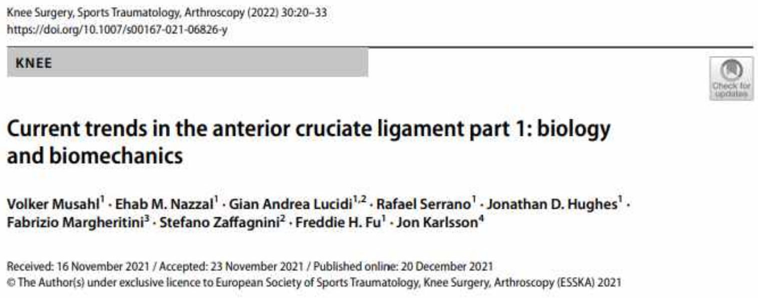
Role of MM in ACL injury

- With knee flexed to 90 degrees, MM abuts against acutely convexed surface of medial femoral condyle and has **<u>"doorstop" effect</u>**, preventing or hindering anterior translation of tibia
- in relatively extended position, small degrees of anterior translation of the tibia may be detected better
  - Comparatively flat weight-bearing surface of femur does not obstruct
  - the **<u>"doorstop" effect is negated</u>**



Role of MM in ACL injury

- Medial meniscus : stability to the joint in the presence of ACL insufficiency
  - posterior horn acts as a wedge
    - reduce anterior tibial translation.
  - Lateral meniscus does not perform a similar function.
- Medial meniscectomy in the ACL-intact knee has little effect on anteroposterior motion
- However, in the ACL-deficient knee, medial meniscectomy results in an increase in anterior tibial translation of up to 58% at 90 degrees of flexion



Knee Surgery, Sports Traumatology, Arthroscopy (2022) 30:20–33
https://doi.org/10.1007/s00167-021-06826-y

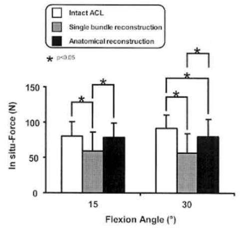
KNEE

Current trends in the anterior cruciate ligament part 1: biology and biomechanics

Volker Musahl[1] · Ehab M. Nazzal[1] · Gian Andrea Lucidi[1,2] · Rafael Serrano[1] · Jonathan D. Hughes[1] · Fabrizio Margheritini[3] · Stefano Zaffagnini[2] · Freddie H. Fu[1] · Jon Karlsson[4]

Received: 16 November 2021 / Accepted: 23 November 2021 / Published online: 20 December 2021

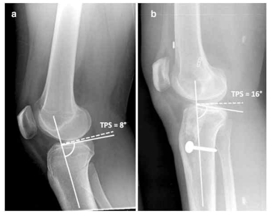
ACL Kinematics

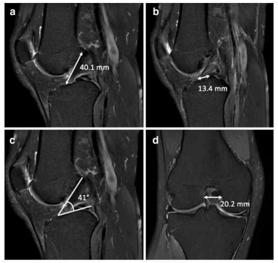


- Nonanatomic ACL-R
  - Fails to restore anterior tibial and rotation forces
- DB techniques
  - More closely restore kinematics compared to SB techniques
- ACL-R + LET
  - May affect the cartilage contact pressures and stability in early postoperative phase
  - Kinematic effect lost by 12 months after surgery → LET stretches out over time
- Anterolateral complex
  - Secondary restraint for knee internal rotation (especially at higher flexion angles)
- MM, LM
  - MM : more important for pure ATT
  - LM : primary restraint to ATT during valgus and rotatory loads (pivoting)

Bony morphology

- Tibial plateau slope > 12°
  - Higher risk of ACL injury
  - Risk factor for failure after ACL-R
- Narrow femoral intercondylar notch
  - Risk of ACL graft rupture
  - Increased impingement and strain on fibers during knee ROM
- Increased distal femoral condylar depth
  - Increased risk of ACL injury





Bony morphology

- ACL tear + displaced posterolateral tibial plateau impaction fracture
  - Increased rotatory knee instability and poorer outcomes
- Deep lateral notch sign
  - Higher risk of graft rupture or persistent instability

Sports Medicine (2019) 49:1837–1859
https://doi.org/10.1007/s40279-019-01171-0

REVIEW ARTICLE

Check for updates

The Effect of Training Interventions on Change of Direction Biomechanics Associated with Increased Anterior Cruciate Ligament Loading: A Scoping Review

Thomas Dos'Santos[1] · Christopher Thomas[1] · Paul Comfort[1] · Paul A. Jones[1]

Published online: 6 September 2019

Introduction

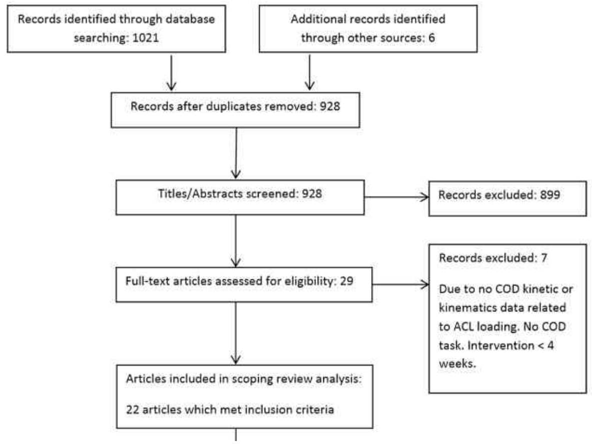
- Change of direction (COD) maneuvers
  - ACL injury risk due to the propensity to generate large multiplanar knee joint loads
- Modifying an athlete's movement mechanics
  - Effective strategy to reduce anterior cruciate ligament loading
  - Biomechanical and neuromuscular informed training interventions associated with hazardous knee joint loading

Purpose of study

- To critically appraise and comprehensively synthesizes the existing literature related to the effects of training interventions on COD biomechanics associated with increased knee joint loads and subsequent ACL loading

Inclusion criteria

- pre-post analysis of a COD task
- Minimum 4-week training intervention
- Assessments of biomechanical characteristics associated with increased ACL loading



25 data sets from 22 articles

1. COD technique modification *n* = 2
2. COD speed and footwork *n* = 1
3. Balance training *n* = 3
4. Mixed training *n* = 5
5. Combined training *n* = 3
6. Resistance training *n* = 2
7. Perturbation enhanced plyometrics *n* = 1
8. Trunk stabilisation training *n* = 1
9. Dynamic core stability training *n* = 1
10. Warm-up interventions: Oslo *n* = 2, F-MARC 11+ *n* = 2, Core-Pac *n* = 2

25 data sets from 22 articles

1. COD technique modification *n* = 2
2. COD speed and footwork *n* = 1
3. Balance training *n* = 3
4. Mixed training *n* = 5
5. Combined training *n* = 3
6. Resistance training *n* = 2
7. Perturbation enhanced plyometrics *n* = 1
8. Trunk stabilisation training *n* = 1
9. Dynamic core stability training *n* = 1
10. Warm-up interventions: Oslo *n* = 2, F-MARC 11+ *n* = 2, Core-Pac *n* = 2

Discussion

- Change of direction technique modifications
  - Reducing lateral trunk flexion
  - Reducing lateral foot plant distances
  - Increasing knee flexion
  - Promoting earlier braking (during the penultimate foot contact)
  - ➢ provide an effective training modality for reducing COD knee joint loading

- Balance training
  - Reduce knee joint loads during cutting
  - ➢ Eliciting safer knee agonist-antagonist muscle patterns and hip and trunk muscle activity

Discussion

- Balance and COD technique modification training
  - Most effective training modalities for reducing knee joint loading

- Dynamic core stability training
  - Effective in reducing knee joint loads
  - Further research needed

- Perturbation-enhanced plyometric training
- the F-MARC 11+soccer specific warm-up
- Oslo Neuromuscular warm-up
- Resistance training
  - Ineffective to reduce COD knee joint loads

- Core-Pac and mixed training program
  - Conflicting findings have been observed

➢ Practitioners should consider incorporating balance and COD technique modification drills into their athletes' training programs to reduce potentially hazardous knee joint loads when changing direction

Reference

- Campbell's Operative Orthopaedics, ' Chapter 43. Knee injuries', 13th edition

- 정형외과학, 제 7판, 대한정형외과학회

- Insall & Scott Surgery of the Knee, 'chapter 8. Cruciate ligaments', 6th edition

- Anterior cruciate ligament tear , Kurt P. Spindler M.D, 2008, NEJM

- Anatomy and Biomechanics of the Anterior Cruciate Ligament, Jay V. kalawadia MD

- Li G, Defrate LE, Rubash HE, Gill TJ. In vivo kinematics of the ACL during weight-bearing knee flexion. J Orthop Res. 2005;23(2):340–344

Nerve syndrome in Upper Extremity

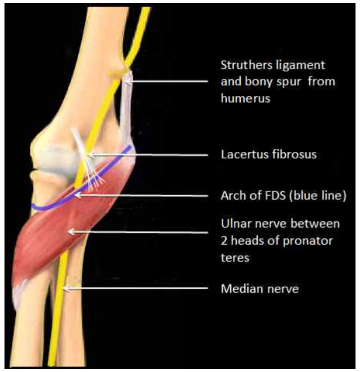
명지병원 정형외과
R2. 김 수 영

Median nerve

MEDIAN NERVE PALSY

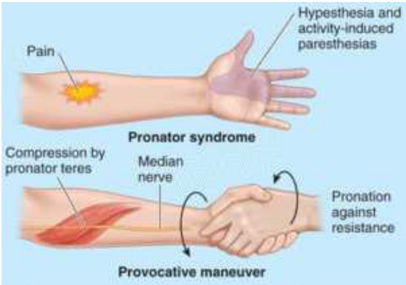
Median nerve

- Compression site
  - Struthers' ligament
  - Bicipital aponeurosis (Lacertus fibrosus)
  - Between 2 heads of pronator teres
  - Carpal tunnel(lower level))



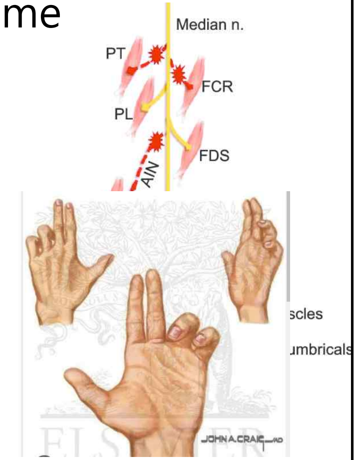
Pronator syndrome

- Compression
  - Between 2 heads of pronator teres
- Test :
  - Enlarged pronator teres
  - Tinnel sign (+) on pronator teres
  - Provocation test



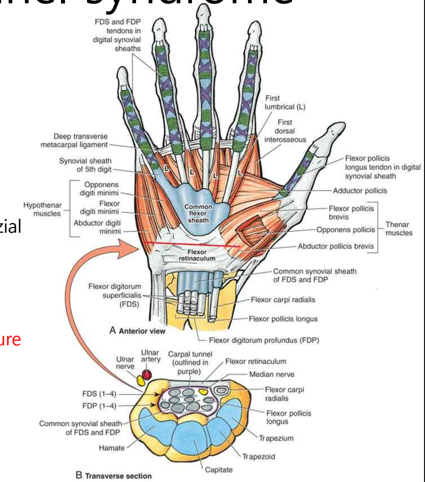
Anterior interosseous nerve syndrome

- Anterior interosseous nerve
  - Forearm fracture or direct injury
  - Pure motor branch of median nerve (below 6cm from lateral epicondyle)
  - Innervation :
    - FPL
    - FDP of 2nd & 3rd finger
    - PQ
  - P/Ex :
    - Benedictine sign
    - Cannot do O.K sign



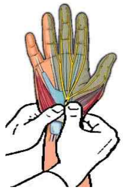
Carpal tunnel syndrome

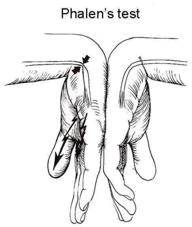
- Anatomy
  - Posterior
    - carpal bone transverse arch
  - Medial
    - hook of hamate, triquetrum, pisiform
  - Lateral
    - Scaphoid tubercle and trapezial ridge
  - Anterior :
    - Flexor retinaculum
  - Internal structures
    - Median n. : superficial structure
    - FDS (4)
    - FDP (4)
    - FPL

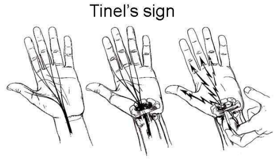


Carpal tunnel syndrome

- Diagnosis
  - Symptoms
    - Paresthesia
    - Pex
      - Phalen test
      - Tinel sign (Percussion test)
      - Carpal tunnel compression (Durkan)
      - Thumb opposition
    - Thenar m. atrophy







Ulnar nerve

ULNAR NERVE PALSY

Ulnar nerve palsy

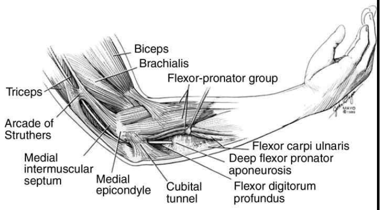
- Compression site
  - Wrist : Guyon's cannal
  - Elbow : Cubital tunnel
  - Common in elbow joint
- Innervation
  - 3,4th lumbrcial m.
  - Interosseous m.(all)
  - Hypothenar m.
  - Adductor pollicis
  - Deep head of FPB

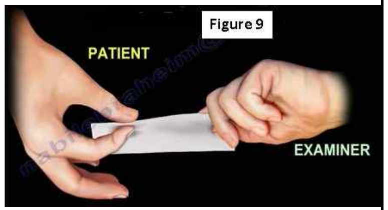
Ulnar nerve palsy

- Lower ulnar nerve palsy
  - Functional deficits
    - Weakness of pinch (pinch = opposition + thumb adduction)
    - Weakness of grip
    - Clawing of 4th & 5th fingers
- High ulnar nerve palsy
  - Functional deficits
    - Low ulnar n. palsy + 4th & 5th FDP + FCU

Cubital tunnel syndrome

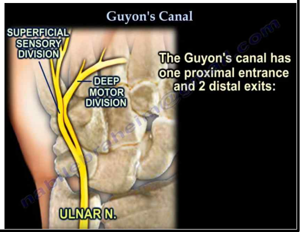
- Cubital tunnel
  - Anatomy
    - Medial epicondyle of the humerus
    - Olecranon process
    - FCU
  - Pex
    - Aggravated in flexion
    - Froment's sign



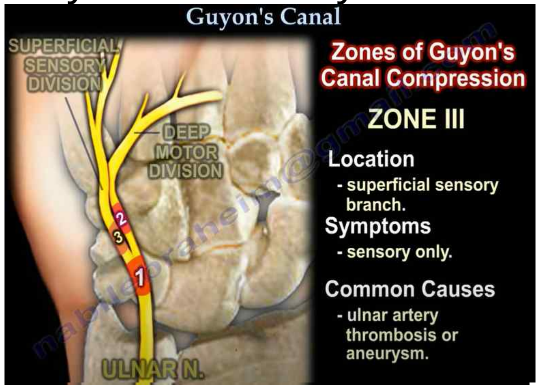


Guyon's canal syndrome

- Ulnar tunnel (Guyon's canal)
  - Anterior : superficial transverse carpal ligament (flexor retinaculum fibrotic band)
  - Posterior : Deep transverse carpal ligament
  - Medial : pisiform
  - Lateral : Hook of hamate



Guyon's canal syndrome



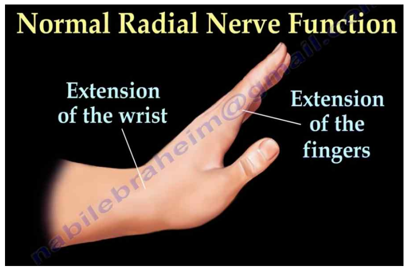
High ulnar vs Low ulnar

- Symptom
  - Motor + sensory
    - At least >8.0cm proximal to pisiform → volar & dorsal sensory + motor complaints
    - <8.0cm proximal to pisiform → palmar sensory + motor complaints
  - Claw hand
    - Compression of deep br. of ulnar n.
    - → instrinsic muscle deficit
    - → extension of IP joint deficit

RADIAL NERVE PALSY

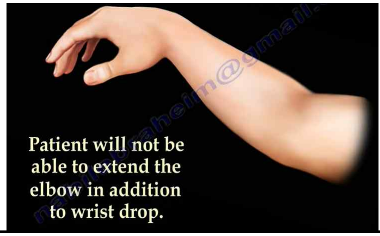
Radial nerve injury

- Low radial nerve palsy
  - ECRL, ECRB, brachioradialis spare → wrist extension intact



Radial nerve injury

- High radial nerve palsy
  - ECRL, ECRB, brachioradialis deficit→ wrist drop
  - Compressed at the axilla level → triceps muscle will be affected → Deficit of elbow extension

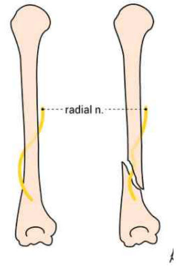


Radial nerve injury

- High radial nerve palsy
  - Howlstein-Lewis fracture

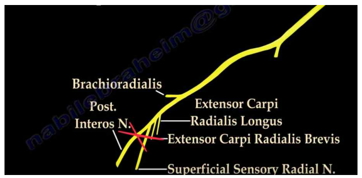
  : simple spiral fracture of the distal third of the shaft of humerus with distal bone fragment displaced and the proximal end deviated toward the radial side

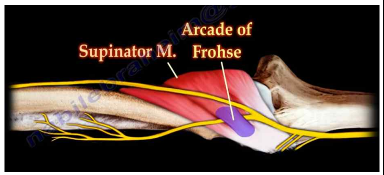
  : High radial nerve palsy



Radial tunnel syndrome

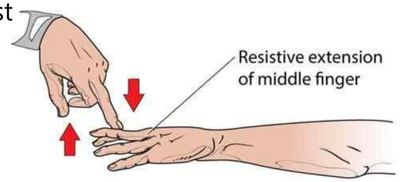
- Entrapment
  - Posterior interosseous br of radial nerve
  - Arcade of Frohse
    - Radial tunnel : proximal origin of the supinator muscle ~ H-R joint
  - Monteggia fracture





Radial tunnel syndrome

- Radial nerve
  - Innervation
    - Sensory : Elbow joint, posterolateral forearm, wrist & hand
    - Motor : APL, EPL, EPB, digital extensors
  - Provocation test
    - Middle finger test



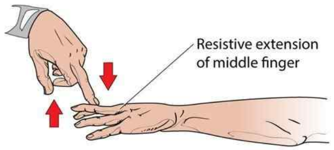
Provocative tests elicit pain over radial tunnel

Radial tunnel syndrome

- Symptoms

- Deep aching pain in dorsoradial proximal forearm
  - from lateral elbow to wrist
  - increases during forearm rotation and lifting activities

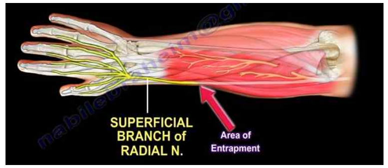
- Muscle weakness
  - because of pain and not muscle denervation

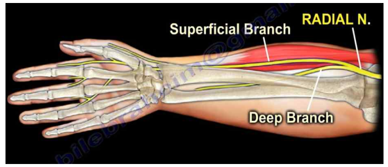


Provocative tests elicit pain over radial tunnel

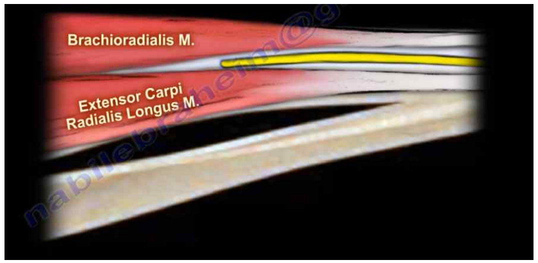
Cheiralgia paresthetica (Wartenberg's syndrome)

- Compression to the superficial branch of the radial nerve.
- Typically on the back or side of the hand at the base of thumb, near the anatomical snuffbox.
- Between brachioradialis & ECRL





Cheiralgia paresthetica (Wartenberg's syndrome)



Cheiralgia paresthetica (Wartenberg's syndrome)

- Symptoms
  - Numbness, tingling and paresthesia on posterior aspect of the thumb
  - No weakness
  - Aggravated by ulnar deviation or wrist flexion (repititively)

Reference

- James H. Calandruccio. Chapter 76. Carpal tunnel syndrome, ulnar tunnel syndrome, and stenosing tenosynovitis. Campbell's Operative Orthopaedics. Vol.4. p.3750-3764, 13th edition.

- 석세일, 제 7판 정형외과학, II. 주관절 및 손의 병변, 신경포착증후군. 제 1권, p.750-755

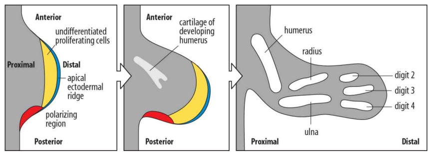
Congenital anomalies

명지병원 정형외과
R3. 이준우

Classification

- Failure of formation of parts
- Failure of differentiation of parts
- Duplication
- Overgrowth
- Undergrowth
- Miscellaneous anomalies

Failure of formation



- **Transverse deficiencies**
  - complete absence of parts distal to some point (amputation like stump)
  - 6.8 per 10,000
  - no sexual predilection
  - mostly unilateral, most common level is forearm upper 1/3
  - failure of the apical ectodermal ridge possibly secondary to infarct
  - no genetic basis

Failure of formation

- **Transverse deficiencies**
  - newborn with a transverse deficiency usually has a slightly bulbous, well pad stump
  - In more distal deficiency, rudimentary vestigial digital 'nubbins' are common
    : non functional but intact supination & pronation

Failure of formation

- **Transverse deficiencies**
  - Prosthetic management usually consists of early prosthetic fitting of the deficient limb
  - Surgical treatment is few indications amputation of nonfunctional digital remnants often is performed for psychologic and cosmetic benefits

Failure of formation

- Longitudinal deficiencies
  - Phocomelia
  - Radial clubhand
  - Cleft hand
  - Ulnar clubhand

Failure of formation

- **Phocomelia**
  - most profound expression of longitudinal reduction of a limb
  - no genetic basis
  - extremely rare
  - Thalidomide-related

Failure of formation

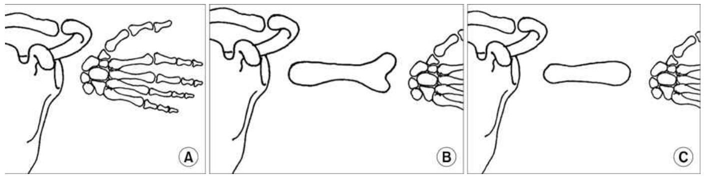
Generally conservative treatment

- **Phocomelia**

  type I : complete phocomelia with absence of all limb bones

  type II : absence or extreme hypoplasia of prox. limb bones

  type III : hand attached directly to the humerus

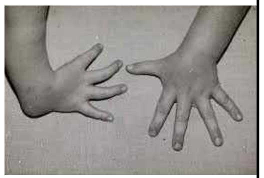


Failure of formation

- **Radial clubhand**

  all malformations with longitudinal failure of formation of parts along the preaxial or radial border of the upper extremity

  Features :
  deficient or absent thenar m.
  shortened, unstable or absent thumb & radius



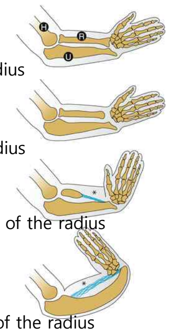
Failure of formation

- **Radial clubhand**

  occurs 1 per 50,000 live births
  complete radial absence is more common than partial absence
  no sexual predilection
  bilateral deformities occur in approx. 50%
  right side is more commonly affected

Failure of formation

- Heikel's classification

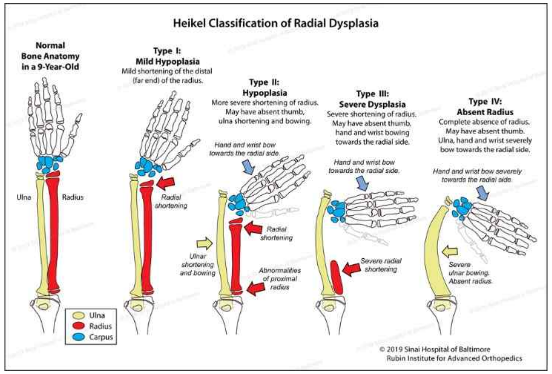


Short distal radius

Hypoplastic radius

Partial absence of the radius

Total absence of the radius



Failure of formation

- Radial longitudinal deficiency treatment goal
  - Straighten (when necessary) the radial bow
  - Correct radial and volar subluxation of the carpus
  - Optimize limb length
  - Reconstruct the thumb when necessary

Failure of formation

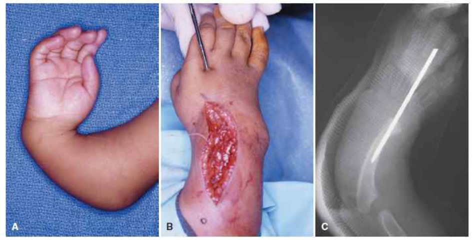
- **Radial clubhand**

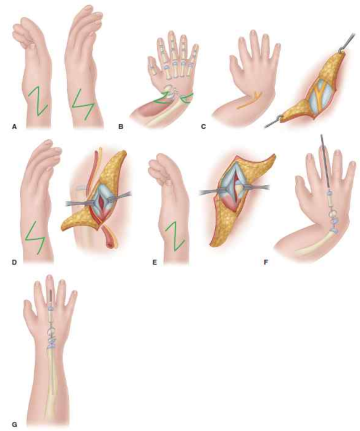
  Treatment
  - immediately after birth, can be corrected passively and early casting and splinting generally are recommended
  - surgical procedure may be postponed for 2 to 3 yrs with adequate splinting
  - inadequate radial support of the carpus, operative correction at 3-6 months of age is general agreement

Failure of formation

- **Radial clubhand**

  centralization of hand





Failure of formation

- **Cleft hand**
  - 2^{nd}, 3^{rd}, 4^{th} ray longitudinal formation failure
  - also can include severe suppression of the radial 4 rays leaving 5^{th} ray alone
  - occurs one per 90,000 live births

Failure of formation

- **Cleft hand**

  Typical & Atypical patterns
  - Typical : central V-shaped cleft
  - Atypical : U-shaped cleft (only thumb & little finger attached)

Failure of formation

- **Cleft hand**

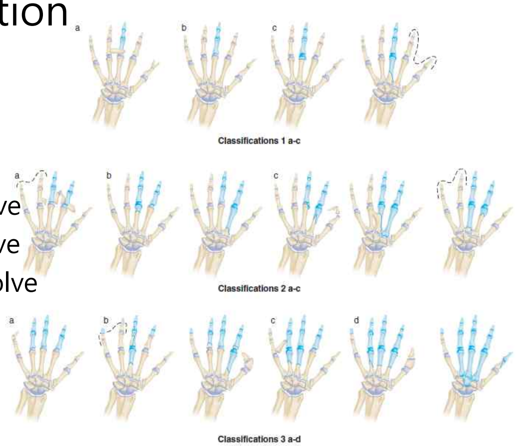
  Flatt's classification

  Group 0: normal

  Group 1: one ray involve

  Group 2: two ray involve

  Group 3: three ray involve



Failure of formation

- **Cleft hand**

  Treatment

  - no appropriate nonoperative treatment is available
  - good pinch and grasp are the primary goals

Failure of formation

- **Cleft hand**

  Treatment

  - surgical reconstruction involve

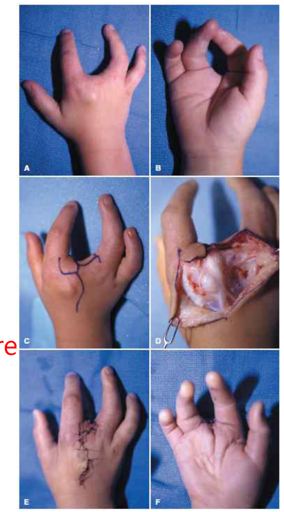
    closure of cleft

    release of syndactyly

    correction of thumb adduction contracture

    removal of deforming bony elements

    correction of delta phalanx



Failure of formation

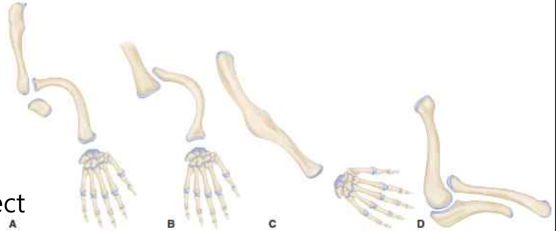
- **Ulnar clubhand**
  - most common form is a partial deficiency of the ulna and the ulnar two digits
  - relative incidence one tenth to one third that of radial deficiencies

Failure of formation

- **Ulnar clubhand**

  Swanson classification

  type I: partial defect
  type II: complete defect
  type III: humeroradial synostosis
  type IV: congenital wrist amputation



Failure of formation

- **Ulnar clubhand**

  Treatment

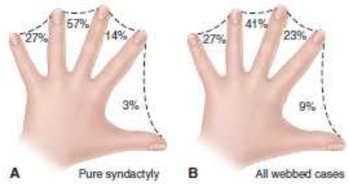
  - Corrective casting and splinting until 6 months old
  - Surgical Ix.

    syndactyly
    radial bowing and presence of an ulnar anlage
    dislocation of the radial head with limited elbow extension
    → one bone forearm
    humeral rotation deformity

Failure of differentiation

- **Syndactyly**

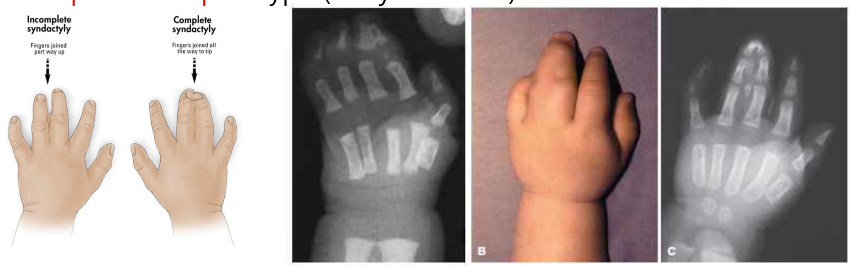
  failure of the fingers to separate during embryologic development
  most common congenital anomaly of the hand
  occur one per 2,000 births
  abnormal slow growth and development of the finger buds
  during 7-8wks of gestation



Failure of differentiation

- **Syndactyly**

  complete & incomplete type (finger tip)
  simple & complex type (bony structure)

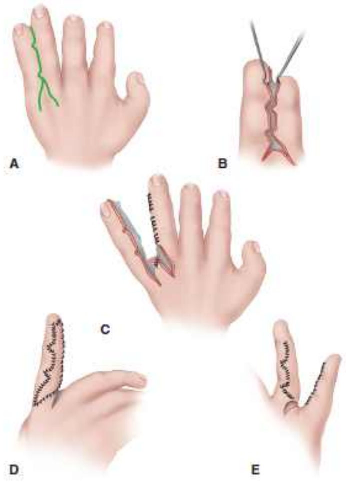


Failure of differentiation

- **Syndactyly**
  Treatment
  surgical treatment is not urgent
  surgical reconstruction is best done
  - before the child is of school age
  - results are reportedly better in children older than 18 months

  multiple digits are involved, should be release early

Failure of differentiation



- **Syndactyly**
  Surgical procedure involve
  - separation of the digits
  - commissure reconstruction
  - resurfacing of the intervening borders of the digits

Failure of differentiation

- **Apert syndrome**
  Atypical facies & multiple complex syndactylies
  single gene mutation(FGFR-2 in 10q26)
  dominant and recessive forms

  high, broad forehead
  flattened occiput
  eyes are widely set
  outer canthus lower than the inner canthus
  lower jaw is prominent, maxilla is shortened

Failure of differentiation

- **Apert syndrome**
  Upton classification
  type 1: separate thumb with complete syndactyly of other digits
  type 2: syndactyly involving all digits
  type 3: complex syndactyly with distal synostosis between the thumb and index

Duplication

- **Polydactyly**

  9,000 to 10,000 new cases are recorded each year

  classified into three main categories

  1. preaxial : bifid thumb
  2. central : 2, 3, 4 finger duplication
  3. postaxial : small finger duplication

Duplication

- Preaxial polydactyly

  bifid thumb : complete or partial duplication of the thumb

  most common pattern in white and Asian

  occur one per 10,000 births

  usually unilateral

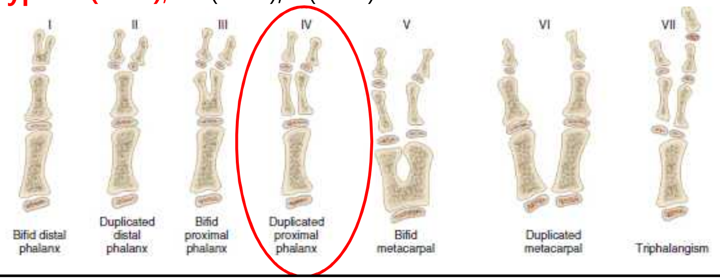
  Wassel classification

Duplication

- Preaxial polydactyly

  Wassel classification

  type IV(47%), VII(20%), II(15%)…



Duplication

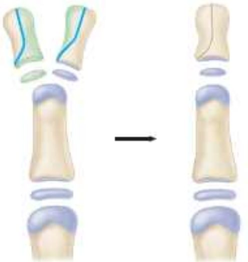
- Preaxial polydactyly

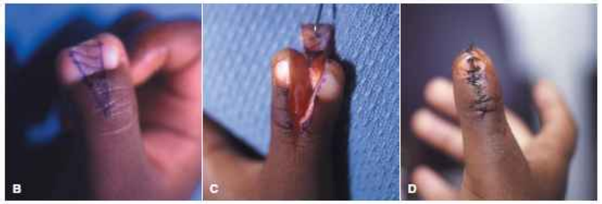
  Treatment

  - Surgical reconstruction generally is performed when the child is about 18 month
  - No later than 5 yrs old if possible
  - Later revisions may be required and fusions needed for late angular deformities and instability at 8 to 10 yrs old

Duplication

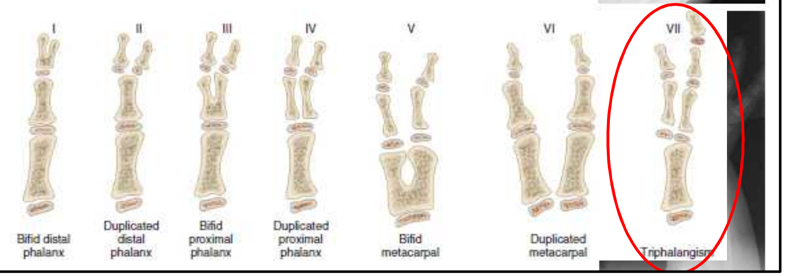
• Preaxial polydactyly
  Bilhaut-Cloquet technique





Duplication

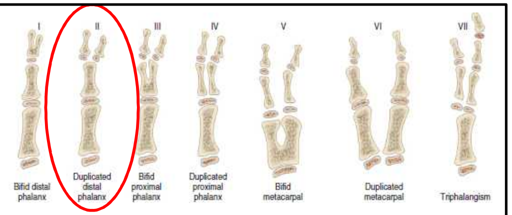
• **Triphalangeal thumb**
  - Three phalanges instead of the normal two
  - Inherited as autosomal dominant
  - Tw
  (1)
  (2)



Duplication

• Triphalangeal thumb
  Treatment
  operation is not required especially type I children
  The goal of operative treatment
  - correct angular deformity
  - restoration of length
  - correction of web contracture
  - improvement of opposition

Duplication



• **Central polydactyly**
  2, 3, 4th finger duplication
  most typical pattern is type 2 central polydactyly
  concealed within a syndactyly between 3, 4th finger
  inherited as autosomal dominant

Duplication

- **Central polydactyly**

  Treatment

  - excision of the most hypoplastic digit
  - in case of polysyndactyly, syndactyly reconstruction with excision of the extra digit
  - surgical reconstruction should be performed by the time the child is 6 months

Duplication

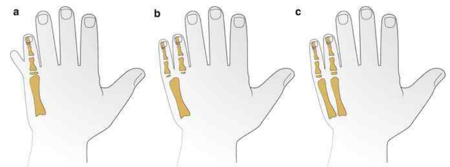
- **Postaxial polydactyly - Small finger duplication**

  Stelling & Turek classification

  type 1: duplication soft parts only

  type 2: partial duplication including osseous structure

  type 3: complete duplication including metacarpal



Overgrowth

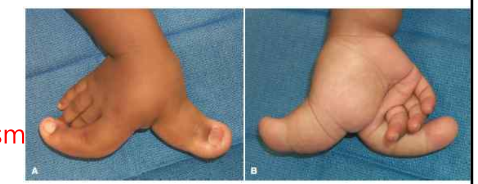
- **Macrodactyly**

  Rare congenital anomaly with enlargement of finger

  Index finger involved most frequently

  Three possible factors

  - abnormal nerve supply
  - abnormal blood supply
  - abnormal humoral mechanism



Barsky classification

Static type / Progressive type

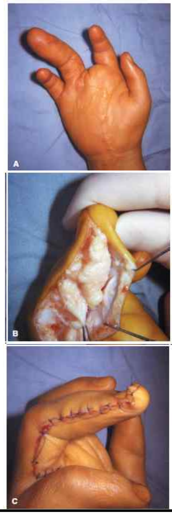
Overgrowth

- **Macrodactyly**
  - skin may be thickened
  - nail may be hypertrophied
  - nerves enlarged
  - begins to lose motion
  - symptoms of Carpal tunnel syndrome develop
  - Trophic ulcers

Overgrowth

- **Macrodactyly**

  Treatment
  - debulking
  - physeal arrest by drilling
  - digital shortening



Undergrowth

- **Hypoplastic thumb**

  Blauth classification

  type 1: minor generalized hypoplasia (**short thumb**)

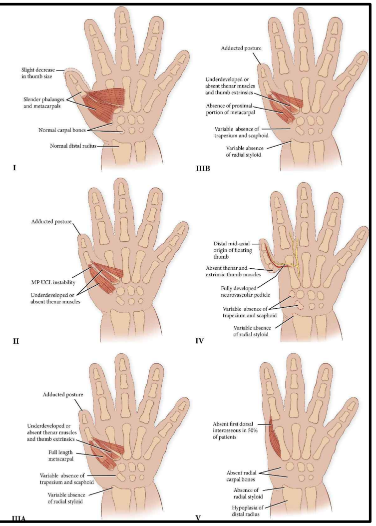
  type 2: adduction contracture with deficient intrinsics and unstable MCP joint (**adducted thumb**)

  type 3: type2 + deficient extrinsic m.

  type 4: deficient osseous structure (**floating thumb**)

  type 5: absent

  Manske dividing the type 3 into type 3A, 3B according to CMC joint stability



Undergrowth

- **Hypoplastic thumb – Short thumb**

  when its length less than normal(extends to 2nd PIP)

  Frequently associated with other anomalies and syndromes

  May be radially deviated or very short and stubby

Undergrowth

- **Hypoplastic thumb – Short thumb**

  Treatment
  - generally no need surgical correction
  - If prehension is significantly limited, deepening of the web space may be sufficient

Undergrowth

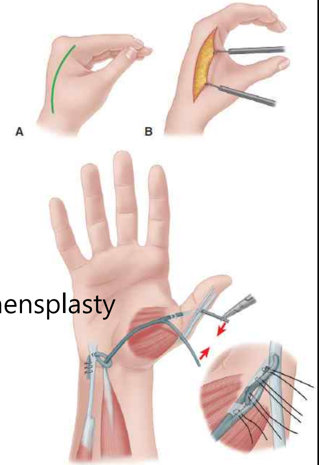
- **Hypoplastic thumb - Adducted thumb**

  absence or partial absence of the thenar muscles
  → deficient opposition
  often lack a functional FPL m.
  radial collateral ligament of the MCP joint may be deficient
  usually transmitted as an autosomal dominant trait

Undergrowth

- **Hypoplastic thumb - Adducted thumb**

  Treatment
  correction of the adduction contracture
  → two-limb Z-plasty, dorsal sliding flap
  restoration of opposition
  → ring flexor superficialis tendon opponensplasty
  abductor digit quinti opponensplasty



Undergrowth

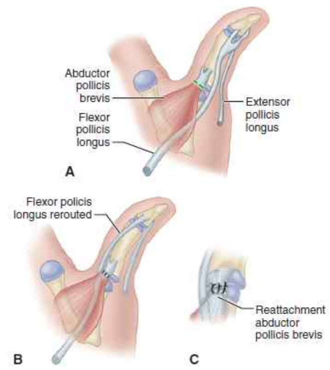
- **Hypoplastic thumb - Abducted thumb**

➢ described in 1969 by Tupper
➢ mildly hypoplastic thumbs and associated abduction deformities
➢ resulted from an abnormal insertion of the FPL into an otherwise normal EPL
➢ thenar musculature deficiency
➢ adduction contracture of the metacarpal with web space deficiency
➢ laxity of the ulnar collateral ligament
➢ radial and superficial displacement of the FPL
➢ inability to flexion of thumb

Undergrowth

- **Hypoplastic thumb - Abducted thumb**

  Treatment
  release of the anomalous slip to EPL,
  with an ulnarward shift of the FPL at MCP joint



Undergrowth

- **Hypoplastic thumb - Floating thumb**
  typically there are two phalanges, a fingernail
  no MCP joint
  no first metacarpal bone
  trapezium and scaphoid also often absent
  no function intrinsics and extrinsics

Undergrowth

- **Hypoplastic thumb - Floating thumb**
  Treatment
  amputation (TOC), followed by index finger pollicization

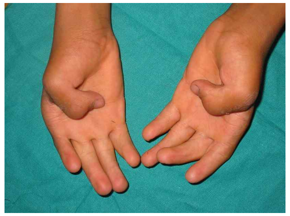
Undergrowth

- **Hypoplastic thumb – Absent thumb**
  most severe manifestation of the hypoplastic thumb

  Treatment
  index finger pollicization
  the best time is between 6-12 months old

Undergrowth

- **Hypoplastic thumb – Absent thumb**
  Congenital clasped thumb
  thumb is positioned in adduction and extreme flexion at MP joint
  underlying hypoplasia or absence of EPB, EPL



Undergrowth

- **Hypoplastic thumb – Absent thumb**

  Heiple classficiation

  group 1: deficient extension only (X-linked recessive trait)

  group 2: flexion contracture combined with deficient extension

  group 3: hypoplasia of thumb including tendon and m. deficiency

  group 4: deformities do not fit any other three groups

  if no active extension at the MP joint until 3 months,
  the diagnosis is established

Undergrowth

- **Hypoplastic thumb – Absent thumb**

  Treatment

  conservative tx.

  group 1: splint in abduction and extension

  operative tx.

  group 2: tendon graft (PL, brachioradialis, ECRL) for inadequate EPL
  tendon graft (EIP) for inadequate EPB

  group 3: chondrodesis
  replacement of EPL with EIP, APL with PL

Miscellaneous anomalies

- **Camptodactyly**

  flexion deformity of the PIP joint

  usually involve 5^{th} finger

  inherited autosomal dominant

  distinguish from clinodactyly (radioulnar curvature)

  caused by a relative imbalance between flexors and extensors
  relative shortening in the FDS muscle-tendon unit

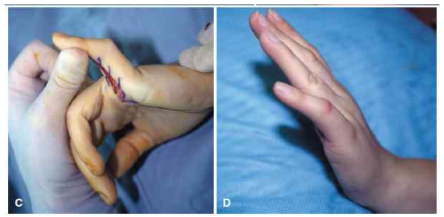
Miscellaneous anomalies

- **Camptodactyly**

  treatment

  dynamic splinting

  before 3yrs, passive stretching



  surgical intervention

  Z-plasty, FDS tenotomy, collateral ligament & volar plate release

1. 우측 제3.4수지 합지증이 있는 9개월된 환아에서 합지 분리 수술 후 발생할 수 있는 가장 흔한 합병증은? 17B/17I

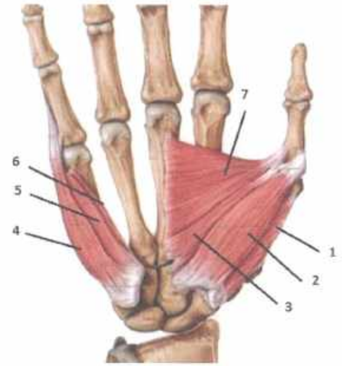
㉮ 굴곡건 손상
㉯ 반흔에 의한 재발
㉰ 수지 강직
㉱ 수지 괴사
㉲ 수지 신경 손상

	Syndactyly	Polydactyly
역학	남>여 대개 양측성 bilaterality : 50%	남>여 대개 편측성 bilaterality : 20%
호발 부위	3rd Web	thumb
유전성	ring-little, middle-ring complex type의 distal stuff가 붙은 type	axial, post axial type
동반 syndrome	Alpert's syndrome Poland's syndrome	Alpert's syndrome Fanconi's syndrome Holt-Oram syndrome VACTER syndrome Rubinstein-Taybi syndrome trisomy 21
동반 이상	clinodactyly camptodactyly symphalangism brachdactyly delta phalanx	Syndactyly brachdactyly abscent tibia cleft plalate and lip deafness imperforate anus 척추 이상 nail dystrophy
Cx	scar deformity circular insufficiency	late. angular deformity instability

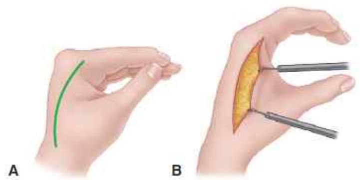
1. 우측 제3.4수지 합지증이 있는 9개월된 환아에서 합지 분리 수술 후 발생할 수 있는 가장 흔한 합병증은? 17B/17I

㉮ 굴곡건 손상
㉯ 반흔에 의한 재발
㉰ 수지 강직
㉱ 수지 괴사
㉲ 수지 신경 손상

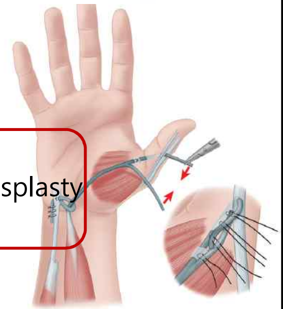
1. Hypoplastic adducted thumb에서 opposition을 restoration 하기 위하여 이용되는 근육을 그림에서 고르시오. 15B2/14B/12B



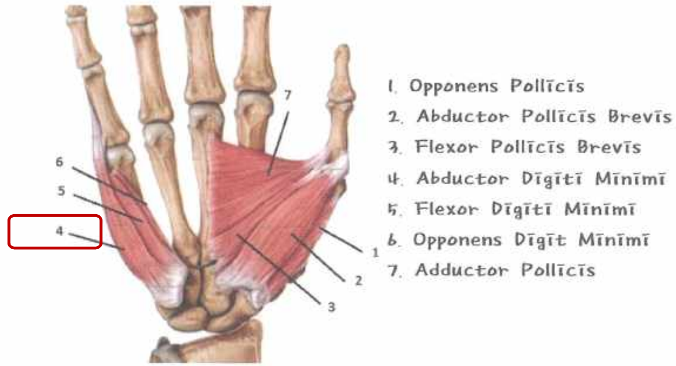
Undergrowth



- Hypoplastic thumb
  treatment
   surgical reconstruction for
    correction of the adduction contracture
    -> two-limb Z-plasty, dorsal sliding flap
    and restoration of opposition
    -> ring flexor superficialis tendon opponensplasty
       abductor digit quinti opponensplasty



1. Hypoplastic adducted thumb에서 opposition을 restoration 하기 위하여 이용되는 근육을 그림에서 고르시오. 15B2/14B/12B



Elbow & Forearm
- surgical approach -

명지병원 정형외과
R3. 이준우

Surgical approach

TABLE 1-7

Summary of Surgical Approaches to the Elbow and Proximal Forearm

AUTHOR	TISSUE PLANE
POSTERIOR APPROACHES	
Campbell	Midline triceps split
Campbell	Triceps aponeurosis tongue
Extended Kocher/ Ewald	ECU and anconeus/triceps
Wadsworth	Triceps aponeurosis tongue and full-thickness deep head
Bryan, Morrey	Elevate triceps mechanism from medial olecranon and reflect laterally
Boyd	Lateral border of triceps/ulna and anconeus/ECU
Muller, MacAusland	Olecranon osteotomy—transverse or chevron
LATERAL APPROACHES	
Kocher	Between FCU and anconeus
Cadenat	Between ECRB and ECRL
Kaplan	Between ECRB and ECU
Key, Conwell	Between BR and ECRL
MEDIAL APPROACH	
Hotchkiss	Between FCU and PL/FCR; brachialis resected laterally with PL/FCR/PT
Molesworth	Medial epicondyle osteotomy
GLOBAL APPROACH	
Patterson, Bain, Mehta	Kocher interval; ± lateral epicondyle osteotomy; ± Kaplan interval; ± Hotchkiss interval; ± Taylor interval
ANTERIOR APPROACH	
Henry	Between mobile wad and biceps tendon; elevate supinator from radius

Surgical approach

1. Elbow

1-1. Posterolateral approach
1-2. Posterior approach to the elbow by olecranon osteotomy
1-3. Lateral approaches
- (1) Kocher approach
- (2) Kaplan approach
- (3) EDC splitting approach

1-4. Medial approaches
- (1) Hotchkiss (Over the top) approach
- (2) FCU splitting approach
- (3) Taylor and Scham approach

2. Forearm

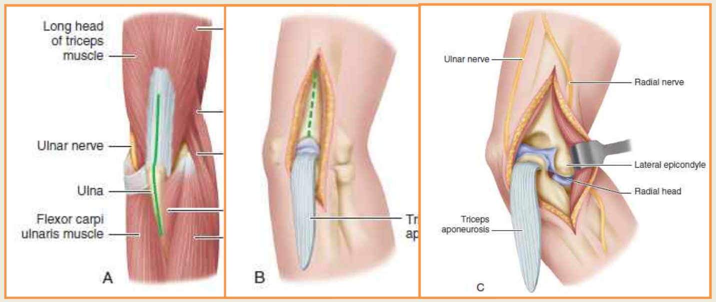
2-1. Posterolateral approach to radius head and neck
2-2. Approach to proximal and middle third of posterior surface
2-3. Anterolateral approach to the radius shaft
2-4. Approach to proximal 1/3 of ulna and 1/4 of radius

1-1. Posterolateral approach

▣ Posterolateral approach

- ▶ Elbow posterior D/L, Fx. distal humerus involving the joint, Arthroplasty
- ▶ Triceps contracture O → Tongue shaped flap
- ▶ Triceps contracture X → Muscle & aponeurosis : mid-line longitudinally divide

1-1. Posterolateral approach



▶ Skin incision 10 cm Proximal to the elbow + Distally for 13 cm
▶ Dissection through the fascia & Expose the aponeurosis of the triceps
▶ Triceps muscle has been contracted by fixed extension of the elbow
→ free the aponeurosis proximally to distally in a tongue-shaped flap and retract it distally to its insertion
▶ Elevate the periosteum together with the triceps muscle

1-2. Posterior approach to the elbow by olecranon osteotomy

▣ In a comparative anatomic study,

▶ Wilkinson and Stanley showed that an olecranon osteotomy exposed significantly more articular surface of the distal humerus than a triceps reflecting approach.

▣ Procedure

▶ Expose the elbow posteriorly through an incision beginning 5 cm distal to the tip of the olecranon and extending proximally medial to the midline of the arm to 10 to 12 cm above the olecranon tip.
▶ Reflect the skin and subcutaneous tissue to either side carefully to expose the olecranon and triceps tendon.
▶ Expose the distal humerus through a trans-olecranon approach.

1-2. Posterior approach to the elbow by olecranon osteotomy

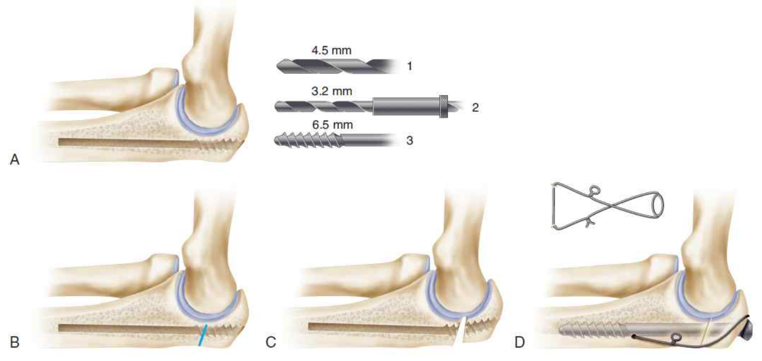
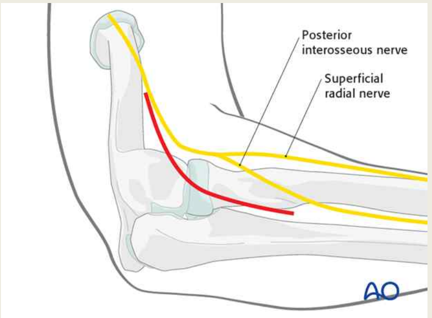


FIGURE 1-130 Osteotomy of olecranon. **A,** Preparation of hole for 6.5-mm cancellous screw. **B,** Incomplete osteotomy made with thin saw or osteotome. **C,** Osteotomy completed by fracturing bone. **D,** Lag screw (6.5 mm) and tension band wire fixation. This technique also is useful for internal fixation of olecranon fractures. **SEE TECHNIQUE 1-104.**

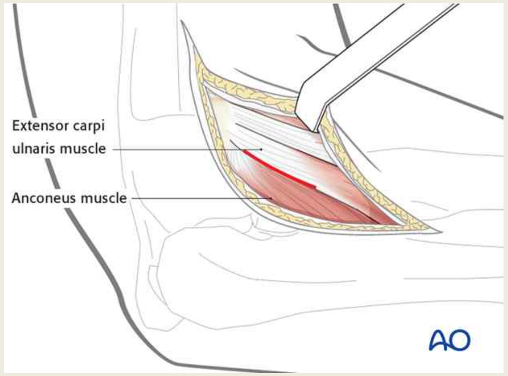
1-3. Lateral approaches

(1) Kocher approach (Lateral J approach)
▶ Radial head Fx.
▶ between the anconeus and extensor carpi ulnaris
(2) Kaplan approach
▶ between the extensor carpi radialis brevis and extensor digitorum communis
▶ excellent exposure of the common extensor tendon origin and the lateral epicondyle

(3) EDC splitting approach
▶ provides greater exposure of the anterior half of the radial head for easier fixation of radial head fractures
▶ lateral to the Kaplan interval

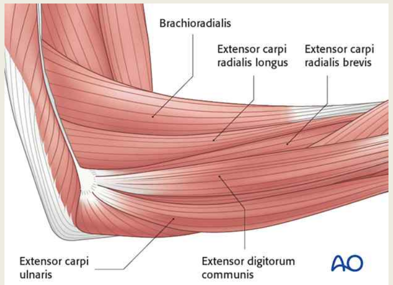


- Either a posterior skin incision with a lateral skin flap or a lateral skin incision can be used.
- For a lateral skin incision, place the elbow at 90 degrees and try to pinch the lateral condyle. Make a straight skin incision directly over the middle of the lateral condyle. Start with a small incision (6-8 cm or so) and extend proximal or distal as needed.
- *Note: The posterior interosseous nerve, within the supinator muscle, crosses the posterior radius, from anteriorly, three finger-breadths distal to the radial head. It must be protected during this approach.*



Kocher interval

- The interval between the anconeus and extensor carpi ulnaris (Kocher interval) is relatively more posterior and thus risks injuring the lateral collateral ligament complex.



Kaplan interval

- the interval between the extensor carpi radialis brevis and extensor digitorum communis
- can also be identified by elevating the origin of the ECRB from the supracondylar ridge
  → elevating the brachialis from the anterior humerus, then continuing distally until the joint is entered and the capitellum is visualized.
  (Elevating these muscles is necessary to exposure the coronoid from the lateral side.)

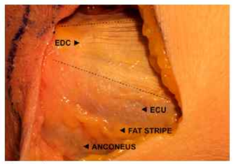


Fig. 7-A

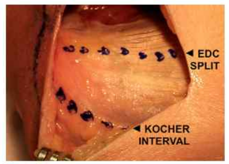


Fig. 7-B

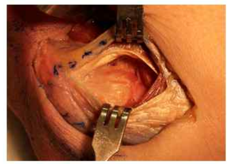
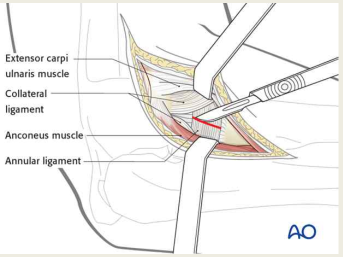


Fig. 8

EDC splitting approach

- EDC tendon is identified and bisected longitudinally starting proximally at its origin on the lateral epicondyle and extending 20 mm distally from the radiocapitellar joint
- With the forearm fully pronated, longitudinally bisect the EDC tendon centered over the radial head. Retract the split EDC tendon anteriorly and posteriorly.



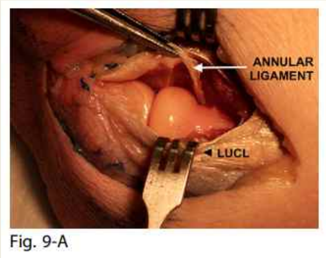


Fig. 9-A

- The annular ligament and joint capsule are then incised
- Ensure that the forearm is fully pronated to protect the posterior interosseous nerve.
- Begin proximally 2 mm anterior to the equator of the capitellum to avoid iatrogenic injury to the origin of the lateral ulnar collateral ligament
- Place two small Hohmann retractors within the radiocapitellar joint to gently displace soft tissues anteriorly and posteriorly
- Do not extend the capsular incision beyond the distal edge of the annular ligament or retract aggressively, to avoid injury to the posterior interosseous nerve.

1-4. Medial approaches

(1) Hotchkiss approach (over the top)

▶ good access to the anterior elbow capsule and the tip of the olecranon

▶ The interval that splits the flexor-pronator mass and elevates the anterior part (pronator teres (PT), flexor carpi radialis (FCR), and palmaris longus (PL)) along with brachialis from the anterior elbow capsule

(2) FCU split approach

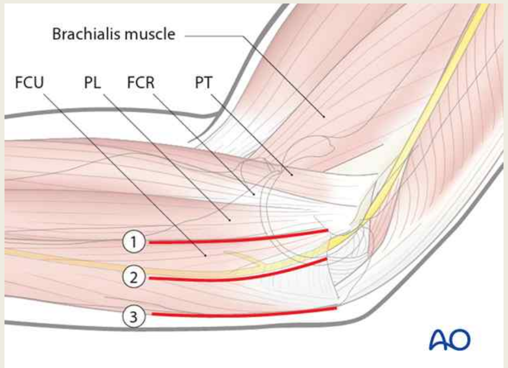
▶ For access to the medial facet

▶ The interval where the ulnar nerve lies between the heads of the flexor carpi ulnaris

(3) Taylor and Scham approach

▶ med. epicondyle fracture, coracoid process fracture

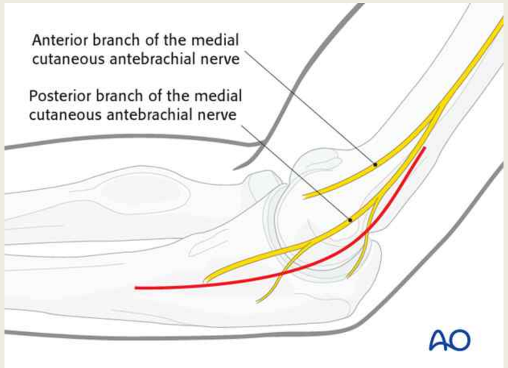
▶ By elevating the entire flexor-pronator mass from posterior to anterior



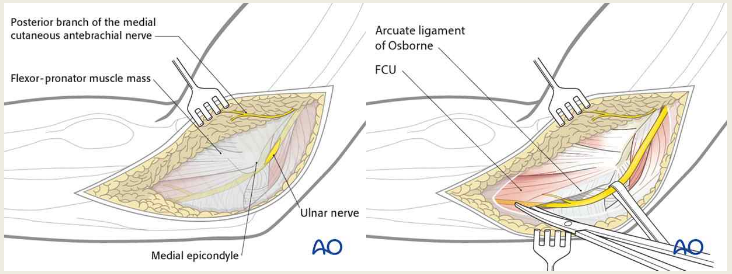
(1) Hotchkiss approach (over the top)

(2) FCU split approach

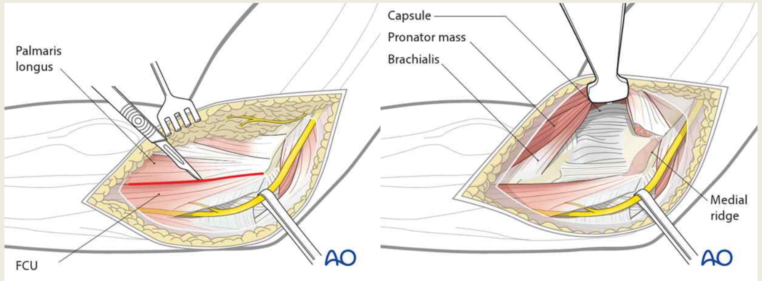
(3) Taylor and Scham approach



- The skin incision can either be posterior with a medial skin flap or direct medial, taking care to protect branches of the medial antebrachial cutaneous nerve which travels more anteriorly.

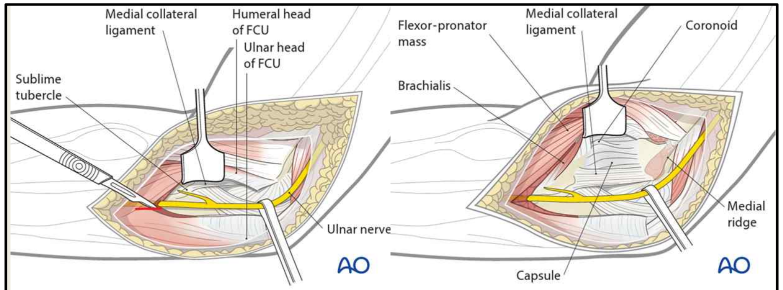


- The ulnar nerve should be identified and protected. Generally, it is unroofed for 6 centimeters proximal and distal.
- *Always start with the exposure of the ulnar nerve proximally. It is easier and safer*



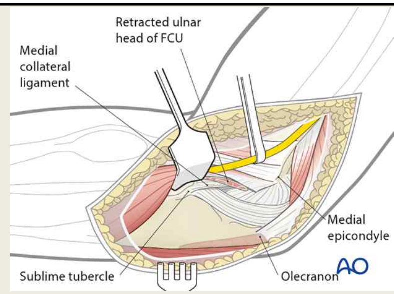
Hotchkiss (Over the top) approach

- Use blunt dissection to identify the anterior edge of the flexor-pronator mass, over the top of the brachialis and near to where the median nerve and brachial artery lie. With the ulnar nerve identified posteriorly, the flexor-pronator mass can be split, usually in the middle of the anterior-posterior width.
- Elevate the palmaris longus, flexor carpi radialis and pronator teres origins off the medial epicondyle.
- Extend this dissection proximally by extra-periosteal dissection of the brachialis muscle and the flexor-pronator mass off the medial supracondylar ridge of the distal humerus and the anterior elbow capsule.



FCU splitting approach

- Use the course of the ulnar nerve to distinguish the humeral and the ulnar part of the FCU. Start the dissection distally and elevate the humeral part of the FCU extra-periosteally off the coronoid, medial collateral ligament (MCL), and anterior elbow capsule. The MCL travels from the medial epicondyle to the sublime tubercle which is usually palpable.
- For better exposure to the medial coronoid, the exposure can be extended distally and proximally.



Taylor and Scham approach

- Elevate the FCU and the entire flexor-pronator mass extraperiosteally from posterior to anterior starting at the crest of the ulnar shaft and the flat surface of the olecranon using a blunt elevator. You should expose the base of the coronoid fracture. If the ulnar nerve is at risk, transpose it anteriorly into the subcutaneous tissues.
- Pearl: It is crucial to preserve the medial collateral ligament. Sometimes it gets difficult to distinguish the tendinous origin of FCU from the fibers of the medial collateral ligament. It is helpful to dissect from distal to proximal towards the sublime tubercle which is usually palpable. As long as the dissection is extra-periosteal and only muscle is elevated from the bone, the ligament should be safe.
- If access to the anterior capsule is needed, make a second more anterior interval such as the "over the top" exposure. Elevation of the origin of the flexor-pronator mass off the medial supracondylar ridge of the distal humerus, gives good exposure, but is destructive and should be avoided if possible.

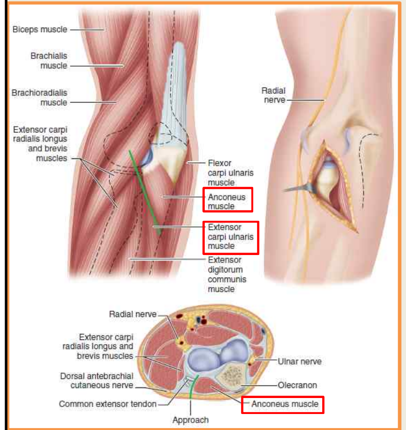
2-1. Posterolateral approach to radius head and neck

▣ **Corresponds to the distal limb of the Lateral J approach of Kocher**

▣ **Best approach for excising radial head**

▶ Extensile proximally and distally without danger to major vessels or nerves
▶ Preserves the nerve supply to the anconeus
▶ It is safer
  → Endanger the posterior interosseous nerve X
  → Full pronation of the forearm for maximal protection of the nerve

2-1. Posterolateral approach to radius head and neck



▶ Begin an oblique incision over the posterior surface of the lateral humeral condyle and continue it obliquely distally and medially to a point over the posterior border of the ulna 3 to 5 cm distal to the tip of the olecranon (Fig. 1-137).

▶ Divide the subcutaneous tissue and deep fascia along the line of the incision and develop the fascial plane between the extensor carpi ulnaris and the anconeus muscles.

▶ Retract the anconeus toward the ulnar side and the ECU toward the radial side, exposing the joint capsule in the depth of the proximal part of the wound.

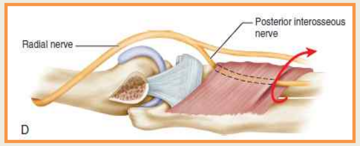
▶ Locate the joint capsule in the depth of the wound, incise it, and expose the head and neck of the radius (Fig. 1-137). The deep branch of the radial nerve that lies between the two planes of the supinator remains undisturbed.

2-2. Approach to proximal and middle third of posterior surface

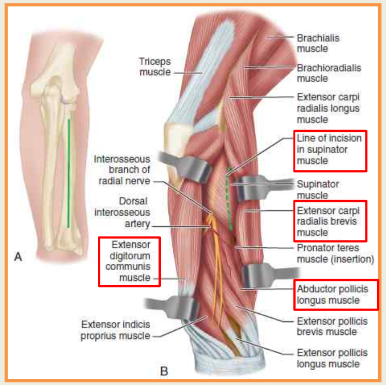
▣ **Exposing the proximal third of the radius is difficult because the deep branch of the radial nerve (posterior interosseous) traverses it within the supinator muscle (Arcade of Frohse)**

▣ **Thompson approach**

▶ Develop the interval between EDC and ECRB
▶ Retract these structures to the ulnar and radial sides



2-2. Approach to proximal and middle third of posterior surface



▶ Make the skin incision over the proximal and middle thirds of the radius along a line drawn from the center of the dorsum of the wrist to a point 1.5 cm anterior to the lateral humeral epicondyle when the forearm is pronated, this line is nearly straight.

▶ Develop the interval between EDC & ECRB, and retract these structures to the ulnar and radial sides.

▶ Reflect the EDC toward the ulna to expose the supinator muscle, or for a wider view, detach the EDC from its origin on the lateral epicondyle and retract it further medially

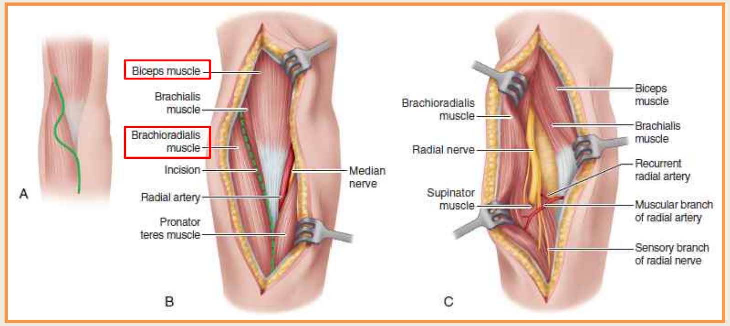
▶ Expose the part of the radius covered by the supinator by one of two means. Either divide the muscle fibers down to the deep branch of the radial nerve and carefully retract the nerve or free the muscle from the bone subperiosteally and reflect it proximally or distally along with the nerve; the latter is the better method if the exposure is wide enough

2-3. Anterolateral approach to the radius shaft

▣ **Approach to Proximal half**

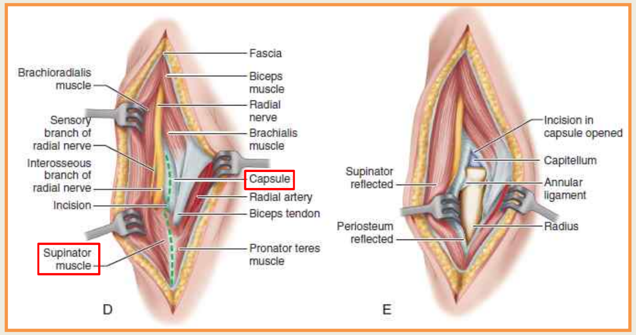
▶ Proximal : lateral border of the biceps tendon
  Distal : medial border of the brachioradialis
▶ Full supination → supinator divide (posterior interosseous n. injury X)
▶ Isolate and ligate the recurrent radial artery and vein immediately
  (retract hematoma → Ischemic (Volkmann) contracture of the forearm flexor muscles)

2-3. Anterolateral approach to the radius shaft



A, Incision. **B,** Fascia has been incised to expose brachioradialis laterally and biceps and brachialis medially. Lacertus fibrosus has been divided to permit dissection to be deepened between biceps tendon and pronator teres medially and brachioradialis laterally. **C,** Dissection has been deepened to expose radial nerve. Nerve and its sensory branch are protected, and recurrent radial artery is ligated and divided.

2-3. Anterolateral approach to the radius shaft



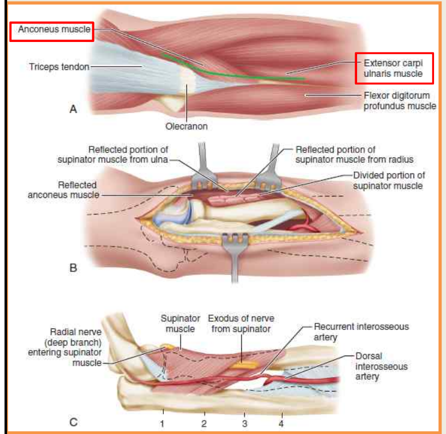
D, Broken line represents incision to be made through joint capsule and along medial border of supinator to expose capitellum and proximal radius. E, Forearm has been supinated, and approach has been completed by reflecting supinator. Radial nerve, which courses in supinator, is protected.

2-4. Approach to proximal 1/3 of ulna and 1/4 of radius

▣ **Boyd technique**

▶ Fx. proximal 1/3, ulna + Radial head D/L (Monteggia fractures)
▶ Less danger to the deep branch of the radial nerve
▶ Ulna & anconeus & ECU → dissection
▶ Posterior interosseous n . injury

2-4. Approach to proximal 1/3 of ulna and 1/4 of radius



▶ Begin the incision about 2.5 cm proximal to the elbow joint just lateral to the triceps tendon, continue it distally over the lateral side of the tip of the olecranon and along the subcutaneous border of the ulna, and end it at the junction of the proximal and middle thirds of the ulna (Fig. 1-141A).

▶ Develop the interval between the ulna on the medial side and the anconeus and extensor carpi ulnaris on the lateral side.

▶ Peel the supinator from the proximal fourth of the radius and reflect radially the entire muscle mass, including the anconeus, and the proximal part of the ECU (Fig. 1-141B). This amply exposes the lateral surface of the ulna and the proximal fourth of the radius. The substance of the reflected supinator protects the deep branch of the radial nerve (Fig. 1-141C and D).

Reference

▣ Campbell's Operative Orthopaedics,
' Chapter 1. Surgical techniques and approaches ', 13th edition
P113 ~ 128

Polydactyly

정의

- 족지가 6개 이상인 경우
- 발생빈도 : 출생 신생아 1000명당 1명, 많게는 10명
- 분류 : preaxial, postaxial, central
- 대부분 산발성이나 상염색체 우성으로 유전

Venn-Watson Classification of Polydactyly

- post-axial (lateral side of the foot)
  - 'Y' metatarsal
  - 'T' metatarsal
  - wide metatarsal head
  - complete duplication
- central (not part of the original classification)
  - duplication of the second, third or fourth toe
- pre-axial (medial side of the foot)
  - short block first metatarsal
  - wide metatarsal head

Treatment

- 축전성인 경우 내측 잉여지를 절제
- 잉여지 절제 후 관절낭과 내재근의 복원

- 중심성인 경우 잉여지 절제 후 중족골간인대를 복원

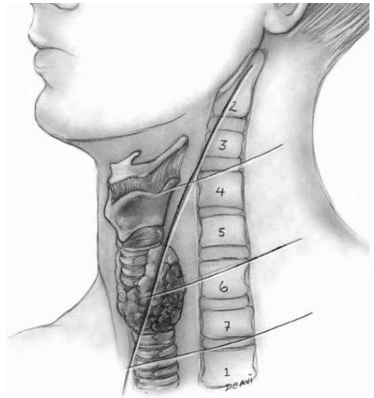
- 축후성 다지증은 가장 치료 경과가 좋다
- 대부분 외측 잉여지를 절제하나 내측 잉여지 발육이 현저하게 저하된 경우 내측 잉여지를 절제

Neck & Pectoral Region
Surgical approach

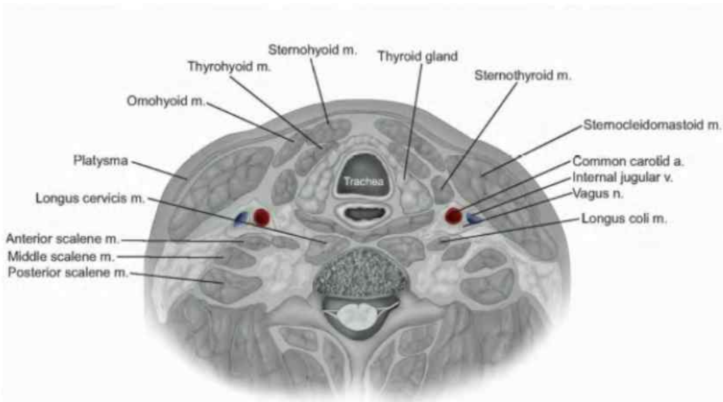
명지병원 정형외과
R3. 이준우

Palpable landmarks (Neck)

- C3 : Hyoid bone
- C4-5 : Thyroid cartilage
- C5-6 : Cricoid cartilage
- C6 : Carotid tubercle



Fascial plane



Surgical approaches

1. Ant. transoral approach
2. Ant. retropharyngeal approach
3. Ant. approach
4. Anterolateral approach
5. Post. approach

1. Ant. transoral approach

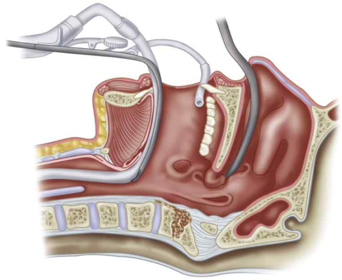
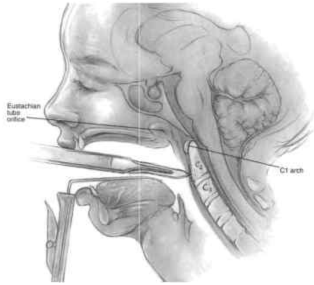
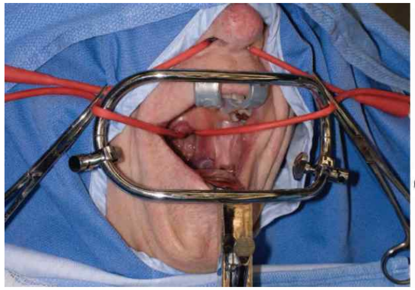


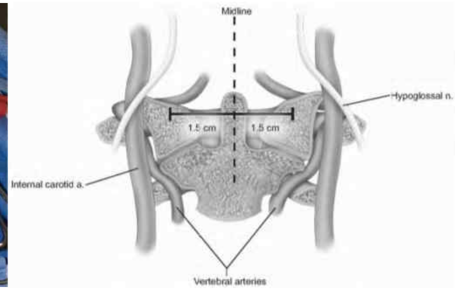
FIGURE 37.9 **Anterior transoral approach (see text).** (Redrawn from Spetzler RF: Transoral approach to the upper cervical spine. In Evarts CM, editor: *Surgery of the musculoskeletal system*, New York, 1983, Churchill Livingstone.) **SEE TECHNIQUE 37.1.**



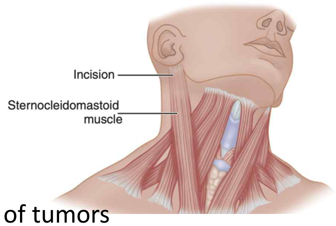
Indications
- C1-2 level
- odontoid with basilar invagination
- infection
- tumors
- irreducible odontoid fractures
- congenital disorders of the anterior axis or atlas

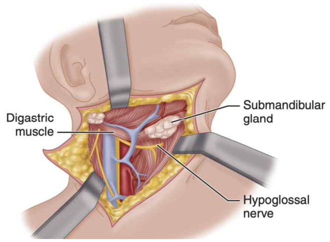
1. Ant. transoral approach



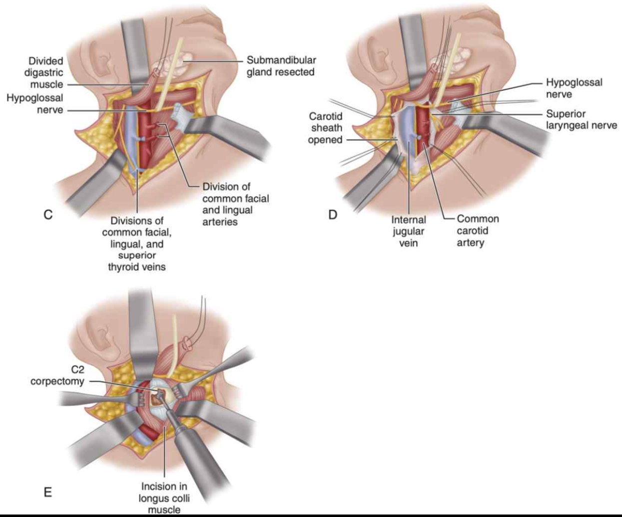


2. Ant. retropharyngeal approach





Indications
- debridement of tumors
- infection
- stabilization of the atlantoaxial segment
- expose the C1-2 facet articulation



3. Ant. approach

Indications
- cervical radiculopathy
- myelopathy
- tumor
- odontoid fracture
- infection & epidural abscess

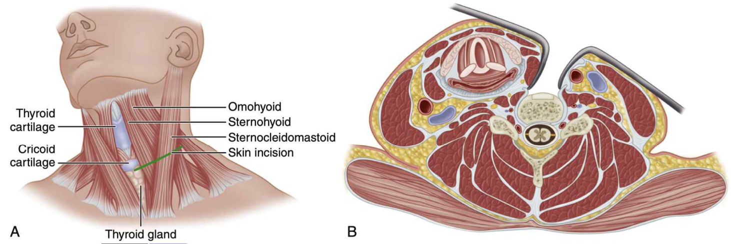
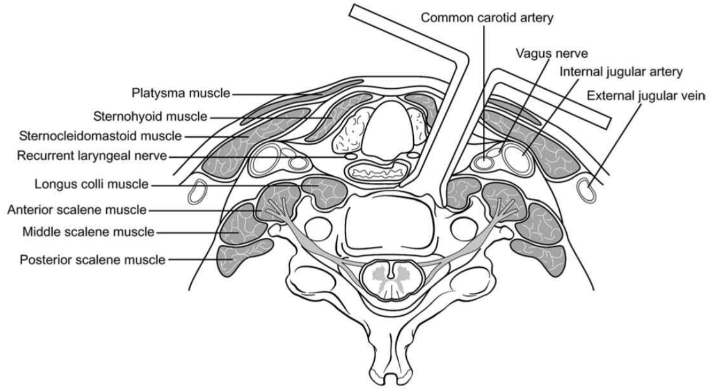


FIGURE 37.12 Anterior approach to C3-7 (see text). **A,** Incision. **B,** Thyroid gland, trachea, and esophagus have been retracted medially, and carotid sheath and its contents have been retracted laterally in opposite direction. **SEE TECHNIQUE 37.5.**



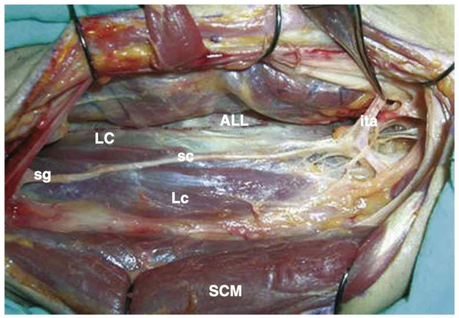
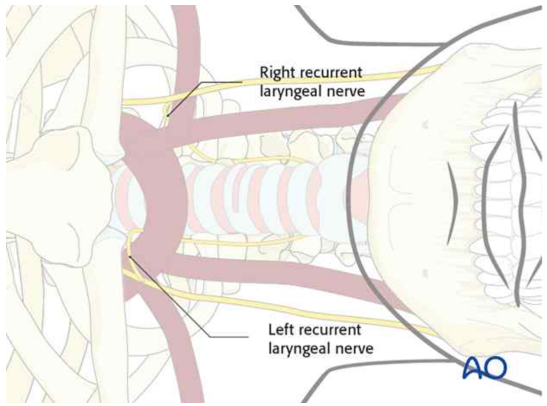
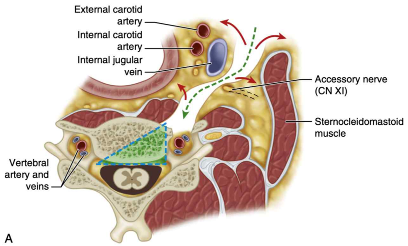
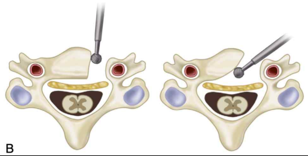


FIGURE 37.14 Anatomic dissection showing the relation of the cervical sympathetic chain *(sc)* to the longus coli muscle *(Lc)*. Also shown are the sternocleidomastoid muscle (SCM), the anterior longitudinal ligament *(ALL),* the longus capitis muscle *(LC),* the inferior thyroidal artery *(ita),* and the superior ganglion of the sympathetic trunk *(sg)*. (Left side is cranial and right side is caudal.) (From Civelek E, Karasu A, Cansever T, et al: Surgical anatomy of the cervical sympathetic trunk during anterolateral approach to the cervical spine, *Eur Spine J* 17:991, 2008.)



4. Anterolateral approach





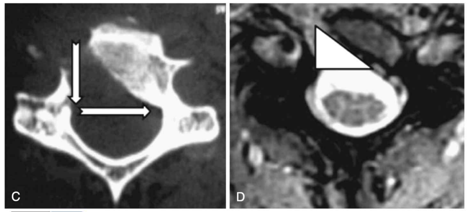


FIGURE 37.15 **A,** Anterolateral approach to the cervical spine through the interval between the sternocleidomastoid laterally and along the internal jugular vein medially with the other vascular structures including the internal carotid and external carotid. The XI cranial nerve is identified at C2 to 4 *(CN XI)*. The longus coli aponeurosis is longitudinally opened and the sympathetic chain is identified and carefully protected while exposing the uncovertebral joints and the anterior surface of the transverse process. The foramen is opened over the vertebral artery. **B,** Bony exposure through wedge-shaped lateral decompression. **C,** CT after wedge decompression. **D,** Postoperative MRI showing decompression. (From Chibbaro S, Mirone G, Bresson D, George B: Cervical spine lateral approach for myeloradiculopathy: technique and pitfalls, *Surg Neurol* 72:318, 2009.) **SEE TECHNIQUE 37.6**.

5. Posterior approach

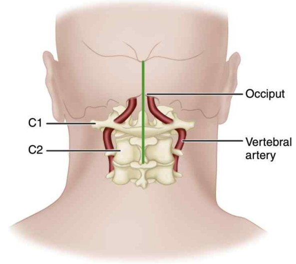


FIGURE 37.38 Posterior approach to upper cervical spine (see text). **SEE TECHNIQUE 37.21**.

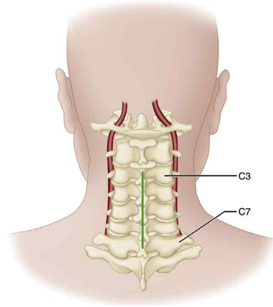


FIGURE 37.39 Posterior approach to lower cervical spine (see text). **SEE TECHNIQUE 37.22**.

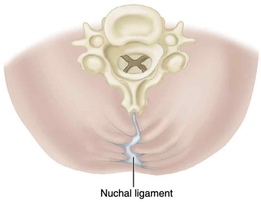
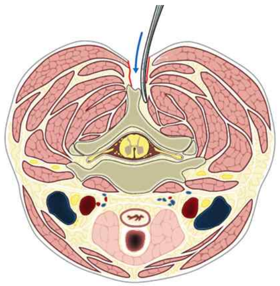
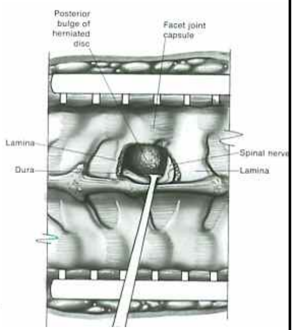


FIGURE 37.40 Posterior approach to lower cervical spine. Nuchal ligament is irregular. To maintain dry field, surgeon must stay within ligament. **SEE TECHNIQUE 37.22**.





SURGICAL PROBLEMS RELATIVE TO SPECIFIC HIP DISORDERS

명지병원 정형외과

2023.03.08

R2. 김 수 영

Index

- ▣ ARTHRITIC DISORDERS
- ▣ OSTEONECROSIS
- ▣ PROTRUSIO ACETABULI
- ▣ DEVELOPMENTAL DYSPLASIA
- ▣ ARTHRODESIS

ARTHRITIC DISORDERS

▣ OSTEOARTHRITIS

▶ Most common indication for THA

▶ Shortened leg slightly
→ Femoral head or Acetabulum : Erosion, Deformity
→ Flexed, Externally Rotated, Adduction : Deformity

▶ Dislocate hip safely
→ Removal of the osteophytes from the ant. or post. margin of the acetabulum

▶ Subchondral bone of the acetabulum is thick & hard
→ Considerable reaming

ARTHRITIC DISORDERS

▣ OSTEOARTHRITIS

▶ Femoral head : displaced laterally
→ Intra-articular osteophytes may thicken the bone
→ Require deepening of the acetabulum to contain cup fully
→ Medialization

▶ Inadequate deepening of acetabulum : Degenerative arthritis with intra-articular osteophyte formation & lateral subluxation

▶ Medial osteophytes were not removed : socket remains in lateralized position

ARTHRITIC DISORDERS

▣ RHEUMATOID ARTHRITIS

▶ Relieve pain & increase ROM for THA

▶ Dermatitis, Vasculitis, Fragile skin, Osteopenia

▶ Risks of Fx during surgery & infections↑ after surgery
→ IV Steroid

▶ Femoral head & neck collapse, Intra-pelvic protrusion
→ Femoral canal : wide
→ Cortex : Thin & easily penetrated or fractured

OSTEONECROSIS

▣ OSTEONECROSIS

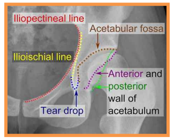
▶ Alcoholism, corticosteroids, renal transplantation
▶ Osteonecrosis of the femoral head remains a challenge for diagnosis and for treatment

▶ Capsule & synovial tissue proliferation
→ Quite hyperemic
→ Considerable amount of bleeding

▶ Large synovial effusion
→ Suspicion of infection

PROTRUSIO ACETABULI

▣ Primary PROTRUSIO ACETABULI



▶ Arthrokatadysis (Otto pelvis)
→ involves both hips
→ occurs most often in younger women
→ Pain & Limitation of motion at a relatively early age

▶ Primary protrusio acetabuli
Otto pelvis in 52-year-old woman
Femoral head has migrated
medial to ilioischial (Kohler) line
Hip motion is severely limited

PROTRUSIO ACETABULI

▣ Secondary PROTRUSIO ACETABULI

▶ Migration of endoprosthesis
▶ Septic arthritis
▶ Prior acetabular Fx.

▶ Bilateral Protrusio acetabuli
→ Paget disease
→ Arachnodactyly (Marfan syndrome)
→ Rheumatoid arthritis
→ Ankylosing spondylitis
→ Osteomalacia

PROTRUSIO ACETABULI

▣ PROTRUSIO ACETABULI

▶ Principles of reconstruction of a protrusion deformity

▶ Hip center must be placed in an anatomical location
→ to restore proper joint biomechanics
▶ Intact peripheral rim of the acetabulum
→ Used to support the acetabular component
▶ Remaining cavitary & segmental defects in the medial wall
→ must be reconstructed, preferably with bone grafting

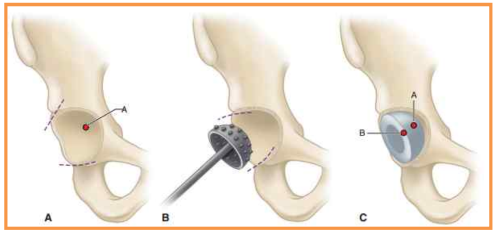
PROTRUSIO ACETABULI

▣ PROTRUSIO ACETABULI

A, Protrusio deformity in 52-year-old woman with lupus.
B, After total hip arthroplasty. Hip center was restored to more lateral and inferior position.
Large acetabular component allowed rim fixation without need for screws
medial deficits were grafted with cancellous autograft from femoral head with excellent incorporation.
Low neck resection and high-offset stem design helped avoid overlengthening of limb.

PROTRUSIO ACETABULI

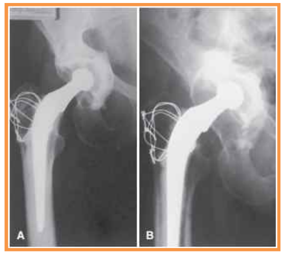
▣ PROTRUSIO ACETABULI



Insertion of acetabular component for protrusio
A, Peripheries of acetabular walls are divergent & hip center is displaced superiorly and medially.
B, Peripheral reaming creates new rim with convergent walls.
C, Implanted component is stable on prepared rim.
Hip center shifted from point A to point B and is now in more anatomical location.

PROTRUSIO ACETABULI

▣ PROTRUSIO ACETABULI

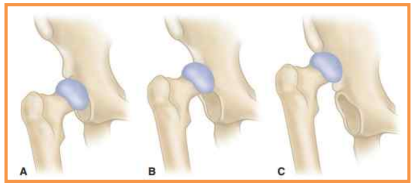


Incomplete reconstruction of protrusio deformity
A, Shortly after surgery. Hip center remains in superior and medial location
medial wall has been perforated
B, Progression of deformity with loosening of socket and destruction of medial wall.

DEVELOPMENTAL DYSPLASIA

▣ DEVELOPMENTAL DYSPLASIA

▶ Dysplastic hips are classified by the amount of subluxation
type I, less than 50% / type II, 50% to 75% / type III, 75% to 100%
/ type IV, greater than 100% subluxation



Developmental subluxation or dislocation.
A, Dysplastic hip with defect in superior aspect of acetabulum.
B, Intermediate congenital dislocation with false acetabulum above true acetabulum,
usually with shallow groove connecting two acetabula.
C, High dislocation of hip, with some reactive bone on side of ilium where head impinges on cortex.

DEVELOPMENTAL DYSPLASIA

▣ DEVELOPMENTAL DYSPLASIA

▶ DDH는 THA 어렵다

→ Intermediate or High dislocation에서는 매우 어렵다
→ Pain이 없는 Subluxation or Dislocation은 Arthroplasty 안 한다
→ OP indication은 생활에 저해할 정도의 통증이 있을 때만!

DEVELOPMENTAL DYSPLASIA

▣ DEVELOPMENTAL DYSPLASIA

▶ 수술 시, 고려해야하는 bone & soft tissue deformity

→ Femoral head : small & deformed
→ Femoral neck : narrow & short & marked anteversion
→ GT : small & often located posteriorly
→ Femoral canal : narrow
(LT 2 cm inferior의 평균 width only 1.5 cm)
→ Femur shaft : anterior bowing of the proximal 1/3
→ Acetabulum : oblong & its roof is eroded
→ High and intermediate dislocations
: formation of a false acetabulum
thickest bone available usually is in the true acetabulum, and
the cup should be implanted there if possible

DEVELOPMENTAL DYSPLASIA

▣ DEVELOPMENTAL DYSPLASIA

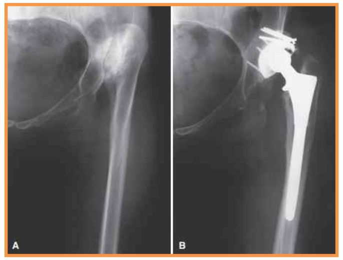
▶ 수술 시, 고려해야 하는 bone & soft tissue deformity

→ Abductor, adductors, psoas, hamstrings, rectus femoris muscles
: usually are shortened
→ Capsule : elongated & redundant

→ Sciatic nerve has never assumed its normal length and is
susceptible to stretch injury

DEVELOPMENTAL DYSPLASIA

▣ DEVELOPMENTAL DYSPLASIA

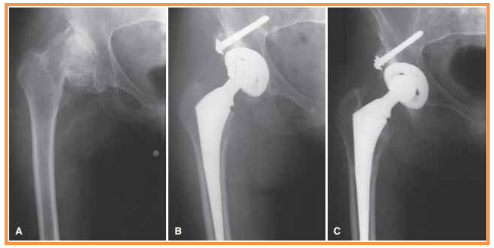


Placement of cup in false acetabulum
A, Dislocation in 35-year-old woman.
B, Cup was implanted in false acetabulum with high hip center.
Limb remains 4 cm short, and abductor function is poor

DEVELOPMENTAL DYSPLASIA

▣ DEVELOPMENTAL DYSPLASIA

▶ Technique is most important : Solid acetabular bone grafts



Grafting of superior segmental defect of acetabulum with part of femoral head
A, Sequelae of dysplasia in 54-year old woman.
B, Cementless socket is placed in true acetabulum.
Autogenous graft is fixed with cancellous screws and covers about 30% of implant
C, At 5 years, graft has united and socket is stable

ARTHRODESIS

▣ ARTHRODESIS AND ANKYLOSIS

▶ THA Ix. Of arthrodesis
→ Fused hip causes severe, persistent low back pain
→ Pain in the ipsilateral knee or contralateral hip
→ Pseudarthrosis after an unsuccessful fusion is sufficiently painful

▶ Hip is fused in poor position
▶ Flexed > 30 degrees, adducted > 10 degrees
→ Osteotomy to correct the position should be considered

ARTHRODESIS

▣ ARTHRODESIS AND ANKYLOSIS

A, Arthrodesis in 61-year-old woman who developed disabling back pain
4 decades after successful arthrodesis of hip
B, After conversion to hybrid total hip arthroplasty. Trochanteric osteotomy provided excellent exposure.
Patient had persistent Trendelenburg limp after surgery, but back pain had diminished.

Exercise # 1

▣ 문제 1. 32세 여자 환자로 좌측 하지 단축과 파행을 주소로 내원하였다. 과거력 상 좌측 결핵성 고관절염으로 고관절 유합술을 받았고, 이후 정상 분만한 과거력이 있다. 진찰 소견에서 허리 및 양측 슬관절, 우측 고관절에 통증은 없었고, 우측 고관절과 양측 슬관절 운동범위는 정상이었다. 양측 다리 길이 차이가 4cm 일 때 이 환자에게 가장 적절한 처치는 ?

① 경과관찰
② 하지 연장술
③ 비구 절골술
④ 절제 관절 성형술
⑤ 인공 고관절 전치환술

Exercise # 1

▣ 문제 1. 32세 여자 환자로 좌측 하지 단축과 파행을 주소로 내원하였다. 과거력 상 좌측 결핵성 고관절염으로 고관절 유합술을 받았고, 이후 정상 분만한 과거력이 있다. 진찰 소견에서 허리 및 양측 슬관절, 우측 고관절에 통증은 없었고, 우측 고관절과 양측 슬관절 운동범위는 정상이었다. 양측 다리 길이 차이가 4cm 일 때 이 환자에게 가장 적절한 처치는 ?

① 경과관찰
② 하지 연장술
③ 비구 절골술
④ 절제 관절 성형술
⑤ 인공 고관절 전치환술

Exercise # 2

▣ 문제 3. 다음과 같은 Deformity를 동반한 환자에게 Hip center of rotation을 회복하기 위한 대퇴골 부위에서의 해결방법 중 시행할 수 있는 것은?

① Large head
② Medial offset 긴 것을 이용한다
③ Anterior offset을 증가시킨다
④ Vertical offset 긴 것을 사용한다
⑤ 굵은 대퇴 스템을 사용한다

Exercise # 2

▣ 문제 3. 다음과 같은 Deformity를 동반한 환자에게 Hip center of rotation을 회복하기 위한 대퇴골 부위에서의 해결방법 중 시행할 수 있는 것은?

① Large head
② Medial offset 긴 것을 이용한다
③ Anterior offset을 증가시킨다
④ Vertical offset 긴 것을 사용한다
⑤ 굵은 대퇴 스템을 사용한다

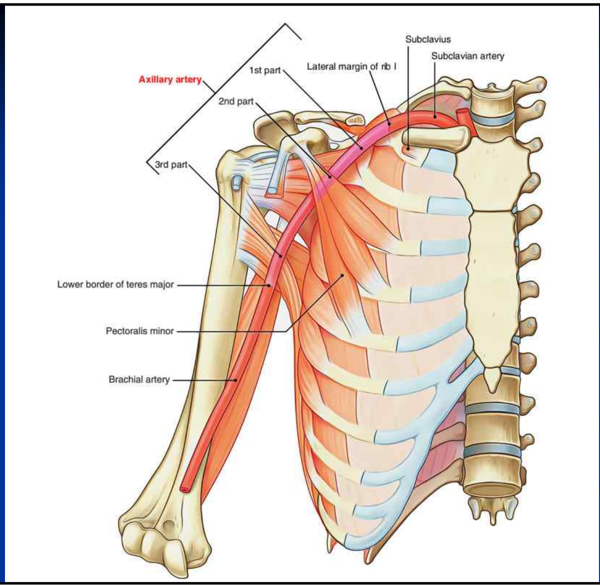
Reference

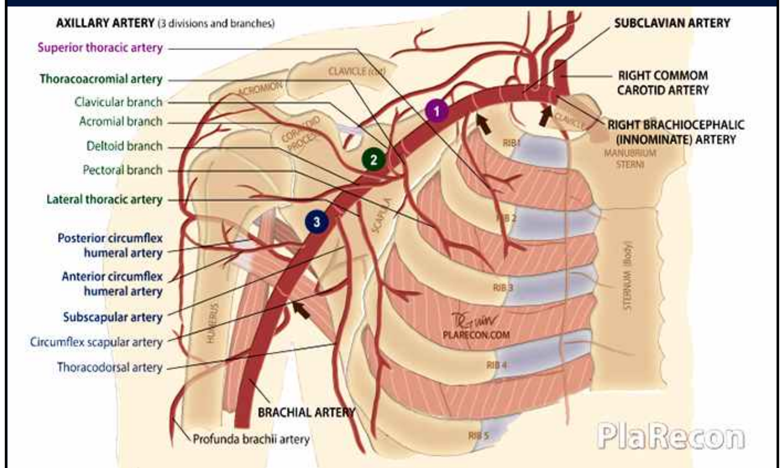
▣ Campbell
Chapter 3. Arthroplasty of the hip
P 207~228

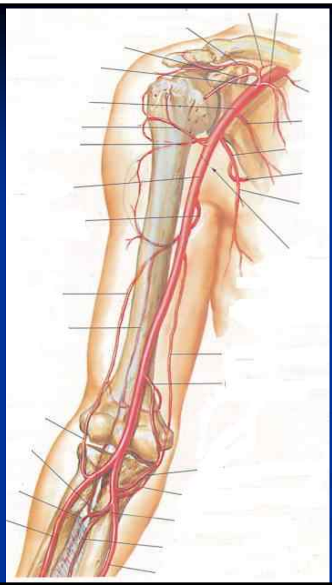
Neurovascular of Shoulder & Arm

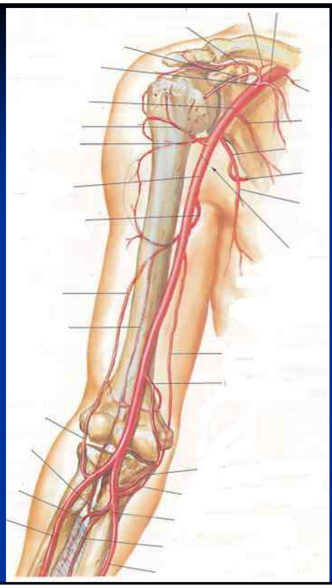
2023년 3월 12일
R2 우창우

Angiology

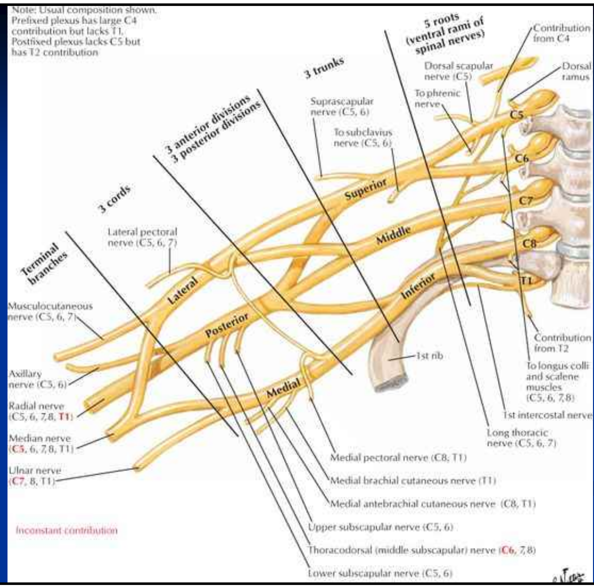




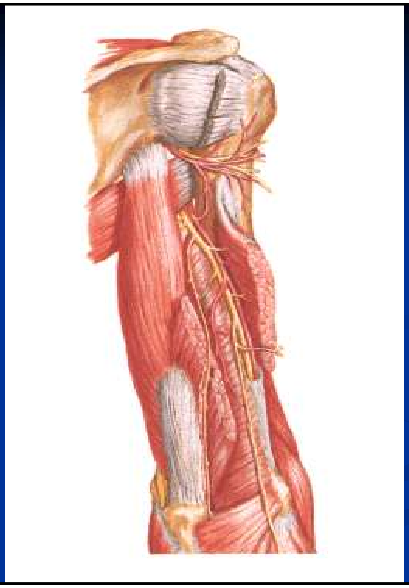


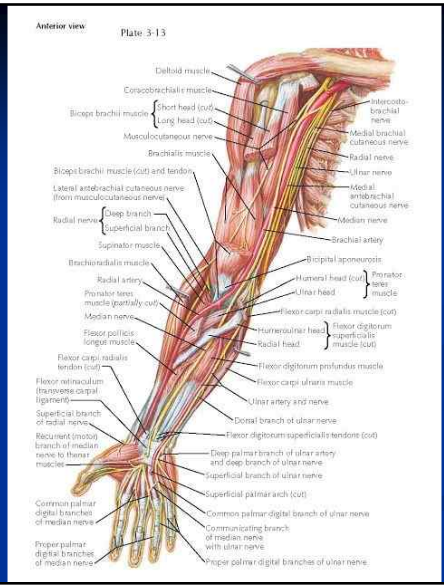


Neurology

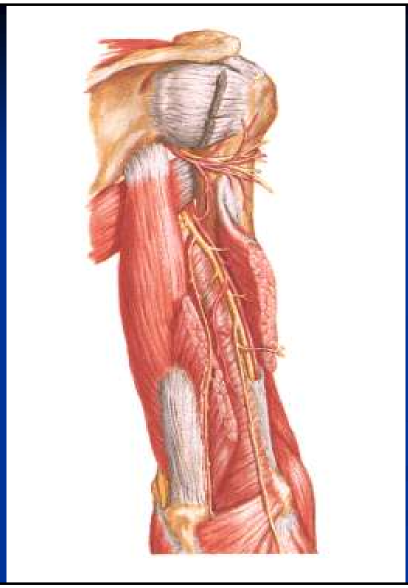


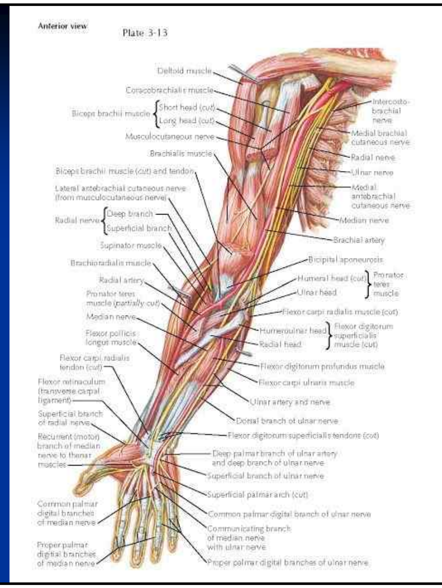
Note: Usual composition shown.
Prefixed plexus has large C4 contribution but lacks T1.
Postfixed plexus lacks C5 but has T2 contribution
5 roots (ventral rami of spinal nerves)
Contribution from C4
3 trunks
Dorsal scapular nerve (C5)
Dorsal ramus
To phrenic nerve
Suprascapular nerve (C5, 6)
To subclavius nerve (C5, 6)
3 anterior divisions
3 posterior divisions
3 cords
Lateral pectoral nerve (C5, 6, 7)
Terminal branches
Superior
Middle
Inferior
Lateral
Posterior
Medial
C5
C6
C7
C8
T1
Musculocutaneous nerve (C5, 6, 7)
Axillary nerve (C5, 6)
Radial nerve (C5, 6, 7, 8, T1)
Median nerve (C5, 6, 7, 8, T1)
Ulnar nerve (C7, 8, T1)
1st rib
Contribution from T2
To longus colli and scalene muscles (C5, 6, 7, 8)
1st intercostal nerve
Long thoracic nerve (C5, 6, 7)
Medial pectoral nerve (C8, T1)
Medial brachial cutaneous nerve (T1)
Medial antebrachial cutaneous nerve (C8, T1)
Upper subscapular nerve (C5, 6)
Thoracodorsal (middle subscapular) nerve (C6, 7, 8)
Lower subscapular nerve (C5, 6)
Inconstant contribution



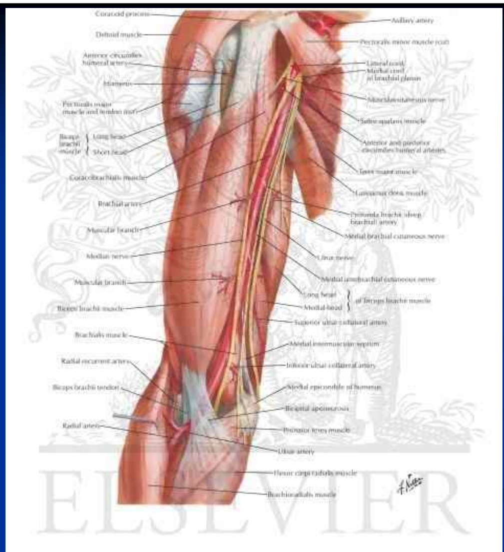


Anterior view
Plate 3-13
Deltoid muscle
Coracobrachialis muscle
Biceps brachii muscle
Short head (cut)
Long head (cut)
Musculocutaneous nerve
Brachialis muscle
Biceps brachii muscle (cut) and tendon
Lateral antebrachial cutaneous nerve (from musculocutaneous nerve)
Radial nerve
Deep branch
Superficial branch
Supinator muscle
Brachioradialis muscle
Radial artery
Pronator teres muscle (partially cut)
Median nerve
Flexor pollicis longus muscle
Flexor carpi radialis tendon (cut)
Flexor retinaculum (transverse carpal ligament)
Superficial branch of radial nerve
Recurrent (motor) branch of median nerve to thenar muscles
Common palmar digital branches of median nerve
Proper palmar digital branches of median nerve
Intercosto-brachial nerve
Medial brachial cutaneous nerve
Radial nerve
Ulnar nerve
Medial antebrachial cutaneous nerve
Median nerve
Brachial artery
Bicipital aponeurosis
Humeral head (cut)
Ulnar head
Pronator teres muscle
Flexor carpi radialis muscle (cut)
Humeroulnar head
Radial head
Flexor digitorum superficialis muscle (cut)
Flexor digitorum profundus muscle
Flexor carpi ulnaris muscle
Ulnar artery and nerve
Dorsal branch of ulnar nerve
Flexor digitorum superficialis tendons (cut)
Deep palmar branch of ulnar artery and deep branch of ulnar nerve
Superficial branch of ulnar nerve
Superficial palmar arch (cut)
Common palmar digital branch of ulnar nerve
Communicating branch of median nerve with ulnar nerve
Proper palmar digital branches of ulnar nerve





Anterior view
Plate 3-13
Deltoid muscle
Coracobrachialis muscle
Biceps brachii muscle
Short head (cut)
Long head (cut)
Musculocutaneous nerve
Brachialis muscle
Biceps brachii muscle (cut) and tendon
Lateral antebrachial cutaneous nerve (from musculocutaneous nerve)
Radial nerve
Deep branch
Superficial branch
Supinator muscle
Brachioradialis muscle
Radial artery
Pronator teres muscle (partially cut)
Median nerve
Flexor pollicis longus muscle
Flexor carpi radialis tendon (cut)
Flexor retinaculum (transverse carpal ligament)
Superficial branch of radial nerve
Recurrent (motor) branch of median nerve to thenar muscles
Common palmar digital branches of median nerve
Proper palmar digital branches of median nerve
Intercosto-brachial nerve
Medial brachial cutaneous nerve
Radial nerve
Ulnar nerve
Medial antebrachial cutaneous nerve
Median nerve
Brachial artery
Bicipital aponeurosis
Humeral head (cut)
Ulnar head
Pronator teres muscle
Flexor carpi radialis muscle (cut)
Humeroulnar head
Radial head
Flexor digitorum superficialis muscle (cut)
Flexor digitorum profundus muscle
Flexor carpi ulnaris muscle
Ulnar artery and nerve
Dorsal branch of ulnar nerve
Flexor digitorum superficialis tendons (cut)
Deep palmar branch of ulnar artery and deep branch of ulnar nerve
Superficial branch of ulnar nerve
Superficial palmar arch (cut)
Common palmar digital branch of ulnar nerve
Communicating branch of median nerve with ulnar nerve
Proper palmar digital branches of ulnar nerve



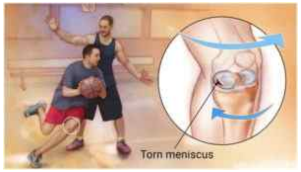
Coracoid process
Deltoid muscle
Median nerve
Radial artery
Axillary artery
Long head
Medial head
Bicipital aponeurosis
Ulnar artery

Meniscus Injury & Treatment

명지병원 정형외과
R3. 이 규 환
2023.03.13

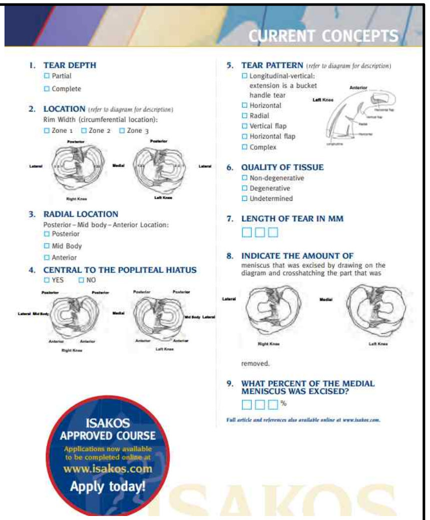
Mechanism of tear

- Most commonly torn
  - By rotation
    - Flexed knee moves toward an extended position
  - Medial meniscus (esp. MMPH)
    - Being far less mobile on tibia → can become impaled between the condyles
  - Longitudinally
- Risk factors (+) → torn by less trauma or expose meniscus to abnormal mechanics
  - Cystic formation
  - Discoid lateral meniscus
  - Aging
  - Abnormal mechanical axis
  - Ligamentous disruptions



Classification

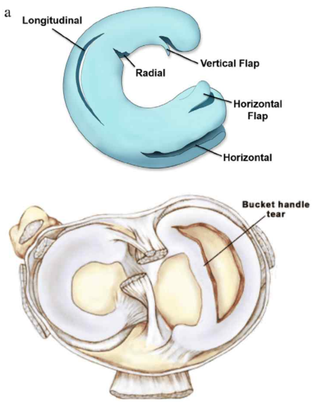
- Tear depth
- Location
- Radial location
- Central to the popliteal hiatus
- tear pattern
- quality of tissue
- length of tear in MM
- percent of MM excision


CURRENT CONCEPTS

1. TEAR DEPTH
   - ☐ Partial
   - ☐ Complete
2. LOCATION (refer to diagram for description)
   Rim Width (circumferential location):
   ☐ Zone 1 ☐ Zone 2 ☐ Zone 3
3. RADIAL LOCATION
   Posterior – Mid body – Anterior Location:
   - ☐ Posterior
   - ☐ Mid Body
   - ☐ Anterior
4. CENTRAL TO THE POPLITEAL HIATUS
   ☐ YES ☐ NO
5. TEAR PATTERN (refer to diagram for description)
   - ☐ Longitudinal-vertical: extension is a bucket handle tear
   - ☐ Horizontal
   - ☐ Radial
   - ☐ Vertical flap
   - ☐ Horizontal flap
   - ☐ Complex
6. QUALITY OF TISSUE
   - ☐ Non-degenerative
   - ☐ Degenerative
   - ☐ Undetermined
7. LENGTH OF TEAR IN MM
   ☐☐☐
8. INDICATE THE AMOUNT OF meniscus that was excised by drawing on the diagram and crosshatching the part that was removed.
9. WHAT PERCENT OF THE MEDIAL MENISCUS WAS EXCISED?
   ☐☐☐%

Full article and references also available online at www.isakos.com.

Classification



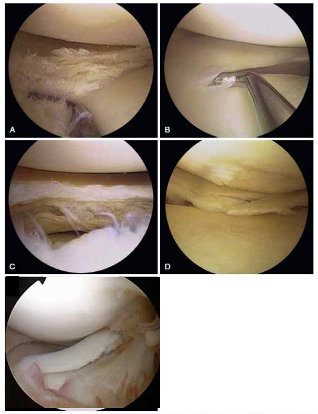


FIG 37.3 (A) Degenerative tear, (B) radial tear, (C) horizontal cleavage tear, (D) flap tear, and (E) parrot-beak tear.

Diagnosis

- Careful history taking
- Physical examination
- Radiographs

Diagnosis

- Locking (+)
  - Must compare with normal opposite knee
  - Usually occurs in longitudinal tears, much more in bucket-handle tear of medial meniscus
  - But not pathognomonic, other conditions can cause locking
    - Intra articular tumor, OCD, loose body, etc.

Diagnosis

- False locking
  - Conditions soon after an injury
  → prevents complete extension of knee
    - Hemorrhage around posterior part of capsule or collateral ligament with associated hamstring spasm
  - Aspiration & rest of short period
    - If symptoms subsided → false locking

Diagnosis

- Locking (-)
  - Difficult to diagnosis
  - Degenerative often present in pattern
  - "Giving way"
    - Distinguish other disturbance of knee
      - Ligamentous injury
      - Muscle weakness (ex. Q muscle) → feeling of instability during simple flexion of knee against resistance (walking down stairs)
    - When associated with meniscus tear in posterior part
      - Noticeable in rotary movements of the knee
      - Feeling of subluxation

Diagnosis

- Locking (-)
  - "Effusion": indicates that something is irritating the synovium
    - Hemarthrosis
      - Sudden onset of effusion
      - When vascularized periphery of meniscus is torn
    - Non-bloody effusion
      - Body of meniscus or degenerative area
      - Chronic synovitis (repeated irritation of synovium by pedunculated meniscus)

Diagnosis

- Locking (-)
  - "Atrophy of musculatures around the knee"
    - Vastus medialis especially
    - Suggest recurring disability of the knee but does not indicate its cause
  - "medial or lateral joint line tenderness"
    - Most common in posteromedial or posterolateral portion
    - Meniscus itself is without nerve fiber except periphery
      → Pain is related with synovitis in the adjacent capsular and synovial tissues

Diagnosis

- McMurray test : supine & knee flexed forcibly / "Click"
  - Medial meniscus
    - Palpating posteromedial margins of joint
    - Keep the knee flexed → External rotation fully → slowly extend the knee
  - Lateral meniscus
    - Palpating posterolateral margins of joint
    - Keep the knee flexed → Internal rotation fully → slowly extend the knee

Diagnosis

- Apley grinding test : prone & 90' knee flexion / anterior thigh is fixed against table
  - Leg & foot are pressed downward & rotate as the joint is slowly flexed and extended → torn meniscus make popping sound or pain
  - Leg & foot are pulled upward & rotate → place rotational strain on the ligaments → torn ligament become painful

FIG. 5
The distraction test

FIG. 6
The grinding test

Diagnosis

- Squat test
  - Repetitions of a full squat with feet & legs alternately fully internally and externally rotated.
    - Pain in the external rotation → medial meniscus injury
    - Pain in the internal rotation → lateral meniscus injury

Imaging studies

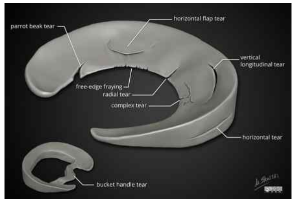
- Radiography
  - Will not confirm diagnosis of torn meniscus → but essential to exclude
    - Osteocartilaginous loose bodies, OCD, etc.
- Arthrography
  - Good diagnostic procedure
  - But with improvements in CT and MRI scanning, arthrography is rarely used.
- Other diagnostic studies
  - CT, MRI, bone scan, ultrasonography, etc.
  - Although MRI appears to be efficient in detecting meniscal tears, it has not been shown to be effective in predicting the reparability of such tears.
- Arthroscopy

Treatment

- Non-operative management
  - Incomplete tears or small peripheral tears are difficult to confirm without arthroscopy
  - Many incomplete tears will not progress to complete tears if the knee is stable
  - Small stable peripheral tears have been observed to heal after 3 to 6 weeks of protection
  - Many undiagnosed small peripheral tears in vascularized zone → heal without surgical treatment
  - Untreated meniscal tear (even minor radial tears) → had evidence of development of osteoarthritis

Treatment

- Non-operative management
  - Stable vertical longitudinal tears
    - Tend to occur in peripheral vascular portions of the menisci → heal without operative treatment
    - Involving the body of the meniscus was classified as stable
      - Portion is central to the tear
      - Could not be displaced more than 3mm from the intact peripheral rim
    - Most tears ≤ 1cm
    - All partial-thickness tears were classified as stable



Treatment

- Non-operative management
  - Chronic tears with superimposed acute injury
    - Cannot be expected to heal with non-operative treatment
    - Patients with symptoms → need operative treatment

Treatment

- Non-operative management
  - Cylinder leg cast or knee immobilizer for 4-6weeks
    - Crutch gaiting with touch-down weight bearing
    - Progressive isometric exercise with cast or immobilizer
    - Hamstrings, quadriceps, gastrocnemius, soleus muscles around knee
  - Most important aspect of non-operative treatment → restoration of the power of the muscles around the injured knee to a level of opposite knee

Treatment

- Operative management
  - Justification of total meniscectomy was based on short term functional recovery criteria
    - With long term f/u, increasing degenerative changes were noted (esp. after total meniscectomy)
  - The greatest degenerative changes occur after total rather than subtotal meniscectomy
    - The amount is directly proportional to the amount of meniscus removed
      - Long term degenerative change < present discomfort

Treatment

- Operative management
  - Significant portion of the peripheral rim can be retained by subtotal meniscal excision → long-term result is improved
  - Complete removal of the meniscus is justified only when it is irreparably torn & meniscal rim should be preserved if at all possible
    - Total meniscectomy is no longer considered the treatment of choice in young athletes requiring vigorous use of the knee.

Treatment

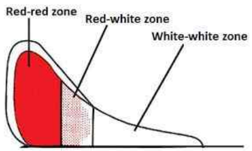
- 3 important steps
  - Appropriate patient selection
    - m/c single vertical longitudinal tear in outer 1/3
  - Tear debridement and local synovial, meniscal, and capsular abrasion
    - Stimulate proliferative fibroblastic healing response
  - Suture placement to reduce and stabilize meniscus

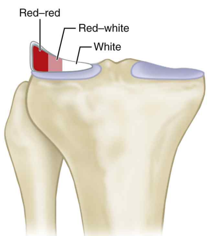
Treatment

- M/C accepted criteria for meniscal repair
  - Complete vertical longitudinal tear longer than 10mm in length
  - Tear within peripheral 10% -30% of meniscus or within 3 or 4 mm of the meniscocapsular junction
  - Peripheral tear, can be displaced toward center of the plateau by probing
  - Absence of secondary degeneration or deformity
  - Tear in active patient

Treatment

- Operative management
  - Meniscus repair
    - Tears in periphery and vascularized zone heal when sutured and protected
    - Ideal indication
      - Acute, 1-2cm, longitudinal, peripheral tear (repaired in conjunction with ACL)
    - According to vascularized zone



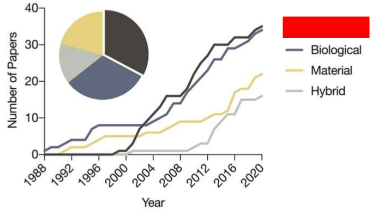


Treatment

- Operative management
  - 10-15% of meniscal tear can be repaired
  - Positive correlations with healing
    - Narrowed peripheral meniscal rim (<4mm)
    - Repair done within 8 weeks of injury
    - Fibrin clot – reported to increase the healing rate

Treatment

- Operative management
  - Repair technique
    - Inside-out repair
    - Outside-in repair
    - All-inside repair
  - Develop of suture fixators
    - Hybrid repair



BOX 51-1

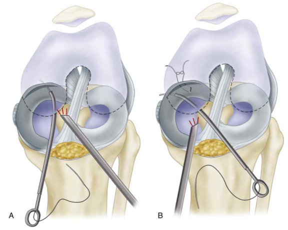
Repair Techniques and Indications

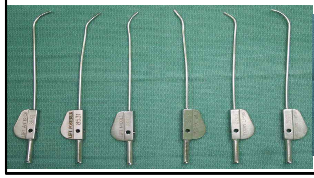
Outside-in sutures	Anterior horn tears, midthird tears, radial tears, complex tears, reduction of bucket-handle tears
Inside-out sutures	Posterior horn tears, midthird tears, displaced bucket-handle tears, peripheral capsular tears, meniscal allografts
Fixator implants	Posterior horn tears, tears with > 2- to 3-mm rim width, vertical/longitudinal tears, midthird tears, radial tears

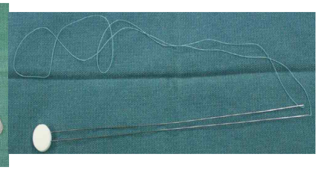
Modified from Sgaglione NA: Instructional course 206. The biological treatment of focal articular cartilage lesions in the knee: future trends? Arthroscopy 19:154, 2003.

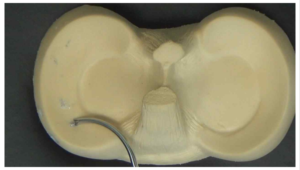
Treatment

- Inside-to-outside technique
  - Pass the cannula of the suturing instrumentation
  - Each meniscus
    - three zone : anterior, middle, posterior
    - each zone specific cannula
      - Major curve to the Rt. or Lt.
        (Linvatec, Inc., Largo, Florida)



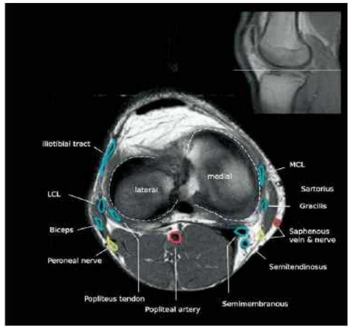






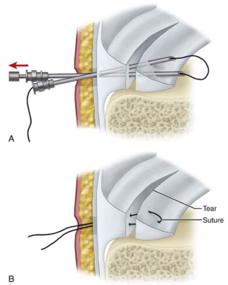
Treatment

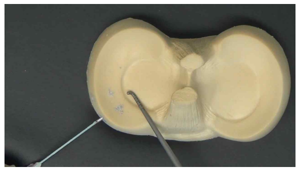
- Posteromedial or posterolateral
  - Neurovascular bundle injury
  - Lateral : common peroneal nerve
    - Suture : 90 degree flexion
      or figure of 4
  - Medial : saphenous nerve
    - Suture : 10-15 degree flexion
  - Post : popliteal vessels



Treatment

- Outside-to-inside technique
  - Spinal needle insertion
  - Wire loop
    - retrieve the first suture and pull it back through the meniscus, a mattress repair





Treatment

- All-inside technique
  - Easy & rapid

Treatment

(A)

(B)

	Radial	Vertical	Horizontal	Ramp	Root	Comment
Inside-Out	Used as hybrid or augment	Gold Standard	Ideal	Gold Standard	Used as hybrid or augment in root repair	Used as hybrid or augment in root repair
All-Inside	Not suitable	Very Common	Acceptable	Used with Posteromedial portal	Not suitable	Higher risk of complication
Outside-In	Acceptable	Acceptable	Acceptable	Risk of neurovascular injury	Not suitable	Useful for Anterior Horn tears
Transtibial Pull-out	Used as hybrid or augment	Not suitable	Not suitable	Not suitable	Gold Standard	Used with Inside-out suturing for radial, root tears

Treatment

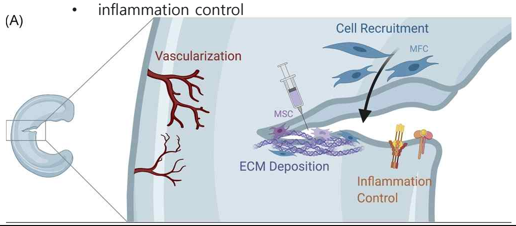
- Biological augmentation of meniscal repair
  - Desire to preserve meniscal tissue
  - Efforts to extend region of viable meniscal repair to the center

  - fibrin clots
  - platelet-rich plasma (PRP)
  - mesenchymal stem cells (MSCs)

Treatment

- Sonia bansal et al.(2021)
- 4 biologic-based functions
  - enhance the various stages of meniscal repair
    - cell recruitment
    - vascularization
    - matrix deposition
    - inflammation control

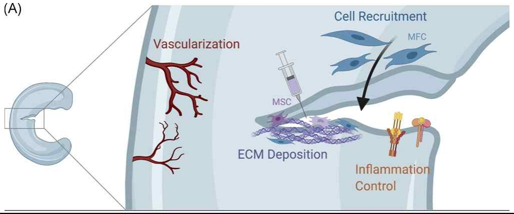
(A)



Treatment

- Cell recruitment
  - d/t relatively avascular and acellular nature of the meniscus
    - bone-marrow
    - adipose-derived MSCs
    - synovial stem cells,
    - blood vessel-derived stem cells
    - chondrocytes

(A)

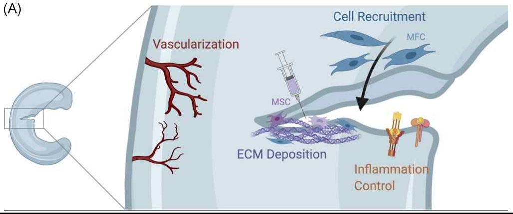


Treatment

- Vascularization
  - differences in regional vascularity
  - radial perforation → insignificant improvement
  - the outer 1/3 vascularized meniscus contains blood-vessel derived stem cells (CD34+, CD146+)

  → enhanced avascular tear repair in a rat model

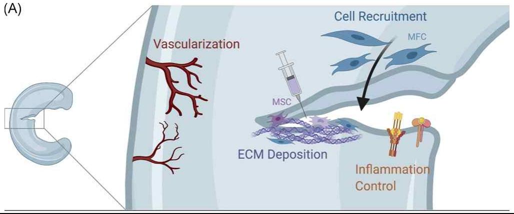
(A)



Treatment

- matrix deposition
  - the factor most utilized in meniscus regeneration is transforming growth factor β3 (TGF-β3)
    - increased both collagen and PG production and integration strength between two edges of a meniscus tear in vivo

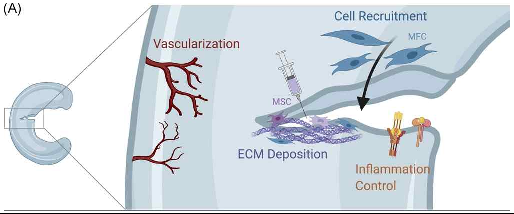
(A)



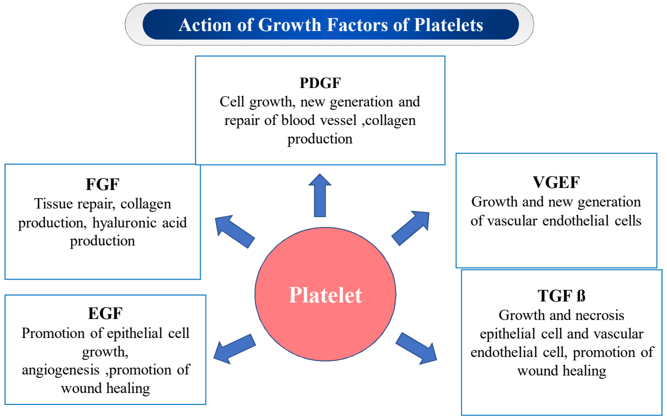
Treatment

- inflammation control
  - if not harnessed to augment the repair, will likely inhibit the regenerative process

(A)



Treatment



Pereira et al., Arthroscopy, 2011

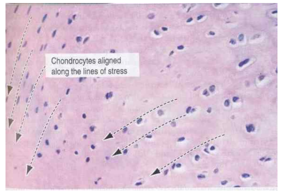
Treatment

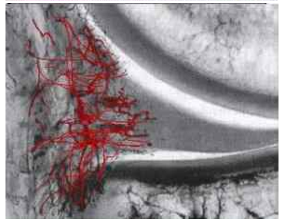
- **Fibrin clot formation**

→ proliferation of vessels from peri meniscal capillary plexus

→ differentiation of mesenchymal cells

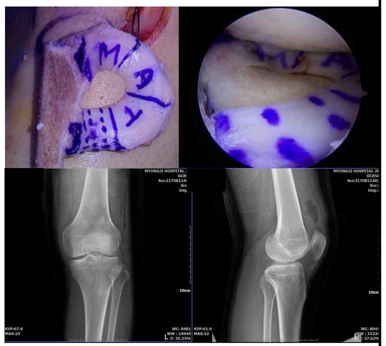
→ cellular fibrovascular scar tissue formation





Treatment

- Meniscus allograft transplantation
  - To resolve dilemmas that young, active, healthy individual with an arthritic knee who is not a candidate for TKA.
  - Short ~ medium term success
    - Pain relief, improved function, peripheral healing of the graft
  - Long term success
    - Prevention of arthritic change



Treatment

- Meniscus allograft transplantation Ix.
  - Previous subtotal or total meniscectomy
  - <50yrs (<40yrs for ideal)
  - Tibiofemoral localized symptom
  - Normal mechanical alignment
  - Stable knee
  - Articular cartilage defect : OB I~II
  - Joint space ≥ 2mm (standing 45' PA view)


Meniscal Displacement and Loss of Load-Transmission Function After Radial Tear of the Lateral Meniscus in a Porcine Model

New Insights Into the Functional Dynamics of the Injured Meniscus

Takehito Hirose,*† MD, Tatsuo Mae,‡ MD, PhD, Issei Ogasawara,§ PhD, Satoshi Yamakawa,‡ PhD, Ken Nakata,§ MD, PhD, Tomoki Ohori,† MD, PhD, Akira Tsujii,† MD, PhD, and Seiji Okada,† MD, PhD
Investigation performed at Osaka University, Osaka, Japan

- AJSM 2022

- On injury, the meniscus often becomes displaced from its physiological position and extrudes from the tibial plateau

→ meniscal extrusion/translation can be one of the features of a torn meniscus on MRI

- Any relationship between meniscal displacement and the degree of meniscal tear or load-transmission function of the LM remains unclear

- If the relationship between the dynamics and function of the injured LM in knees, it would become easier for clinicians to understand the meniscal functional state before and after treatment

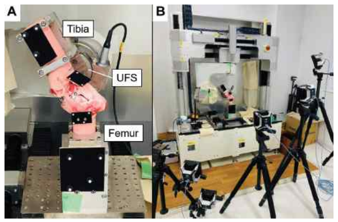
→ would help in decision making for meniscal repair, especially in young and athletes

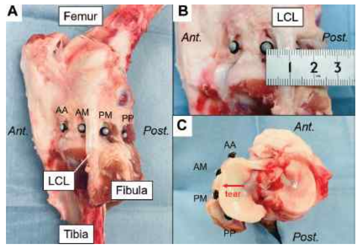
---

- This study
  - to clarify the relationship between the width of the radial tear of the LM
  - (1) the meniscal displacement
  - (2) the resultant force through the meniscus under axial compressive load
    (represents a force carried only by the meniscus in response to the load applied to the whole knee)

- Hypothesis
  - the greater the radial tear, the greater the displacement of the LM and the lower the resultant force through the meniscus

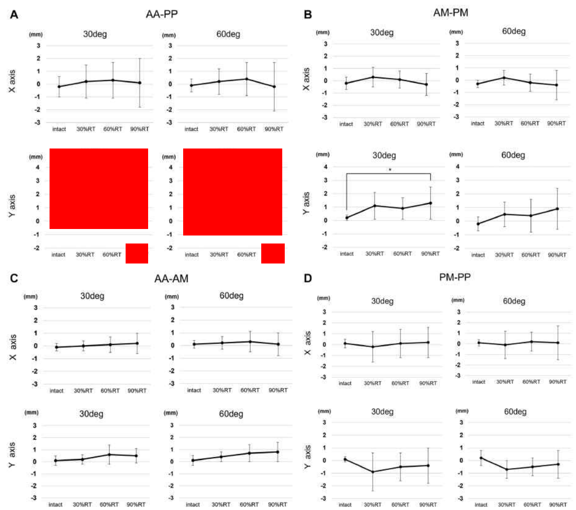
---





- Meniscus radial tear intact / 30% / 60% / 90%
- Knee flexion 30′ / 60′

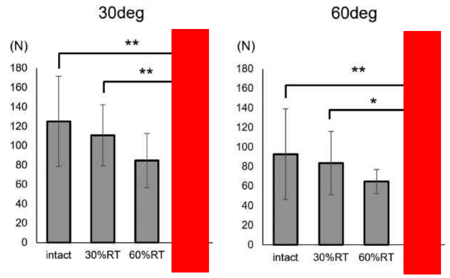
- Meniscal displacement
- Resultant force through the meniscus



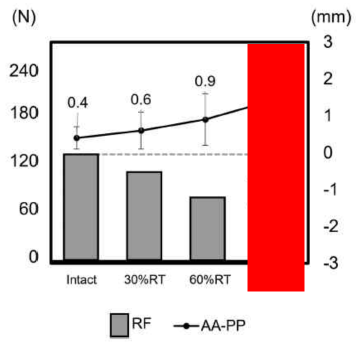
- Meniscal displacement

x axis – ML direction

y axis – AP direction



- Resultant force through LM



- Previous study
  - complete tear in LM causes a large lateral displacement under loading, resulting in a decrease in the load concentrated in the meniscal region and an increase of the joint pressure
  - the relationship between the amount of meniscal displacement in knees with an incomplete radial tear of the LM and the load-transmission function of the meniscus was unclear

- This study
  - increased significantly in LMs with a radial tear involving 90% of their width
  - the greater the radial tear, the greater the displacement of the meniscus and the lower the resultant force through the meniscus

- LM with a 90% radial tear was axially loaded
  - a significant movement of 1.4 mm and a reduction of approximately 60% in the resultant force

→ even 1 mm of displacement in the acute phase after meniscal injury suggests that the load sharing of the meniscus is greatly impaired

→ If torn LM is diagnosed, meniscal repair surgery should be considered

- Torn LM without displacement, the degree of radial tear would be small, and the loss of load transmission function might not be as great

→ it may be possible to leave the meniscal tear unrepaired

What Is the Relationship Between the Distal Semimembranosus Tendon and the Medial Meniscus?

A Gross and Microscopic Analysis From the SANTI Study Group

Etienne Cavaignac,*†‡§ MD, PhD, Rémi Sylvie,† MD, Maxime Teulières,† MD, Andrea Fernandez,|| MD, Karl-Heinz Frosch,¶ MD, PhD, Anne Gomez-Brouchet,# MD, PhD, and Bertrand Sonnery-Cottet,** MD
Investigation performed at CHU Toulouse, Toulouse, France

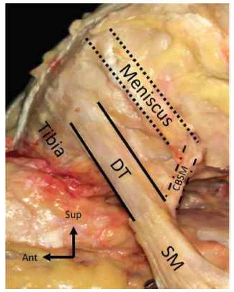
- AJSM 2020

- Some authors
  - the semimembranosus tendon and its distal capsular insertion adjacent to the posterior meniscocapsular region

- Hughston et al.
  - contraction of the semimembranosus in response to excessive anterior tibial subluxation secondary to rupture of the ACL

  → put the posteriomedial capsule under tension while the meniscus was trapped between the femur and the tibia

  → leading to a meniscocapsular ligament (MCL) and/or MTL tear.



- Semimembranosus
  - origin - ischial tuberosity of the pelvis
  - insertion - many anatomic descriptions

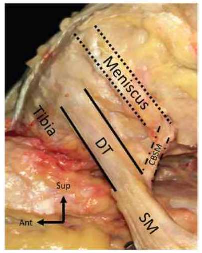
  - The direct tendon (DT) is always found (posteromedial corner of the upper end of the tibia)

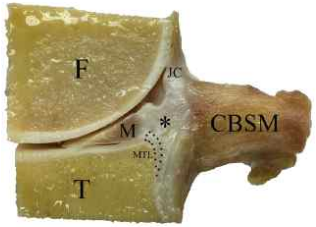
  - Multiple additional branches have been described but are still being debated

  - 1 of these branches is closely attached to the posterior capsule and the medial meniscus

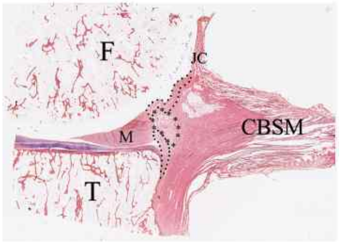
  → its potential role in the mechanism of ramp lesions when the semimembranosus contracts secondary to ACL rupture

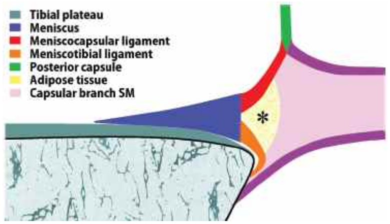
- DePhillipo et al and Greif et al
  - a common insertion of the MTL and MCL on the posterior surface of the meniscus
  - doing routine repair of ramp lesions support the MTL being located on the posteroinferior edge of the medial meniscus
- This study
  - Histological nature of the posterior horn of the medial meniscus and structures inserted on it
  - Cadaveric study
- Hypothesis
  - (1) the semimembranosus tendon has a tendinous branch inserting into the posterior horn of the medial meniscus
  - (2) the MTL is inserted on the posteroinferior edge of the medial meniscus





- Gross exam
- a direct branch of the semimembranosus tendon (DT) and a branch ending behind the posterior horn of the medial meniscus: the capsular branch (CBSM) in all case
- MTL inserted on the inferior part of the medial meniscus, specifically on the posteroinferior edge
- MCL, inserted in all cases on the posterosuperior edge of the medial meniscus





- Microscopic exam
- CBSM were in fact tendinous, but they were less dense and less well-organized than were the DT fibers inserted in the tibia
- MTL(inf.) & MCL(sup.) inserted directly on the base of the medial meniscus
- a particularly well-vascularized area of adipose tissue in behind MMPH and front of CBSM

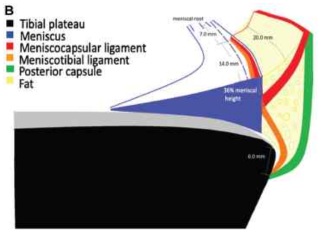
- This study
  - branch protruding from the tendon of the semimembranosus muscle to the posteromedial joint capsule facing the posterior horn of the medial meniscus
  - actual posterior displacement of the posteromedial joint capsule while exerting traction in the axis of the semimembranosus muscle

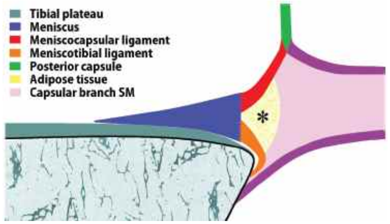
  → in line with previous study
- no tendinous fibers inserting directly into the meniscal tissue of the posterior horn of the medial meniscus

→ posterior traction of the medial meniscus is not transmitted directly by the semimembranosus tendon but through the capsular tissue and an abundantly vascularized intermediary tissue (adipose tissue)

→ a good potential for spontaneous healing

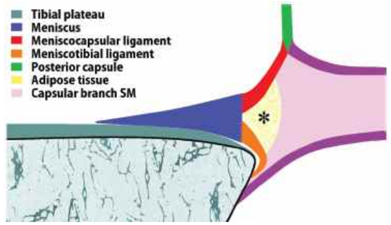
→ explain the low failure rate of ramp lesion repairs





- Previous study (DePhillipo et al and Greif et al)
  - the MTL is shown as inserting on the posterior surface of the meniscus, leaving the posteroinferior edge of the medial meniscus free
  - a common attachment of the MCL and MTL on the posterior horn of the medial meniscus
- This study
  - found the MTL clearly inserted on the posteroinferior edge
  - 2 separate attachments on the posteroinferior edge (for the MTL) and the posterosuperior edge (for the MCL)

  → totally independent and did not share the same attachment



- Clinical implications
  - ramp repair techniques that utilize a horizontal trajectory (eg, all-inside suture devices) cannot anatomically re-create the MTL because they are unable to capture the tibial stump
  - To anatomically repair the MTL, the technique must capture the MTL stump and the meniscus (eg, suture hook repair).

- In the presence of a ramp lesion, isolated ACL repair does not restore normal knee kinematics, and residual laxity persists
- repairing these ramp lesions (in addition to ACL reconstruction) seems to eliminate this residual pathologic instability
- The semimembranosus seems to have an active role in posteromedial stability
- To restore anatomy, it is mandatory to re-establish MTL continuity in ramp repairs

Reference

- Campbell's orthopedic surgery. Chapter 45 Knee Injuries. P. 2144-2153
- Etienne Cavaignac et al. *What Is the Relationship Between the Distal Semimembranosus Tendon and the Medial Meniscus?* Am J Sports Med 2021;49(2):459-466
- Takehito Hirose et al. *Meniscal Displacement and Loss of Load-Transmission Function After Radial Tear of the Lateral Meniscus in a Porcine Model*, Am J Sports Med 2022;50(7):1850–1857

2023 Anatomy Seminar

NECK & PECTORAL REGION

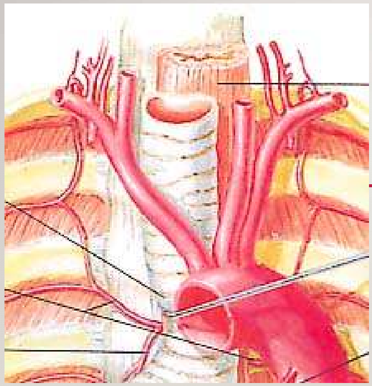
ANGIOLOGY & NEUROLOGY

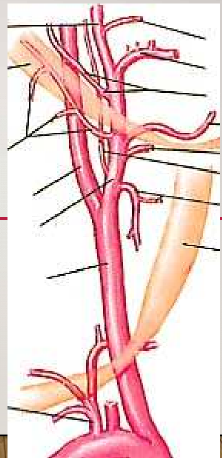
2023.03.15

R2 김 수 영

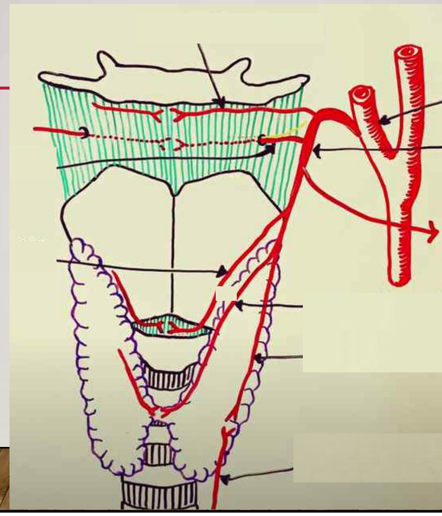
ANGIOLOGY

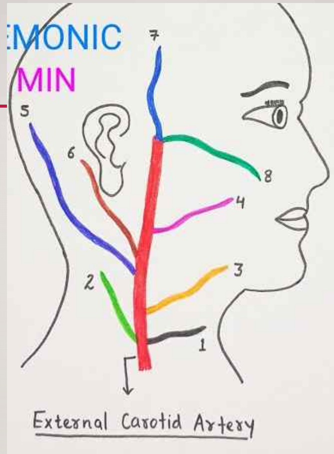
CAROTID ARTERY



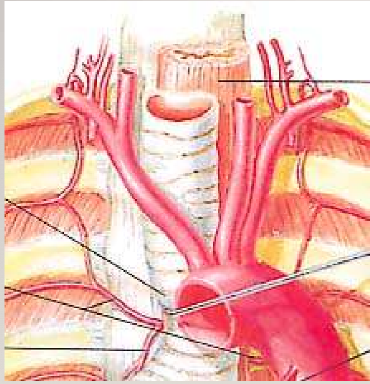


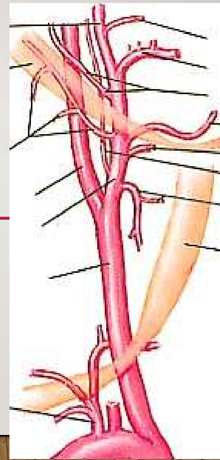
Superior thyroid artery



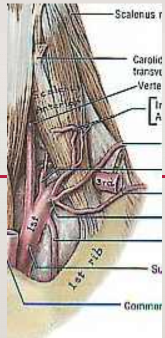


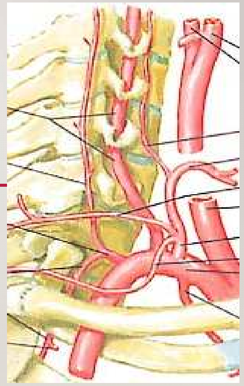
CAROTID ARTERY



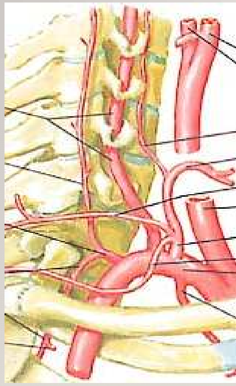


SUBCLAVIAN ARTERY

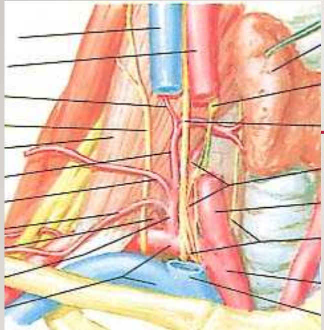




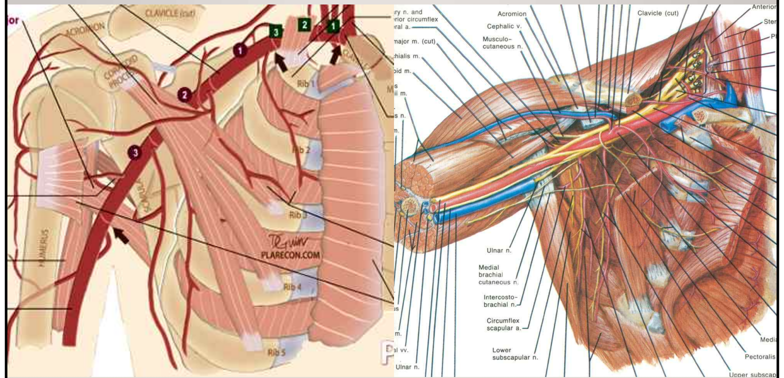
VERTEBRAL ARTERY



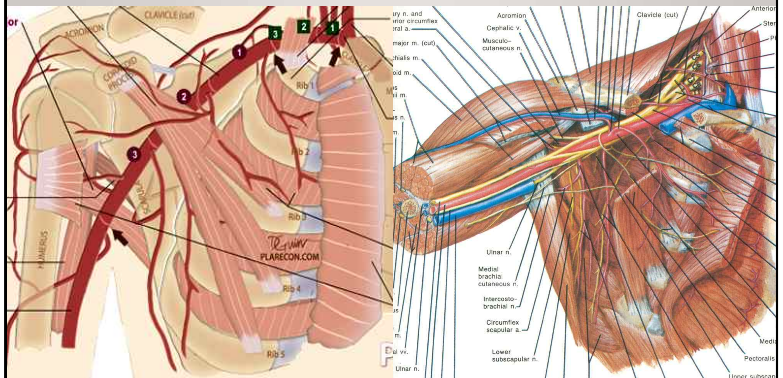
THYROCERVICAL TRUNK & OTHER BRANCH



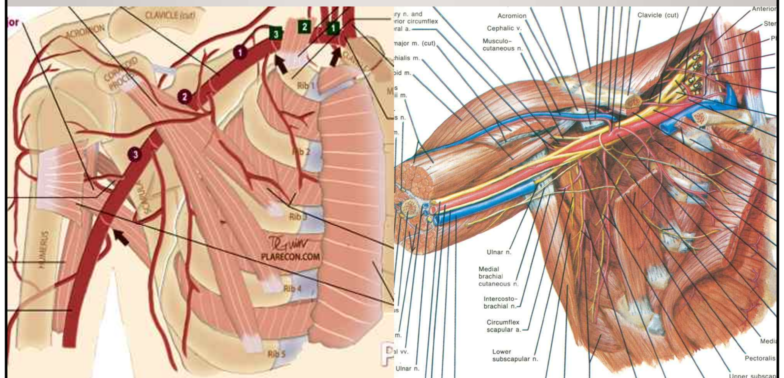
AXILLARY ARTERY



AXILLARY ARTERY

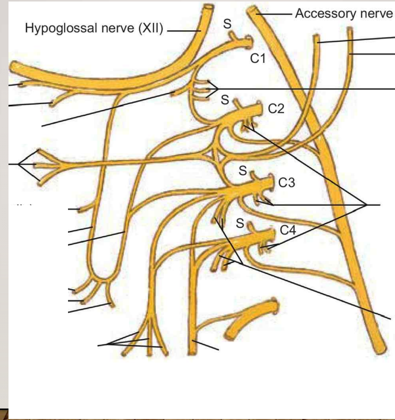


AXILLARY ARTERY

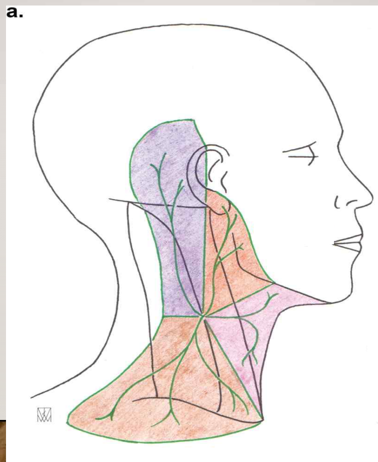


NEUROLOGY

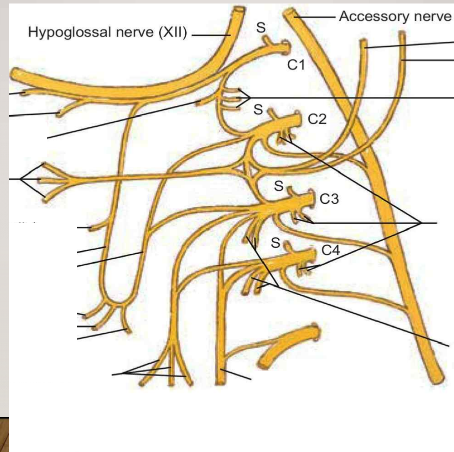
CERVICAL PLEXUS



CERVICAL PLEXUS



CERVICAL PLEXUS



Infections of the Spine

명지병원 정형외과
R3. 이규환

Infections of the Spine

- 3% to 5% of all osteomyelitis, relatively uncommon
- no pathognomonic clinical signs or definitive laboratory tests
- categorized into different groups based on location, transmission, pathogen
- Location
  - vertebral body
  - disc space
  - paraspinal region
  - epidural space

Infections of the Spine

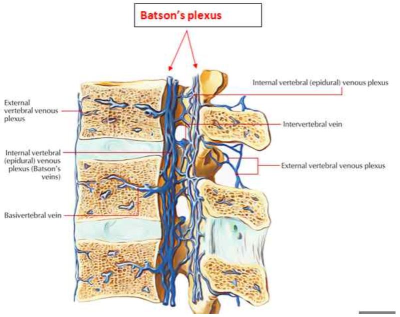
- Transmission
  - hematogenous seeding
  - contiguous spread
  - direct inoculation
- Pathogen
  - Staphylococcus aureus(m/c)
  - gram negative
  - fungal
  - acid-fast

Spinal anatomy

- Coventry et al. in 1945
  - adults(>30) : there is no direct vascular supply to the disc
  - multiple openings in the end plates of the vertebral bodies
    → allow for the transport of nutrients through the end plates into the central portion of the adult disc
- Microvasculature of the vertebral bony end plates oriented obliquely
  - the circumferential vessels fed from the arterial plexus outside the perichondrium
  - nearby metaphyseal marrow vessels
- The perforations in the cartilaginous end plates of the disc may allow the ingress of bacterial or fungal pathogens into the disc
- Hematogenous spread of infection is more commonly arterial than venous

Spinal anatomy

- Batson's plexus
  - pelvic veins drains into the spinal venous plexus
  - frequent metastasis of tumor & infection to spine



Epidemiology

- Pyogenic osteomyelitis & discitis
  - 3% to 5% of all cases of pyogenic osteomyelitis
  - bimodal age distribution - small peak in childhood & larger spike in 50
  - Male > Female
  - Lumbar (50%~60%) > thoracic (30%~40%) > cervical (10%)
  - More higher, more likely to present with neurologic deficit
  - S. aureus (m/c, 65%)
  - Hematogenous spread

  → originate from urinary tract, respiratory tract, soft tissue

Clinical presentation

- back pain & neck pain
  - not pathognomonic → delay in diagnosis
  - intensity varies from mild to extreme
- Fever
  - not severe
- Localized tenderness
- Kernig sign (+)
  - severe tightness of the hamstring
- Generalized weakness
- Neurologic sign
  - the possibility of neural compression from abscess formation, bone collapse, or direct neural infection
  - progress rapidly unless active decompression or drainage is undertaken

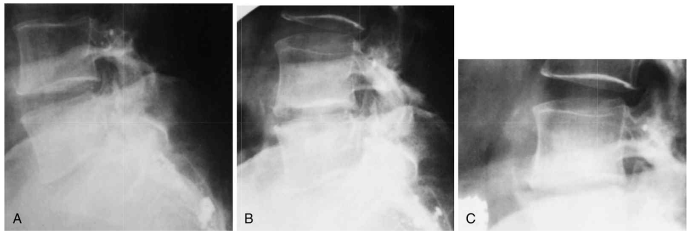
Lab

- ESR
  - not diagnostic and indicates only an inflammatory process
  - Post OP - peaking at 5 days but may stay elevated for 4 weeks
  - Persistent elevation at 4 weeks after surgery+ associated clinical findings

  → indicates the presence of infection
- CRP
  - more sensitive marker for early detection of postoperative spine infections than ESR
  - peak within the first 2 postoperative days and then decline rapidly
  - continued elevation of the CRP in POD 4 to 7 days or a second rise is a strong indicator of an infection
- PCT
  - More recently useful marker for infection generally
  - Aljabi et al. → more sensitive and specific infection marker than CRP
- Leukocytosis
  - not especially helpful in diagnosing spinal infection

Image

- Plain radiograph
  - appear 2 weeks to 3 months after the onset of the infection
  - disc space narrowing
  - vertebral end plate irregularity
  - loss of the normal contour of the end plate
  - defects in the subchondral portion of the end plate
  - hypertrophic (sclerotic) bone formation



Image

- CT
  - identify paravertebral soft-tissue swelling and abscesses much more readily
  - can monitor changes in the size of the spinal canal
  - Finding
    - lytic defects in the subchondral bone
    - destruction of the end plate with irregularity or multiple holes visible in the cross-sectional views sclerosis near the lytic irregularities
    - hypodensity of the disc
    - flattening of the disc itself
    - disruption of the circumferential bone near the periphery of the disc
    - soft-tissue density in the epidural and paraspinal regions

Image

- MRI
  - diagnosis of choice for identifying spinal infection (sensitivity & specificity ↑)
  - not differentiate between pyogenic and non-pyogenic infections

  - T1-weighted images
    - a decreased signal intensity in the vertebral bodies and disc spaces
  - T2-weighted images
    - the signal intensity is increased in the vertebral disc and is markedly increased in the vertebral body
  - Diffusion-weighted imaging(DWI)
    - used to characterize fluid collections to differentiate spondylodiscitis from benign reactive marrow changes

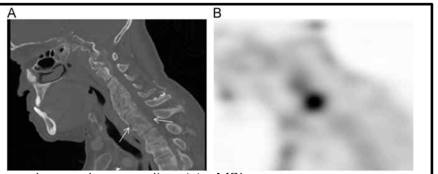
Image

- f/u MRI
  - to follow the response to treatment of spine infections may not be clinically useful
  - bony findings of vertebral body enhancement, marrow edema, and compression fractures often appeared unchanged or worse in the setting of clinical improvement

  → serial MRI should be used to monitor soft-tissue findings not bony findings

  - the clinical findings (decreased pain and improved neurologic function) seem to be better indicators than an improvement seen on MRI

Image



- Radionuclide Scanning
  - relatively effective in identifying spinal infection and can be used as an adjunct to MRI
  - The 99mTc bone scan
    - three basic phases: angiogram, blood pool images, and delayed static images
    - In infection, diffuse increased activity is seen on the blood pool images
  - The 67Ga scan
    - alone are not as accurate as the combination of 99mTc scan and a 67Ga scan for identifying infection
  - 111In WBC
    - useful in detecting abscesses but it is not reliable in acute infections
    - differentiates between noninfectious lesions, such as hematomas or seromas and true infection, all which may appear as a mass or an abscess-like cavity on MRI or CT

Image

- Diagnostic biopsy
  - the best method of determining infection and identifying the causative agent so that appropriate antibiotics can be administered
  - guidelines recommend withholding antibiotics in hemodynamically stable patients without neurologic deficits until after biopsy is done
  - Administration of antibiotics before biopsy, inadequate biopsy, or the elapse of a long period between the onset of the disease and the biopsy may result in a negative biopsy
  - Negative results from percutaneous biopsy should not preclude open biopsy if there is good clinical evidence of infection

Non-operative Tx.

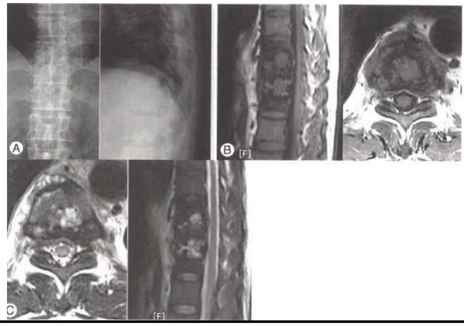
- Antibiotic treatment
  - primary therapy in adults
  - evaluated by observing clinical symptoms and serially following CRP levels and PCT levels
  - Failure of antibiotic therapy suggests the presence of a multi-organism infection
    - repeat biopsy, including open biopsy, should be considered
    - surgical debridement of sequestered bone and abscess drainage
  - Intravenous antibiotics usually are continued for about 6 weeks and are followed by oral antibiotics as indicated by the CRP, ESR, and clinical response

Operative Tx.

- Surgical intervention Ix.
  - medical management(antibiotics) has failed
  - neurologic deficit from either an abscess
  - instability with deformity
- In neurologic Sx.
  - Decompression & anterior spinal fusion through ant. approach
    → d/t vertebral osteomyelitis & discitis affect ant. column
  - DO not Post. decompression through post. approach by laminectomy
    → d/t paralysis worsening & lead to instability
  - In recent, ant. interbody fusion & post. instrumentation d/t prevention of kyphosis and early rehabilitation

문제 1.

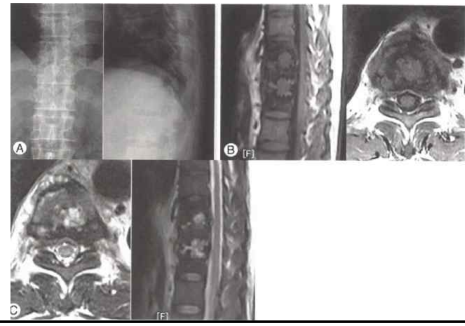
- 59세 남자환자 2개월 전부터 지속되는 배부통으로 내원하였으며 과거력상 2년 전부터 전신에 70%의 화상으로 치료받은 기왕력이 있었다. 혈액검사상 WBC, ESR, CRP 증가 소견을 보였고 영상소견이 다음과 같을때 진단은?



문제 1.

- 59세 남자환자 2개월 전부터 지속되는 배부통으로 내원하였으며 과거력상 2년 전부터 전신에 70%의 화상으로 치료받은 기왕력이 있었다. 혈액검사상 WBC, ESR, CRP 증가 소견을 보였고 영상소견이 다음과 같을때 진단은?

- Pyogenic osteomyelitis



Tubercular spinal infection

정형외과
R1.김현진

Introduction

- Mycobacterium tuberculosis - 2% to 3%
- Bone and joint infection – 1/3~1/2
- Most commonly infected area – Thoracolumbar spine
- Incidence of infection – Increase with age
- Paralysis is common when the upper and middle portions of the thoracic spine(T4-9) "Pott's paraplegia"

X-ray findings

- Early
  - subtle decrease in one or more disc spa
- Late
  - Vertebral collapse 'concertina collapse'
  - soft tissue swelling & late calcification

CT & MRI findings

- MRI i choice for h contrast being
  - T1
  - T2
- The p ons are typ nscribed, with well-define rgins

Pyogenic vs Tuberculous infection

	Pyogenic	Tuberculous
Progression	Rapid	Slow
Disc involvement	Usually involved (early and rapid loss)	Sparing (later and slowly)
Posterior element involve	rare	Relatively common
Multi-segment involve	rare	common
calcification	-	+
Sclerotic reactive bone formation	common	later and less marked
fever	+	+-
subligamentous spreading	rare	common

Tb medical treatment

- A 9month treatment with a combination of INH, RFP, and EMB
- Treatment response is evaluated using ESR and CRP
- Event of primary drug-resistant tuberculosis, secondary drugs such as ethionamide, cycloserine, kanamycin, capreomycin, and para-aminosalicylic acid may be used as second-line

Indication of surgical treatment

- Severe kyphosis with active disease
- Sign & Sx of cord compression
- Progressive impairment of pulmonary function
- Progression of kyphotic deformity
- Resistance to chemotherapy & recurrence of the disease

Surgical treatment principles

- Adult
  - I&D + Anterior fusion
- Pediatric
  - I&D + Anterior and Posterior fusion
    - Anterior - posterior fusion indication
      - Around 10 years old
      - 60-70° Kyphosis
      - Transitional level like C-T, T-L

Pott's paraplegia (T4-T9)

- Tuberculous paraplegia

- Early-onset
  - infectious thrombosis causing impaired blood supply

- Late-onset
  - reactivation of tuberculosis or fibrosis of the parenchyma

J Shoulder Elbow Surg (2023) 32, 820–831

ELSEVIER

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

Comparative analysis of superior capsule reconstruction between long head of biceps tendon autograft and human dermis allograft

Doo Sup Kim, MD, PhD[a], Jin Young Han, MD[a,*], Yeon Jae Park, BS[b], Ji Woong Kwak, MD[a], Bum Seok Lee, MD[a]

[a]Department of Orthopedic Surgery, Wonju College of Medicine, Yonsei University, Wonju Severance Christian Hospital, Wonju, Republic of Korea
[b]Department of Medical Statistics, Wonju College of Medicine, Yonsei University, Wonju Severance Christian Hospital, Wonju, Republic of Korea

2023.04.25
명지병원 정형외과
R2. 김수영

Introduction

- For Irreparable rotator cuff tear
- Superior capsule reconstruction (SCR) using fascia lata (FL) autograft
  - Early clinical outcomes with improved range of motion (ROM) and muscle strength
  - However, FL harvest requires additional incisions, which may lead to harvest-site morbidity, as well as a longer operative time
- Human dermal (HD) allograft was developed, method introduces other problems such as its high cost

- N … f the g … re c
- N … 2 graft r
- A

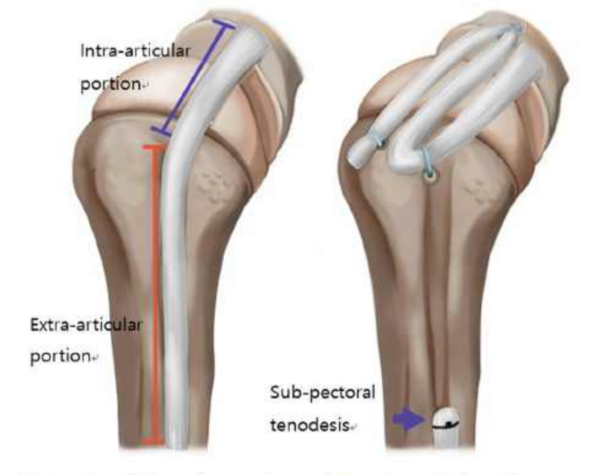


Figure 1 Schematic overview using snake technique for superior capsule reconstruction with biceps tendon autograft.

Method

- Retrospective case-control study
- Wonju Severance Christian Hospital from March 2016 to May 2018
- 72 patients : 43 received LHBT autograft and 29 received HD allograft.
- 19 Excluded : leaving a total of 53 patients
  - 4 patients who simultaneously underwent distal clavicle resection
  - 9 patients who were lost to follow-up (4 with BT autograft and 5 with HD allograft)
  - 6 patients who underwent revision owing to persistent symptoms (4 with BT autograft and 2 HD allograft)
- All patients were operated on by a single orthopedic surgeon

Method

- Clinical outcomes were evaluated by a nurse practitioner
- ROM : external rotation (ER), Internal rotation (IR)
- The vertebral level that the thumb touched was scored as follows
  - 0 points when below the sacral level
  - 1 point when at the sacral level
  - 2 points when at the L5 spine level
  - an additional 1 point for each vertebra above L5
- Strength testing : forward flexion, ER, and IR
- The American Shoulder and Elbow Surgeons (ASES) score, Constant score (CS), and visual analog scale (VAS) score were assessed before surgery and 3, 6, 12, and 24 months after surgery

Method

- X-ray : arm in a neutral position were taken before surgery, after surgery, and at 3 months, 6 months, and 2 years
- The acromiohumeral distance (AHD) was measured on the radiograph from each period
- The Hamada classification was used to assess cuff arthroplasty
  - Grade 1 : the AHD was maintained with minimal radiographic change
  - Grade 2 : the AHD was 5 mm
  - Grade 3 : was acetabularization of the acromion
  - Grade 4 : glenohumeral joint narrowing
  - Grade 5 : humeral head collapse

Method

- Magnetic resonance imaging (MRI)
- Performed before surgery, 6months, 2 years after surgery.
- preoperative MRI scans : Fatty infiltration was assessed in accordance with the Goutallier classification.
- 6months, 2 years after surgery : evaluate the graft integrity and thickness.

Method

- LHBT graft : If the LHBT had a partial tear <20%, no severe inflammation signs, and favorable anchor conditions, the technique of SCR using BT autograft (SCR BT) was selected.
- If the LHBT had a tear >20%, a superior labrum anterior-posterior (SLAP) lesion, severe inflammation, or subluxation, the technique of SCR using HD allograft (SCR HD) was chosen. : 3.0-mm Bio-Composite SutureTak (Arthrex) was used

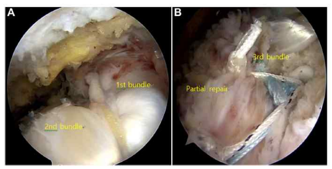


Figure 2 Arthroscopic images using Wilmington portal (right shoulder) for superior capsule reconstruction with biceps tendon autograft. (**A**) Superior capsule reconstruction using 2 bundles. (**B**) Superior capsule reconstruction using 3 bundles.

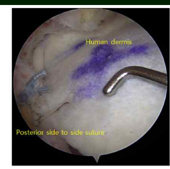


Figure 3 Arthroscopic image using Wilmington portal (right shoulder) for superior capsule reconstruction with human dermis allograft.

Results

Table I Patient demographic characteristics

	SCR BT group (n = 31)	SCR HD group (n = 22)	P value
Age, yr	58.29 ± 4.41	60.18 ± 3.85	.104*
Sex			.3
Male	20	11	
Female	11	11	
Symptom duration, mo	28.68 ± 2.85	32.03 ± 7.62	.2266†
Side			.768‡
Dominant	21	16	
Nondominant	10	6	
Smoking			.068‡
Yes	5	0	
No	26	22	
Fatty infiltration grade			
Supraspinatus			.49‡
0	0	0	
1	1	1	
2	9	8	
3	10	3	
4	11	10	
Infraspinatus			.15†
0	0	0	
1	6	6	
2	13	3	
3	9	4	
4	3	9	
Subscapularis			.344†
0	6	7	
1	17	12	
2	4	0	
3	3	1	
4	1	2	
Teres minor			.406†
0	14	11	
1	14	8	
2	3	1	
3	0	0	
4	0	2	
Subscapularis tendon tear			.561
Tear	13	11	
No tear	18	11	
Hamada classification, n (%)			.849†
1	7 (22.58)	4 (18.18)	
2	23 (74.19)	18 (81.82)	
3	1 (3.23)	0 (0.00)	

SCR BT, superior capsule reconstruction with biceps tendon autograft; *SCR HD*, superior capsule reconstruction with human dermis allograft. Data are presented as mean ± standard deviation or number of patients unless otherwise indicated. *P* values were determined using the χ^2 test unless otherwise indicated.
* *P* value from independent 2-sample t test.
† *P* value from Mann-Whitney U test.
‡ *P* value from Fisher exact test.

Results

Table II Comparison of clinical outcomes after surgery between SCR BT group (n = 31) and SCR HD group (n = 22)

	Mean ± standard deviation					P value (SCR HD group vs. SCR BT group)				
	Pre	3 mo	6 mo	1 yr	2 yr	Pre	Pre to 3 mo	Pre to 6 mo	Pre to 1 yr	Pre to 2 yr
ROM										
FF										
SCR BT group, °	122 ± 43	117 ± 33	148 ± 22	149 ± 16	149 ± 17	.964*	.902	.468	.588	.628
SCR HD group, °	129 ± 28	125 ± 29	146 ± 20	150 ± 16	149 ± 18					
ER										
SCR BT group, °	38 ± 18	36 ± 15	48 ± 19	50 ± 18	51 ± 18	.720*	.702	.061	.087	.067
SCR HD group, °	39 ± 15	38 ± 1	58 ± 11	60 ± 10	61 ± 12					
IR										
SCR BT group	5.3 ± 2.6	4.4 ± 2.3	5.0 ± 2.1	5.5 ± 1.8	5.6 ± 1.8	.469†	.616	.061	.132	.138
SCR HD group	4.8 ± 2.5	4.3 ± 2.2	6.0 ± 1.0	6.4 ± 1.0	6.4 ± 1.1					
Strength										
FF										
SCR BT group, N	11.6 ± 6.5	12.3 ± 4.9	15.5 ± 5.7	16.1 ± 5.8	16.1 ± 5.8	.089*	.291	.554	.641	.693
SCR HD group, N	15.4 ± 8.0	15.1 ± 6.0	17.5 ± 3.8	18.1 ± 3.8	18.5 ± 3.8					
ER										
SCR BT group, N	9.0 ± 6.5	9.1 ± 5.8	13.2 ± 6.3	13.9 ± 5.4	14.0 ± 5.3	.077*	.466	.776	.88	.93
SCR HD group, N	12.1 ± 6.2	12.7 ± 5.8	17.2 ± 4.0	18.1 ± 4.3	18.1 ± 4.3					
IR										
SCR BT group	12.3 ± 7.4	13.3 ± 6.5	16.6 ± 6.1	17.3 ± 5.7	17.4 ± 5.6	.507†	.757	.921	.969	.986
SCR HD group	13.6 ± 6.5	14.9 ± 6.0	17.8 ± 4.2	18.7 ± 4.2	18.9 ± 4.1					
VAS score										
SCR BT group	4.00 ± 2.03	2.00 ± 1.39	0.97 ± 1.08	1.13 ± 1.48	1.10 ± 1.47	.167†	.345	.465	.469	.521
SCR HD group	4.73 ± 1.58	2.27 ± 1.45	1.23 ± 1.07	1.23 ± 1.45	1.18 ± 1.47					
ASES score										
SCR BT group	61.3 ± 13.3	68.3 ± 12.5	77.9 ± 10.6	82.0 ± 9.8	82.5 ± 9.7	.608†	.872	.841	.921	.956
SCR HD group	59.5 ± 10.6	67.0 ± 12.6	77.9 ± 10.5	80.8 ± 10.3	81.2 ± 10.2					
Constant score										
SCR BT group	63.7 ± 11.3	66.8 ± 14	77.2 ± 9.8	79.4 ± 9.9	79.3 ± 9.5	.475†	.623	.66	.787	.843
SCR HD group	65.9 ± 10.7	70.6 ± 10.3	82.3 ± 5.8	84.9 ± 5.8	85.1 ± 5.3					
AHD, mm										
SCR BT group	4.6 ± 1.4	8.6 ± 1.4	7.6 ± 1.3		7.1 ± 1.4	.506†	.943	.74		.795
SCR HD group	4.4 ± 1.1	8.4 ± 1.1	7.6 ± 1.0		7.2 ± 1.1					
Graft thickness on MRI, mm								<.001* (6 mo)		<.001* (2 yr)
SCR BT group			3.6 ± 0.4		3.5 ± 0.4					
SCR HD group			2.5 ± 0.4		2.5 ± 0.4					

The level of significance was defined as $P < .05$. *P* values were determined using a linear mixed model.
SCR BT, superior capsule reconstruction with biceps tendon autograft; *SCR HD*, superior capsule reconstruction with human dermis allograft; *Pre*, preoperatively; *ROM*, range of motion; *FF*, forward flexion; *ER*, external rotation; *IR*, internal rotation; *VAS*, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons; *AHD*, acromiohumeral distance.
* *P* value from Mann-Whitney U test.
† *P* value from independent 2-sample *t* test.

Results

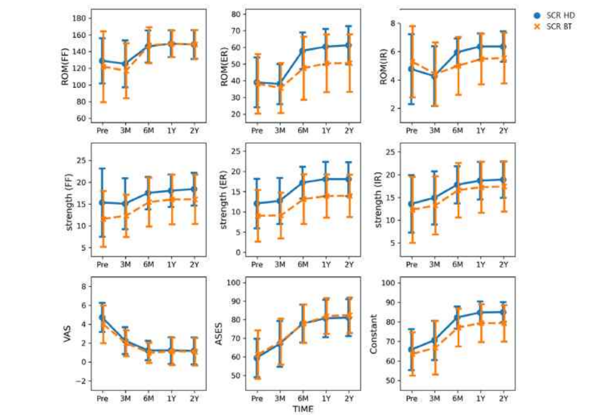


Figure 4 Comparison of range of motion (*ROM*), strength, visual analog scale (*VAS*) score, American Shoulder and Elbow Surgeons (*ASES*) score, and Constant score between group undergoing superior capsule reconstruction with human dermis allograft (*SCR HD*) and group undergoing superior capsule reconstruction with biceps tendon autograft (*SCR BT*). *FF*, forward flexion; *ER*, external rotation; *IR*, internal rotation; *Pre*, preoperatively; *M*, months; *Y*, years.

Results

Table III Clinical outcomes according to MRI graft thickness (measured in millimeters) and AHD between SCR BT group (n = 31) and SCR HD group (n = 22)

	6-mo MRI graft thickness and 6-mo outcome				2-yr MRI graft thickness and 2-yr outcome				2-yr AHD and 2-yr outcome				AHD change (2 yr − Pre) and 2-yr outcome			
	SCR BT group (n = 31)		SCR HD group (n = 22)		SCR BT group (n = 31)		SCR HD group (n = 22)		SCR BT group (n = 31)		SCR HD group (n = 22)		SCR BT group (n = 31)		SCR HD group (n = 22)	
	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value
ROM																
FF	−0.144	.440	0.284	.201	−0.257	.163	0.408	.06	0.058	.757	0.030	.895	0.271	.141	0.216	.335
ER	−0.006	.976	0.096	.671	−0.232	.209*	0.224	.316	−0.151	.418*	0.314	.154	−0.251	.173*	0.129	.567
IR	−0.323	.077	−0.475	.026	−0.466	.008	0.085	.706	−0.086	.647	0.154	.493	0.363	.045	0.149	.508
Strength																
FF	−0.001	.995	0.222	.321	0.036	.874	−0.173	.352*	0.021	.912*	0.235	.292	−0.057	.761*	0.064	.778
ER	−0.200	.281	0.030	.895	0.15	.507	0.022	.905*	0.115	.536*	0.128	.571	−0.171	.359*	−0.235	.293
IR	0.200	.281	−0.022	.921	0.015	.946	0.06	.749*	−0.110	.557*	0.008	.972	−0.159	.394*	−0.232	.299
VAS score	−0.141	.451	−0.266	.231	−0.158	.481	−0.208	.261	0.125	.504	0.226	.312	−0.238	.198	0.186	.406
ASES score	0.068	.716	−0.369	.091	−0.012	.956	−0.092	.624	−0.088	.637	0.083	.714	0.177	.341	−0.017	.942
Constant score	−0.001	.994	−0.061	.788	0.099	.662	−0.019	.921	−0.296	.106	0.196	.381	0.035	.851	0.051	.82

The level of significance was defined as $P < .05$. *P* values were determined using Spearman correlation.
MRI, magnetic resonance imaging; *AHD*, acromiohumeral distance; *SCR BT*, superior capsule reconstruction with biceps tendon autograft; *SCR HD*, superior capsule reconstruction with human dermis allograft; *Pre*, preoperatively; *ROM*, range of motion; *FF*, forward flexion; *ER*, external rotation; *IR*, internal rotation; *VAS*, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons.
* *P* value from Pearson correlation.

Results

Table IV Correlation of MRI graft thickness and AHD change (from preoperatively to 2 years postoperatively) between SCR BT group (n = 31) and SCR HD group (n = 22)

	2-yr MRI graft thickness	
	SCR BT group (n = 31)	SCR HD group (n = 22)
AHD change (2 yr – Pre)	$P = .486$*	$P = .420$

MRI, magnetic resonance imaging; *AHD*, acromiohumeral distance; *SCR BT*, superior capsule reconstruction with biceps tendon autograft; *SCR HD*, superior capsule reconstruction with human dermis allograft; *Pre*, preoperatively.
P values were determined using Spearman correlation.
* *P* value from Pearson correlation.

Discussion

- Mihata et al. introduced the concept of SCR to treat irreparable rotator cuff tears, and various techniques have been developed since.
- Graft selection has been based on the surgeon's preference as there have not been studies that compared the clinical outcomes of different graft techniques.
- Hence, the clinical outcomes of HD allograft and LHBT autograft techniques have been analyzed and compared.

Discussion

- ROM : SCR HD group showed greater improvements in ER and IR ROM, but no significant correlation was observed
- Postoperative MRI showed greater graft thickness in the SCR BT group than the SCR HD group.
  : LHBT's average diameter is 5-6 mm
  HD ArthroFlex has a thickness of 3 mm
- According to MRI findings 6 months after surgery, the thicker SCR HD graft showed lower 6-month postoperative IR ROM
- According to MRI findings 2 years after surgery, the thicker SCR BT graft showed decreased 2-year postoperative IR ROM
- It is thought that as graft thickness increases, the graft becomes tighter during rotation, which results in increased resistance and limitation in rotation

Discussion

- A decrease in rotator cuff function leads to superior migration of the humeral head, and this consequently decreases the AHD
- AHD measurements are important in assessing rotator cuff function
- AHD serves as a predictor of functional outcomes of rotator cuff tear surgery
- However, there does not seem to be an established correlation between postoperative AHD and function of the rotator cuff. In addition, change in the AHD did not appear to be solely related to graft thickness before and 2 years after surgery
- Affected not only by graft thickness but also by SCR technique, graft tension, and various other factors.

Discussion

- Clinical and radiographic outcomes 2 years after SCR BT and SCR HD did not show meaningful differences.
- SCR BT : because the glenohumeral structure is used, autograft tendon can be used without causing morbidity at the existing harvest site
- Furthermore, the advantages of avoiding extra costs of purchasing HD allograft and preserving proprioception and vascularity also make SCR BT a good option
- But more complex : 10-20 minutes longer than the time to complete SCR HD

Discussion

- Strength improved in both the SCR BT group and the SCR HD group 2 years after surgery, and no significant difference was observed
  - Strength value : do not reflect the stability and ultimate tensile strength of the graft material
  - Flexion and abduction angles of the shoulder increase
    → deltoid muscle contribution increases linearly
    → effect of the deltoid and teres minor muscles
  - Sex and age are similar : deltoid strength and teres minor strength are thought to be similar, resulting in no significant difference in strength
- VAS score, ASES score, and CS : Both group showed improvement. No significant difference was observed.

Limitations

- 1. Short-term retrospective study carried out with limited data.
- 2. Study population was rather small.
- 3. Traditional SCR using FL autograft was not compared
- 4. Various outcomes such as operative time and cost-effectiveness were not included in the comparative analysis.
- 5. The fixation method was different for each graft material, and because the preferred fixation technique for each graft was different, clinical results may vary.

Conclusion

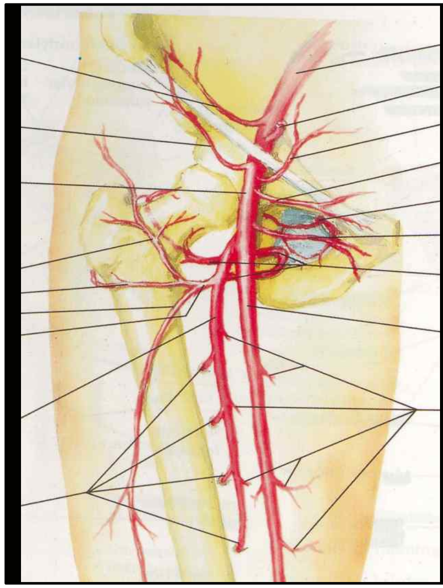
- Both SCR using BT autograft and SCR using HD allograft tissue showed favorable results, and no significant difference was noted between the 2 techniques.
- Given that the 2 techniques show equally favorable results, the surgeon's personal preference in choosing the SCR technique appears acceptable. Understanding the costs and patient's characteristics may aid the surgeon in deciding on the graft material.

2023 Anatomy Seminar

Hip & Femur
-Neurovascular-

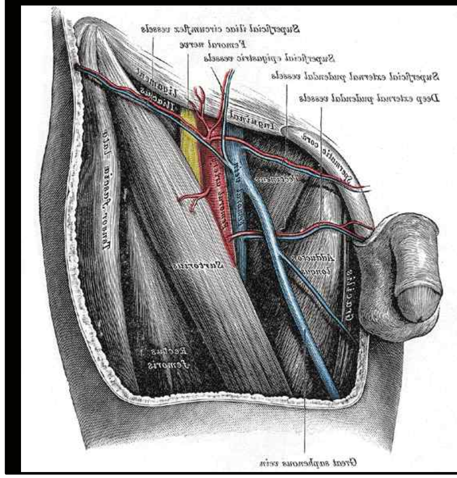
2023.04.19
R2. 우창우

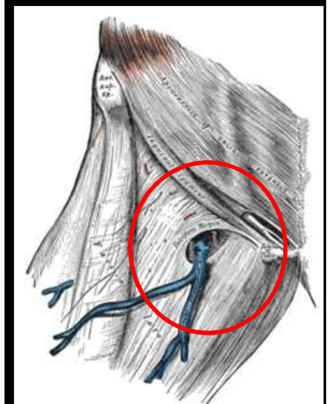
Angiology

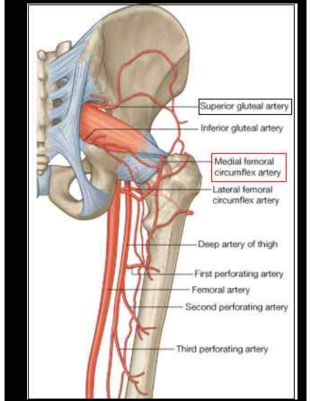


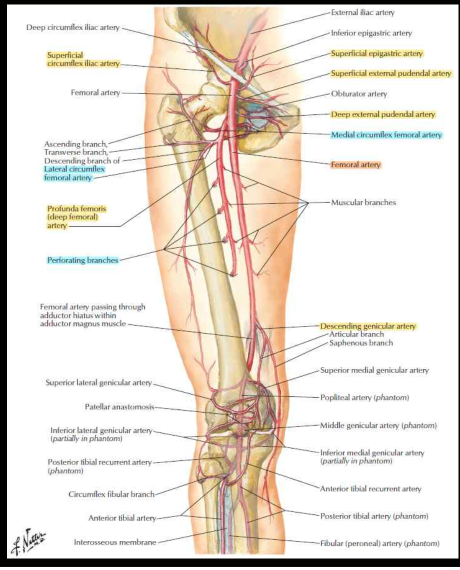
Femoral artery

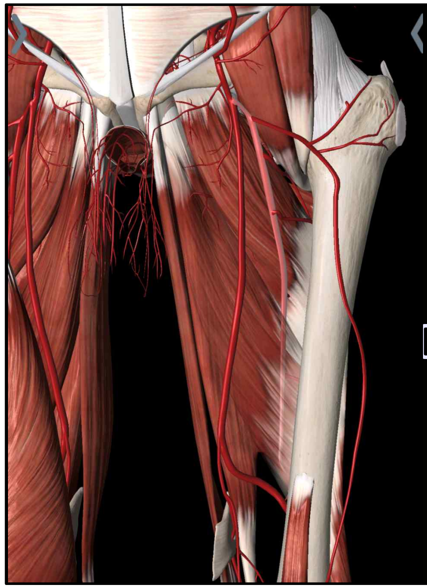
Femoral artery



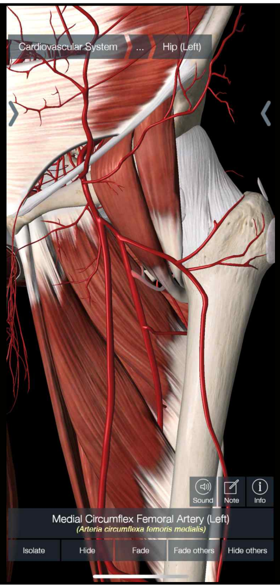


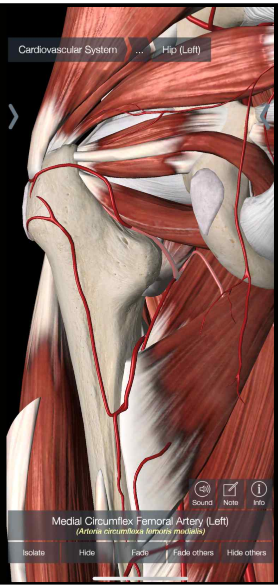


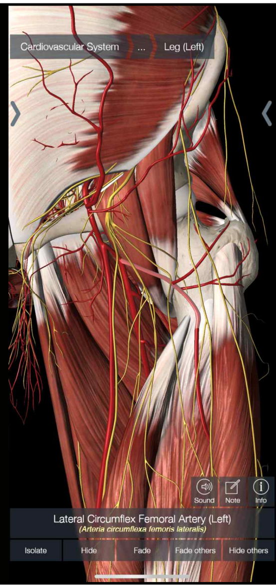


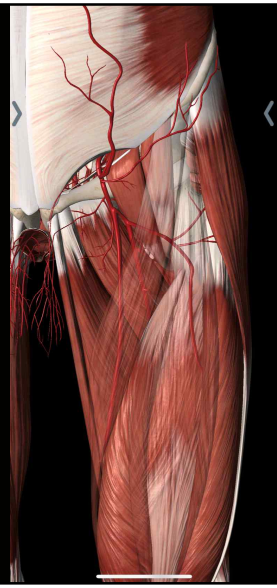


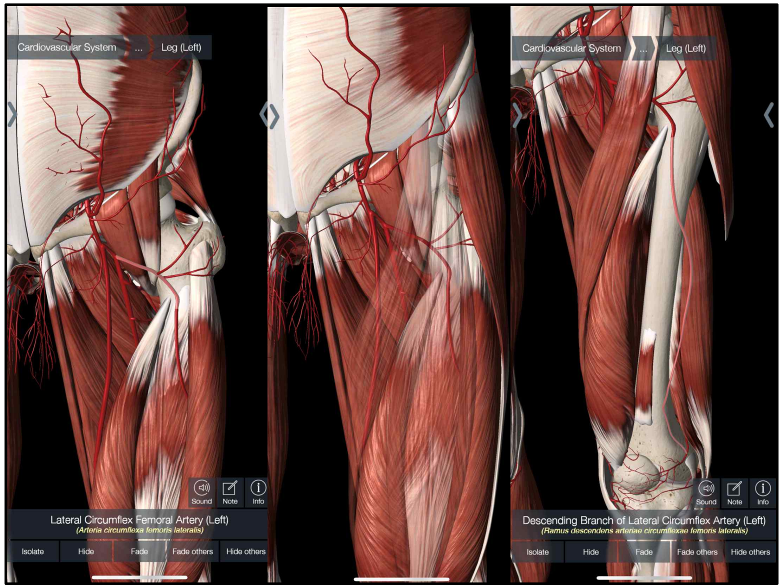
Profunda Femoris Artery
=
Deep femoral a.



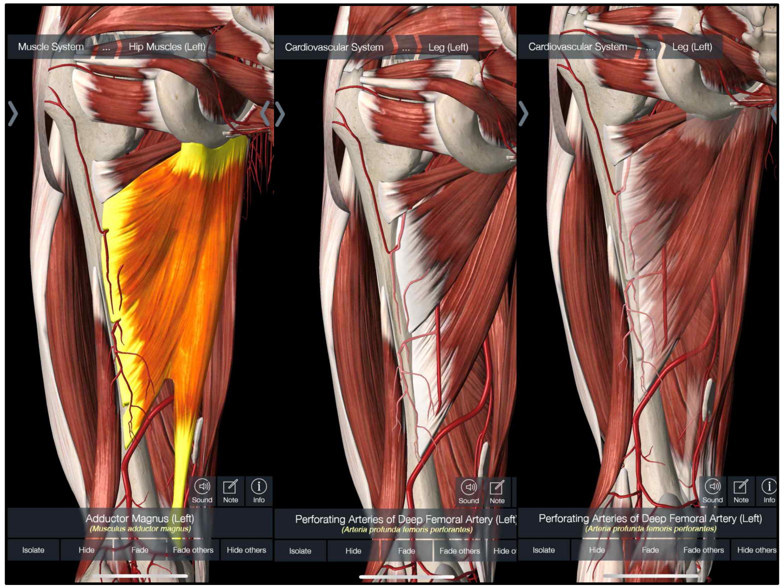




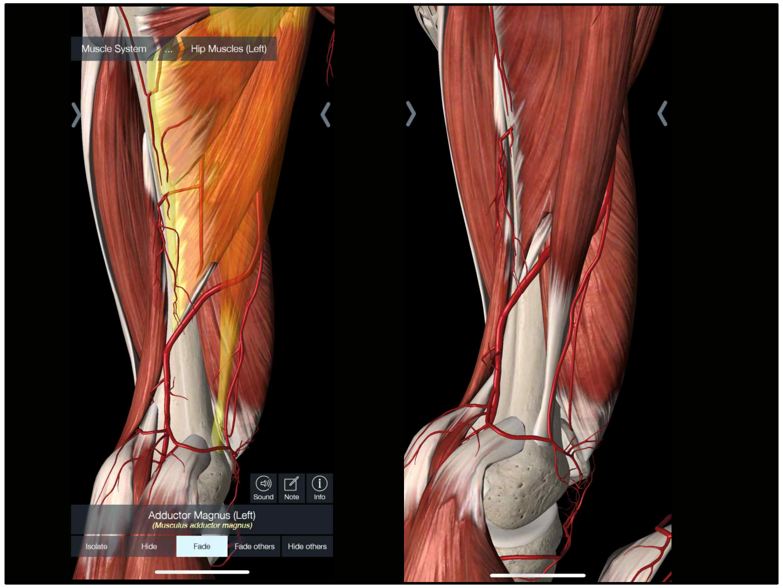




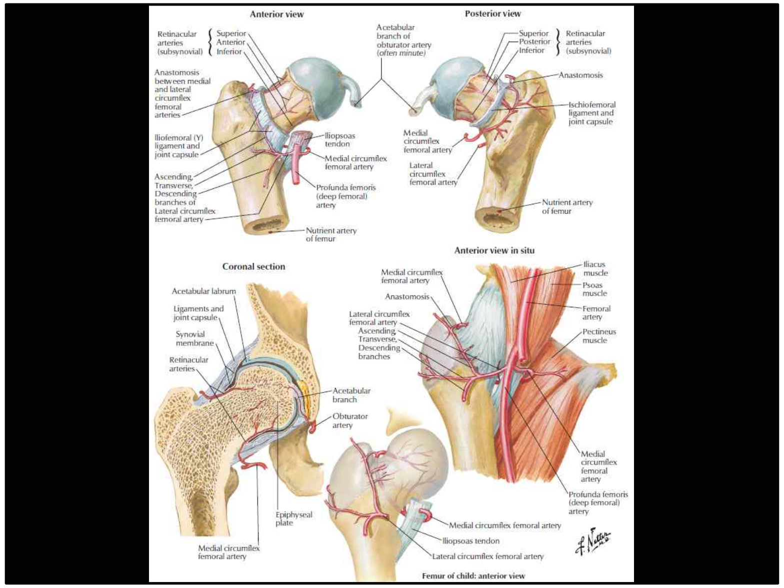
Cardiovascular System
...
Leg (Left)
Sound
Note
Info
Lateral Circumflex Femoral Artery (Left)
(Arteria circumflexa femoris lateralis)
Isolate
Hide
Fade
Fade others
Hide others
Cardiovascular System
...
Leg (Left)
Sound
Note
Info
Descending Branch of Lateral Circumflex Artery (Left)
(Ramus descendens arteriae circumflexae femoris lateralis)
Isolate
Hide
Fade
Fade others
Hide others



Muscle System
...
Hip Muscles (Left)
Sound
Note
Info
Adductor Magnus (Left)
(Musculus adductor magnus)
Isolate
Hide
Fade
Fade others
Hide others
Cardiovascular System
...
Leg (Left)
Sound
Note
Perforating Arteries of Deep Femoral Artery (Left
(Arteria profunda femoris perforantes)
Isolate
Hide
Fade
Fade others
Cardiovascular System
...
Leg (Left)
Sound
Note
Info
Perforating Arteries of Deep Femoral Artery (Left)
(Arteria profunda femoris perforantes)
Isolate
Hide
Fade
Fade others
Hide others

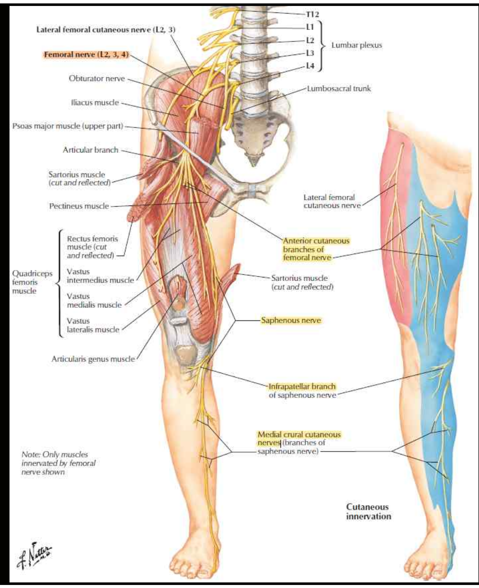


Muscle System
...
Hip Muscles (Left)
Sound
Note
Info
Adductor Magnus (Left)
(Musculus adductor magnus)
Isolate
Hide
Fade
Fade others
Hide others



Anterior view
Retinacular arteries (subsynovial)
Superior
Anterior
Inferior
Anastomosis between medial and lateral circumflex femoral arteries
Iliofemoral (Y) ligament and joint capsule
Ascending, Transverse, Descending branches of Lateral circumflex femoral artery
Iliopsoas tendon
Medial circumflex femoral artery
Profunda femoris (deep femoral) artery
Nutrient artery of femur
Acetabular branch of obturator artery (often minute)
Posterior view
Superior
Posterior
Inferior
Retinacular arteries (subsynovial)
Anastomosis
Ischiofemoral ligament and joint capsule
Medial circumflex femoral artery
Lateral circumflex femoral artery
Nutrient artery of femur
Coronal section
Acetabular labrum
Ligaments and joint capsule
Synovial membrane
Retinacular arteries
Acetabular branch
Obturator artery
Epiphyseal plate
Medial circumflex femoral artery
Anterior view in situ
Medial circumflex femoral artery
Anastomosis
Lateral circumflex femoral artery
Ascending, Transverse, Descending branches
Iliacus muscle
Psoas muscle
Femoral artery
Pectineus muscle
Medial circumflex femoral artery
Profunda femoris (deep femoral) artery
Medial circumflex femoral artery
Iliopsoas tendon
Lateral circumflex femoral artery
Femur of child: anterior view
F. Netter M.D.

Neurology



T12
L1
L2
L3
L4
Lumbar plexus
Lateral femoral cutaneous nerve (L2, 3)
Femoral nerve (L2, 3, 4)
Obturator nerve
Lumbosacral trunk
Iliacus muscle
Psoas major muscle (upper part)
Articular branch
Sartorius muscle (cut and reflected)
Pectineus muscle
Lateral femoral cutaneous nerve
Quadriceps femoris muscle
Rectus femoris muscle (cut and reflected)
Vastus intermedius muscle
Vastus medialis muscle
Vastus lateralis muscle
Anterior cutaneous branches of femoral nerve
Sartorius muscle (cut and reflected)
Saphenous nerve
Articularis genus muscle
Infrapatellar branch of saphenous nerve
Medial crural cutaneous nerves (branches of saphenous nerve)
Note: Only muscles innervated by femoral nerve shown
Cutaneous innervation

THA complication 3 (Infection, Loosening, Osteolysis)

2023.04.19

R3. 이규환

Infection

Infection

• Most common organism
 - coagulase negative staphylococci -> S. aureus

• Prophylactic antibiotics
 - cefazolin and cefuroxime
 - MRSA -> vancomycin

• Tsukayama classification
 - early postoperative infection : 수술 후 1개월 내
 - late chronic infection : 수술 후 1개월 이후, insidious onset
 - acute hematogenous infection : 수술 후 1개월 이후, acute onset

Infection

• **Diagnosis**

 - Hx & Pex. : pain, fever, wound drainage or erythema
 - Radiography : progressive radiolucencies or periosteal reaction
 - Lab : ESR, CRP, IL-6
 - Aspiration
   WBC count > 3000/mL (PMN>80%)
 - Alpha defensin-1
   a synovial fluid peptide produced by neutrophils in response to
   infected joint replacement. 100% sensitivity and 95% specificity

Infection

(6) Periprosthetic Infection (The Journal of arthroplasty, 2018)

Step	Score
Step 1	
Serum CRP >1 mg/dL[a]	2
Serum D-dimer > 860 ng/mL[a]	2
Serum ESR >30 mm/h	1
Step 2	
Synovial WBC count >3000 (cells/μL)[a]	3
Synovial alpha-defensin	3
Synovial LE (++)[a]	3
Synovial PMN% >80%	2
Synovial CRP >6.9 mg/L	1
Step 3	
Histology[b]	3
Purulence	3
Single culture	2

CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; LE, leukocyte esterase; PMN%, polymorphonuclear %; WBC, white blood cell.

[a] The following demonstrated a high collinearity ($r > 0.7$) and thus were grouped into a single criterion in the final model.

[b] Greater than 5 neutrophils per high-power field in 5 high-power fields observed from histologic analysis of periprosthetic tissue at 400× magnification.

Infection

- **Management**

(1) early postop. Infection
- superficial infection : irrigation & debridement
- deep infection : joint aspiration in hip dislocation

(2) late choronic infection
- surgical debridement & component removal

(3) acute hematogenous infection
- same as early infection

Infection

- **Reconstruction after infection and component removal**

- Single stage implantation (direct exchange)

- Two stage or delayed reimplantation - prefered

  optimal timing for reimplantation

  IV antibiotics 6weeks

  ESR, CRP improved

  repeat aspiration (-) for 3months

Loosening

Loosening

- Most serious long-term complication of THA
- Most common indications for revision

- Dignosis
  : symptom + serial x-ray

  symptom : pain on weight bearing and motion
  that are relieved by rest

  serial x-ray : progressive radiolucency
  (loosening VS normal age-related change)

FIGURE 3-131 Differences in radiolucencies at bone-cement interface. A and B, Cemented femoral component in a 76-year-old woman immediately after surgery (A) and 9 years after surgery (B). Hip is asymptomatic with excellent function. Widening radiolucency at bone-cement interface is caused by age-related expansion of medullary canal and thinning of femoral cortex, rather than by loosening. C and D, Cemented femoral component in a 56-year-old laborer immediately after surgery (C) and 7 years after surgery (D). Patient has marked thigh pain. Sharply defined, widening radiolucency at bone-cement interface indicates loosening with progressive osteolysis.

FIGURE 3-133 Cementless stem with bone ingrowth. No radiolucent lines are present. Trabeculae directed towards porou surface indicate stable fixation. Note lack of calcar atrophy.

FIGURE 3-134 Unstable cementless stem. Stem has subsided over time. Radiolucencies surround entire stem, revealing lack of bone ingrowth.

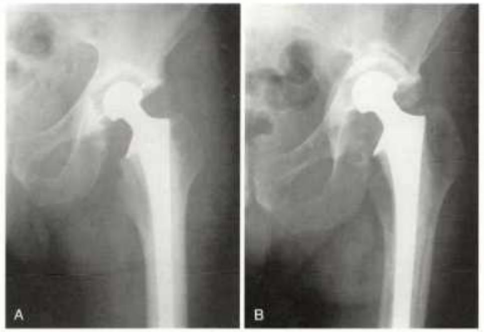


FIGURE 3-136 Change in position of cemented cup in a 59-year-old woman. A, Immediately after surgery. B, Seven years later, pain developed. Complete radiolucency has developed, and cup has migrated proximally and become more horizontal. Change in position of cup is definite evidence of loosening.

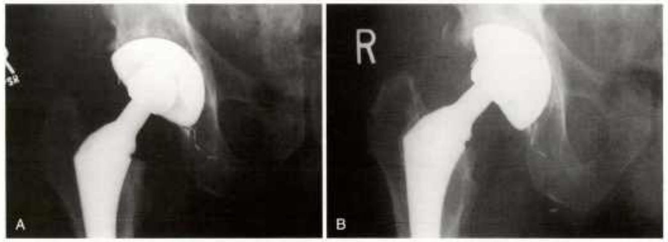


FIGURE 3-137 Change in position of cementless cup in a 62-year-old man. **A,** Immediately after implantation of cementless hydroxyapatite-coated cup. **B,** Four years after surgery, hip became painful. Acetabular component has migrated into more vertical position without excessive wear. Revision was required.

Osteolysis

Osteolysis

- Mechanism

  - generation of wear particle (<1um) by abrasive, adhesive wear mechanism

  - particles moving through joint fluid

  - macrophages produce collagenase, PGE2, cytokines (IL-1, IL-6) ->osteolysis

FIGURE 3-139 Distal femoral osteolysis. Five years after cementless reconstruction for osteonecrosis. Femoral component was not circumferentially porous coated. Large lytic defects have developed around middle and distal portions of stem *(arrows)*.

FIGURE 3-140 A and B, Middle-aged woman with painful osteolysis and acetabular wear with well-fixed components. She was treated with liner and femoral head exchange along with bone grafting through acetabular screw holes.

Osteolysis

- X-ray follow-up after THA
  - progressive wear and development of osteolysis
  - asymptomatic until catastrophic failure
  - osteolysis -> f/u x-ray every 3-6 months

Osteolysis

- Treatment
  - Implant fixation compromised by lytic process
    : complete revision of the component
  - Implant fixation stable but periprosthetic bone loss
    : bone grafting
  - Lytic defects only in middle & distal portions
    : removal though well fixed stem

1. 1년전 인공 고관절 전치환술을 받았던 50세 환자가 2개월 전부터 시작된 수술부위의 동통과 발열을 호소하였다. 관절 천자액의 세균 배양검사에서 메티실린(methicillin) 저항성 황색 포도상 구균이 검출되었다. 가장 적절한 치료는? 17B/16B/13B/10B

㉮ 항생제 투여
㉯ 변연절제술
㉰ 일단계 재치환술
㉱ 이단계 재치환술
㉲ 고관절 유합술

1. 1년전 인공 고관절 전치환술을 받았던 50세 환자가 2개월 전부터 시작된 수술부위의 동통과 발열을 호소하였다. 관절 천자액의 세균 배양검사에서 메티실린(methicillin) 저항성 황색 포도상 구균이 검출되었다. 가장 적절한 치료는? 17B/16B/13B/10B

㉮ 항생제 투여
㉯ 변연절제술
㉰ 일단계 재치환술
㉱ 이단계 재치환술
㉲ 고관절 유합술

답: ㉱

<Kim's solution>

환자의 problem list
1) late chronic infection
2 MRSA culture (+)
-> single stage implant에 poor prognostic factor로 second stage implantation 한다

5) Reconstruction after infection and component removal

(1) 대부분 two-stage or delayed reimplantation을 선호함
(2) THA 후 girdlestone operation은 대개 not satisfactory
(3) single stage implantation (direct exchange)
① good prognosis factor
Ⅰ) wound complication이 없을 때
Ⅱ) general health가 좋을 때
Ⅲ) methicillin-sensitive organism
Ⅳ) sensitive한 antibiotics를 cement와 함께 사용할 때
Ⅴ) systemic symptoms of sepsis are absent
② poor prognosis factor
Ⅰ) polymicrobial
Ⅱ) gram-negative
Ⅲ) MRSA, group D streptococcal infection
Ⅳ) lack of preoperative identification of the infecting organism
Ⅴ) presence of sinus track
Ⅵ) soft-tissue compromise possibly requiring flap coverage

1. 3년전 인공 고관절 치환술을 받은 환자가 통증을 주소로 내원하였다. 통증의 양상은 앉았다가 일어날 때 또는 가만히 있다가 출발할 때 근위 대퇴부에 발생하였으며 계속 걷거나 쉬면 호전되는 양상이었다. 단순 방사선 소견은 다음과 같다. 이환자에게 가장 적절한 치료는? 18B2/17B2/16B2

㉮ 경과관찰
㉯ 보조기 착용 후 침상 안정
㉰ 대퇴 스템 재치환
㉱ 대퇴 스템은 유지한 채 대퇴 골두와 라이너 교체
㉲ 이단계 재치환술

1. 3년전 인공 고관절 치환술을 받은 환자가 통증을 주소로 내원하였다. 통증의 양상은 앉았다가 일어날 때 또는 가만히 있다가 출발할 때 근위 대퇴부에 발생하였으며 계속 걷거나 쉬면 호전되는 양상이었다. 단순 방사선 소견은 다음과 같다. 이환자에게 가장 적절한 치료는? 18B2/17B2/16B2

<Kim's solution>

환자의 problem list
1) pain on weight-bearing
- thigh or groin startup pain
- 처음에 힘들고 걸으면 호전 (stem이 stable 한 위치로 변한다)
- rest에 의해 relief 되고 rotation 하면 aggravated
2) Formation of bony pedestal in zone 4 at the stem tip
-> The diagnosis of loosening is accepted in most instances if progressive radiolucency or implant migration occurs and a patient has symptoms on weight bearing and motion that are relieved by rest
-> stem revision indication에 해당한다

㉮ 경과관찰
㉯ 보조기 착용 후 침상 안정
㉰ 대퇴 스템 재치환
㉱ 대퇴 스템은 유지한 채 대퇴 골두와 라이너 교체
㉲ 이단계 재치환술

답: ㉰

1. 5년전 인공 고관절 치환술을 시행한 환자가 통증을 주소로 내원하였다. 환자의 단순 방사선 사진에서 비구컵 주위에 골용해 소견이 진행하는 양상이 관찰되었다. 단순 방사선 사진에서 비구컵과 대퇴 스템은 안정적으로 잘 유지되는 것처럼 보였으며, 비구컵의 inclination 45도, anteversion 20도 소견을 보였다. 상기 환자의 적절한 치료 방법은? 14B2/13B2

㉮ 경과관찰
㉯ 보조기 착용 후 침상 안정
㉰ 비구부 재치환술
㉱ 비구컵은 유지한 채 대퇴 골두와 라이너 교체 및 골이식
㉲ 대퇴 스템 재치환 및 대퇴 골두의 라이너 교체

1. 5년전 인공 고관절 치환술을 시행한 환자가 통증을 주소로 내원하였다. 환자의 단순 방사선 사진에서 비구컵 주위에 골용해 소견이 진행하는 양상이 관찰되었다. 단순 방사선 사진에서 비구컵과 대퇴 스템은 안정적으로 잘 유지되는 것처럼 보였으며, 비구컵의 inclination 45도, anteversion 20도 소견을 보였다. 상기 환자의 적절한 치료 방법은? 14B2/13B2

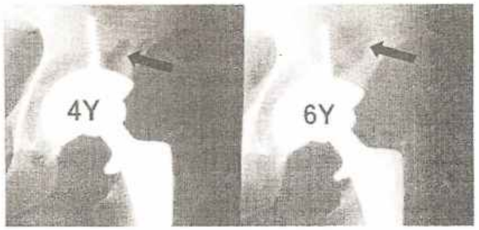
㉮ 경과관찰
㉯ 보조기 착용 후 침상 안정
㉰ 비구부 재치환술
㉱ 비구컵은 유지한 채 대퇴 골두와 라이너 교체 및 골이식
㉲ 대퇴 스템 재치환 및 대퇴 골두의 라이너 교체

답: ㉱

<Kim's solution>

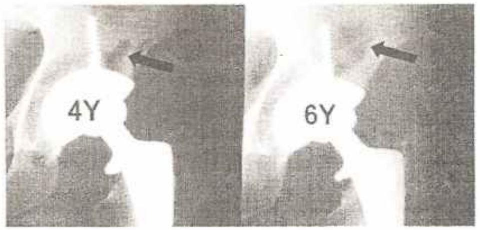
implant가 periprosthetic bone loss 에도 불구하고 stable 한 경우이다.
- 이러한 경우 cup 교체는 안하고, liner 교체 + BG

1. 무시멘트성 고관절 전치환술을 시행받은 환자의 고관절 전후면 방사선 추시 사진이다. 환자는 통증을 포함한 고관절의 특별한 증상을 호소하지는 않았으며 보행 장애도 없었다. 가장 적절한 처치는? 12B/10B/11I



㉮ 경과관찰
㉯ 침상안정
㉰ 소파 및 골이식
㉱ 비구컵 재치환술
㉲ 인공 고관절 재치환술

1. 무시멘트성 고관절 전치환술을 시행받은 환자의 고관절 전후면 방사선 추시 사진이다. 환자는 통증을 포함한 고관절의 특별한 증상을 호소하지는 않았으며 보행 장애도 없었다. 가장 적절한 처치는? 12B/10B/11I



㉮ 경과관찰
㉯ 침상안정
㉰ 소파 및 골이식
㉱ 비구컵 재치환술
㉲ 인공 고관절 재치환술

답: ㉰

progressive acetabular osteolysis
- 증상이 없더라도 수술해야 한다.
- Osteolysis 가 더 진행하면, revision 은 힘들어진다.
- cup은 stable한 상태로 cup 교체는 안하고, curettage, liner 교체 + BG

1. 5년전 인공 고관절 치환술을 받은 환자가 통증을 주소로 내원하였다. 환자의 단순 방사선 사진에서 비구컵 주위에 골용해 소견이 진행하는 양상 및 PE liner의 마모가 관찰되었다. 단순 방사선 사진에서 비구컵과 대퇴 스템은 안정적으로 잘 유지되는 것처럼 보였으며, 비구컵의 inclination 60도, anteversion 0도 소견을 보였다. 상기 환자의 적절한 치료 방법은? 19B

㉮ 경과관찰
㉯ 보조기 착용 후 침상 안정
㉰ 비구부 재치환술
㉱ 비구컵은 유지한 채 대퇴 골두와 라이너 교체 및 골이식
㉲ 대퇴 스템 재치환 및 대퇴 골두의 라이너 교체

1. 5년전 인공 고관절 치환술을 받은 환자가 통증을 주소로 내원하였다. 환자의 단순 방사선 사진에서 비구컵 주위에 골용해 소견이 진행하는 양상 및 PE liner의 마모가 관찰되었다. 단순 방사선 사진에서 비구컵과 대퇴 스템은 안정적으로 잘 유지되는 것처럼 보였으며, 비구컵의 inclination 60도, anteversion 0도 소견을 보였다. 상기 환자의 적절한 치료 방법은? 19B

㉮ 경과관찰
㉯ 보조기 착용 후 침상 안정
㉰ 비구부 재치환술
㉱ 비구컵은 유지한 채 대퇴 골두와 라이너 교체 및 골이식
㉲ 대퇴 스템 재치환 및 대퇴 골두의 라이너 교체

답: ㉰

<Kim's solution>

환자의 problem

- progressive wear through of the acetabular liner c malpositioned acetabular component

-> Complete acetabular revision of the liner and modular shell

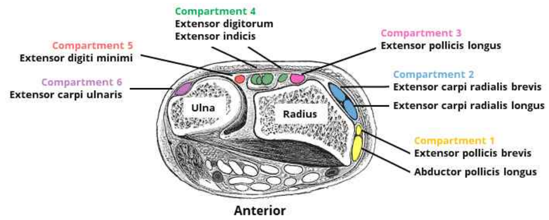
-> In a retrospective comparison of patients with acetabular osteolysis treated with either liner exchange and bone grafting versus complete acetabular revision, Restrepo et al. found a 10% rate of loosening of retained acetabular shells. They recommended complete revision in cups with broken locking mechanisms, complete wear-through of the acetabular liner, or malpositioned components which could predispose to dislocation (Campbell)

Trigger finger

명지병원 정형외과
2023.04.21
R1. 정승호

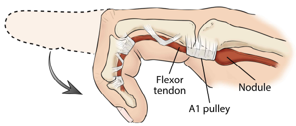
Definition

- Stenosing tenosynovitis
- Mechanical impingement of a tendon in the hand or wrist caused by narrowing of its retinacular sheath
- De quervain's disease



Symptom

- Painful catching or popping of the involved flexor tendon as the patient flexes and extends the digits
- Lock in flexion and require passive manipulation of the digit into extension on occasion
- Rarely, a digit may be locked in extension
- Lump or nodule in the palm



Demographics

- Predominantly healthy middle aged women with a frequency of two to six times
- Involvement of several fingers : usual
- Secondary trigger finger can be seen in patients
  - Diabetes, gout, renal disease, RA et al.
  - Worse prognosis
- Rarely, localized enlargement of the flexor digitorum profundus can trigger at a stenotic A3 pulley and lead to persistence of symptoms after routine surgical incision of the A1 pulley
- Up to a quarter of trigger digits in patients with RA may be due to profundus entrapment by synovitis at the superficialis decussation

Classification

by Quinnell and modified by David Green

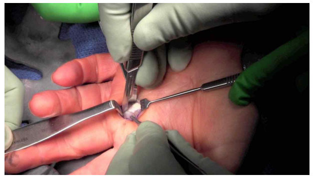
- Grade 1 (pretriggering)
  - pain : history of catching, but not demonstrable on physical examination; tenderness over the A1 pulley
- Grade 2 (active)
  - Demonstrable catching, but the patient can actively extend the digit
- Grade III (passive)
  - Demonstrable catching requiring passive extension (grade IIIA) or inability to actively flex (grade IIIB)
- Grade IV (contracture)
  - Demonstrable catching with a fixed flexion contracture of the PIP joint

Nonoperative management

- Corticosteroid injection or splinting
  - Corticosteroid 1mL + lidocaine 0.9 mL + sodium bicarbonate 0.1 mL
- 60% success
- Highly satisfactory rate of success, particularly in nondiabetic patients with involvement of a single digit, a discrete palpable nodule, and a short duration of symptoms
- Transient rise in blood and urine glucose levels is common in diabetics for 5 days

Operative management

- A1 pulley release
- Avoid division of the A2 pulley and consequent bowstringing
- Up to 25% of either end of the A2 pulley can be divided without any detrimental mechanical effect on digital flexion
- Supervised hand therapy is usually necessary only for patients with preoperative fixed flexion contractures



Complication

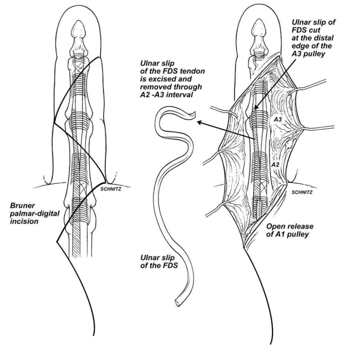
- Poor results in 3 to 31% after surgical treatment
- Dissatisfaction rate as high as 26%
- Complications
  - Reflex sympathetic dystrophy
  - Infection
  - Persistent triggering
  - Stiffness
  - Nerve injury
  - Flexion deformity
  - Pulley rupture
  - Flexor tendon bowstringing
  - Recurrence

PIPJ contracture

- In long-standing trigger fingers, there may be a persistent fixed flexion deformity of PIPJ
- This fixed flexion deformity may be due to degenerative enlargement of the flexor tendons within the fibrous digital canal, caused by chronic repetitive friction
- Thus, simple release of the A1 pulley may not restore full PIPJ extension

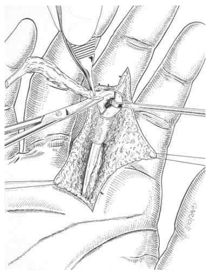
PIPJ contracture

- Treatment of PIPJ contracture
  - ➢ partial FDS resection
  - ➢ complete FDS resection
  - ➢ reduction tenoplasty of FDP

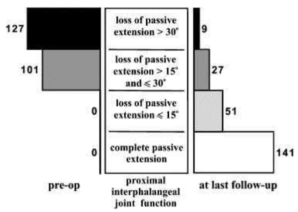


PIPJ contracture

- 228 trigger fingers with a persistent PIPJ contracture
- USSR (ulnar superficialis slip resection)
- average gain of 26° in passive extension of the PIP joint (33° → 7°)
- full extension was attained in 141 of 228 fingers



D Le Viet et al, Journal of Hand Surgery, 2004



PIPJ contracture

- 39 trigger fingers with PIPJ contracture
- Full resection of FDS
- mean contracture : 24° → 4°
- 28 fingers (72%), full extension was achieved
- 11 fingers (28%), a postop residual contracture (range, 5° → 15°)
- However, all fingers achieved a full range of motion after physical therapy and an injection of betamethasone

Y Favre et al, Journal of Hand Surgery, 2012

PIPJ contracture

ARTICLE IN PRESS

SCIENTIFIC ARTICLE

Comparative Study of A1 Pulley Release and Ulnar Superficialis Slip Resection in Trigger Finger With Flexion Contracture of the Proximal Interphalangeal Joint

Jong Hun Baek, MD, PhD,* Jeung Hwan Seo, MD,† Jae Hoon Lee, MD, PhD‡

PIPJ contracture

- From January 2016 to December 2019
- Retrospective study
- Trigger fingers with preoperative PIPJ contractures of 10 degrees
- 2 surgical procedures
  - ➢A1 pulley release with ulnar superficialis slip resection (group A, 26 fingers)
  - ➢Simple A1 pulley release (group B, 29 fingers)
- Follow-up > 1 year
- Outcome
  - VAS score
  - DASH score
  - degree of PIP joint flexion contracture
  - grip strength
  - pinch strength

PIPJ contracture

TABLE 1. Demographic Data of the Patients

Characteristics	Group A,* 26 Fingers	Group B,† 29 Fingers
Mean age	61.4 (SD, 9.9)	59.5 (SD, 8.5)
Sex, M:F	7:17	10:17
Symptom duration, y	2.2 (SD, 1.9)	2.1 (SD, 1.7)
Steroid injection, times	2.2 (SD, 1.2)	2.5 (SD, 1.1)
Diabetics	11	12
Chronic renal failure	3	3

*Group treated with A1 pulley release with USSR.
†Group treated with simple A1 pulley release.

PIPJ contracture

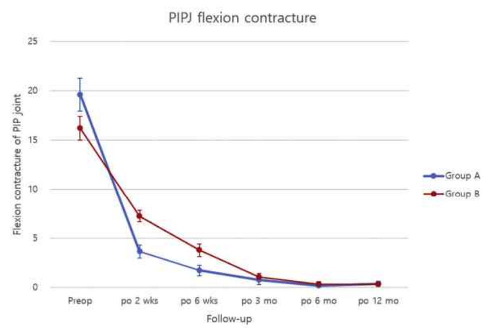


FIGURE 1: Flexion contracture of the PIP joint, expressed as means ± standard errors. Preop, preoperative; PO, postoperative.

PIPJ contracture

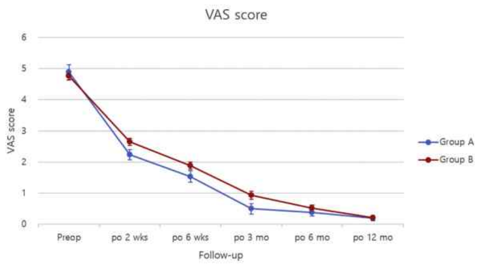


FIGURE 2: The VAS score, expressed as means ± standard errors. Preop, preoperative; PO, postoperative.

PIPJ contracture

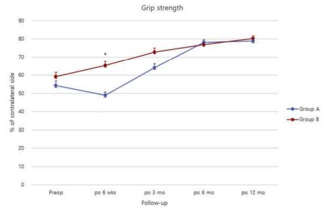


FIGURE 3: The grip strength, expressed as means ± standard errors. *P <.05. Preop, preoperative; PO, postoperative.

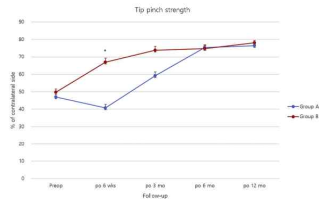


FIGURE 4: The tip pinch strength, expressed as means ± standard errors. *P <.05. Preop, preoperative; PO, postoperative.

PIPJ contracture

TABLE 2. DASH Scores of 2 Groups

Assessment Time	Group A,* 26 Fingers	Group B,† 29 Fingers	P Value
Before surgery	27.8 (SD, 7.9)	30.0 (SD, 10.1)	.47
12 months after surgery	5.3 (SD, 3.1)	5.3 (SD, 3.4)	.99

*Group treated with A1 pulley release with USSR.
†Group treated with simple A1 pulley release.

Conclusion

- **PIPJ flexion contracture measurements and clinical scores did not differ between groups at the final follow-up**
- **Therefore, we recommend use of a simple A1 pulley release, which is simpler than an A1 pulley release with ulnar superficialis slip resection, in cases of trigger finger with PIP joint flexion contracture**

Spinal Cord Syndrome

명지병원 정형외과
R3. 이준우

Introduction

- Spinal shock
  - 정의 : 척수가 손상되어 손상 부위 이하 척수의 반사 기능 등 모든 생리적 기능이 일시적으로 정지되는 현상
  - Cervical or upper thoracic level injury
    - hypotension, hypothermia, bradycardia → neurogenic shock
    - 심장으로 향하는 교감신경은 정지, vagus n.로 인한 부교감만 계속 작용
  - Lower sacral level injury
    - plantar reflex, anal reflex, bulbocavernous reflex → 소실됨
  - 손상받은 척수보다 원위부에서 다음 세가지가 모두 나타나면 Spinal shock
    - 근력 완전소실 → 이완성 마비
    - 모든 감각의 소실
    - Sacral reflex 소실

- 대개 24시간 이내에 회복되나 수일 ~ 수주까지 지속되는 경우도 있다.
- 쇼크 지속되는 동안 척수손상이 완전 마비인지 부분마비인지 구분불가
- 회복 될 때
  - Plantar reflex → anal reflex → bulbocavernous reflex 순서로 회복됨.
  - DTR는 보통 1-2주 후에 회복됨

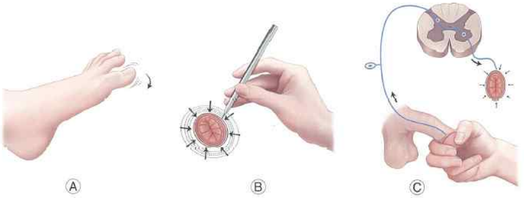


그림 VIII-76. (A) 족저 반사(plantar reflex), (B) 항문 반사(anal wink reflex), (C) 구해면체 반사(bulbocavernous reflex).

- Sacral reflex의 반사가 나타난 후에도 운동 및 감각신경 기능의 회복이 전혀 없다면, 이는 척수의 완전 마비를 의미하며, 마비에서 회복의 가능성은 희박함.
  - 하지만 조금이라도 남아 있다면 불완전 척수 손상으로 회복의 가능성이 있다.
  - 특히 sacral sensory sparing (항문주위) 또는 sacral motor sparing (anal sphincter active contraction, great toe flexion) 남아 있다면 불완전 마비로 진단
    (sacral segment ~ cerebral cortex 사이 연결이 남아있는 것을 의미)

- 손상 원위부의 운동 및 감각 신경이 많이 보존될수록, 빠른 회복 속도를 보일수록 많은 회복이 기대되며, 새로운 회복이 나타나지 않고 정체 상태이면 더 이상의 회복은 기대하기 어렵다.

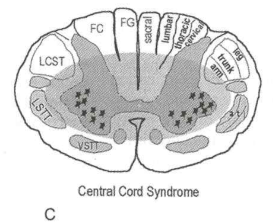
- Complete
  - All motor or sensory function is lost distal to the cord injury
  - Bulbocavernous reflex (+) but no recovery of sacral motor or sensory
- Incomplete
  - Some motor or sensory function is spared distal to the cord injury

	Bulbocavernous reflex	Sacral sparing
Spinal shock	-	-
Incomplete cord injury	+	+
Complete cord injury	+	-

Spinal Cord Syndrome

- Central cord syndrome
- Brown-sequard syndrome
- Anterior cord syndrome
- Posterior cord syndrome
- Conus medullaris syndrome
- Cauda equina syndrome

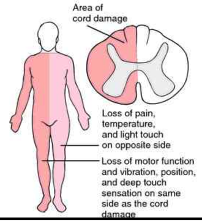
Central cord syndrome



- The most common, common in old age
- Destruction of the central area
- Arm tracts (corticospinal tract) → the most severely affected
- Leg tracts → a lesser extent.
  - Quadriparesis involving the upper extremities to a greater degree than the lower
- Usually sacral sensation is preserved
- Prognosis : variable
  - more than 50% of patients have return of bowel and bladder control, become ambulatory, but permanent loss of hand function

Brown-sequard syndrome

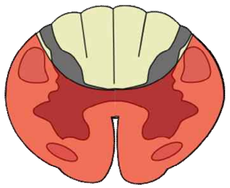
- Injury to either half of the spinal cord (hemicord syndrome)
- Unilateral lamina or pedicle fracture, penetrating injury, or a rotational injury resulting in a subluxation, acute HIVD, etc.
- Ipsilateral → motor weakness
- Contralateral (spinothalamic) → loss of pain and temperature sensation
- Prognosis for recovery ; good (90%)



Anterior cord syndrome

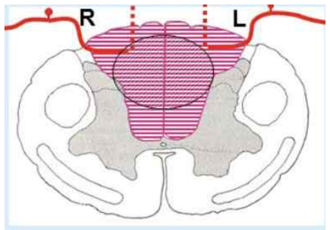
- Hyperflexion injury → compressing the anterior spinal artery & cord
- Complete motor loss
- Loss of pain and temperature discrimination below the level of injury
- Posterior cord sparing → deep sensory, pressure sense, 2 point discrimination (+)
- Prognosis ; very poor → 보행, 방광 및 대장 조절 기능의 회복을 기대할 수 없다.

Anterior Cord Syndrome



Posterior cord syndrome

- Loss of deep sensory, proprioception, vibrating sense
- Preserving other sensory and motor functions
- Rare and caused by an extension injury
- Prognosis : good



Conus medullaris syndrome
Cauda equina syndrome

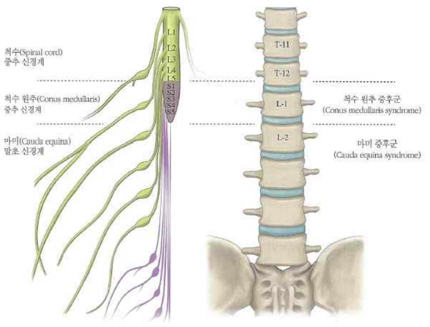


그림 VIII-78. 척수 원추 증후군(conus medullaris syndrome)과 마미 증후군(cauda equina syndrome).

Conus medullaris syndrome

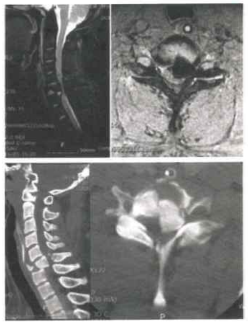
- Injury of the sacral cord and lumbar nerve roots within the spinal canal (T11-L2)
- Flaccid sphincter, areflexic bladder, bowel and lower extremities
- Injury of sacral cord → absence of the bulbocavernosus reflex and the perianal wink
  - Parasympathetic paralysis → Erection (-), urinary retention
  - Sympathetic preserved → Ejaculation (+)
- Saddle anesthesia (S3-S5)
- Motor function in the lower extremities between L1 and L4 may be present if nerve root sparing occurs
- Upper motor neuron lesion으로 회복은 제한적임.

Cauda equina syndrome

- Injury between Conus and Lumbosacral nerve root area (below L2)
- 이 부위의 손상은 PNS에 가깝다
- usually incomplete, reversible, DTR ↓
- Nerve root가 완벽하게 손상되지 않았다면 기능회복 가능성이 있음 → decompression 등 적극적인 수술적 치료

	Conus medullaris syndrome	Cauda equina syndrome
손상부위 (척추 분절)	**T11-L2**	**L2-천추**
손상부위 (척수 분절)	천수와 신경근	요천추 신경근
요통	**심함**	덜 심함
방사통	덜 심함	**심함**
운동 기능 소실	**양측성**으로 덜 심함	**편측성**으로 심함, 근 위축 흔함
감각 기능 소실 (회음부 감각)	**대칭적**	**비대칭적**
반사 기능 소실	아킬레스건 반사	무릎 반사 및 아킬레스건 반사
발기 부전	흔함	덜 흔함
회복 가능성	제한적	가능

1. 다이빙 직후 제 6 경추 신경이하로 운동 신경의 완전 마비와 동통과 온도 감각이 없고, 가벼운 촉각과 진동 감각은 정상이다. 불완전 척수 손상 분류 중 가장 적절한 것은? 17B2/15I



㉮ 중심성 척수 증후군(central cord syndrome)
㉯ Brown-Sequard 증후군(Brown-Sequard syndrome)
㉰ 전방 척수 증후군(anterior cord syndrome)
㉱ 후방 척수 증후군(posterior cord syndrome)
㉲ 마미 증후군(cauda equine syndrome)

1. 경추 손상 후 가장 흔한 척수 손상으로 상지가 하지보다 심하게 마비가 오며 50% 정도에서 하지 보행이 가능하였고, 대소변 기능은 회복되었으나 상지의 기능은 회복이 없었다. 설명하는 척수 손상은? 13B/12B

㉮ Anterior cord syndrome
㉯ Brown-sequard syndrome
㉰ Central cord syndrome
㉱ Posterior cord syndrome
㉲ Conus medullaris syndrome

Reference

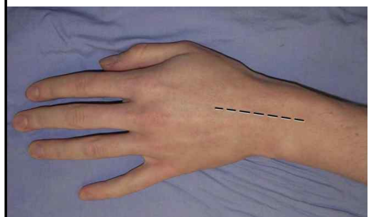
- 정형외과학 제8판 p.1345-1413

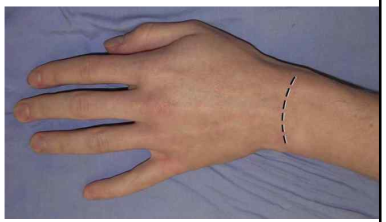
Anatomy Seminar

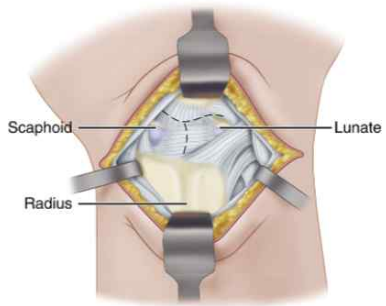
Surgical Approach of the Wrist and Hand

R3. 이 규 환
2023. 04. 27

Dorsal Approach to the Wrist

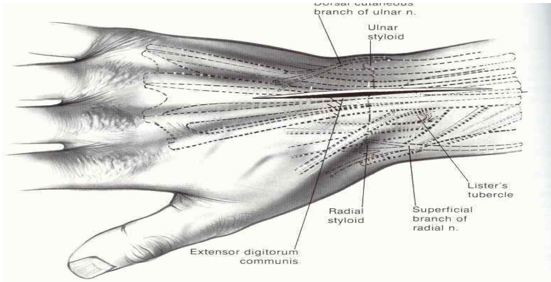


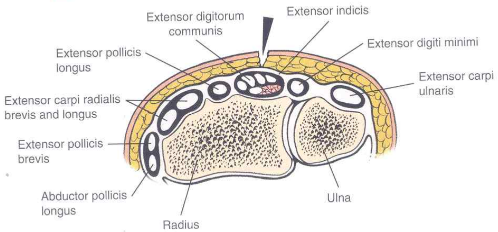


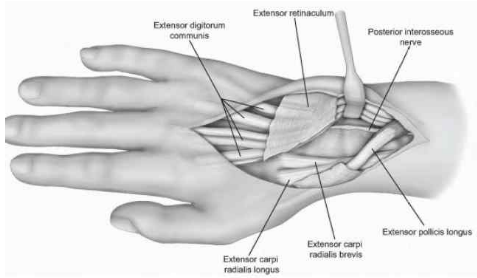


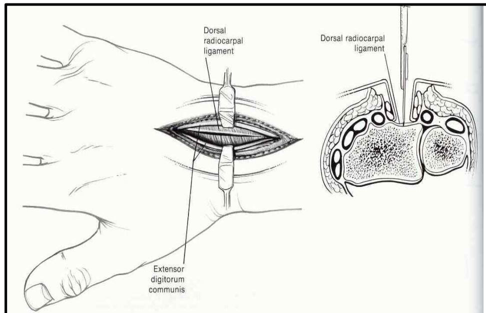
B

- Transverse incision
  - Scaphoid, lunate, and distal radius have been exposed
  - Retract the extensor tendons of the fingers medially(to ulna) to expose the dorsum of the wrist joint



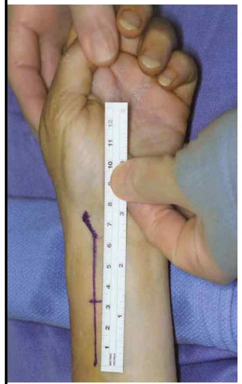


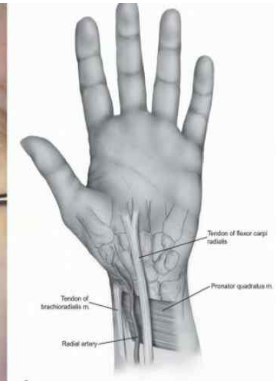


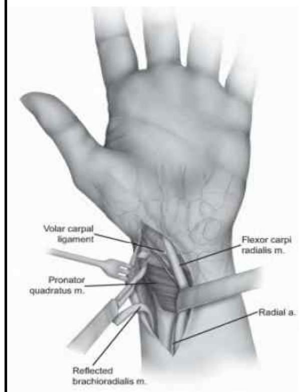


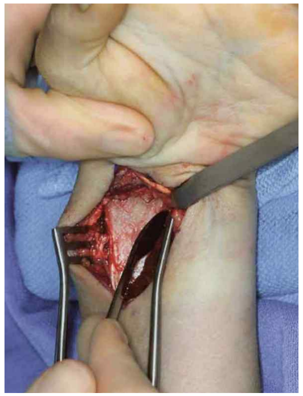
Volar Approach to the Wrist

Volar approach to the distal radius
(trans FCR sheath approach)

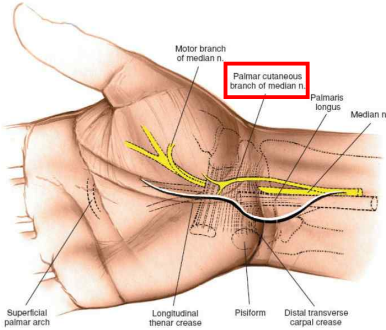


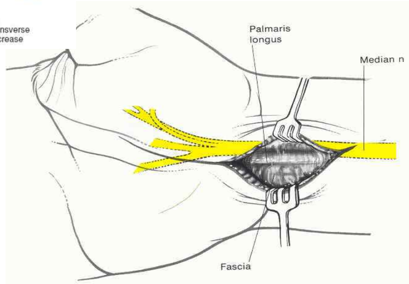


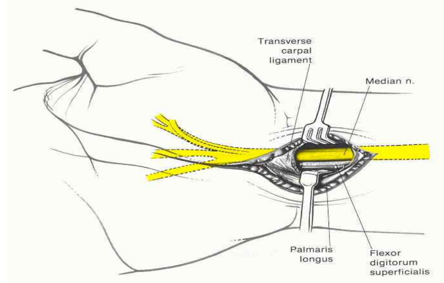


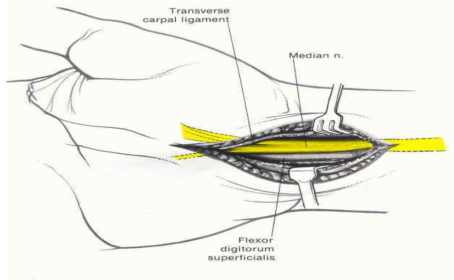


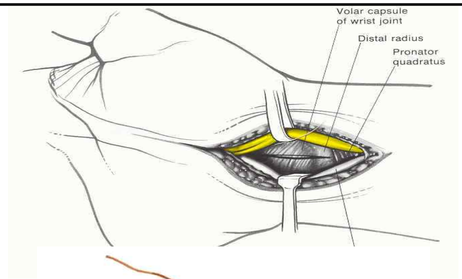
Volar Approach to the carpus

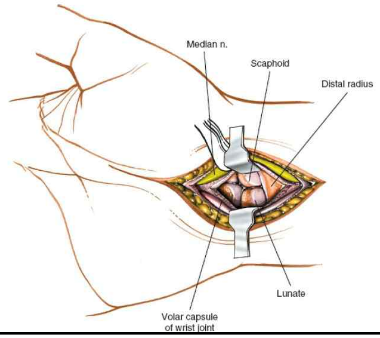




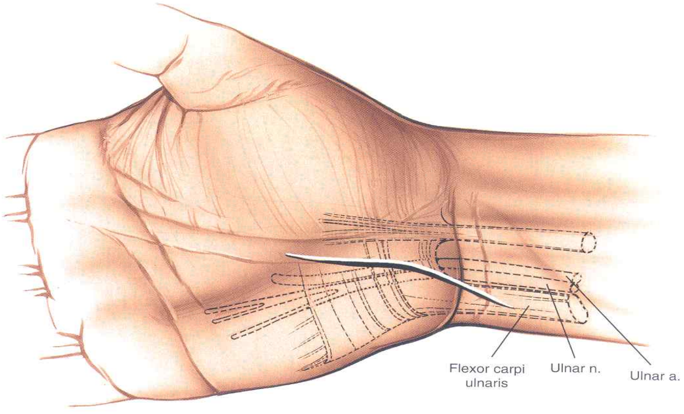


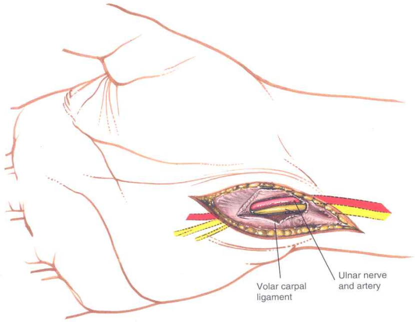


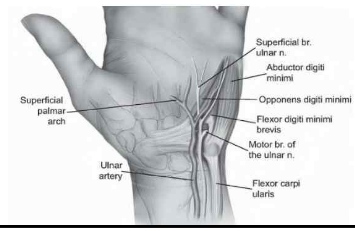


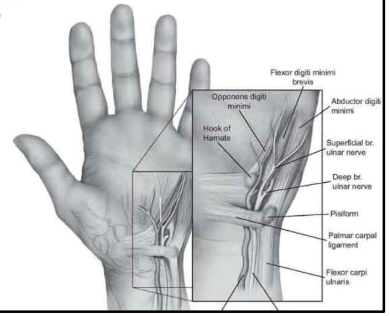


Volar Approach to the Ulnar Nerve

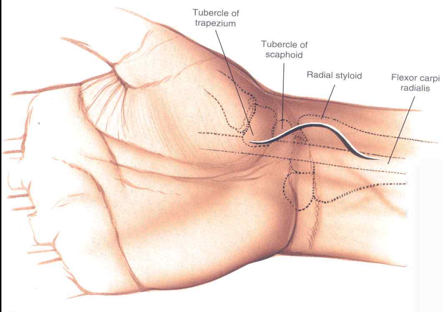


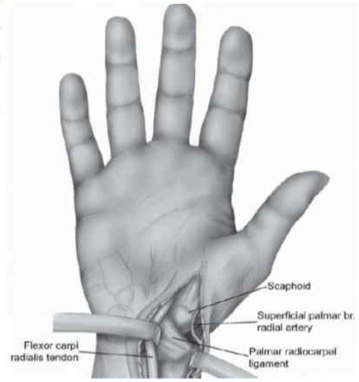


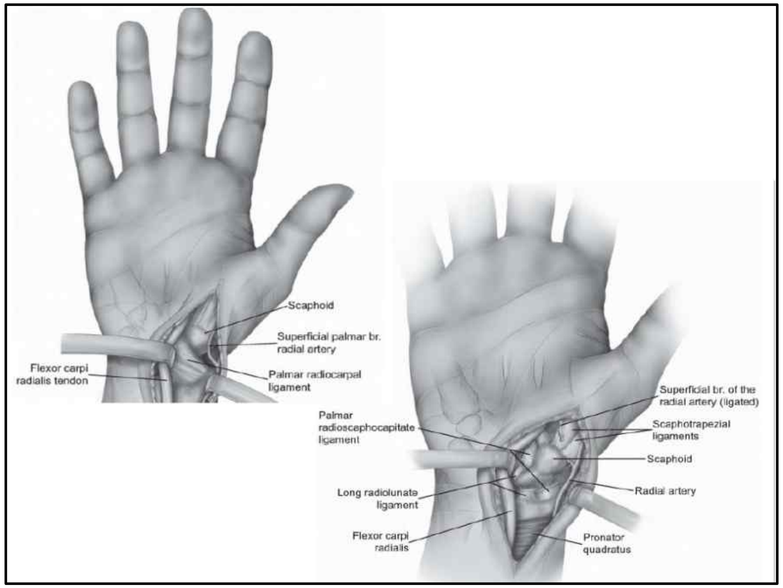




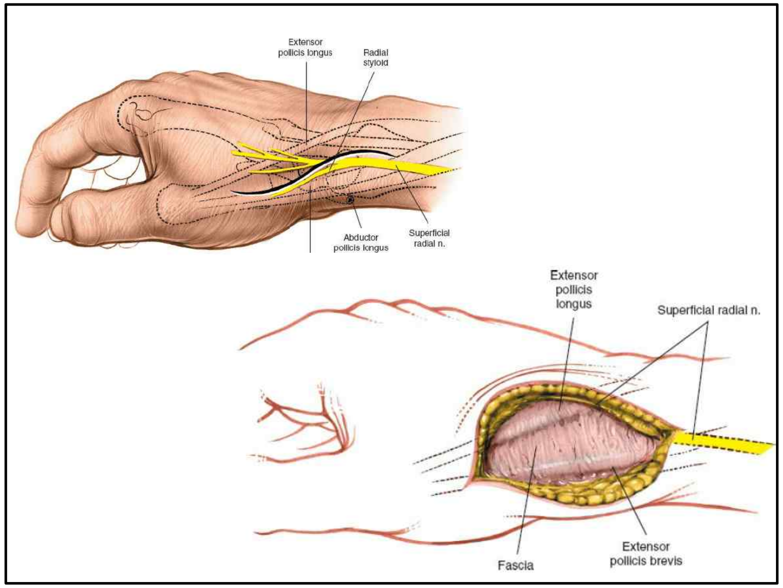
Volar Approach to the Scaphoid

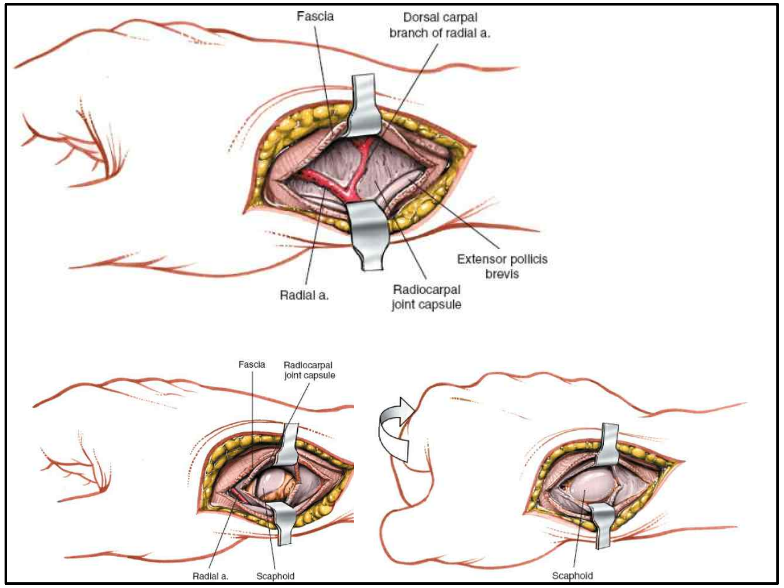


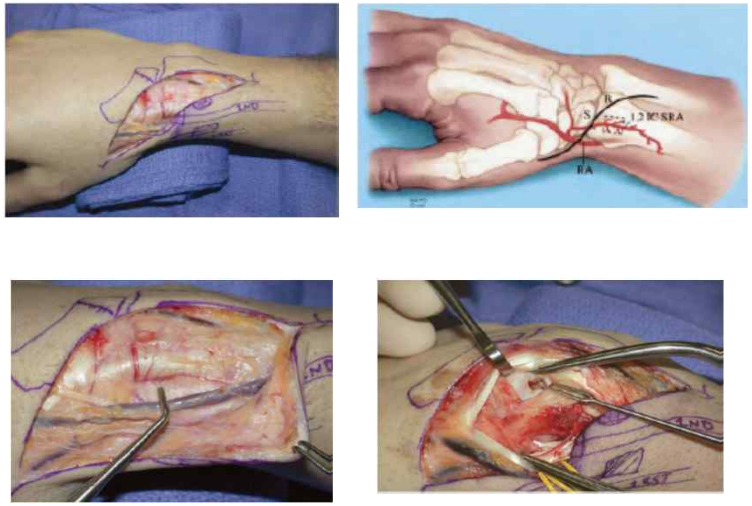




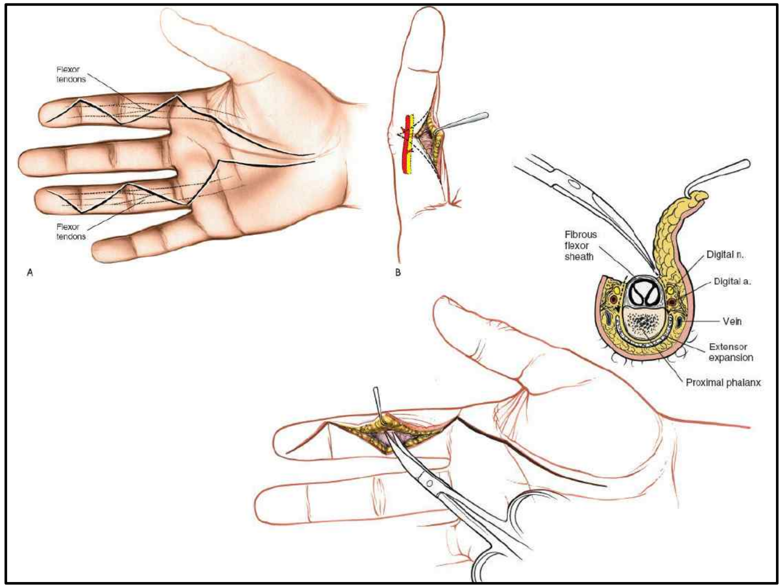
Dorsolateral Approach
to the Scaphoid

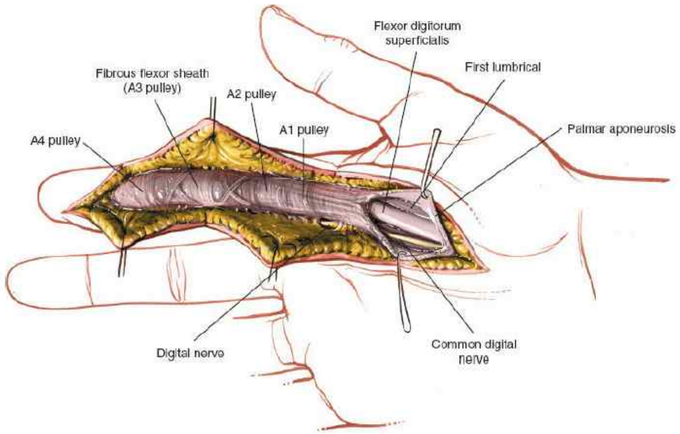




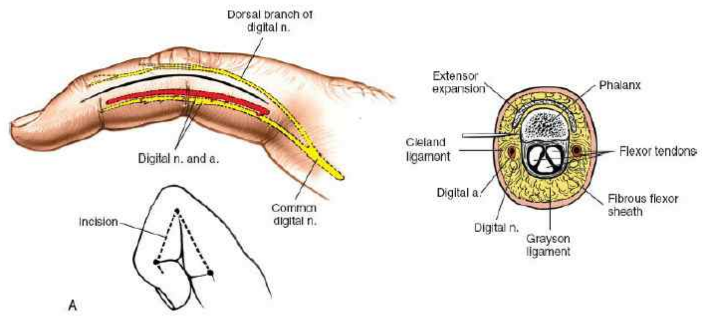


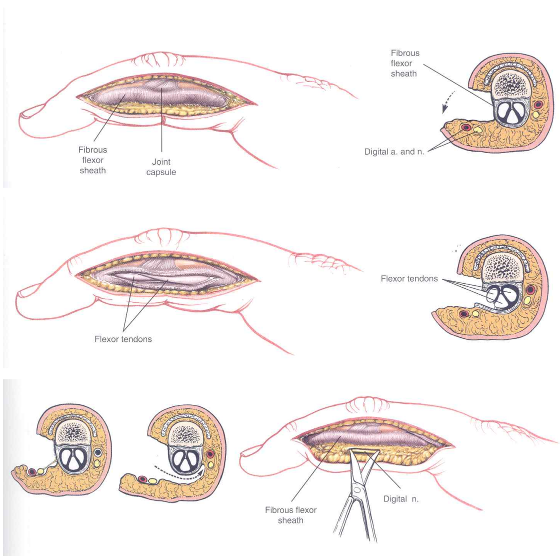
Volar Approach
to the Flexor Tendons





Midlateral Approach to the Finger





Thank you for listening

2023 Anatomy Seminar

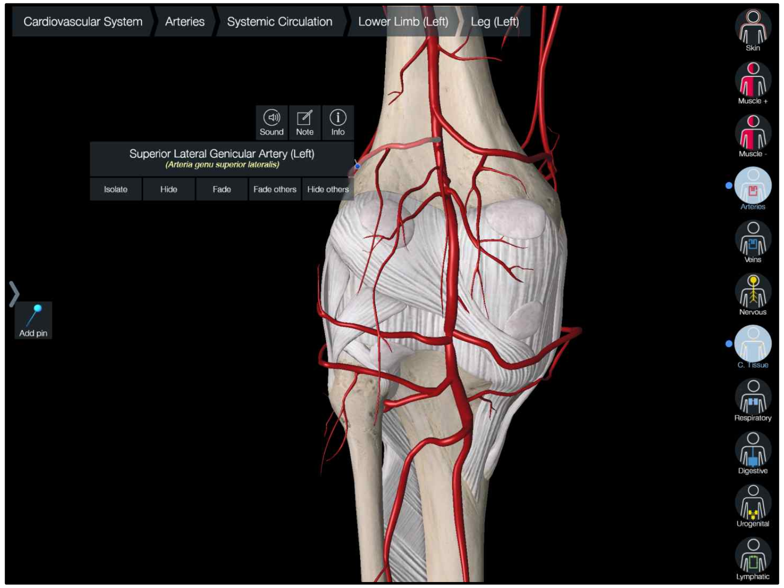
KNEE

ANGIOLOGY & NEUROLOGY

2023.04.27

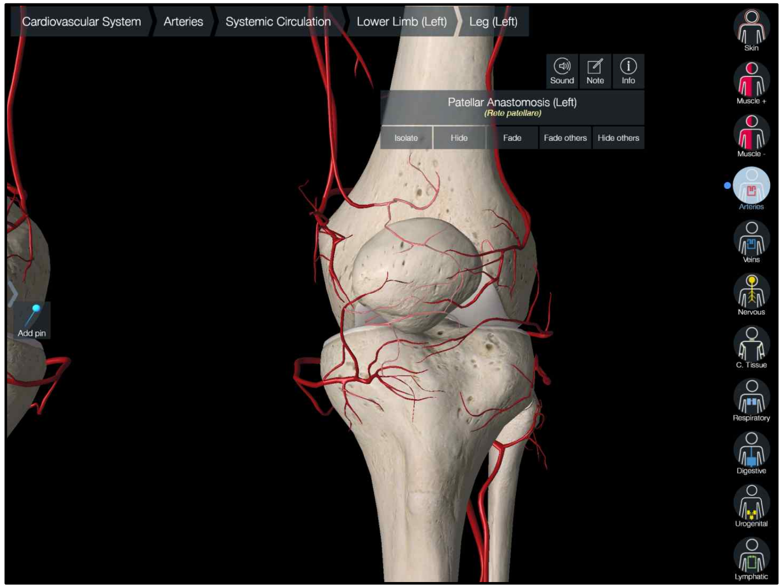
R2 김수영

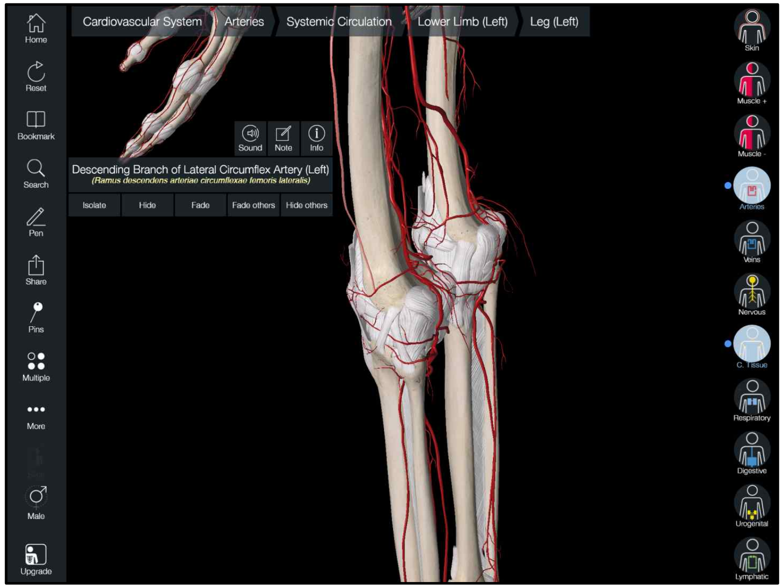
ANGIOLOGY

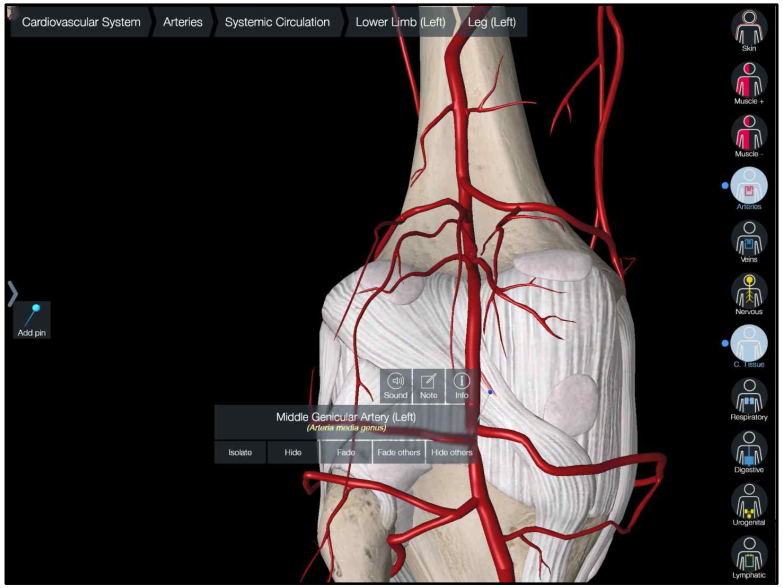


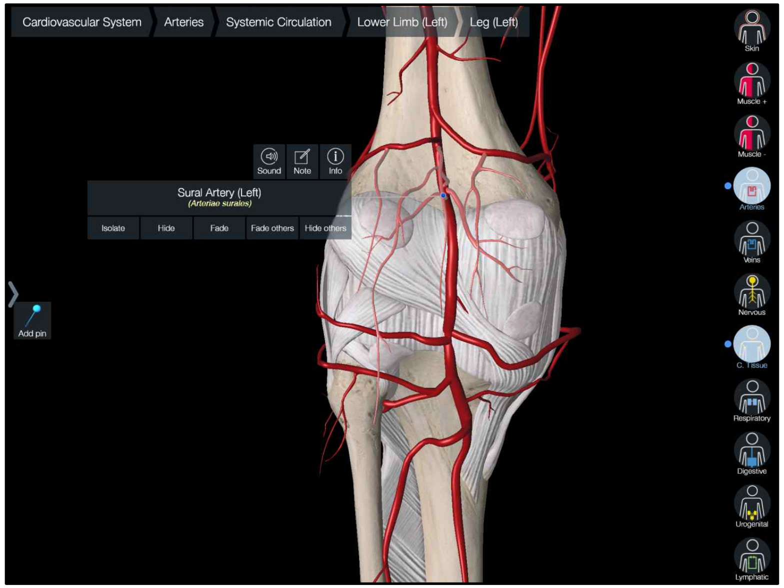

Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Sound
Note
Info
Inferior Medial Genicular Artery (Left)
(Arteria genu inferior medialis)
Isolate
Hide
Fade
Fade others
Hide others
Add pin
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic

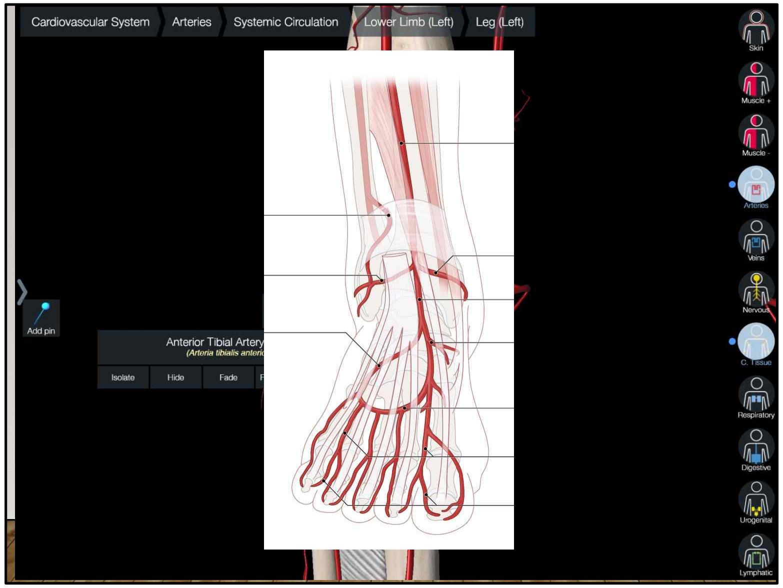

Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Sound
Note
Info
Inferior Lateral Genicular Artery (Left)
(Arteria genu inferior lateralis)
Isolate
Hide
Fade
Fade others
Hide others
Add pin
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic

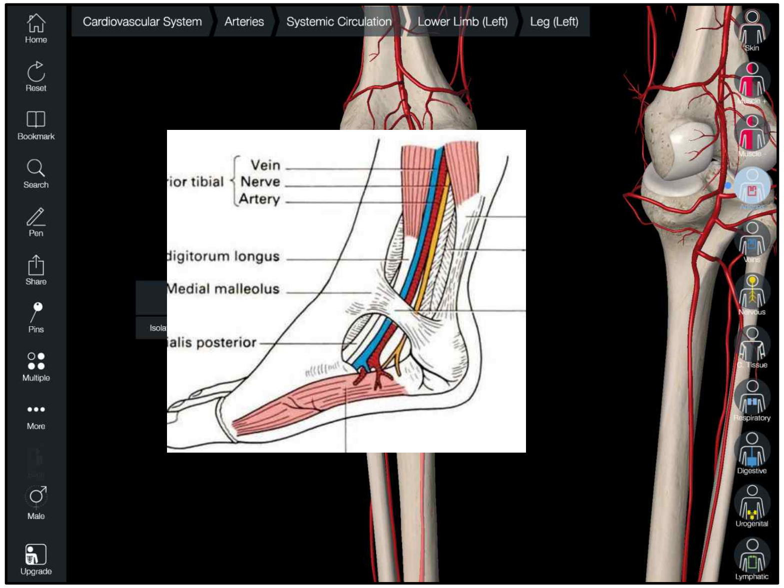

Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Sound
Note
Info
Patellar Anastomosis (Left)
(Rete patellare)
Isolate
Hide
Fade
Fade others
Hide others
Add pin
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic

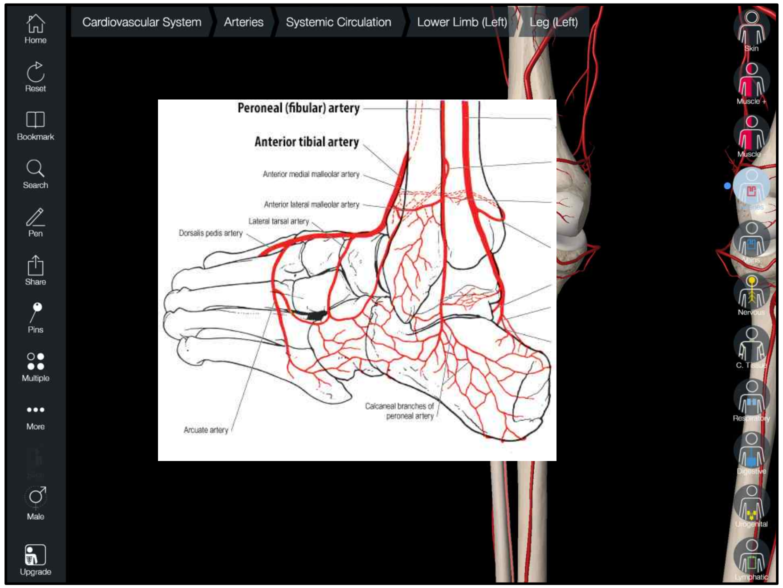

Home
Reset
Bookmark
Search
Pen
Share
Pins
Multiple
More
Male
Upgrade
Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Sound
Note
Info
Descending Branch of Lateral Circumflex Artery (Left)
(Ramus descendens arteriae circumflexae femoris lateralis)
Isolate
Hide
Fade
Fade others
Hide others
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic


Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Add pin
Sound
Note
Info
Middle Genicular Artery (Left)
(Arteria media genus)
Isolate
Hide
Fade
Fade others
Hide others
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic

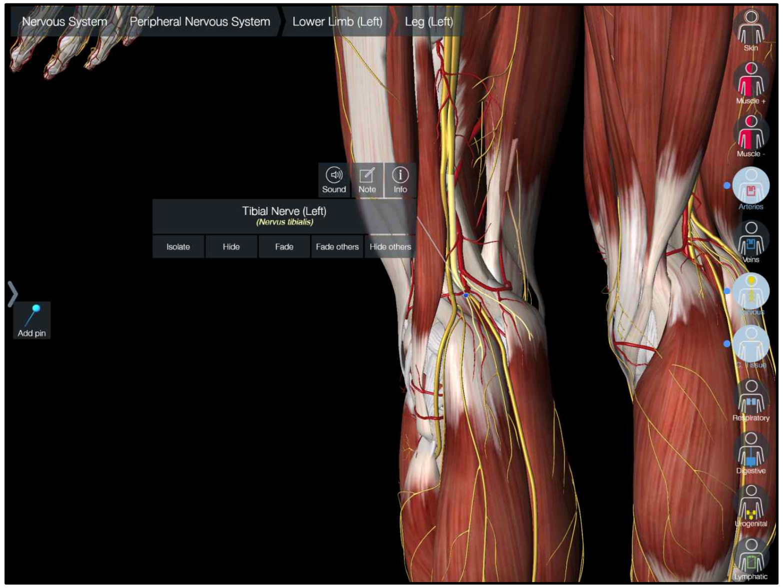

Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Add pin
Sound
Note
Info
Sural Artery (Left)
(Arteriae surales)
Isolate
Hide
Fade
Fade others
Hide others
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic


Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Add pin
Anterior Tibial Artery
Isolate
Hide
Fade
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic


Home
Reset
Bookmark
Search
Pen
Share
Pins
Multiple
More
Male
Upgrade
Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Vein
Nerve
Artery
digitorum longus
Medial malleolus
alis posterior
Digestive
Urogenital
Lymphatic

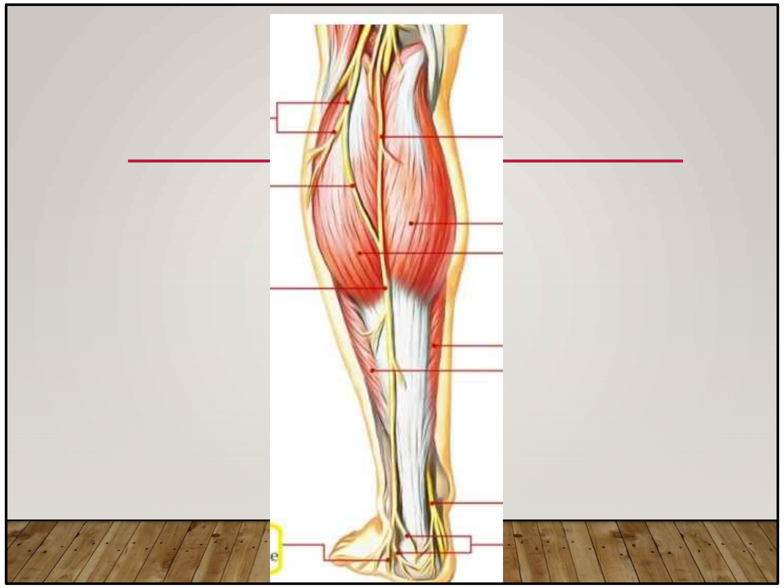

Cardiovascular System
Arteries
Systemic Circulation
Lower Limb (Left)
Leg (Left)
Home
Reset
Bookmark
Search
Pen
Share
Pins
Multiple
More
Male
Upgrade
Peroneal (fibular) artery
Anterior tibial artery
Anterior medial malleolar artery
Anterior lateral malleolar artery
Lateral tarsal artery
Dorsalis pedis artery
Calcaneal branches of peroneal artery
Arcuate artery
Skin
Muscle +

NEUROLOGY


Nervous System
Peripheral Nervous System
Lower Limb (Left)
Leg (Left)
Sound
Note
Info
Tibial Nerve (Left)
(Nervus tibialis)
Isolate
Hide
Fade
Fade others
Hide others
Add pin
Skin
Muscle +
Muscle -
Arteries
Veins
Respiratory
Digestive
Urogenital
Lymphatic


Nervous System
Peripheral Nervous System
Lower Limb (Left)
Leg (Left)
Sound
Note
Info
Common Fibular Nerve (Left)
(Nervus peroneus communis)
Isolate
Hide
Fade
Fade others
Hide others
Add pin
Skin
Muscle +
Muscle -
Arteries
Veins
Respiratory
Digestive
Urogenital
Lymphatic


Nervous System
Peripheral Nervous System
Lower Limb (Left)
Leg (Left)
Skin
Muscle +
Muscle -
Arteries
Veins
Nervous
C. Tissue
Respiratory
Digestive
Urogenital
Lymphatic
Add pin
Sound
Note
Info
Saphenous Nerve (Left)
(Nervus saphenus)
Isolate
Hide
Fade
Fade others
Hide others

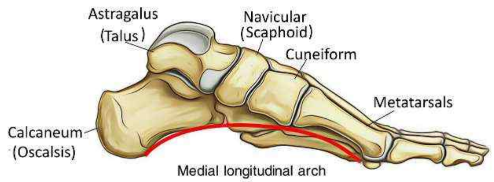


Flat foot

Date : 2023-04-28
R2. 김수영

Definition

- Flat foot = Pes planus
- Foot with no or very low medial longitudinal arch



Characteristics

- Hindfoot valgus
- Midfoot abduction at the midtarsal joint
- Forefoot pronation, primarily at the midtarsal joint

FIGURE 83.1 **A,** Patient with asymmetric pes planus. **B,** Talus slides distally, medially, and plantarward with loss of posterior tibial tendon and probable insufficiency of plantar calcaneonavicular ligament. **C,** Long-standing deformity. Achilles tendon contracture exacerbates heel valgus. **D,** In sitting position, when asked to hold foot in plantarflexion-inversion after being placed there passively by examiner, patient unconsciously used anterior tibial tendon. Also note increased supination (forefoot varus relative to longitudinal axis of calcaneus).

원인 및 병적 기전

- 발의 발달 과정
  - 출생 시 : 두꺼운 지방층, 관절의 과유연성으로 편평함
  - 2~3세 : 활발이 걷기 시작하면서 내측 세로 궁 발달
  - 4~5세 : 내측 세로 궁 자발적 형성

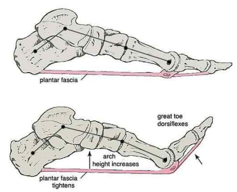
  **5~20% 성인될 때 까지 편평족으로 남는다

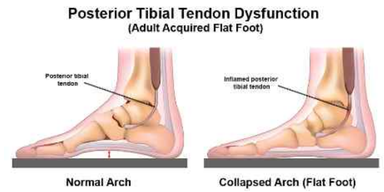
- 원인
  - 대부분 알 수 없다
  - 소아 : 족근골 결합, 부 주상골, 선천성 수직 거골, 대부분 flexible
  - 성인 : 어릴때 발생한 편평족 변형이 남은 경우
    외상 후 변형, 후 경골 건 기능 부전, 류마티스 관절염,
    아킬레스건 단축, 소아마비, 중추신경계 손상, 신경근육성
    질환, 당뇨에 의한 신경성 관절증

Classification

세로 궁의 유연성에 따라

- 유연성 (flexible) : 체중 부하 시 세로 궁이 소실되지만 제 1족지 배굴시킬 때 감아올림 기전(windlass mechanism) → 세로 궁 형성
  : Functioning posterior tibial tendon
- 강직성 (rigid) : 체중 부하와 관계없이 항상 족저부가 편평함
  : Posterior Tibial tendon insufficiency





Symptoms & Diagnosis

- Inspection
  - Hindfoot valgus
  - Midfoot abduction at the midtarsal joint
  - Forefoot pronation, primarily at the midtarsal joint
- Foot & ankle fatigue
- Pain : medial at first but localizes laterally
  - Anterior surface of the lateral process of the talus impinges on the floor of the sinus tarsi

Symptoms & Diagnosis

- **Single heel rise test**
- Examiner should have the patient toe-stand while holding on to the examiner or the examining table for balance only and not support
- Gradually rising on only the affected foot to the tip-toe position
- Inverting the heel at the end stage without concomitant external support is not possible for a patient with complete loss of continuity of the tendon

Symptoms & Diagnosis

- **Silfverskiöld test**

- Contracture of the gastrocnemius or gastrocsoleus complex frequently accompanies this condition early in the course of the disease.
- The hindfoot valgus position shortens the moment arm for the heel cord, leading to the contracture.
- By preventing dorsiflexion and inversion, the contracture further worsens the hindfoot valgus.

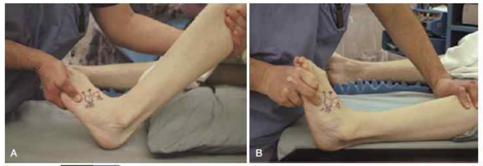


FIGURE 83.5 Silfverskiöld test to determine selective gastrocsoleus muscle tightness and contracture. Passive range of dorsiflexion of ankle is measured with knee flexed **(A)** and extended **(B)**. Significant reduction of dorsiflexion with knee extended may indicate need for gastrocnemius recession.

Radiologic findings

- 기본적으로 모든 검사는 체중 부하 후 촬영
- Foot series , ankle series
- CT
- MRI

- In a normal foot : the talus–first metatarsal angle is 0 to 10 degrees on a standing lateral view : An increased angle indicates loss of the medial longitudinal arch
- Overlapping metatarsals or loss of height of the medial cuneiform also indicates depression of the medial longitudinal arch
- Loss of the calcaneal pitch angle : indicate both loss of the longitudinal arch and contracture of the gastrocsoleus complex
- The standing lateral tibial-calcaneal angle has been found to be significantly increased in adults with flatfeet and Achilles tendon contracture

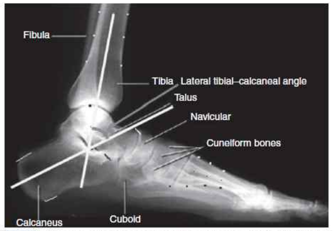


FIGURE 83.6 **Measurement of standing lateral tibial-calcaneal angle (see text).** (From Arangio GA, Wasser T, Rogman A: The use of standing lateral tibial-calcaneal angle as a quantitative measurement of Achilles tendon contracture in adult acquired flatfoot, *Foot Ankle Int* 27:685, 2006.)

FIGURE 83.7 Incongruency angle is determined by drawing line joining lateral extent of talar articular surface *(point A)* and lateral extent of navicular surface *(point B)*. Second line is drawn between lateral aspect of talar neck at its narrowest segment *(point C)* and lateral extent of talar articular surface *(point A)*. Distal and lateral interval between these two lines forms incongruency angle. **A,** Incongruency angle in normal foot. **B,** Incongruency angle in type IIb flatfoot deformity. (From Ellis SJ, Yu JC, Williams BR, et al: New radiographic parameters assessing forefoot abduction in the adult acquired flatfoot deformity, *Foot Ankle Int* 30:1168, 2009.)

FIGURE 83.8 Depiction of hindfoot alignment angle measurements taken on a patient with flatfoot (A) and normal control patient (B). (From Williamson ERC, Chan JY, Burket JC, et al: New radiographic parameter assessing hindfoot alignment in stage II adult-acquired flatfoot deformity, *Foot Ankle Int* 36:417, 2015.)

MRI

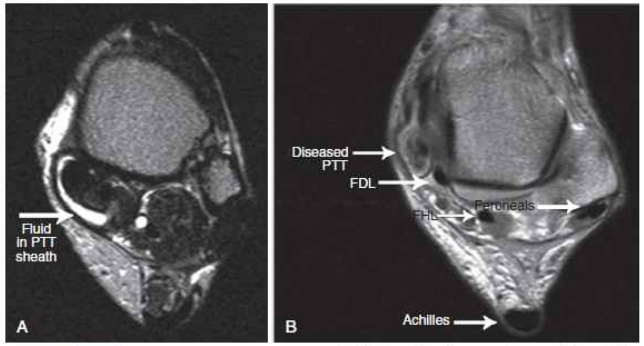


FIGURE 83.9 Magnetic resonance imaging is helpful to identify peritendinous effusion (A) and degeneration within the tendon (B).

치료

- 증상이 없는 편평족
  - 3~4세 : 치료 불필요
  - 3~9세 : 경과관찰
  - 교정신발, 내재근 강화 운동

→ 증상이 없는 편평족 치료 불필요

치료

- 증상이 있는 유연성 편평족
  1) 보존적 치료 : 내측 후족부 쐐기 삽입물, 주상골패드 착용, 정형화된 보조기(UCBL)
  2) 수술적 치료 :
     ㄱ) 종골 내측 전위 골절술(medial sliding calcaneal osteotomy)
     : 종골 결절을 내측으로 이동시켜 체중 부하의 축을 재정렬
     ㄴ) Evans의 종골 연장술(lateral column legthening osteotomy)
     : 거골하 관절의 전방과 중간 소관절 사이에서 절골술
     ㄷ) 관절 유합술
     : 변형 교정에 효과적이나 인접 관절의 퇴행성 관절염 발생 등의 문제

치료

- 강직성 편평족
  - 관절염과 변형을 동반한 경우 많다
  - 관절 유합술(삼중 관절 유합술) 많이 사용

TABLE II Myerson Modification of Johnson and Strom Classification of Adult-Acquired Flatfoot Deformity

Stage	Description
I	Mild medial pain and swelling with no deformity, can perform heel-rise test but demonstrates weakness on repetition, tenosynovitis on pathology with normal tendon length
II	Moderate pain with or without lateral pain, flexible deformity, unable to perform heel-rise test, elongated tendon with longitudinal tears
IIA	<30% talar head uncoverage
IIB	>30% talar head uncoverage
III	Severe pain, fixed deformity, unable to perform heel-rise test, visible tears on pathology
IV	Lateral talar tilt
IVA	Flexible ankle valgus without severe arthritis
IVB	Fixed ankle valgus with or without arthritis

치료

- 보존적 치료
  - 1기, 2기는 깔창사용, 6~8주간 부목고성
  - 재활운동(비골건의 강화운동, 아킬레스 건 신연 운동)
- 수술적 치료
  - 1기 : 후경골 건 부전 : 경골 건의 할액막 절제술 (tenosynovectomy)
  - 2A : 종골 내측 전위 절골술
  - 2B :외측 주 연장술 (controversal)
  - 3기 : 관절 유합술
  - 4기 : 인공관절 전치환술 혹은 관절 유합술

referense

- 대한정형외과학 8th ,2020, 대한정형외과 학회

Arthrogenic Muscle Inhibition (AMI)

명지병원 정형외과
R3. 이준우

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

Introduction

- **Dr. Pierre Chambat's** interest in "flexion contracture" back in 1999
- Unexplained, inconsistent an extension deficit in patients
- Hypotonic vastus medialis oblique (VMO)
  → reflex contracture of hamstring muscles
- Extension deficit → walking abnormalities, proprioception, atrophy and chronic weakness of the quadriceps, stiffness, arthrofibrosis, early arthrosis
- Regain full extension contractions of the VMO through simple exercises

---

Introduction

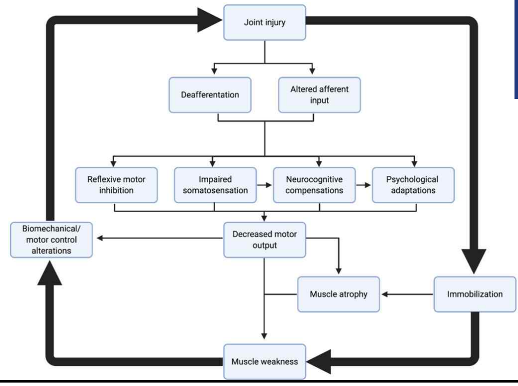
- What is AMI?
- 손상 (외상 혹은 수술) 받은 관절 주변의 손상되지 않은 근골격계의 신경학적 억제
- 즉, 우리 몸의 방어 기제이다.
- 무릎 : 대퇴사두근, 발목 : 비골근

- AMI is observed in patients with OA, RA, anterior knee pain, patella contusion, following anterior cruciate ligament (ACL) rupture and reconstruction, after meniscal damage and menisectomy, and in patients who have undergone knee joint arthroplasty

---

Introduction

- AMI is most severe in the first few days after joint damage before reducing somewhat, plateauing in the medium term (up to 6 months), and then slowly declining in the longer term (18-33 months)



Mechanisms of Arthrogenic Muscle Inhibition

in Journal of Sport Rehabilitation
Click name to view affiliation
Adam S. Lepley and Lindsey K. Lepley
DOI: https://doi.org/10.1123/jsr.2020-0479
Keywords: muscle weakness; reflex inhibition; corticospinal excitability; somatosensation; motor control
First Published Online: 01 Sep 2021
In Print: Volume 31: Issue 6 Page Range: 707–716

Mechanism of AMI

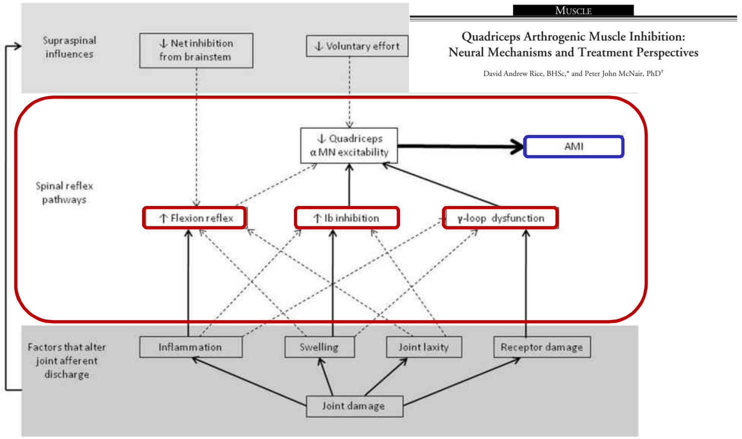
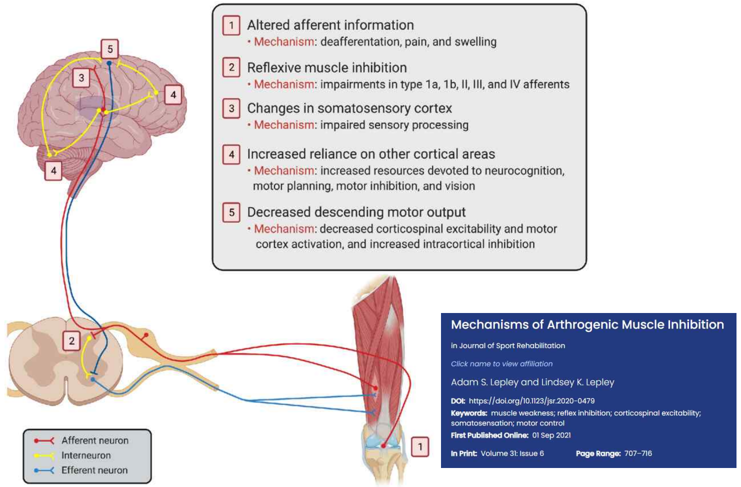


Figure 1 Schematic diagram summarizing the proposed mechanisms contributing to quadriceps arthrogenic muscle inhibition (AMI). Solid lines are mechanisms with stronger evidence to support their existence.

Mechanism of AMI

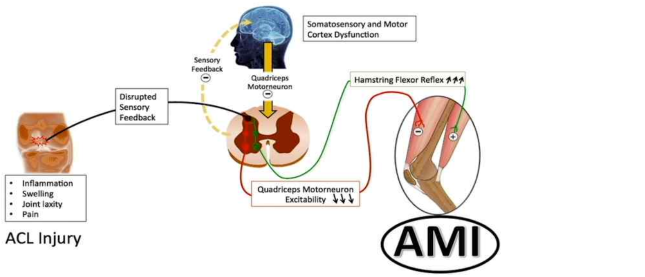


Mechanism of AMI

▣ ACL rupture → pain, laxity, hemarthrosis or something else → trigger the AMI

▣ 3 levels of interaction

- First at the local level: the affected joint
  → Activation of afferent pathways
  → Stimulating the frontal cortex at the origin of the quadriceps inhibition
  → Finally activation of the spinal reflex cause reflex contraction of the hamstrings

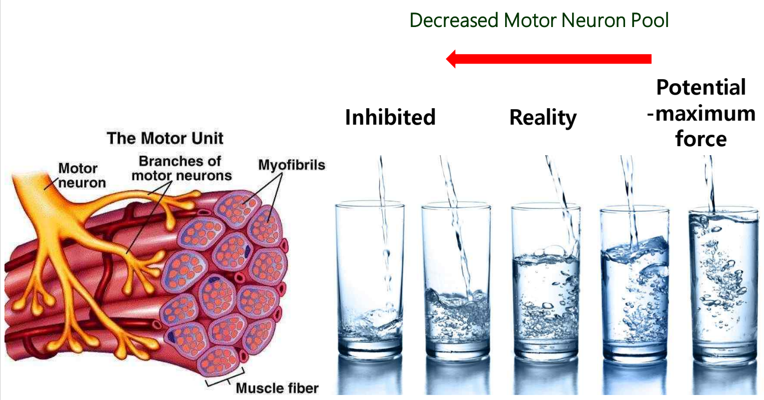


Mechanism of AMI

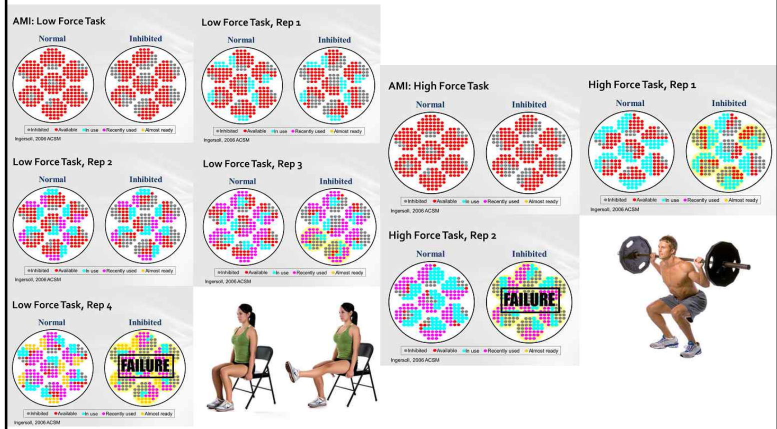
▣ Aspiration

- 1250460 이O훈 M/50
- OP : A/S MM partial meniscectomy + PFJ chondroplasty, knee, both.
- Chief complaint : Sudden Rt. knee pain with stiffness (extension deficit) on POD#1

Mechanism of AMI



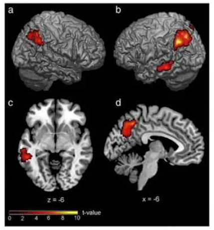
Mechanism of AMI



Functional brain MRI with AMI

▣ 2019.10 – 2022.5 / 28 patients with an ACL rupture in the 4 weeks

▣ A mean age of 24 years with right-handed patients with a recent rupture of ACL of the left knee



▣ Patients with and without motor inhibition

▣ Functional MRI of the three weeks after accident

▣ Significant difference in activation of motor regions in the motor inhibition population
→ The putamen, the superior motor area, and the Insula

Proportion of AMI in ACL rupture

▣ 2021.10 – 2022.2 / 300 patients with ACL rupture in the first six weeks

▣ 56% of patients with a recent ACL rupture had motor inhibition
(Grade 1 – 50% / Grade 2 – 50%)

▣ **80%** of patients were Grade 1 or 2 “**A**”, reducible with a few simple exercises in the consultation room

▣ Patients who had already undergone ipsi or contralateral ACL surgery were 40 times less likely to have AMI

Classification

▣ **Classification of AMI**

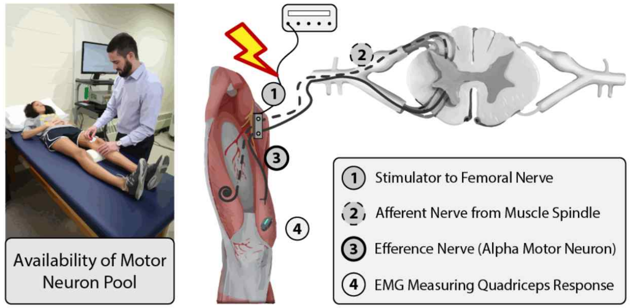
- **Grade 1(1A, 1B) :** motor inhibition of the VMO
- **Grade 2(2A, 2B) :** inhibition of the VMO associated with a reflex contracture of the hamstrings
- **Grade 3 :** Grade 2 for several months, retraction of the posterior capsule, the extension deficit becomes chronic and irreducible
  → extensive posterior arthrolysis is the only treatment

A : when we can remove this reflex mechanism during consultation by the exercises

B : when the removal of this reflex mechanism is not possible during consultation and specific and often long term management by trained physiotherapists is necessary

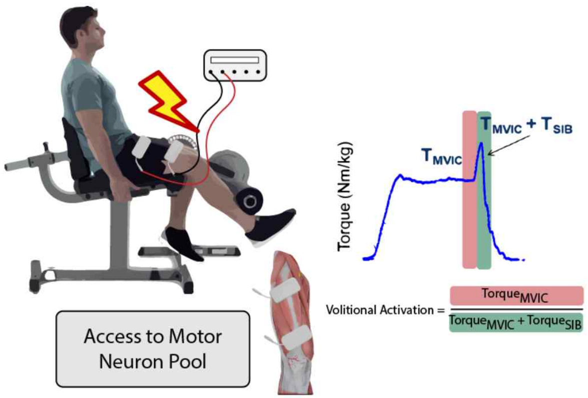
Diagnosis

▣ Hoffmann Reflex to assess motor neuron pool availability



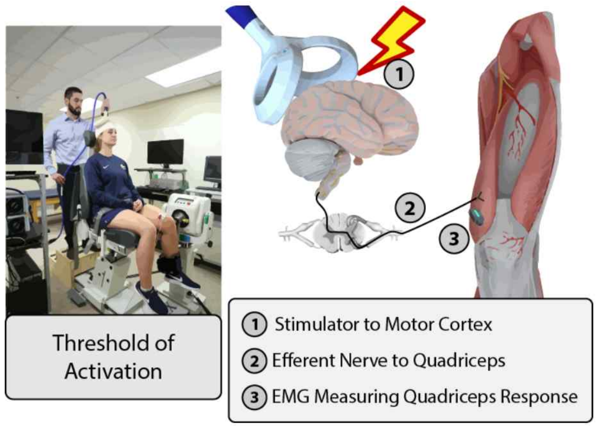
Diagnosis

▣ Superimposed Burst Technique to assess volitional activation

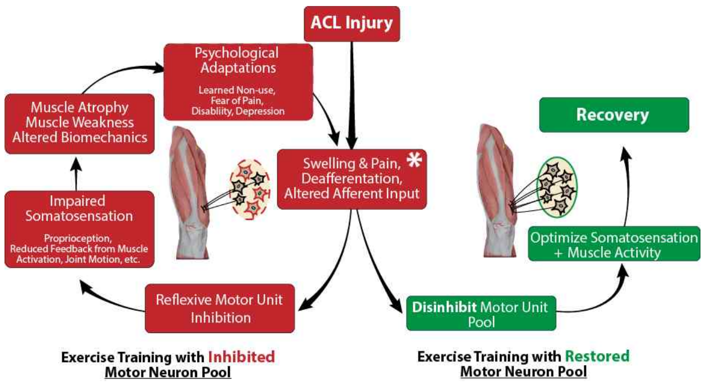


Diagnosis

▣ Transcranial Magnetic Stimulation to assess cortical inhibition



Management



First, Disinhibition

Management

Arthrogenic muscle inhibition after ACL reconstruction: a scoping review of the efficacy of interventions BJSM, 2019

Bertrand Sonnery-Cottet,[1] Adnan Saithna,[2,3] Benedicte Quelard,[4] Matt Daggett,[5] Amrut Borade,[1] Hervé Ouanezar,[1] Mathieu Thaunat,[1] William G Blakeney[1,6]

Therapeutic Interventions- Level of Action

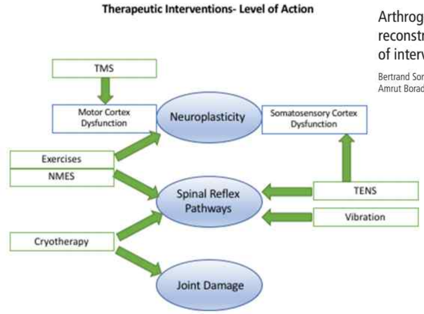


Figure 2 Therapeutic interventions for arthrogenic muscle inhibition and their level of action. NMES, neuromuscular electrical stimulation; TENS, transcutaneous electrical nerve stimulation; TMS, transcranial magnetic stimulation.

Table 3 GRADE table

	Risk of bias	Inconsistency	Indirectness	Imprecision	GRADE score
Cryotherapy	Negligible	Negligible	Serious*	Negligible	Moderate
Exercise	Serious†	Negligible	Negligible	Negligible	Moderate
NMES	Serious‡	Serious§	Negligible	Negligible	Low
TENS	Negligible	Serious§	Serious¶	Negligible	Low
Vibration	Negligible	Negligible	Serious**	Very serious††	Very low
Ultrasound	Negligible	Negligible‡‡	Serious§§	Very serious¶¶	Very low

Management

■ **Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure**

How to Rapidly Abolish Knee Extension Deficit After Injury or Surgery: A Practice-Changing Video Pearl From the Scientific Anterior Cruciate Ligament Network International (SANTI) Study Group

Jean-Romain Delaloye, M.D., Jozef Murar, M.D., Mauricio González Sánchez, M.D., Adnan Saithna, B.Med.Sci.(Hons), M.B.Ch.B., Dip.S.E.M., M.Sc., F.R.C.S.(Tr&Orth), Hervé Ouanezar, M.D., Mathieu Thaunat, M.D., Thais Dutra Vieira, M.D., and Bertrand Sonnery-Cottet, M.D.

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 1: Identification of Quadriceps Activation Failure and Hamstring Contracture**

Fig 1. Knee extension deficit evaluation of right knee (asterisk) with patient in supine position.

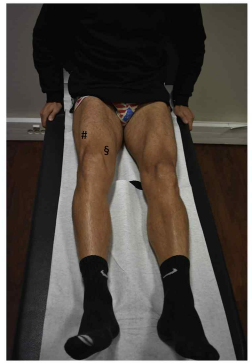


Fig 2. Right quadriceps inactivation with lack of vastus medialis contraction (section sign) and active knee extension deficit. The rectus femoris contraction (pound sign) is maintained with active hip flexion.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 2 : Hamstring fatiguing**

Fig 3. Hamstring fatigue. The patient is asked to repetitively contract against resistance (A) and relax the hamstrings (B). To help fully relax the hamstrings, the practitioner should gently support the foot on its way down to the examination table. A right knee is shown with the patient in the prone position.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 2 : Hamstring fatiguing**

Fig 4. Full knee extension (asterisk) recovery after hamstring fatigue. A right knee is shown with the patient in the prone position.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 2 : Hamstring fatiguing**

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 3 : Reactivation of Quadriceps Muscle Contraction**

Fig 5. Passive muscle contraction of quadriceps. The patient is requested to do a heel lift (arrow) and straighten the knee. The practitioner can facilitate the movement by holding the great toe. A right knee is shown with the patient in the supine position.

Management

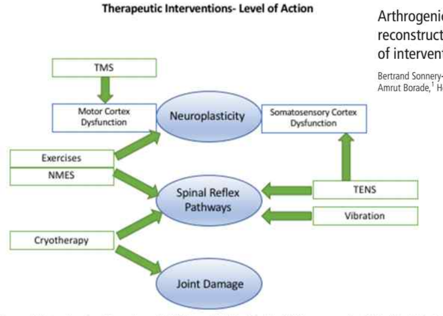
■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 3 : Reactivation of Quadriceps Muscle Contraction**

Fig 6. Active isometric muscle contraction of quadriceps. The patient is asked to contract the muscle without lifting the heel. To check the correct contraction of the muscle, the practitioner should palpate the patella to feel its proximal migration (arrow). A right knee is shown with the patient in the supine position.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management



Arthrogenic muscle inhibition after ACL reconstruction: a scoping review of the efficacy of interventions BJSM, 2019

Bertrand Sonnery-Cottet,[1] Adnan Saithna,[2,3] Benedicte Quelard,[4] Matt Daggett,[5] Amrut Borade,[1] Hervé Ouanezar,[1] Mathieu Thaunat,[1] William G Blakeney[1,6]

Figure 2 Therapeutic interventions for arthrogenic muscle inhibition and their level of action. NMES, neuromuscular electrical stimulation; TENS, transcutaneous electrical nerve stimulation; TMS, transcranial magnetic stimulation.

Table 3 GRADE table

	Risk of bias	Inconsistency	Indirectness	Imprecision	GRADE score
Cryotherapy	Negligible	Negligible	Serious*	Negligible	Moderate
Exercise	Serious†	Negligible	Negligible	Negligible	Moderate
NMES	Serious‡	Serious§	Negligible	Negligible	Low
TENS	Negligible	Serious§	Serious¶	Negligible	Low
Vibration	Negligible	Negligible	Serious**	Very serious††	Very low
Ultrasound	Negligible	Negligible‡‡	Serious§§	Very serious¶¶	Very low

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

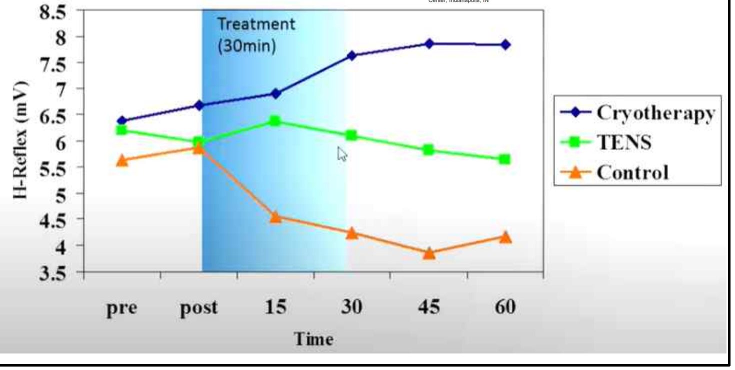
■ **Cryotherapy & TENS**

Journal of Athletic Training 2001;37(1):25–31
© by the National Athletic Trainers' Association, Inc
www.journalofathletictraining.org

Cryotherapy and Transcutaneous Electric Neuromuscular Stimulation Decrease Arthrogenic Muscle Inhibition of the Vastus Medialis After Knee Joint Effusion

J. Ty Hopkins*; Christopher D. Ingersoll†; Jeffrey Edwards†; Thomas E. Klootwyk‡

*Illinois State University, Normal, IL; †Indiana State University, Terre Haute, IN; ‡Methodist Sports Medicine Center, Indianapolis, IN

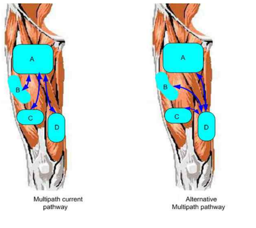


MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ **Isometric quadriceps setting exercise**

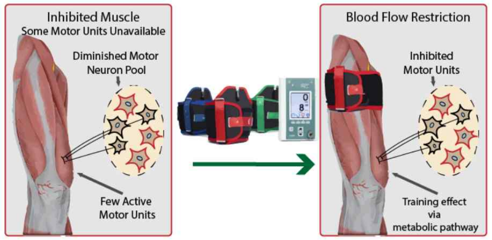
- Quadriceps strength deficits are frequent after knee surgery
- When gross quadriceps weakness, neuromuscular electric stimulation (NMES) is recommended



Management

■ **Blood Flow Restriction Training**

- Benefits with low load = High task



Blood Flow Restrict with Low Resistance Exercise

근육조직에서의 산소결핍

무산소성 대사과정으로 전환
= Type Ⅱ Muscle 동원

IGF-1 Ea
(인슐린유사성장인자 + 국소 성장 인자)

근세포-M-TOR효소 →신호경로 활성화

P70 ribosomal s6 kinase 1,
Ribosomal S6 인산화 증가

단백질 합성의 향상

Management

■ **Blood Flow Restriction Training**

Low-intensity resistance training with blood flow restriction exercise (LRT-BFR)
= **중-저강도**
(2~30% of 1RM)

=

High-intensity resistance training (HRT)
= **고강도**
(70% of 1RM)

Similar effect!!

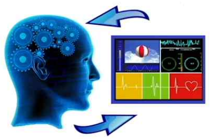
- **Neuromuscular adaptation**
- **Muscle strength**
- **Muscle mass**
- **Functional performance**

Hughes et al. BJSM. 2017
Pereira et al. Int J Phys Med Rehabil. 2019

Management

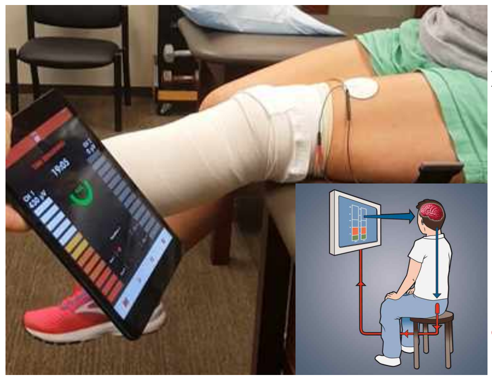
■ The use of an **electrostimulation device with visual control** will allow central stimulation via the eyes

→ **"Biofeedback"** which is used in urology and is very effective for AMI



BIOFEEDBACK

Management



Electromyography
→ Visuomotor feedback
→ Increase cortical motor excitability

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

Conclusion

▣ **Preoperative evaluation of AMI at Myongji hospital**

- **Classification of AMI**

- **Grade 0 —** Normal VMO contraction
- **Grade 1 -** VMO contraction inhibited with no knee extension deficit
  - **1a -** Activation failure reversible within a few minutes of commencing simple active-assisted extension exercises
  - **1b -** Refractory to simple active-assisted extension exercises, requiring longer and specific rehabilitation programs
- **Grade 2 -** VMO contraction inhibited with associated knee extension deficit due to hamstring contracture
  - **2a -** Activation failure and loss of motion reversible within a few minutes of fatiguing the hamstrings and commencing simple active-assisted extension exercises
  - **2b -** Refractory to fatiguing of the hamstrings and/or simple active-assisted extension exercises therefore longer and specific rehabilitation programs required
- **Grade 3 -** Passive chronic extension deficit due to posterior capsular retraction
  - Extensive posterior arthrolysis mandatory with specific preoperative and postoperative rehabilitation programs

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

Conclusion

▣ **Preoperative management of AMI at Myongji hospital**

1. **Exercise (Hamstring fatiguing & Quadriceps muscle contraction)**
2. **Cryotherapy**
3. **Transcutaneous electric neuromuscular stimulation (TENS)**
4. **Neuromuscular electric stimulation (NMES)**
5. **Blood flow restriction training**
6. **Biofeedback – 추후 개발하여 적용**

MYO
SPOR

	Phase 1 (0-3 wks)	Phase 2 (4-6 wks)	Phase 3 (extended)
ROM :			
0-120	O		
0-130		O	
Weight Bearing :			
Tolerable	O		
Modalities :			
Neuromuscular Electrical Stimulation	O	O	O
Blood Flow Restriction	O	O	O
Pain / Swelling Control (Cryotherapy)	O	O	O
Strengthening :			
Q-Set, SLR 4 way	O		
Short Arc Q-set	O		
Active Knee Extension (90-0)		O	
Knee extension machine (90-30)		O	O
Hamstring Curl	O	O	
Wall Sit, Mini Squat, toe raise	O		
Squat, Leg Press		O	O
Split Squat, Lunge		O	O
Single leg squat		O	O
Sidestepping with resistance band		O	O
Proprioception :			
Weight shifting, Single leg balance	O		
Cup walking, Tandem stance	O		
Balance board, Rocker, Roller board, Bosu		O	O
ball		O	O
Perturbation			O
Jump, Plyometric, Agility			

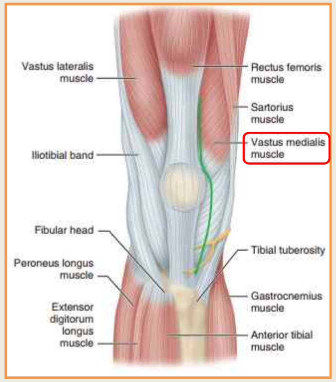
MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

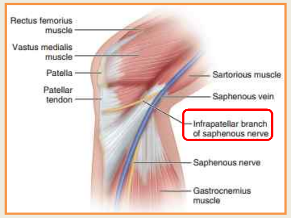
ROM	0-3 wk	4-6 wk	7-12 wk	
	0 - 90º	0 - 120º	0 -130º	Free
WB	0-3 wk	4-7 wk	8wk ~	
	Crutch / Brace (0º Lock) TWB	Brace FWB	Brace off	
M-Strength	0-3 wk	4-6 wk	7-9 wk	10-12 wk
	-Q-muscle Activation -SLR -Bilateral Squat (0-50º, Static)	-Bilateral Squat (Ecc&Con) -Leg extension (90º-45º) -Active Leg curl (No resistance) -Sagittal plane	-Bilateral Lunge -Unilateral foundation exercise -Leg extension -Leg curl(machine)	-Unilateral foundation exercise -Leg extension -Leg curl(machine)
Proprioception	0-3 wk	4-6 wk	7-9 wk	10-12 wk
	weight shifting, Marching	Cup walking, Single Leg Standing Balance board	Single and Double Leg exercise on Balance board	Perturbation
Functional exercise	0-3 wk	4-6 wk	7-9 wk	10-12 wk
	Prepare of Normal Walking	Normal Walking	-Stair -Sagittal, Frontal plane	-Bilateral Landing -Triplanar motion

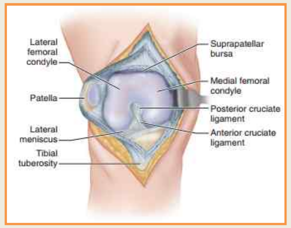
Surgical approach
Knee & Leg

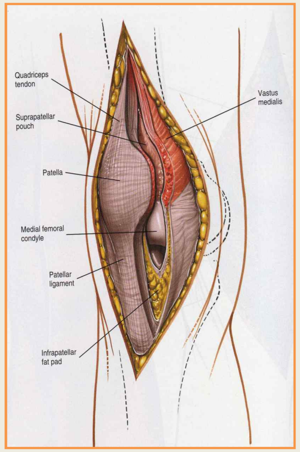
명지병원 정형외과
R3. 이준우

Anteromedial parapatellar approach



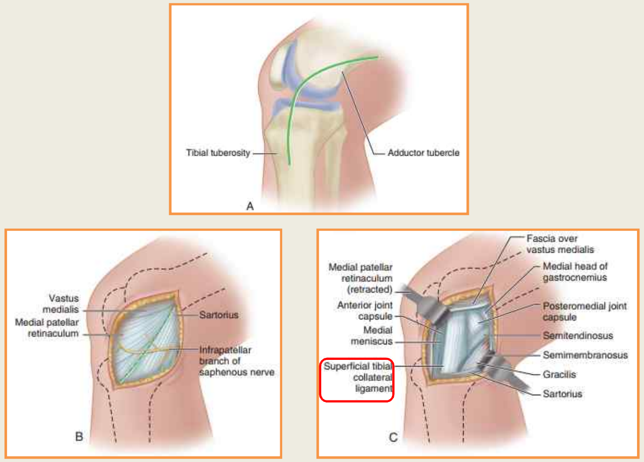


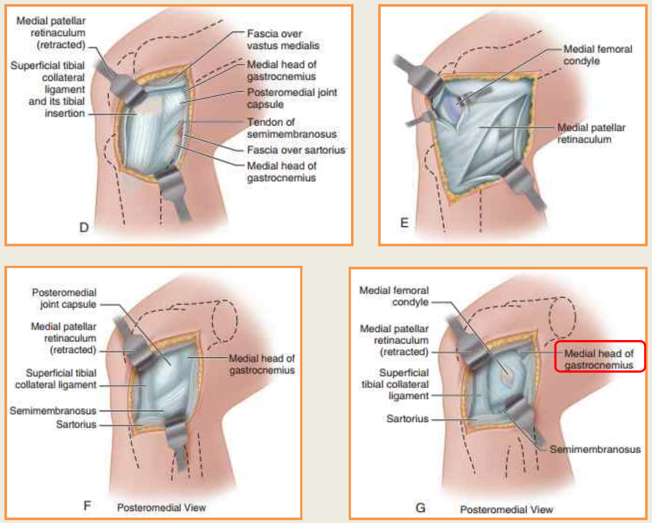




Medial approach to knee and supporting structures

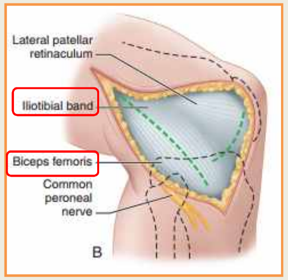
- Sartorius has been retracted posteriorly, exposing semitendinosus and gracilis
- All three components of pes anserinus have been retracted posteriorly to expose posteromedial corner & tibial attachment of tibial collateral ligament
- Medial parapatellar incision has been made through retinaculum and synovium
- Medial head of gastrocnemius has been separated from posterior capsule of knee

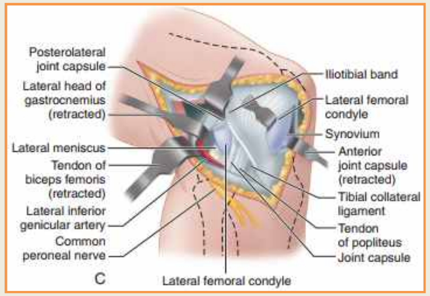




Lateral approaches to knee and supporting structures

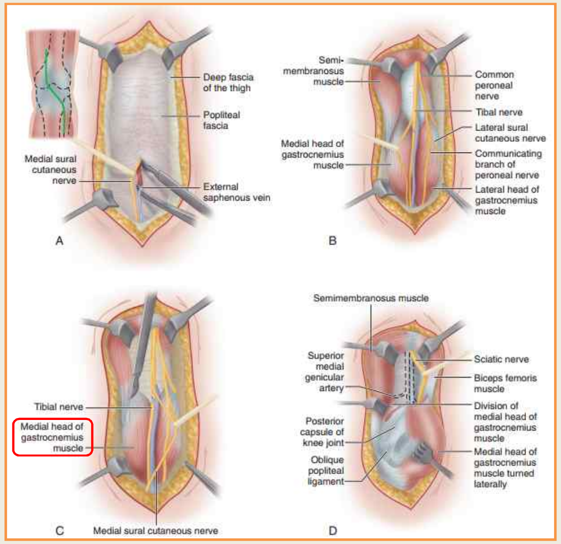
- Incision between biceps femoris and iliotibial band





Posterior approach

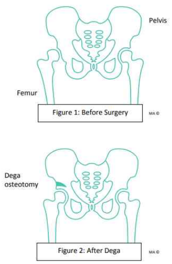
- Posterior curvilinear incision
- Posterior cutaneous nerve of calf exposed and retracted
- Sciatic nerve and its division defined
- Medial head of gastrocnemius muscle exposed
- Tendon of origin of medial head of gastrocnemius muscle divided, exposing capsule of knee joint



Reference

- ▣ Campbells Operative Orthopaedics,13ed (P 41~57)

Pelvic osteotomy
- Dega osteotomy



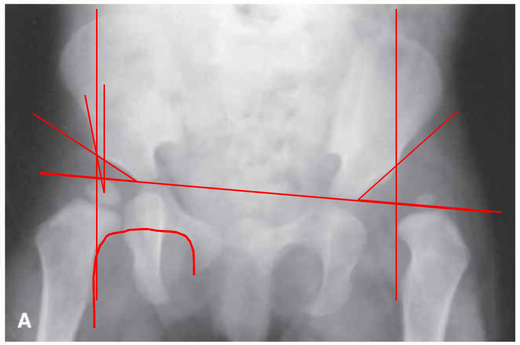
명지병원 정형외과
R4. 이인엘

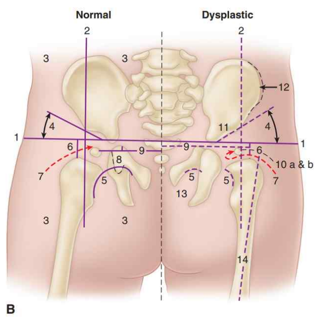
DDH (developmental dysplasia of the hip)

- Subluxation of the femoral head or complete dislocation of the femoral head from the true acetabulum and acetabular dysplasia
- In an older child, the femoral head remains dislocated and secondary changes develops in the femoral head and acetabulum

- Incidence : 1/1000 live births
- Features
  - M < F (70%)
  - Lt. hip joint (60%), bilateral (20%), Rt. hip joint (20%)
  - Risk factor
    - Females
    - Breech deliveries
    - 1st baby
    - Other musculoskeletal abnormalities : congenital torticollis, metatarsus adductus, talipes calcaneovalgus

DDH x-ray (18month~)



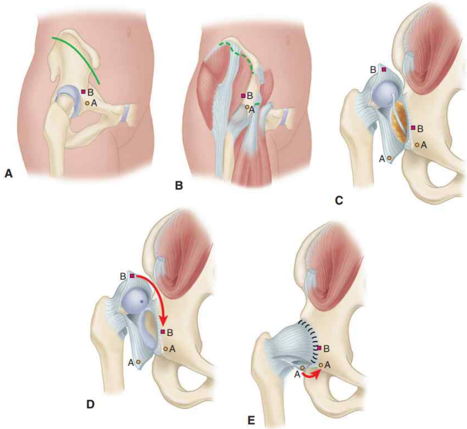


DDH x-ray (18month~)

- DDH x-ray feature
  - Delayed ossification center
  - Head : upward, lat. Displacement
  - Shenton line disruption
  - Acetabular index ↑
  - Center edge angle ↓

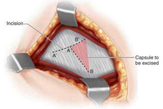
- Petit triad
  - Acetabular index ↑
  - Femoral head developmental Delayed
  - Femoral head H-line ↑
  P-line lat.

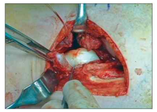
Approach (**anterior**, medial)



- Requires more anatomic dissection but provides greater versatility

1. Bikini incision
2. Division of sartorius and rectus femoris tendons and iliac epiphysis
   * Caution : <u>Lateral femoral cutaneous nerve</u>
3. T-shaped incision of capsule
4. Capsulotomy of hip and use of ligamentum teres to find true acetabulum
5. Reduction and capsulorrhaphy after excision of redundant capsule





Approach (anterior, **medial**)

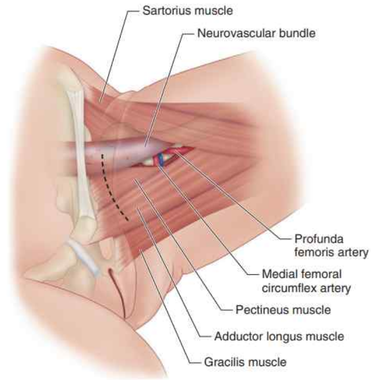


FIGURE 1

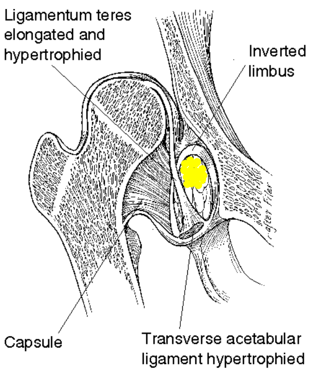
- Ludloff approach

1. Transverse Incision centered at the ant. Margin of the adductor longus, approximately 1cm distal and parallel to the inguinal lig.
2. Open fascia along superior border of the adductor longus. Divide this.
3. Identify ant. Obturator nerve on the surface of the adductor brevis
4. retract pectineus muscle
5. Incise the capsule

Open reduction

- Correct as many of the blocks to reduction
  1) Hourglass constricted capsule
  2) Iliopsoas tendon
  3) Hypertrophied limbus
  4) Inverted labrum
  5) Hypertrophied & elongated ligamentum teres
  6) Transverse acetabular ligament
  7) Excess fibrofatty pulvinar

- The surgeon should strive to correct **all aspects of the deformity in a single surgical** event because revision surgery is challenging



Concomitant osteotomy

1. Hip stable in neutral position → no osteotomy
2. Hip stable in flexion and abduction → innominate osteotomy
3. Hip stable in internal rotation and abduction → proximal femoral de-rotational varus osteotomy
4. "Double-diameter" acetabulum with anterolateral deficiency → Pemberton-type osteotomy

TABLE 30-1 Recommended Osteotomies for Congenital or Developmental Dislocation of the Hip

OSTEOTOMY	AGE	INDICATIONS
Salter innominate osteotomy	18 months-6 years	Congruous hip reduction; <10-15 degrees correction of acetabular index required
Pemberton acetabuloplasty	18 months-10 years	>10-15 correction of acetabular index required; small femoral head, large acetabulum
Steel or Ganz osteotomy	Late adolescence to skeletal maturity	Residual acetabular dysplasia; symptoms; congruous joint
Shelf procedure or Chiari osteotomy	Adolescence to skeletal maturity	Incongruous joint; symptoms; other osteotomy not possible

Contents

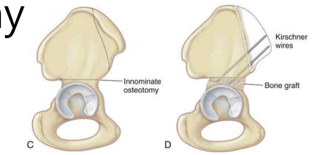
- Osteotomy of the innominate bone
  - **Salter osteotomy**
- Acetabuloplasty
  - **Pemberton acetabuloplasty**
  - **Dega osteotomy**
- Osteotomies that free the acetabulum
  - **Triple innominate osteotomy (Steel)**
  - Pericapsular dial osteotomy (Eppright)
  - Bernese periacetabular osteotomy (Ganz)
- Shelf procedure
  - Staheli

Reconstruction osteotomy

- Salvage operation
  - **Chiari osteotomy**

salvage osteotomy

Salter innominate osteotomy



- ASIS에서 greater sciatic notch로 향하는 osteotomy 시행
- Symphysis pubis를 hinge로 하여 anterolateral을 덮는다.

- Ix
  - 가장 이상적인 나이는 18개월에서 6세
  - 고관절이 congruous, 교정할 acetabular index가 10-15도 이하인 경우 사용

- The entire acetabulum together with the pubis and ischium is rotated as a unit, with the **symphysis pubis acting as a hinge**. The osteotomy is held open anterolaterally by a wedge of bone, and the roof of the acetabulum is shifted more anteriorly and laterally

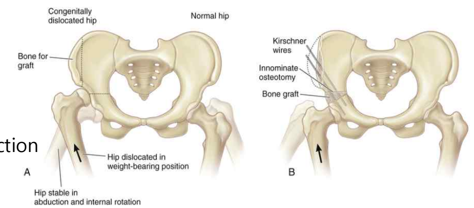
Salter innominate osteotomy

- Prerequisties for the success of the operation

1. Contractures of the iliopsoas and adductor muscles must be released
2. The femoral head must be reduced into the depth of the true acetabulum completely and concentrically
3. The joint must be reasonably congruous.
4. Normal hip joint ROM

- 단점

1. 골두를 충분히 덮기 힘듬
2. 고관절 내 압력을 상승
3. 비구를 외측으로 전위시킴으로 joint reaction force 증가

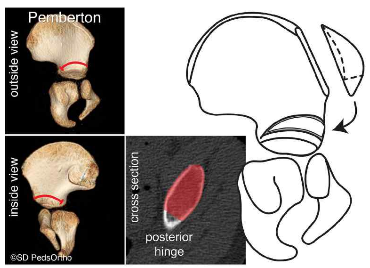


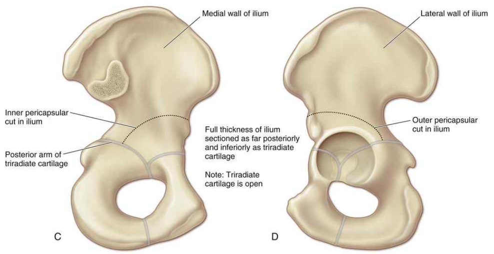
Salter innominate osteotomy

- Residual acetabular dysplasia and subluxation of right hip in 4-year-old girl in whom open reduction had been performed at 9 months of age.
- One year after repeat open reduction and Salter innominate osteotomy

Pemberton acetabuloplasty

- redirect the inclination of the acetabular roof by an osteotomy of the ilium superior to the acetabulum followed by levering of the roof inferiorly





Pemberton acetabuloplasty

- Recommended age : between the age of 1 year and 10 year

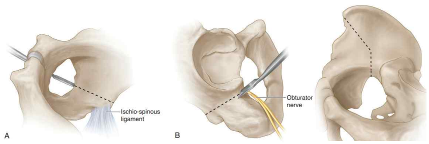
→ when the triradiate cartilage becomes too inflexible to serve as a hinge (about 12 years old in girls and 14 years old in boys)

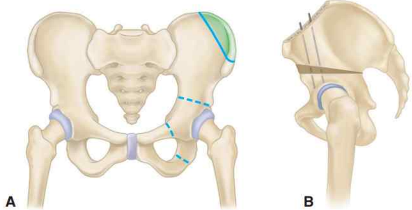
- Advantage
  - Internal fixation is not always required
  - Greater degree of correction

- Disadvantage
  - Technically more difficult
  - Change of capacity & configuration of acetabulum
  - Premature physeal closure risk
  - Join volume decrease

Triple innominate osteotomy (Steel)

- The ischium, the superior pubic ramus, and the ilium superior to the acetabulum all are divided
- The acetabulum is repositioned and stabilized by a bone graft and pins
- for dislocation or subluxation of the hip in older children when this is impossible by any one of the other osteotomies



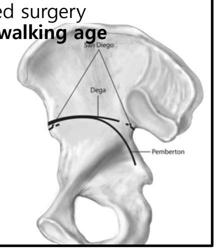


Transiliac (DEGA) osteotomy

- Incomplete transiliac osteotomy
- Osteotomy of the anterior and middle portions of the inner cortex of the ilium
- leaving an intact hinge posteriorly consisting of the intact posteromedial iliac cortex and sciatic notch (hinge : triradiate cartilage)

- This osteotomy is only one component of the comprehensive, complicated surgery required **to treat severe congenital dysplasia of the hip in children of walking age**

- Internal fixation is not always required



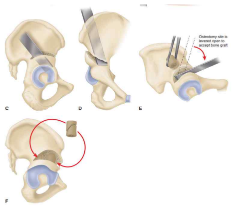
Transiliac (DEGA) osteotomy

Case Presentation: History and Physical

- 11 year old boy with cerebral palsy, spastic quadriplegia GMFCS 4
- Brought by mom for bilateral hip pain, particularly when sitting, and inability to find a comfortable position for him
- He was maintained on G-tube feeding and an ITB pump, which was optimized
- On examination: Windswept lower extremities (right side adducted), hip abduction limited to 20 degrees, popliteal angles less than 20 degrees

Department of Orthopedic Surgery

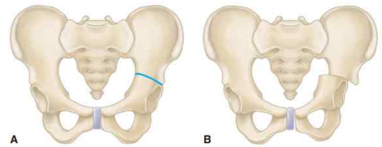
NYU Langone Health



Chiari innominate osteotomy

- Salvage procedure
- a capsular interposition arthroplasty (medial displacement osteotomy)
- only in situations in which other reconstructions are impossible
- improves superolateral femoral coverage

-> 절골한 골반골을 전위시켜 골두를 덮어주는 술식으로 다른 절골술과는 달리 골두 –비구간의 위치가 변하지 않고 아탈구 상태인 고관절에 골두의 체중 부하 면적만을 증가시켜 주는 술식 - 대한정형외과학회 제 8판



Surgical approach

Gluteal & Back of thigh

Myong-ji Hospital
Orthopedics
R3. 이규환

Ant. approach
Ilioinguinal approach to the acetabulum

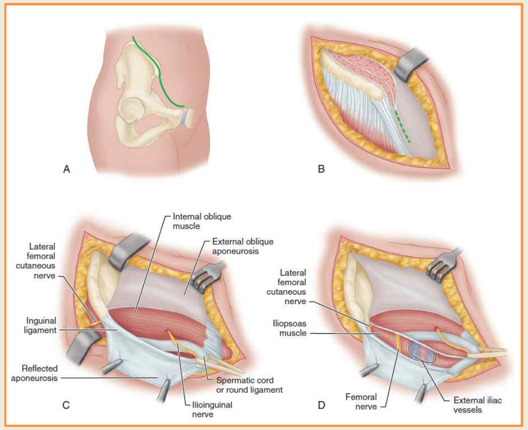
▣ **Indication**

▶ Acetabular ant wall Fx.
▶ Pelvic ant. Column Fx.

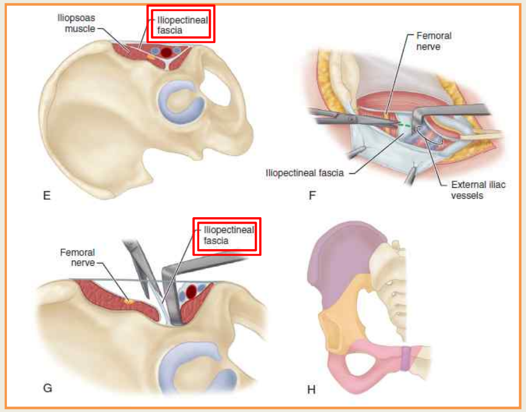
▣ **Procedure**

▶ Skin incision
▶ Expose the internal iliac fossa
▶ Release the muscular attachment from the inguinal ligament
▶ Secure the lateral femoral cutaneous nerve
▶ Develop the iliopectineal fascia
▶ Release the iliopectineal fascia (Lacuna musculorum / Lacuna vasorum)
▶ Expose medial side of acetabulum & Superior pubic ramus

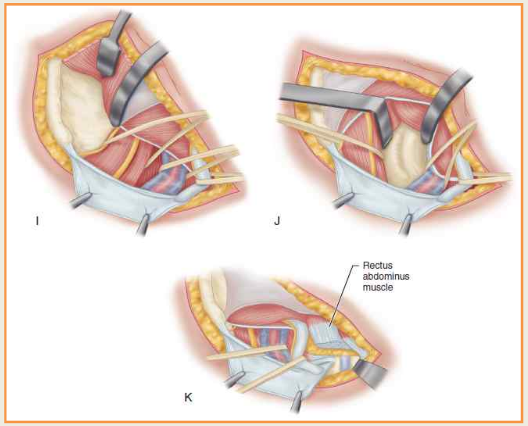
Ant. approach
Ilioinguinal approach



Ant. approach
Ilioinguinal approach



Ant. approach
Ilioinguinal approach



Iliofemoral approach

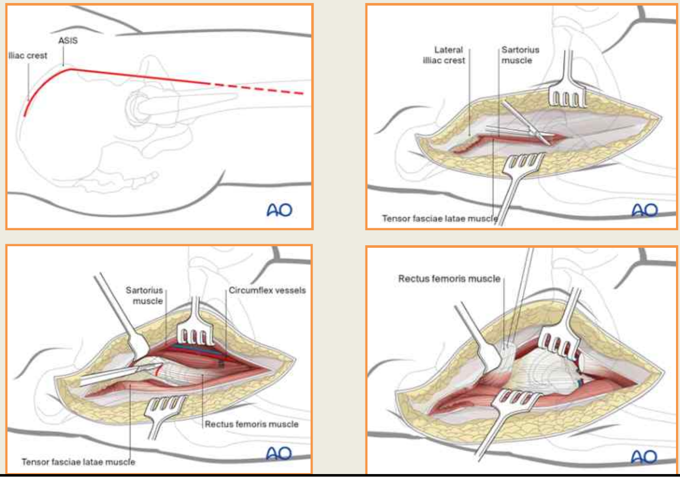
▣ **Indication**

▶ Pelvic ant. Column Fx.

▣ **Procedure**

▶ Skin incision
▶ Develop interval between tensor fascia lata and sartorius
▶ Deep surgical dissection

Iliofemoral approach



Posterior approach
Kocher-Langenbeck technique

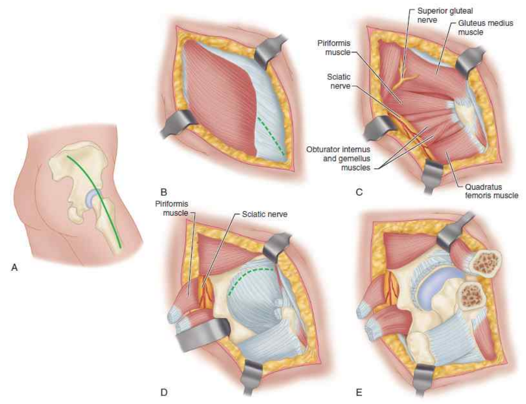
▣ **Indication**

▶ Pelvic post. Column Fx.

▣ **Procedure**

▶ Skin incision
▶ Superficial surgical dissection
: Fascial incision, Split the gluteus maximus, Incise the iliotibial tract
▶ Deep dissection
: Detach the gluteus maximus muscle, Detach the external rotator muscles
▶ Exposure of the posterior wall and column
▶ Trochanteric osteotomy for additional cranial and anterior exposure
▶ Quadratus femoris elevation for additional caudal exposure
▶ Perform a capsulotomy

Posterior approach
Kocher-Langenbeck technique



Modified Kocher approach

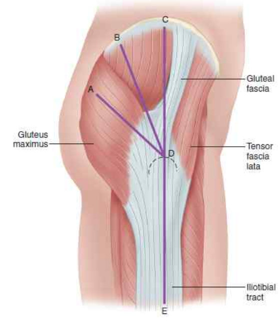


FIGURE 1-95 Modified Kocher approach as described by Gibson. Greater trochanter is dotted line. ADE is the Kocher-Langenbeck incision. BDE is Gibson's original incision. CDE is Moed's modification of the approach. (Redrawn from Moed BR. The modified Gibson posterior surgical approach to the acetabulum, J Orthop Trauma 24:315, 2010.) **SEE TECHNIQUE 1-75.**

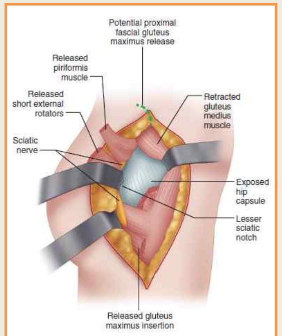


FIGURE 1-96 Deep dissection with gluteus maximus muscle reflected posterior and a retractor in the lesser sciatic notch. Retract the gluteus medius muscle in an anterior direction to expose the hip joint. (Redrawn from Moed BR. The modified Gibson posterior surgical approach to the acetabulum, J Orthop Trauma 24:315, 2010.) **SEE TECHNIQUE 1-75.**

Reference

▣ Campbells Operative Orthopaedics,13ed
P 80 ~ 103

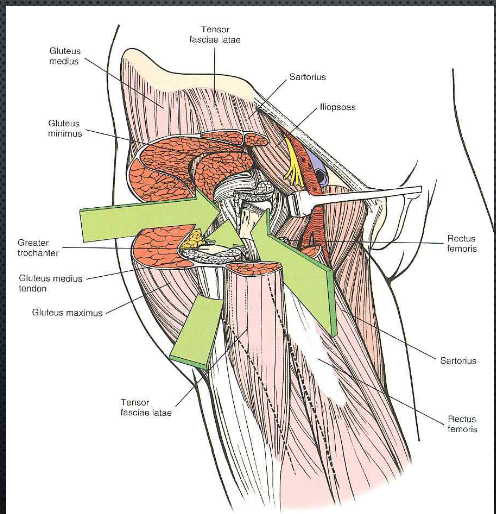
▣ https://surgeryreference.aofoundation.org

Anatomy Seminar

HIP & FEMUR
- SURGICAL APPROACH -

명지병원 정형외과
R3. 이 규 환

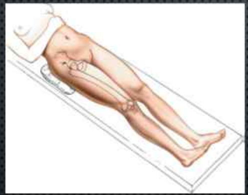
SURGICAL APPROACH OF THE HIP



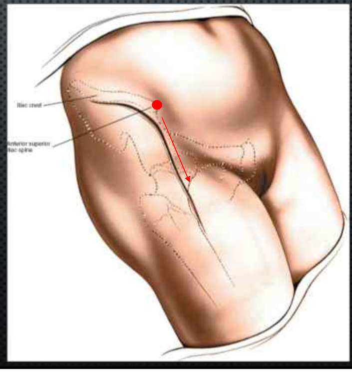
ANTERIOR APPROACH

ANTERIOR APPROACH
< SMITH-PETERSON APPROACH >

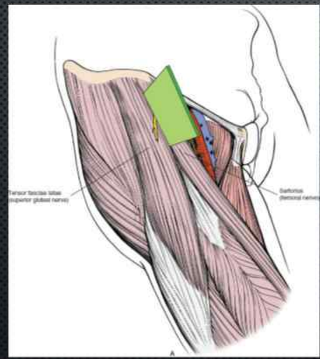
Supine position



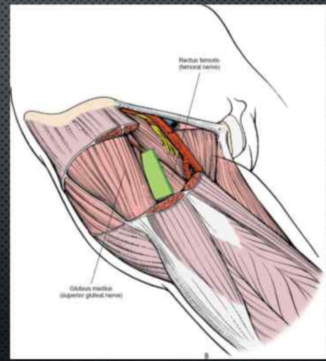
Skin incision : Iliac crest → ASIS
from there vertically for some 8 to 10cm



INTERNERVOUS PLANE

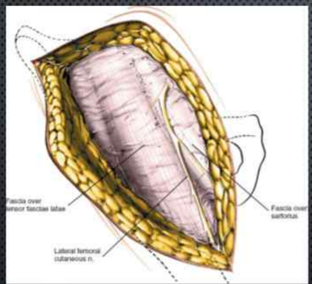


Sartorius (femoral n.)
Tensor fasciae latae (sup. gluteal n.)

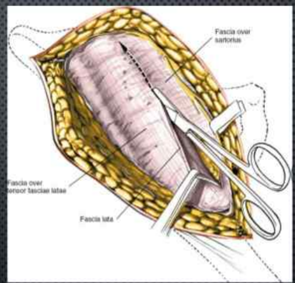


Rectus femoris (femoral n.)
Gluteus medius (sup. gluteal n.)

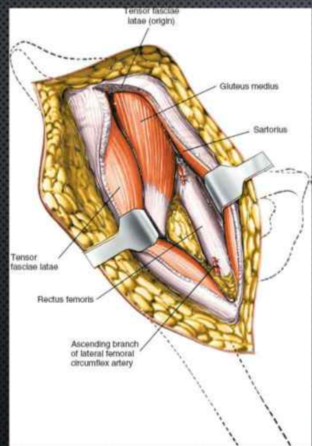
SUPERFICIAL DISSECTION



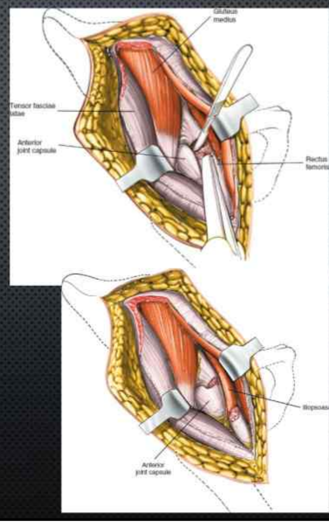
Danger : Lateral femoral cutaneous n.

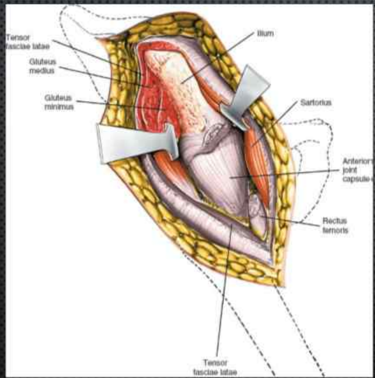


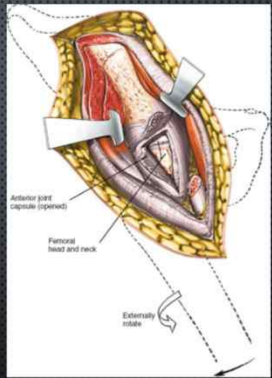
Incise the deep fascia on the medial side of the tensor fasciae latae



lat. femoral circumflex a.



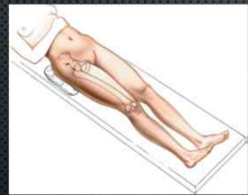




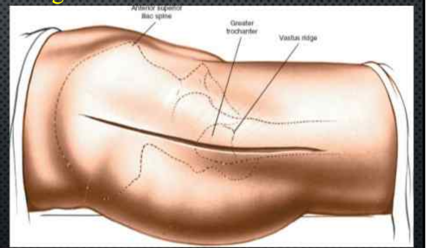
Detach : gluteus medius & minimus
Incise (T-shaped) : hip joint capsule -> femoral head & neck

ANTEROLATERAL APPROACH
< WATSON-JONES APPROACH >

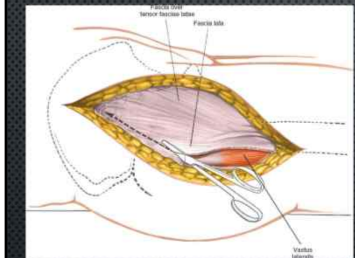
Supine position



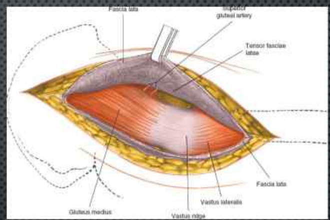
Skin incision : straight longitudinal incision 8 to 15cm centered on the tip of the greater trochanter

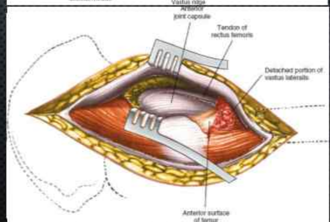


SUPERFICIAL DISSECTION



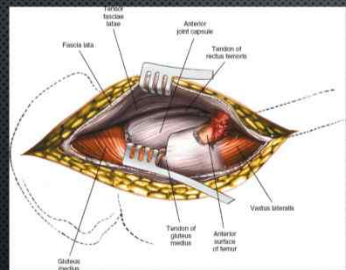
Incise the fascia lata





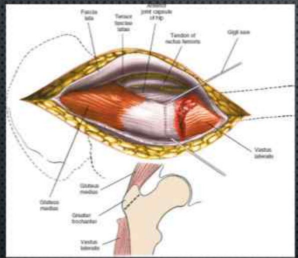
Retract gluteus medius & tensor fasciae latae --> fat over joint capsule

DEEP DISSECTION
- PARTIAL DETACHMENT OF THE ABDUCTOR

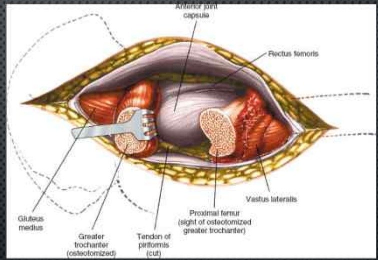


partial resect the gluteus medius tendon from the anterior portion of the trochanter.
--> The joint capsule

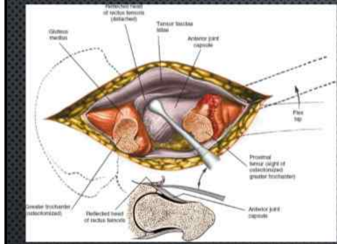
DEEP DISSECTION
- TROCHANTERIC OSTEOTOMY



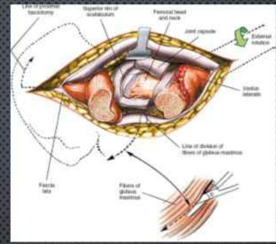
Osteotomize the greater trochanter.



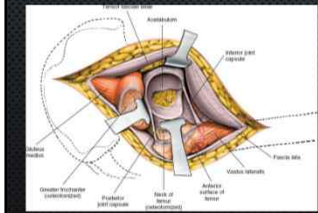
Reflect the osteotomized portion of the trochanter superiorly (with the attached gluteus medius)
--> reveal the joint capsule.



Reflect the head of the rectus femoris



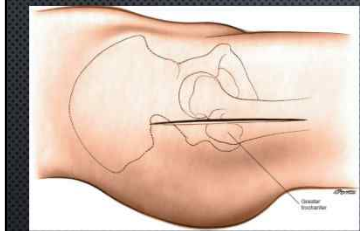
Incise ant. joint capsule to reveal femoral head & neck



To expose the acetabulum, dislocate & resect the femoral head.

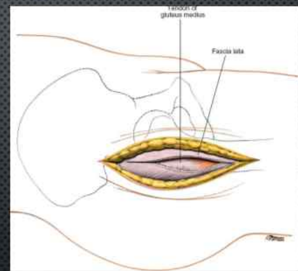
LATERAL APPROACH

Skin incision

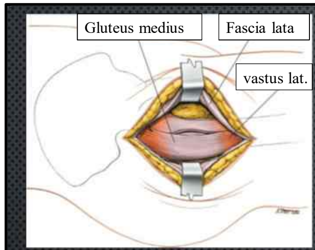


5 cm above the tip of the greater trochanter

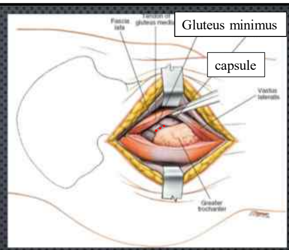
Superficial Surgical dissection



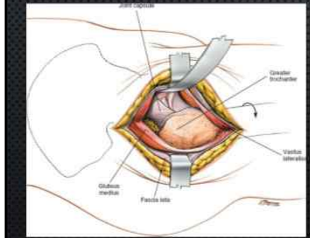
Divide the deep fascia



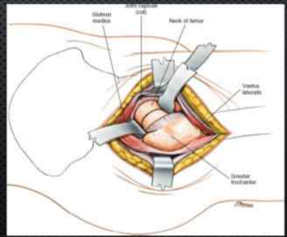
Split the gluteus med. above the tip of GT



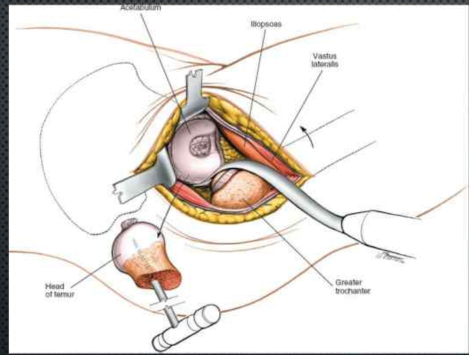
Devide the tendon of gluteus minimus



incise capsule (longitudinal T-shaped)



Osteotomize the femoral neck

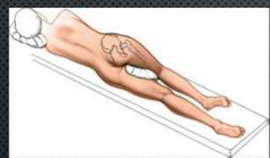


Extract the femoral head. Insert appropriate retractors to reveal the acetabulum.

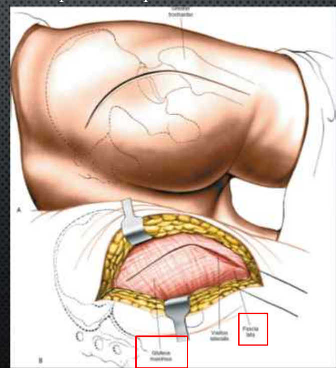
Posterior Approach

POSTERIOR APPROACH

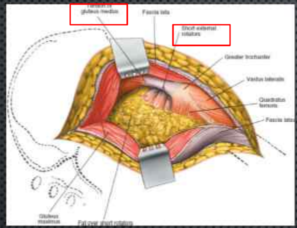
Lateral position



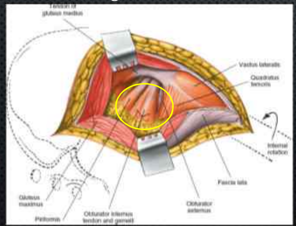
Skin incision : 10- to 15-cm curved incision centered on the posterior aspect of GT



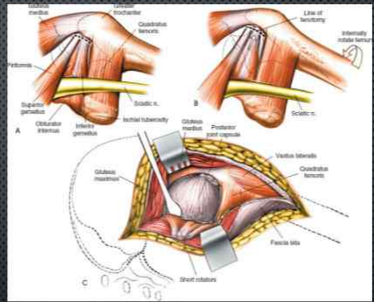
SUPERFICIAL DISSECTION



Retract the gluteus maximus

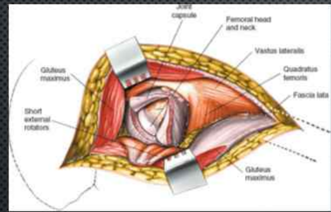


push the pat --> expose short rotator

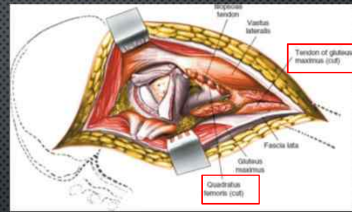


Danger : Sciatic n.
Detach the short rotator muscle (piriformis, sup. gemellus, inf. gemellus)

DEEP DISSECTION
- TROCHANTERIC OSTEOTOMY



Incise the post. joint capsule to expose the femoral head and neck.

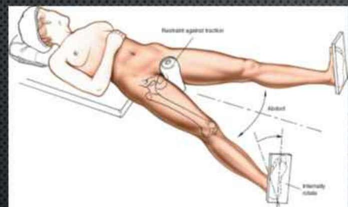


To gain additional exposure, cut the quadratus femoris and the tendinous insertion of the gluteus maximus.

Surgical approach of the Femur shaft

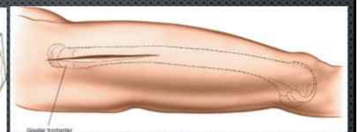
LATERAL APPROACH

Position



Supine or lateral
internally rotate the leg
abduct femur

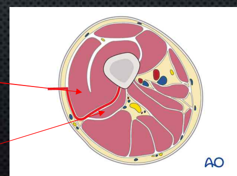
Incision



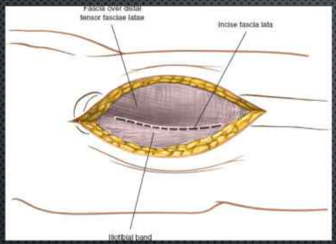
Longitudinal incision over lateral side of femur

vastus lateralis m.

biceps femoris m.
(short head)



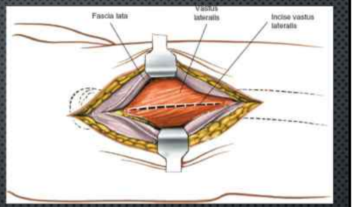
SUPERFICIAL DISSECTION



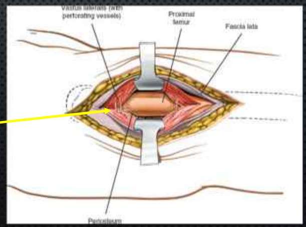
Incise the fascia lata in line with the skin incision.

Perforating branches of the profunda femoris artery

DEEP DISSECTION



Incise the fascia covering the vastus lateralis.



Split the fibers of the vastus lateralis

REFERENCE

1. Surgical exposure in Orthopaedics 6th edition, Stanley Hoppenfeld, M.D.

ACL injury Diagnosis & Treatment

2023.04.03
명지병원 정형외과
R2. 우창우

Categories

- ACL injury diagnosis
- ACL treatment development
- Surgical indication
- Surgical technique

Diagnosis – Physical examination

- Many ways to examine the anterior cruciate ligament
  - But, **two that are most often used clinically**
    - **Lachman test**
      - more sensitive for the posterolateral bundle of the anterior cruciate
    - Anterior drawer test
      - more sensitive for the anteromedial bundle
    - **The pivot-shift test**
      - anterolateral provocative tests

Diagnosis – Physical examination

- Lachmann test
  - Most sensitive test for anterior tibial displacement
  - 95% sensitivity
  - Increased excursion relative to the opposite knee
  - Absence of firm end point
    - Suggest ACL injury

FIG 3.18 The Lachman test is performed in 30 degrees of flexion with anterior force exerted on the proximal end of the tibia. (From Tria AJ Jr, Klein KS: *An illustrated guide to the knee*, New York, 1992, Churchill Livingstone.)

Grade	전방전위
Grade 0	2mm 이하
Grade 1	3~5mm
Grade 2	6~10mm
Grade 3	11mm 이상

FIGURE 45-54 Lachman test for anterior cruciate instability.

Diagnosis – Physical examination

- Pivot shift test
  - Requires a relaxed patient and an intact MCL
  - Hold lower leg with one hand → internal rotate the tibia → placing valgus force with knee flexion
  - 20-30′ : reduction of anteriorly subluxated tibia by IT band

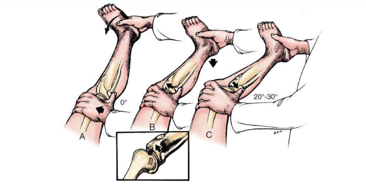
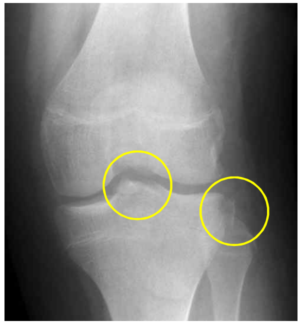
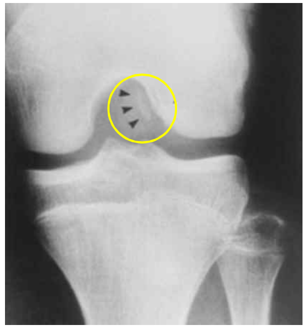


FIG 3.22 The pivot-shift test begins with the knee in full extension, and internal rotation and valgus stress are applied to demonstrate anterolateral subluxation. (From Tria AJ Jr, Klein KS: *An illustrated guide to the knee*, New York, 1992, Churchill Livingstone.)

Grade	정복
Grade 0	건측과 동일
Grade 1	Gliding
Grade 2	Clunk
Grade 3	Locking

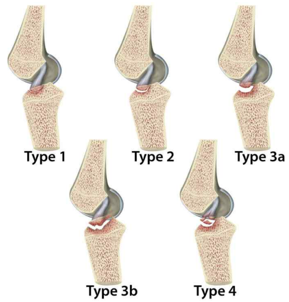
X-ray: Avulsion Fracture





Injured ACL - Avulsion Fracture
(1) tibial spine fracture
(2) Segond fracture
(3) Others

X-ray: tibial spine fracture



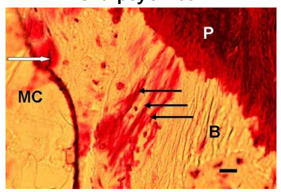
Avulsion of tibial intercondylar eminence

(1) 4 types, often result from **high-energy** (Not high-grade pivot, But)
(2) hyperextension with valgus

MuriloLeie et al, Arthroscopy, 2019

X-ray: tibial spine fracture

Sharpey's fiber



distal femur: 3-6 months
patella: 3-5 years
tibial plateau: present at birth
tibial tuberosity:10-12 years
fibular head: 2-4 years

WA Grana et al, AJSM, 1994

Avulsion of tibial intercondylar eminence

(3) Pediatric > Adults
(4) Poor outcome In Conservative
→ Op indication

A Garcia et al, Am jour Surg. 1958
Christopher S. et al, AJSM, 2001

MRI

FIG 8.8 Sagittal (A) and coronal (B) T2 fat-saturated images show a complete anterior cruciate ligament tear. On the sagittal image (A), the fibers are horizontally oriented *(arrow)*. On the coronal image (B), hematoma replaces the expected location of the ligament *(arrow)*. Sagittal proton density image showing a normal anterior cruciate ligament *(arrow)*.

MRI

FIG 8.9 Sagittal T2 fat-saturated image shows anterior subluxation of the tibia with respect to the femur and demonstrates the measurement used to assess anterior drawer.

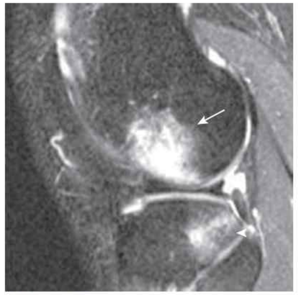


FIG 8.1 Sagittal T2 fat-saturated image demonstrates bone marrow edema, with the lateral femoral condyle *(arrow)* and the posterolateral tibia *(arrowhead)* representing osseous contusions secondary to a pivot-shift injury during a fall while skiing.

ACL treatment development

- Reconstruction of ACL
  - Primary repair if midsubstance ACL tear!

  → Rountinely failed

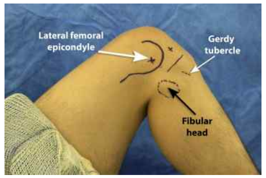
  → Interests are in ACL reconstruction (but intra-articular reconstruction leads to post op stiffness & laxity)

  → Extraarticular ACL reconstruction

  Lateral femoral epicondyle ~ Gerdy's tubercle → for anterolateral instability (Krackow & Brook)

  → but do not re-create the normal anatomy or function of the ACL

  → Extra articular technique alone is associated with high failure rate



→ Intraarticular ACL Reconstruction!!!! & extra articular technique is conjunctional

Surgical indication

- 고령, 활동성 낮음, mild to moderate instability

  → Non operative treatment

  → Aggressive rehabilitation program and counseling about activity level

- 활동성 높음

  → non operative treatment로는 만족스러운 결과 X

  - 재활치료 기다리지 못하고 활동적 생활 지속
  - 불안정성 남아있는 경우

  → ACL, meniscus의 반복적인 손상, 골관절염 발생 증가

Surgical indication

- Operation indication (대정)
  - 신체 검사 및 arthrometer(KT-100) 측정 결과 5mm 이상의 차이
  - 재발되는 giving way 및 불안정 지속되는 경우

- 수술 시기
  - 수상 후 너무 조기 수술시 arthrofibrosis로 인한 LOM
  - 12개월 이상 지연된 경우 동반손상(MM tear, osteochondral lesion) 빈도 높아짐
  - 수상 후 1-3주 정도 지연하여 수술 전 ROM 회복되고 급성 염증소견 소실된 후 수술 시행함

  - Repair 가능한 meniscus bucket handle tear
  - 분리된 연골 혹은 골연골 손상 동반된 경우

  → ROM 회복되지 않은 상태로 조기에 수술하는 것이 바람직함

Church S, Keating JF. Reconstruction of the anterior cruciate ligament: timing of surgery and the incidence of meniscal tears and degenerative change. J Bone Joint Surg Br. 2005 Dec;87(12):1639-42

Systematic Review

Timing of Surgery of the Anterior Cruciate Ligament

Daniel Andernord, M.D., Jón Karlsson, M.D., Ph.D., Volker Musahl, M.D., Mohit Bhandari, M.D., Ph.D., Freddie H. Fu, M.D., D.Ps., D.Sc., and Kristian Samuelsson, M.D., Ph.D.

- Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 29, No 11 (November), 2013: pp 1863-1871

Purpose: We aimed to perform a systematic review of the literature concerned with timing of surgery after anterior cruciate ligament injury. **Methods:** A systematic electronic search in Medline through PubMed, Embase, and the Cochrane Library was carried out in October 2011. All English-language randomized controlled clinical trials, prospective comparative cohort studies, and prognostic and diagnostic studies published from January 1995 to August 2011 were eligible for inclusion. All articles addressing timing of surgery were eligible for inclusion regardless of injury-to-surgery interval, graft type, surgical technique, or rehabilitation. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist guided the reporting and data abstraction. Methodologic quality of all included articles was carefully assessed. **Results:** We included 22 articles (3,583 patients) in the systematic review. Study design, research methodology, surgical technique, and outcome measurements differed greatly among included articles. The injury-to-surgery interval, classified as early and delayed, ranged from within 2 days to 7 months and 3 weeks to 24 years, respectively. Eight articles promoted early reconstruction, whereas the majority of articles found no difference in outcome between early and delayed surgery. Two articles were inconclusive. **Conclusions:** There were few or no differences in subjective and objective outcomes related to timing of anterior cruciate ligament reconstruction. **Level of Evidence:** Level II, systematic review of Level I and II studies.

Surgical indication

- ACL repair / augmentation / reconstruction
- Thermal shrinkage : 50% failure in long term f/u

- Repair of ACL
  - 성장판 손상 가능성으로 재건술하기 어려운 소아
  - 청소년기에 흔한 bony avulsion
  - Primary repair if midsubstance ACL tear!

- Repair of bony tibial avulsions
  - Replaced and fixed with sutures or passed through transosseous drill hole or screws placed through the fragment into the bed (no difference in Lysholm knee score)

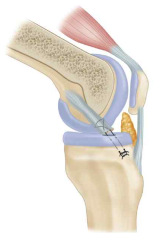


FIGURE 45-108 Repair of avulsion of tibial attachment of anterior cruciate ligament with fragment of bone. Crater in tibia should be deepened, and bone fragment on end of ligament is pulled into crater depth to restore tension in avulsed ligament. **SEE TECHNIQUE 45-18.**

Operative option

- 골격 미성숙 환자에서의 전방십자인대 재건술 알고리즘

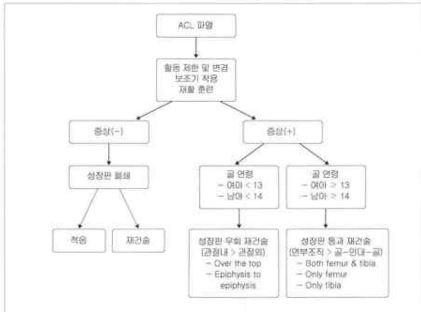


Fig 9. 골격 미성숙 환자에서 전방 십자 인대 손상에 대한 치료 알고리즘(Ganley 2008).

Fig 11. 전방 십자 인대 재건술 : 성장판 비통과 재건술. A : 장경대를 이용하여 관절외 및 관절내 재건술을 시행하는 방법. B : 슬곽건 이식물을 경골 골단 및 대퇴골 골단에 통과시키는 방법.

Fig 12. 전방 십자 인대 재건술: 성장판 통과 재건술. A : 경골 성장판 통과+대퇴골 골단 고정. B : 경골 성장판 통과+대퇴골 성장판 비통과(over-the-top). C : 경골 성장판 통과+대퇴골 성장판 통과.

731

이덕용 소아정형외과학 5판

Surgical technique

- Graft
  - Selection
  - Placement
  - Tensioning
  - Fixation

Graft	Ultimate tensile load(N)	Stiffness(N/mm)	Cross-sectional area(mm²)
Native ACL	2160	242	44
BPTB(10mm) autograft	2977	455	32
BPTB(10mm) allograft	2552	620	35
Quadrupled hamstring autograft	4140	776	53
Quadrupled hamstring allograft	4090	776	53
Quadriceps tendon (10mm) autograft	2174	463	62
Achilles tendon allograft	4617	685	67
Tibialis anterior allograft	4122	460	48

표 9.3.4.2 전방십자인대재건술 시 각 이식물에 대한 생기계적 특성(biomechanical properties)[2-9]

Surgical technique - Graft selection

- Autograft
  - Bone patellar-tendon bone
  - Hamstrings
  - Quadriceps tendon
  - Fascia lata
- Allograft
  - Bone patellar-tendon bone
  - Hamstrings
  - Quadriceps tendon
  - Achilles tendon
  - Tibialis anterior or posterior tendon
  - Fascia lata
- Artificial ligament
  - Goretex ligament // Trevira ligament
  - LARS

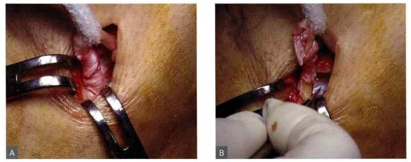


그림 9.3.5.1 자가 슬건의 채취. 반건양건을 겸자로 분리하여 끌어당기고(A), 골막을 포함하여 건의 길이가 최대한 길게 유지되도록 원위부를 자른다(B).

Surgical technique - Graft selection

- Autograft
  - Used most commonly
  - Low risk of adverse inflammatory reaction
  - No risk of disease transmission
  - Biologic graft → revascularization & recollagenization

Surgical technique - Graft selection

- Bone-patellar tendon-bone graft
  - High ultimate tensile load(normal ACL 140%)
  - Firm fixation with interference screw
  - bone to bone healing -> Early rehabilitation(대정)
  - Risk of patellar Fx. & anterior knee pain
- Quadruple hamstring tendon graft
  - Less donor site morbidity
  - Broad surface → vascularization↑
  - Semi-T(75%), Gracilis(49%)
  - Quadruple-stranded ST, ST/Gracilis graft(up to 4108N)(normal ACL 200%)
  - Disadvantage : tendon healing within osseous tunnels / lack of rigid bony fixation / late rehabilitation(대정)
- Quadriceps tendon
  - High ultimate tensile load(2352N)
  - Alternative especially for revision ACL reconstruction & knees with multiple ligamentous injury

TABLE 51-2

Ultimate Load to Failure and Stiffness of Current Graft Selections in Cruciate Ligament Surgery

GRAFT SELECTION	ULTIMATE STRENGTH TO FAILURE (n)	STIFFNESS (n/mm)
Native ACL (Woo et al.)	2160	242
Native PCL (Race, Amis)	1867	—
Patellar tendon (Cooper et al.)	2977	455
Quadruple hamstring tendon (semitendinosus and gracilis) (Hamner et al.)	4140	807
Quadriceps tendon (Stäubli et al.)	2353	326

ACL, Anterior cruciate ligament; *PCL*, posterior cruciate ligament.
From Brand J, Weiler A, Caborn DNM, et al: Graft fixation in cruciate ligament reconstruction, Am J Sports Med 28:761, 2000.

Surgical technique - Placement

- Isometric point

  : Limits changes in graft length and tension during knee flexion and extension

  : may not lead to overstretching or failure of the graft

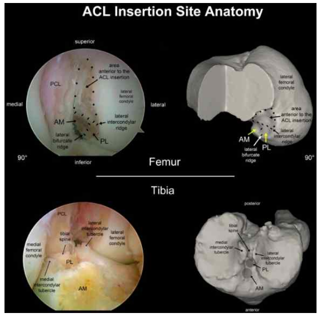
  : More vertical than anatomical point

  : But normal ACL is not isometric

  →Stability of AP translation

  →Do not restore rotational instability

  →Not useful for accurate prediction of the relationship



- Anatomical point

Surgical technique - Tunnel position

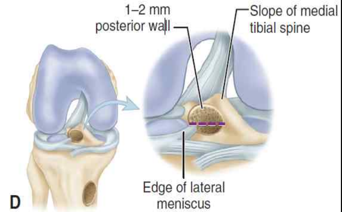
- Tibia tunnel

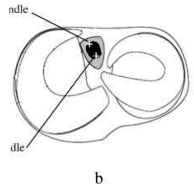
(1) AP plane

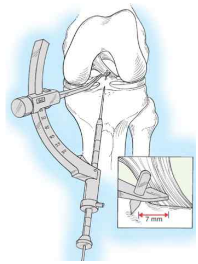
- Inner edge of LMAH
- 7mm anterior to anterior border of PCL
- 2 to 3mm anterior to peak medial spine
- ACL foot print 중심점 혹은 약간 후방(대정)

(2) mediolateral plane

- Base of medial spine
- Medial to center of ACL foot print



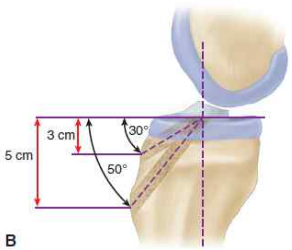




Surgical technique - Tunnel position

- The starting point for the guide pin
  - routinely set the tibial drill guide at 45~55 degrees

- starting point
  - 1 cm proximal to the pes anserinus and
  - 1.5 cm medial to the tibial tuberosity

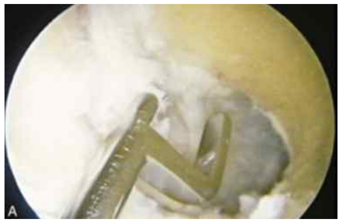


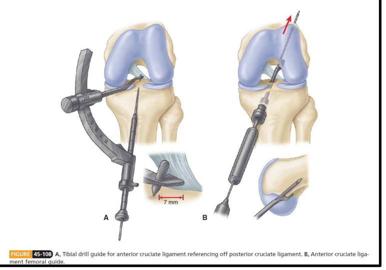
- approximately one fingerbreadth medial to the tibial tubercle and
- two fingerbreadths distal to the medial joint line.

Surgical technique - Graft selection

- Femoral tunnel
  - Over the top(대퇴외과 후방 피질골면)에서 3mm 전방(7mm 대정)
  - slightly posterior to center of foot print
  - Leave 3mm posterior wall(2mm 대정)

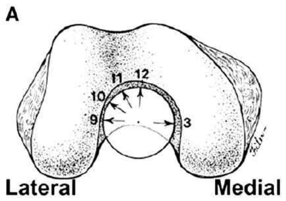
    3mm superior to articular cartilage

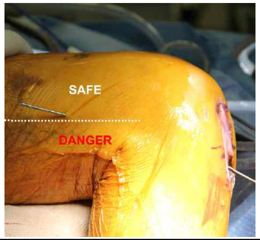




Surgical technique - Tunnel position

- Femoral tunnel
  - 우측 슬관절: 10시30분~11시, 좌측 슬관절: 1시~1시30분(대정)
  - 12시 : rotational instability 잡아주지 못함
  - flex knee 120 degree and use hemispherical reamer
    - Avoid articular damage
  - guidewire above the mid-lateral line
    - posterior cortical breakthrough is exceedingly uncommon





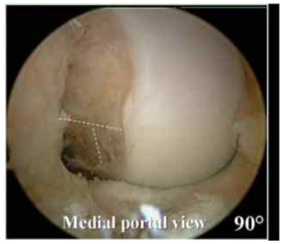
Surgical technique - Notchplasty

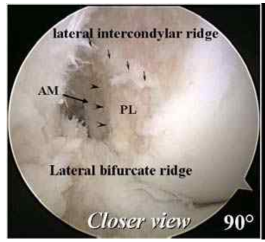
Evolution of anatomic double bundle ACL-R by Fu

AANA, 2009

➢Arthroscopic visualization (knee at 90° of flexion)

- Bifurcate ridge : between AM and PL bundles
- Lateral intercondylar ridge : the upper limit of both AM and PL bundles





Notchplasty destroys the femoral anatomy of the ACL.

So, it's not neccessory !!!

Surgical technique - Tunnel position

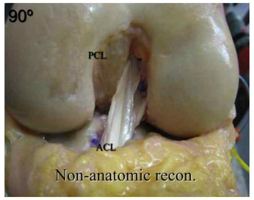
- Femoral tunnel that is too anterior
  - → "Capturing" of the Knee
  - → Loss of flexion or stretching
  - → Failure of the graft as flexion
- Femoral tunnel that is too posterior
  - →Taut in extension but loosens with flexion
- Femoral tunnel that is too vertical
  - → Impingement with PCL
  - → Rotational instability

Surgical technique –Tunnel position

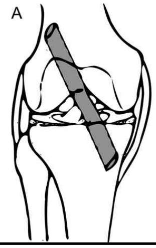
Femoral tunnel	Anterior	Excessive strain in flexion/laxity in extension
	Posterior	Excessive strain in extension/laxity in flexion
	Central/Vertical	Rotational instability
Tibial tunnel	Anterior	Excessive strain in flexion/intercondylar roof impingement in extension
	Posterior	Excessive strain in extension/impingement on PCL
	Medial	Impingement on MFC, PCL
	Lateral	Impingement on LFC

Surgical technique : Single bundle vs Double bundle

- Femoral tunnel in vertical → non-anatomic position
- Reconstructed primarily the AM bundle but not PL bundle
- successful in restoring anterior stability
  - Not very good rotatory stability & continued pivot shift test

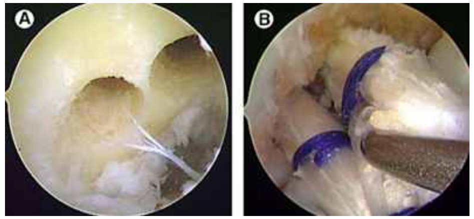


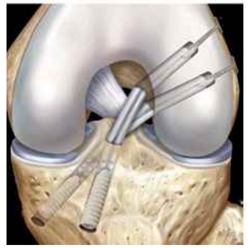
- Failure to eliminate the pivot-shift phenomenon
  - results in continued clinical instability
  - increase the risk of graft failure.



Surgical technique : Single bundle vs Double bundle

- Attempts to restore both AM and PL bundle of ACL
- Restore both anterior translation and rotatory stability





여전히 수술술기 및 터 널의 개수， 고정법 등의 선택 을 두고 논란

Double bundle reconstruction of ACL-R

Systematic Review of Single-Bundle Anterior Cruciate Ligament Reconstruction Outcomes

[illegible]

Paul B. Lewis 2008 AJSM

Conclusion: Systematic review of a significant body of unbiased outcome data on single-bundle anterior cruciate ligament reconstruction demonstrates it to [illegible]

[illegible]

Hermann O. Mayr 2016 Arthroscopy

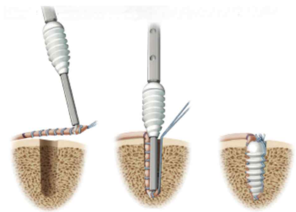
changes and tunnel widening. **Conclusions:** There [illegible] in IKDC subjective and objective scores between patients who underwent anatomic SB ACL reconstruction and those who underwent anatomic DB ACL reconstruction.
Level of Evidence: [illegible]

no difference between the two surgical methods
→ *performed single bundle ACLR*

Surgical techinque : Graft Fixation

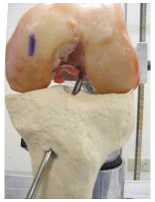
- Direct fixation devices - interference screws, staples, washers, and cross pins
- Indirect fixation devices - polyester tape/titanium button and suture-post
- Interference screw fixation is the most popular fixation method

- Weakest links : fixation site, not graft tissue itself
- If graft tightens more than 2mm with knee flexion
  → remove the graft & move femoral tunnel or both tunnels
  - Should be slightly tighter than a normal ACL



Portal technique

Trans-tibial

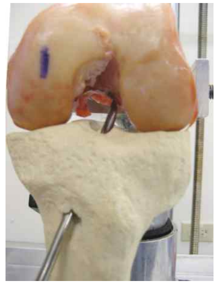


Trans-portal

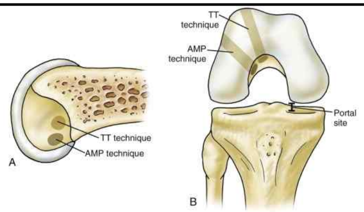
Outside-in

Trans-tibial portal

- Femoral tunnel drilling 시에 90도 이상 knee flexion하지 않아도 됨
- main cause of ACL reconstruction failure
  - Non-anatomical femoral tunnel
- Less chance to modify the location and orientation of the femoral tunnel



Antero-medial portal



- Anatomical femoral tunnel
  - Better recreation of native ACL
- Shorter femoral tunnel than TT

- Hyper-flexion is necessary(120° or higher) to avoid
  - peroneal nerve injury
  - Femoral lateral condyle posterior wall breakage
    → articular cartilage injury of MFC

- maintaining hyper-flexion → technically difficult
- visualization during drilling → may be poor

Outside-in technique

- Femoral tunnel independently by tibial tunnel
- Femoral tunnel entrance in 10 'clock
  - Anatomical femoral tunnel
- Safe in skeletally immature patients
- More oblique graft placement
  → avoiding PCL impingement during knee flexion

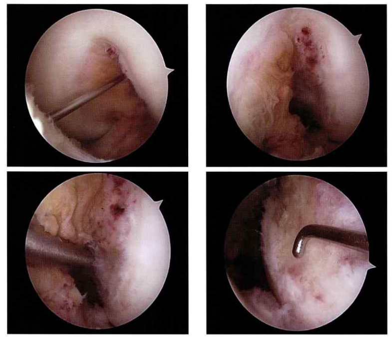
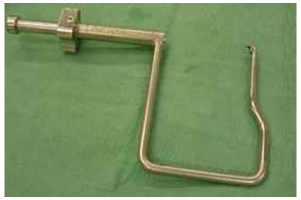
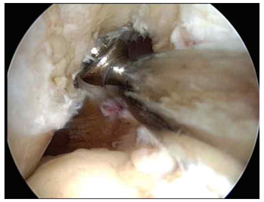


그림 9.3.7.2 슬개건삽입구를 만들어 전방십자인대 대퇴골 부착부를 확인한다.

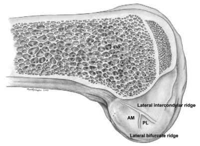
Outside-in technique

- specific rigid femoral drill guide
  - to create the outside-in femoral tunnel
- tip of femoral guide placed in the ACL anatomical footprint
  - lower than roof of the intercondylar notch

Modified Trans-tibial portal

- Initial marking of anatomical femoral center by TransAM portal technique
- Free-hand technique of femoral guide pin
- Gradual widening of femoral tunnel with changing the knee angle
- More stronger fixation of graft (dual fixation method)

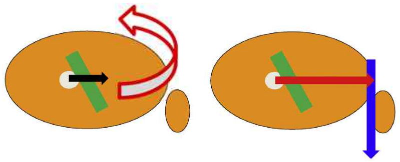



이식 후의 4단계 변화

- Necrosis → revascularization → cellular proliferation → remodeling
- remodeling : large diameter fiber → small 로 conversion
- 골-슬개골-골 이식물 : 6-8주에 골편이 터널에 완전유합
- 연부 조직 이식물 : 건-골 유합 (fibrovascular scar tissue)
  - Transplantation with viable cells or vascular pedicle → do not show better incorporation
- 술 후 6개월 : 관절경상 정상 ACL과 유사 소견
- 술 후 12개월 : 조직학적으로 정상 ACL과 유사 소견

Risk factors of residual pivot

Up to 25%



① young age
② generalized ligamentous laxity
③ pivoting sport
④ high tibial slope
⑤ recurvatum
⑥ preoperative high-grade pivot
⑦ Chronic ACL injury
⑧ revision ACL surgery

Examining the Distribution of Bone Bruise Patterns in Contact and Noncontact Acute Anterior Cruciate Ligament Injuries

Jay Moran,[*†] BS, Michael S. Lee,[†] BS, Kyle N. Kunze,[‡] MD, Joshua S. Green,[†] MS, Lee D. Katz,[†§] MD, Annie Wang,[§] MD, William M. McLaughlin,[†] MD, Stephen M. Gillinov,[†] AB, Andrew E. Jimenez,[†] MD, Timothy E. Hewett,[||] PhD, Robert F. LaPrade,[¶] MD, PhD, and Michael J. Medvecky,[†] MD
Investigation performed at the Department of Orthopaedics and Rehabilitation, Yale School of Medicine, New Haven, Connecticut, USA

Introduction

- 70% of ACL injuries occur in a noncontact manner, during which rapid movement
  - Changing directions, landing, deceleration, or pivoting, can lead to rupture of the ACL
- Subchondral bone marrow edema is present MRI in 80% to 99% of patients who sustain acute ACL injuries
  - Caused by inflammation, edema, microtrabecular fractures
- Tibiofemoral bruises can act as a mechanistic "footprint" of the forces within the joint at the time of ACL injury
  - Potentially lending insight into the kinematic events at the time of injury

Introduction

- Bone bruise patterns in noncontact ACL injuries are well reported in the literature
  - Combination of anterior tibial translation, valgus stress, and internal or external tibial rotation
- However, few studies have investigated the bone bruise patterns incontact ACL injuries
  - Mechanism is less common and considered less preventable than those sustained in a noncontact manner
- Primary purpose of this study was to examine and compare the number and location of bone bruises associated with contact and noncontact ACL injuries

Methods – Patient selection and identification

- 320 consecutive patients were identified
- Inclusion criteria
  1. Less than 30 days between date of thereported injury and date of the MRI
  2. T2-weighted fatsuppressedMRI sequences available in both the coronaland sagittal planes
  3. Clear documentation of the mechanism of injury in clinical notes
  4. No documentation of previous ipsilateral knee injury
  5. No concomitant knee dislocation, fractures, or posterolateral corner and or posterior cruciate ligament injuries

Methods – Determination of mechanism of injury

- Mechanisms
  - Classified as noncontact or contact and patients
  - Separated into these 2 cohorts for comparison
- For patients classified into the contact injury cohort
  - Required clear external force
    - Tackled in American football
    - Collision at the level of the knee
- Conversely, if there was no external force at the time of injury, the mechanism was classified as noncontact

Methods – Classification of preoperative bone bruise

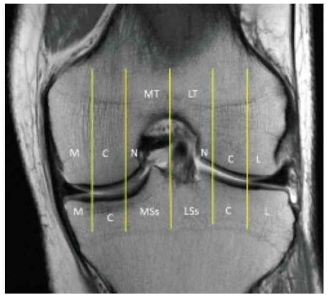


Figure 1. T2-weighted coronal magnetic resonance imagin scan with distinct femoral and tibial zones used to record th location of the lesions in the coronal plane. C, central; L, la eral; LSs, lateral subspine; LT, lateral trochlea; M, media MSs, medial subspine; MT, medial trochlea; N, notch.[8]

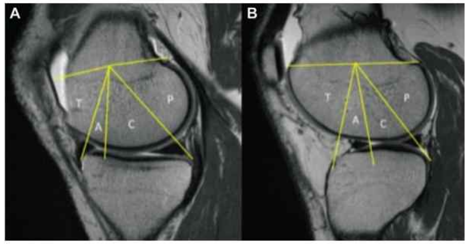


Figure 2. (A) Sagittal proton density magnetic resonance imaging (scan) of the medial knee with 4 zones: trochlea (T), anterior (A), central (C), and posterior (P) for localization. (B) Sagittal proton density MRI scan of the lateral knee with 4 zones: trochlea (T), anterior (A), central (C), and posterior (P) for localization.[8]

Results

TABLE 1
Patient Characteristics for the Entire Cohort[a]

	Contact (n = 78)	Noncontact (n = 142)	*P* Value
Age, y	23.1 ± 9.6	25.6 ± 12.0	.097
Sex			**.030**
Female	24 (30.8)	65 (45.8)	
Male	54 (69.2)	77 (54.2)	
BMI	26.1 ± 5.9	25.7 ± 5.4	.962
Any bone bruise	75 (96.2)	138 (97.2)	.563
Lateral bone bruises only	10 (12.8)	9 (6.3)	.102
Medial bone bruises only	4 (5.1)	11 (7.7)	.494
Both lateral and medial bone bruises	61 (78.2)	118 (83.1)	.373

[a]Values are presented as mean ± SD or n (%). Boldface type indicates statistical significance ($P < .05$). BMI, body mass index.

Results

TABLE 3
Number of Patients With at Least 1 Bone Bruise in the Lateral and/or Medial Tibiofemoral Compartment in Contact and Noncontact ACL Injuries[a]

	Contact (n = 78)	Noncontact (n = 142)	*P* Value
Lateral side			
LFC + LTP	**64 (82.1)**	69 (48.6)	**<.001**
LFC	65 (83.3)	119 (83.8)	>.999
LTP	**70 (89.7)**	77 (54.2)	**<.001**
Medial side			
MFC + MTP	31 (39.7)	**94 (66.2)**	**<.001**
MFC	49 (62.8)	**120 (84.5)**	**<.001**
MTP	47 (60.3)	102 (71.8)	.079

[a]Values are presented as n (%). Boldface type indicates statistical significance ($P < .05$). ACL, anterior cruciate ligament; LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau.

Results

TABLE 4
Frequency and Location of Bone Bruises in the Sagittal Plane on the LFC, LTP, MFC, and MTP for the Contact and Noncontact Cohorts[a]

	Contact (n = 78)	Noncontact (n = 142)	*P* Value
Lateral femoral condyle			
Anterior	22 (28.2)	42 (29.6)	.830
Central	55 (70.5)	93 (65.5)	.448
Posterior	6 (7.7)	5 (3.5)	.153
Lateral tibial plateau			
Anterior	7 (9.0)	9 (6.3)	.471
Central	28 (35.9)	42 (29.6)	.336
Posterior	**67 (85.9)**	46 (32.4)	**<.001**
Medial femoral condyle			
Anterior	10 (12.8)	22 (15.5)	.591
Central	48 (61.5)	**114 (80.3)**	**.003**
Posterior	3 (3.8)	**55 (38.7)**	**<.001**
Medial tibial plateau			
Anterior	6 (7.7)	18 (12.7)	.257
Central	11 (14.1)	28 (19.7)	.297
Posterior	41 (52.6)	**94 (66.2)**	**.047**

[a]Values are presented as n (%). Boldface type indicates statistical significance ($P < .05$). LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau.

Discussion

- Contact ACL injuries
  - Significantly more likely to have posterior LTP bruising
  - Less likely to have combined medial tibiofemoral (MFC + MTP) bone bruises on preoperative MRI
- In comparison with noncontact injuries, it is plausible that a higher-energy mechanism is imparted by the direct valgus forces sustained during contact ACL injuries, leading to more bone bruising within the lateral tibiofemoral compartment
- These findings may further improve our understanding of the different kinematic forces experienced at the time of contact and noncontact ACL injury

Discussion

- Quatman et al
  - Anterior tibial translation is a key underlying mechanism in noncontact ACL injuries
- Noncontact ACL bone bruise patterns have inferred a degree of anterior tibial translation from central MFC and posterior MTP bruising

Conclusion

- Significantly different bone bruise patterns were observed on MRI based on ACL injury mechanism
  - Contact injuries - lateral tibiofemoral compartment
  - Noncnotact injuries – medial tibiofemoral compartment

Reference

- 대한정형외과학 제 8판
- Campbell's operative orthopaedics 14th edition
- 이덕용 소아정형외과학 5판

2023 Anatomy Seminar

GLUTEAL & BACK OF THIGH

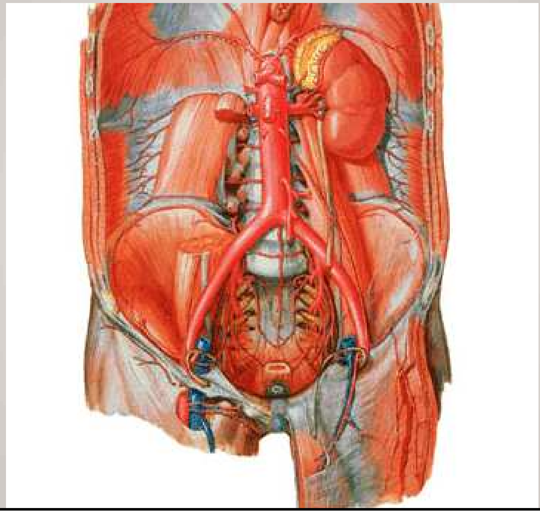
ANGIOLOGY & NEUROLOGY

2023.04.05

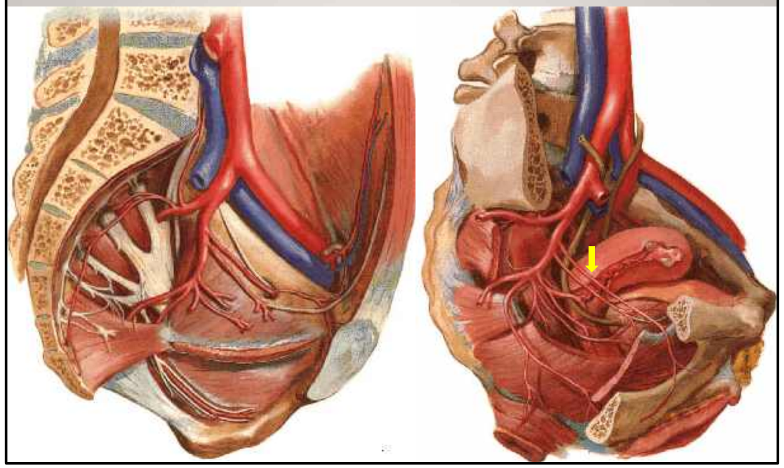
R2 김 수 영

ANGIOLOGY

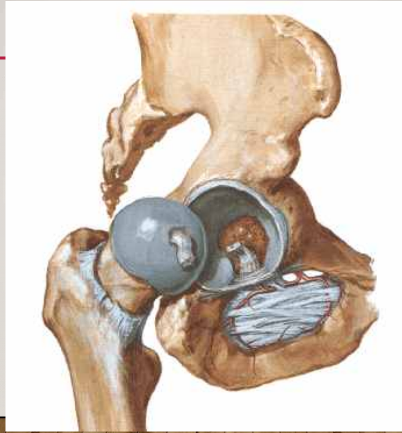
COMMON ILIAC ARTERY



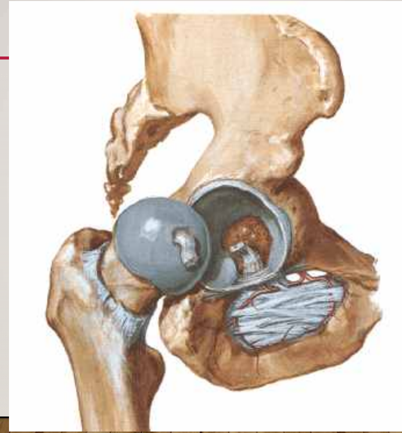
Internal iliac artery



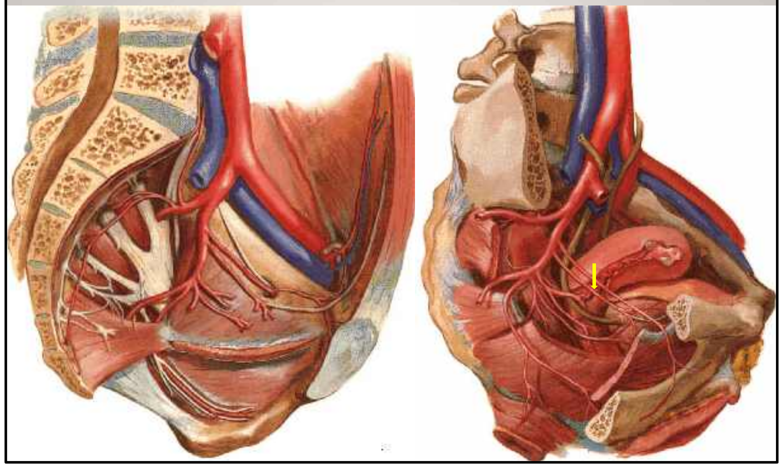
OBTURATOR ARTERY



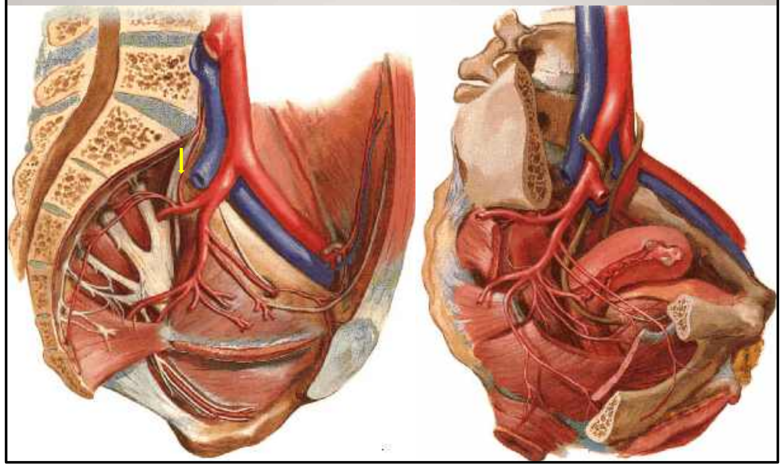
OBTURATOR ARTERY



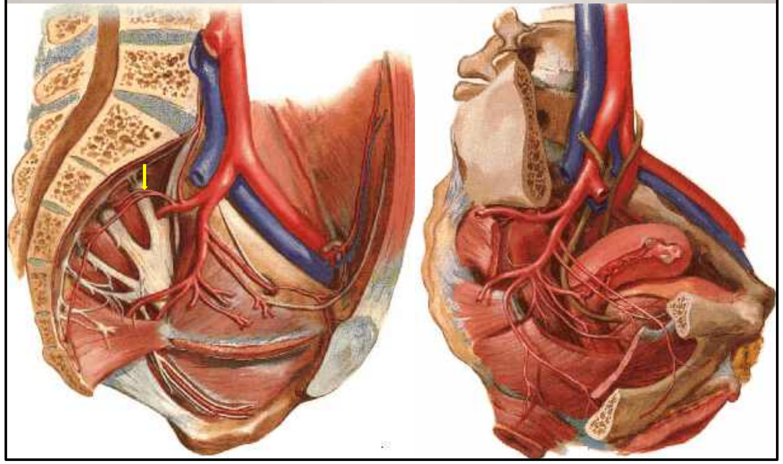
Internal iliac artery



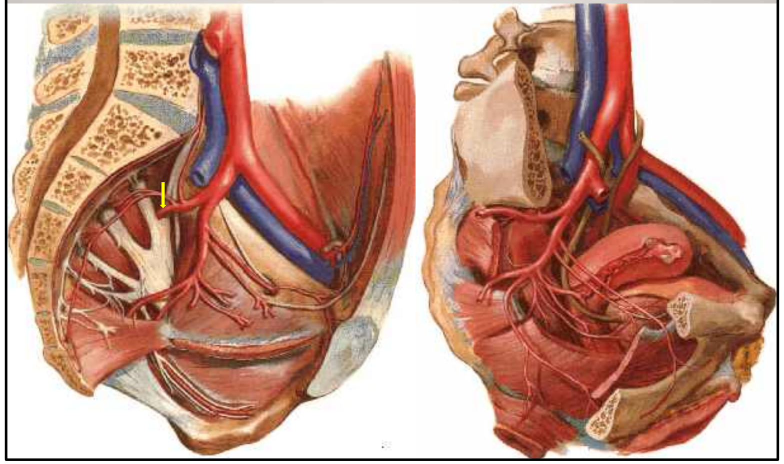
Internal iliac artery



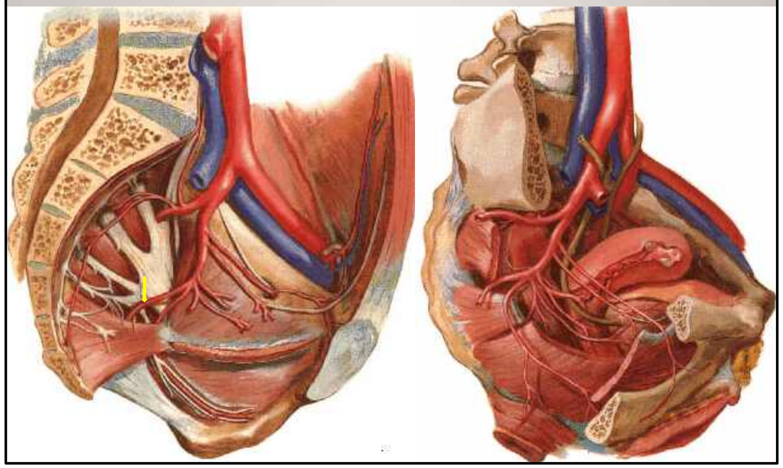
Internal iliac artery



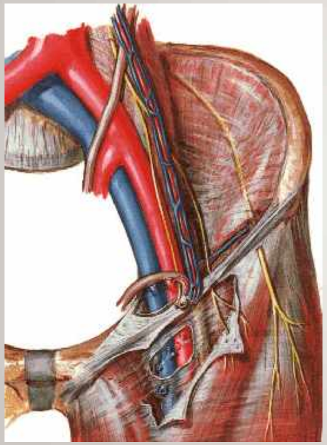
Internal iliac artery

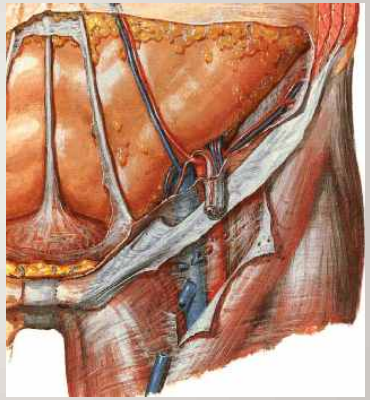


Internal iliac artery



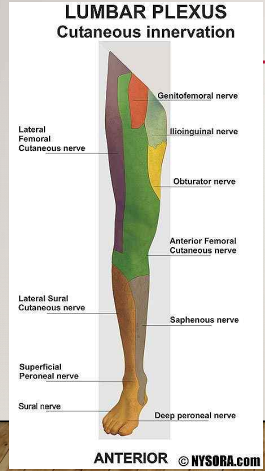
EXTERNAL ILIAC ARTERY

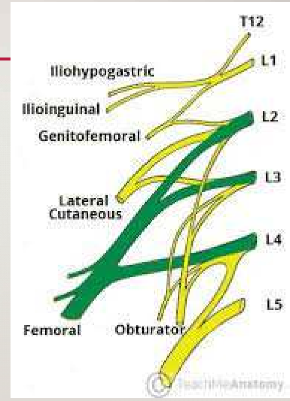


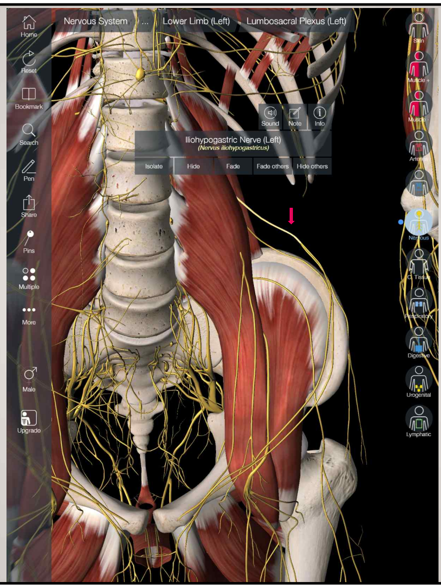


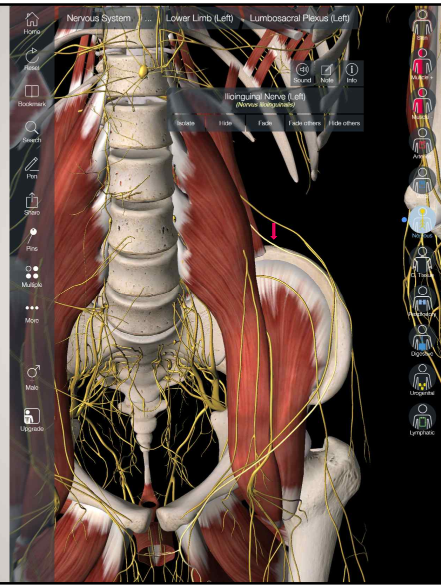
NEUROLOGY

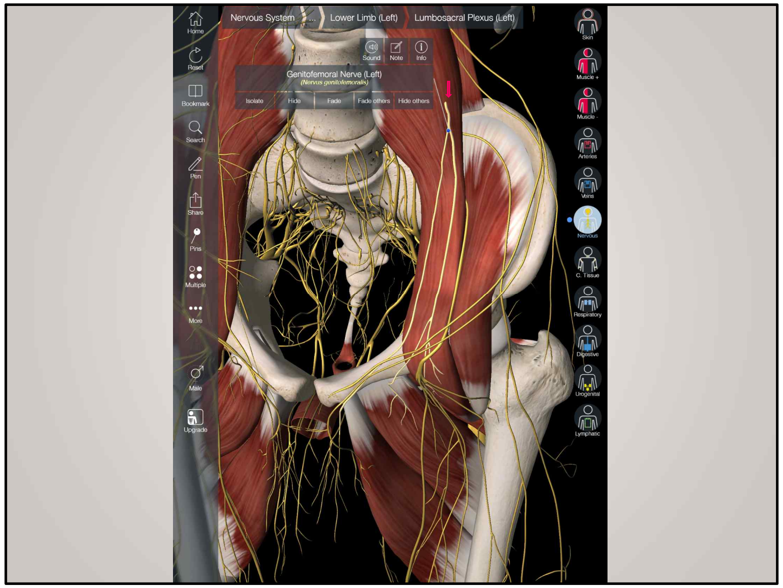
LUMBAR PLEXUS

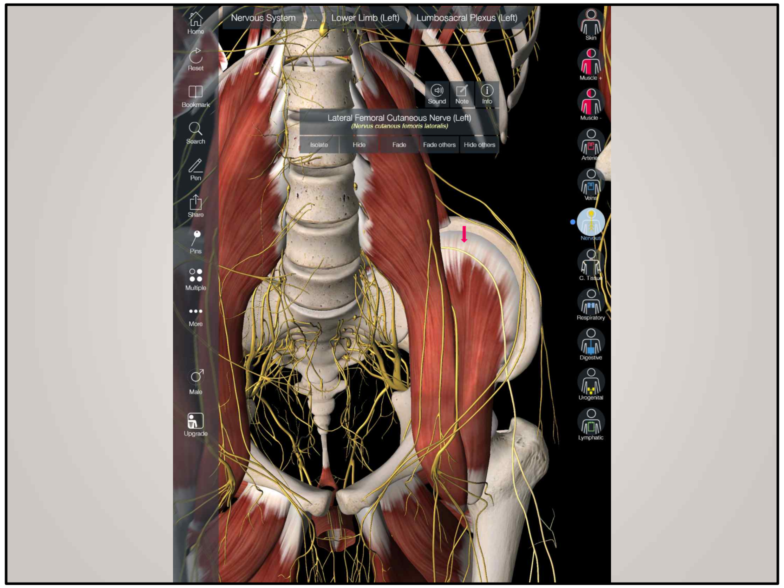




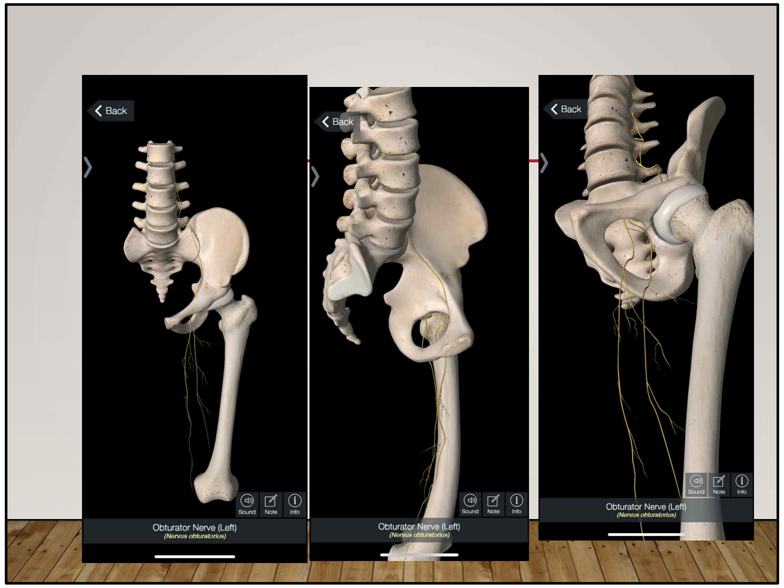


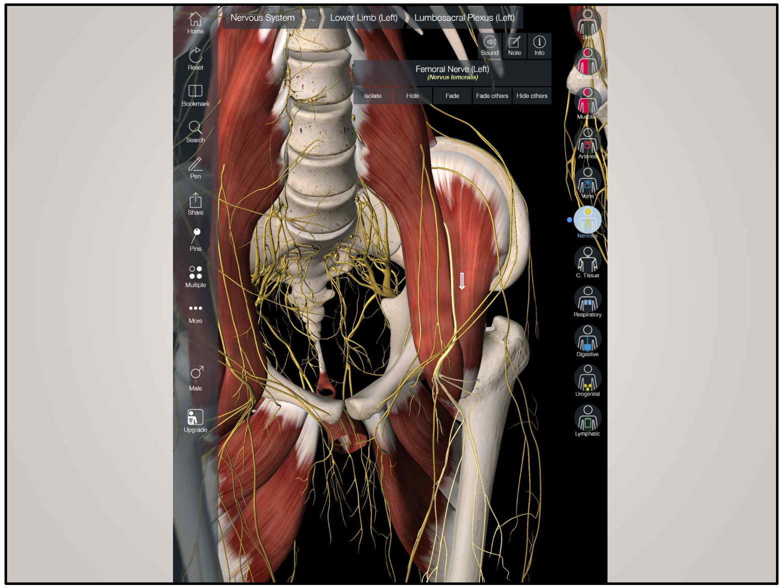



Nervous System
Lower Limb (Left)
Lumbosacral Plexus (Left)
Sound
Note
Info
Genitofemoral Nerve (Left)
(Nervus genitofemoralis)
Isolate
Hide
Fade
Fade others
Hide others

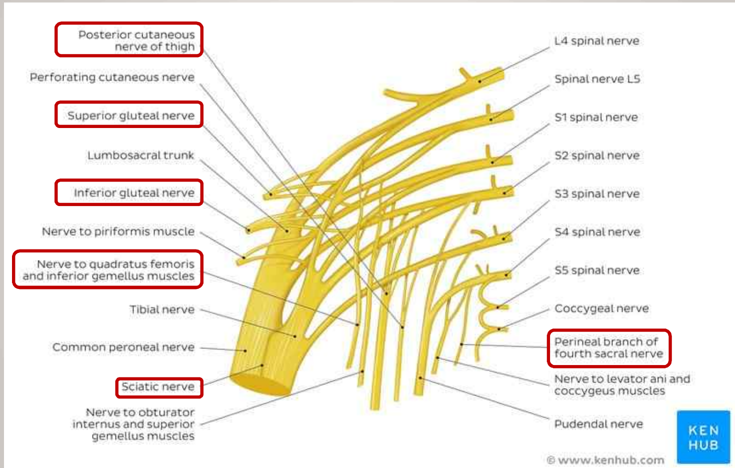

Nervous System
Lower Limb (Left)
Lumbosacral Plexus (Left)
Sound
Note
Info
Lateral Femoral Cutaneous Nerve (Left)
(Nervus cutaneus femoris lateralis)
Isolate
Hide
Fade
Fade others
Hide others

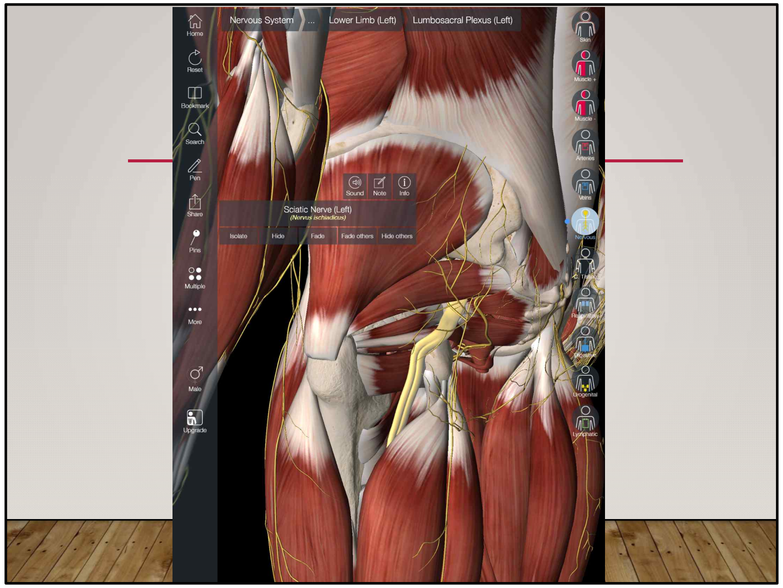

Nervous System
...
Lumbosacral Plexus (Left)
Sound
Note
Info
Obturator Nerve (Left)
(Nervus obturatorius)
Isolate
Hide
Fade
Fade others
Hide others

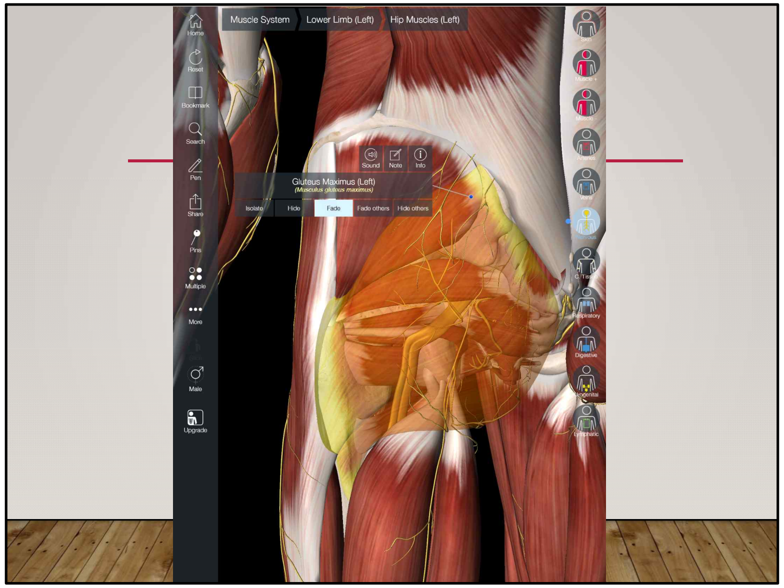

Back
Obturator Nerve (Left)
(Nervus obturatorius)
Back
Obturator Nerve (Left)
(Nervus obturatorius)
Back
Obturator Nerve (Left)
(Nervus obturatorius)



SACRAL PLEXUS







J Shoulder Elbow Surg (2023) 32, 17–23

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Can subcoracoid effusion be a more specific finding for subscapularis tear among rotator cuff pathologies on magnetic resonance imaging?

Baran Sarıkaya, MD[a], Batuhan Bahadır, MD[b,*], İbrahim Kaya, MD[c], Burak Oklaz, MD[b], Pelin Zeynep Bekin Sarıkaya, MD[d], Ulunay Kanatlı, MD[b]

[a]*Department of Orthopaedics and Traumatology, Ankara City Hospital, Ankara, Turkey*
[b]*Department of Orthopaedics and Traumatology, Gazi University Faculty of Medicine, Ankara, Turkey*
[c]*Dr Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Turkey*
[d]*Department of Radiology, Kırıkkale University Faculty of Medicine, Kırıkkale, Turkey*

2023.04.11
명지병원 정형외과
R1. 정승호

Introduction

- Subscapularis tendon tears were initially neglected but are now recognized in up to 50% of arthroscopic rotator cuff surgeries.

  Richards DP. Orthop Clin North Am. 2003

- Preoperative MRI is not always accurate in diagnosing subscapularis tears.
  - Sensitivity reported as 25%-78%

  Adams CR. Arthroscopy. 2012

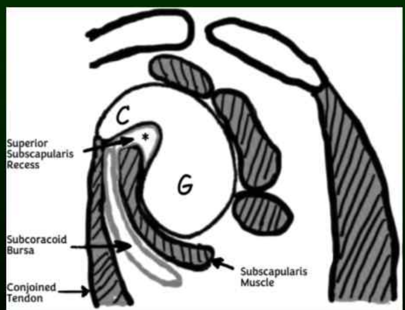
- Supportive MRI findings for subscapularis tears
  - Medial subluxation/dislocation of biceps tendon
  - Subscapularis muscle atrophy
  - Leakage of contrast material onto lesser tuberosity
  - Lesser tuberosity cysts

  Adams CR. Arthroscopy. 2010

Introduction

- 2 synovial-lined structures in subcoracoid space
  - Subcoracoid bursa
  - Subscapular recess

  Crainger AJ. AJR Am J Roentgenol. 2000



Purpose

- Study aims
  - Examine relationship between SE and rotator cuff tears
  - Investigate whether SE is a supportive finding in diagnosing subscapularis tear in preoperative MRI.
- Hypothesis
  - SE is a more specific finding for subscapularis tear than other rotator cuff tears.

Methods

- Background
  - Retrospective evaluation of video recordings and prospective collection of data for patients who underwent arthroscopic surgery in a single institution between 2017 and 2021

Methods

Patient Selection

- 1958 patients collected prospectively.
  - Exclusion criteria
    - Instability
    - Labrum pathologies
    - Chronic and inflammatory arthritis
    - Tumors
    - Previous shoulder surgery
- 1156 patients included

Methods

Patient Selection

- 330 patients with subscapularis tendon tear identified
  - Group 1: 273 patients with rotator cuff tear
  - Group 2: 57 patients with isolated subscapularis tendon tear
  - Group 3: 190 patients with rotator cuff tear without accompanying subscapularis tear
  - Group 4: 263 patients without rotator cuff pathology

Methods

- Lafosse classification
  - Type 1: Partial tear of the tendon
  - Type 2: Complete tear of the superior third of the tendon
  - Type 3: Tears of the superior two-thirds of the tendon, with fatty infiltration in less than 50% of the muscle
  - Type 4: Tears of the superior two-thirds of the tendon, with fatty infiltration in more than 50% of the muscle
  - Type 5: Complete tears usually with anterior glenohumeral subluxation and fatty infiltration in more than 50% of the muscle.

Result

Table I Comparison of demographic and clinical characteristics in 4 groups

Characteristics	Group 1 (n = 273)	Group 2 (n = 57)	Group 3 (n = 190)	Group 4 (n = 263)	*P* value
Age, yr, mean ± SD	60.22 ± 9.57	53.12 ± 8.81	52.19 ± 10.33	49.55 ± 12.68	.001*
Sex					.143
Male	86 (31.5)	24 (42.1)	60 (31.6)	103 (39.2)	
Female	187 (68.5)	33 (57.9)	130 (68.4)	160 (60.8)	
SE					.001*
Yes	258 (94.5)	50 (87.7)	68 (35.8)	64 (24.3)	
No	15 (5.5)	7 (12.3)	122 (64.2)	199 (75.7)	
MRI, subscapular tendon tear					.001*
Yes	187 (68.5)	35 (61.4)	0 (0)	9 (3.4)	
No	86 (31.5)	22 (38.6)	190 (100)	254 (96.6)	

SE, subcoracoid effusion; *MRI*, magnetic resonance imaging.
Unless otherwise noted, values are n (%).
* Significant at $P \leq .05$; 1-way analysis of variance for age, χ^2 test for categorical data.

Result

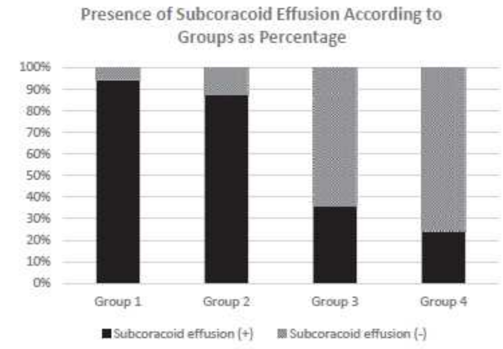


Figure 3 Presence of subcoracoid effusion according to groups.

Result

Table II The relationship between subcoracoid effusion and Lafosse classification

Subcoracoid effusion	Lafosse classification						*P* value
	Total	Type 1	Type 2	Type 3	Type 4	Type 5	
Yes	308 (93.3)	16 (64)	108 (93.1)	116 (96.7)	66 (98.5)	2 (100)	.001*
No	22 (6.7)	9 (36)	8 (6.9)	4 (3.3)	1 (1.5)	0 (0)	

Values are n (%).
* Significant at $P \leq .05$; χ^2 test.

Result

Table III Cross-table of presence of subcoracoid effusion and detection of subscapularis tear on MRIs of patients with arthroscopically proven subscapularis tears (n = 330)

Subcoracoid effusion	Detection of subscapularis tear on MRI				*P* value
	Yes		No		
	Count	Column %	Count	Column %	
Yes	213	95.9	95	88.0	.006*
No	9	4.1	13	12.0	

MRI, magnetic resonance imaging.
* Significant at $P \leq .05$; χ^2 test.

Result

Table II The relationship between subcoracoid effusion and Lafosse classification

Subcoracoid effusion	Lafosse classification						P value
	Total	Type 1	Type 2	Type 3	Type 4	Type 5	
Yes	308 (93.3)	16 (64)	108 (93.1)	116 (96.7)	66 (98.5)	2 (100)	.001*
No	22 (6.7)	9 (36)	8 (6.9)	4 (3.3)	1 (1.5)	0 (0)	

Values are n (%).
* Significant at $P \leq .05$; χ^2 test.

Table IV Relationship between Lafosse classification and detection of subscapularis tear on MRI

Detection of subscapularis tear on MRI	Lafosse classification					
	Total	Type 1	Type 2	Type 3	Type 4	Type 5
Yes	222 (67.3)	8 (32)	61 (52.6)	86 (71.7)	65 (97)	2 (100)
No	108 (32.7)	17 (68)	55 (47.4)	34 (28.3)	2 (3)	0 (0)
P value	.001*	.025*	.001*	.001*	.559	>.99

MRI, magnetic resonance imaging.
Values are n (%).
* Significant at $P \leq .05$; Z test for independent proportions.

Discussion

- This study investigated the relationship between subscapularis tears and the presence of subcoracoid effusion (SE) on MRI scans
- SE was a supportive finding in the diagnosis of subscapularis tears
  - Presence of SE should raise suspicion about the possibility of subscapularis tear in patients who were not diagnosed with subscapularis rupture on MRI in the preoperative period

Discussion

- Diagnosis of subscapularis tears:
  - Not always easy to diagnose subscapularis tears radiologically
  - Lafosse type 1-3 tears cannot always be diagnosed on MRI
  - More than 90% SE detected on MRI in Lafosse type 2-5
  - SE was an effective supportive finding in the diagnosis of early-stage subscapularis tears

Conclusion

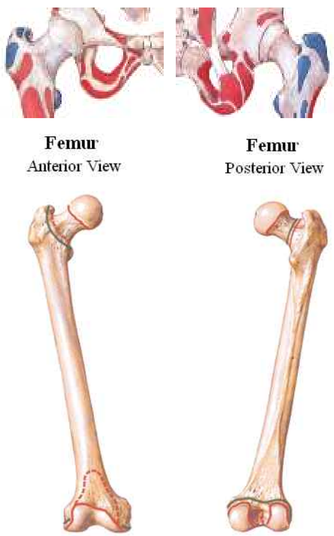
- SE is a more specific finding for subscapularis tears than other rotator cuff pathologies
- Preoperatively, it is not always possible to diagnose subscapularis tears, especially Lafosse type 1-3 tears, on MRI
- SE on MRI should also be considered in patients with a rotator cuff tear in whom subscapularis tear was not detected in preoperative MRI
- Subscapularis tendon should be carefully evaluated during surgery in cases where the effusion is positive

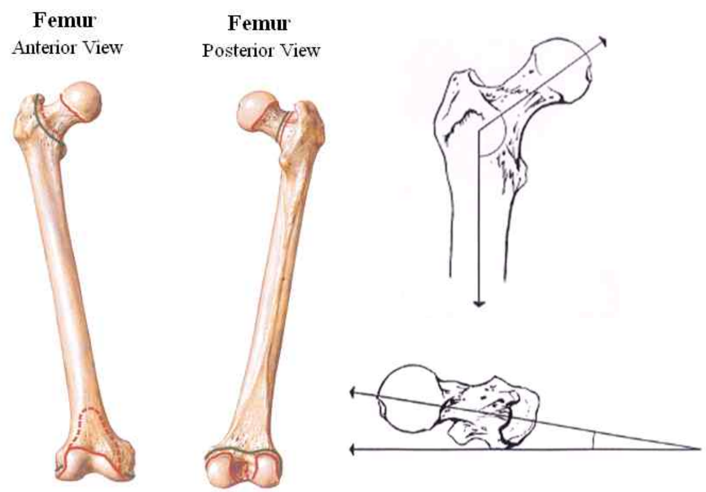
Anatomy Seminar

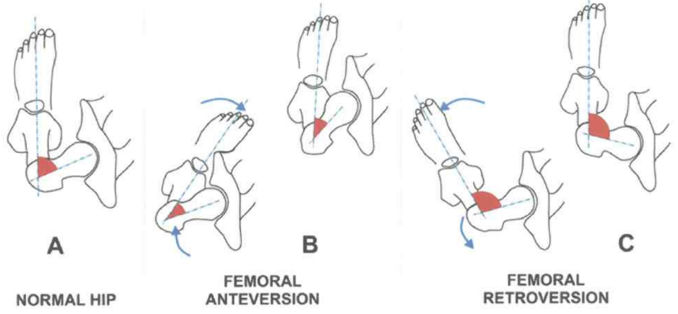
Hip & Femur

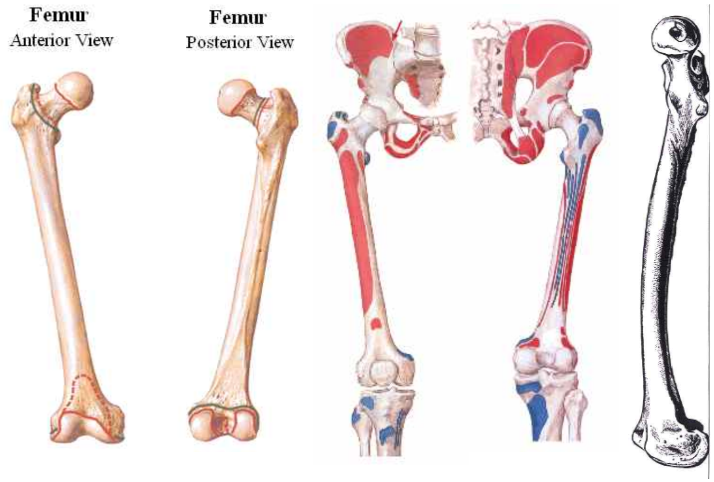
명지병원 정형외과
2023. 04. 12.
R1 정 승 호

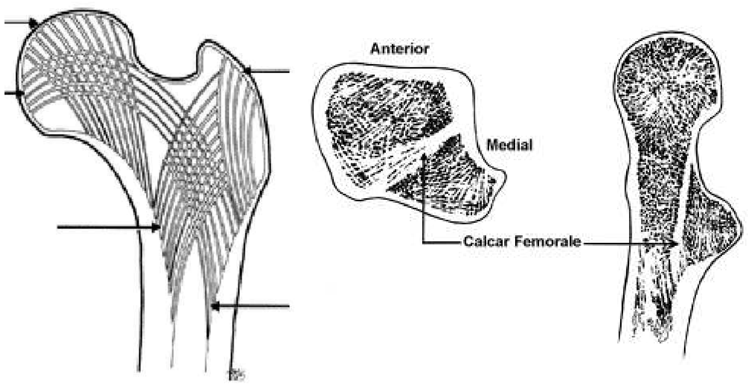
Osteology

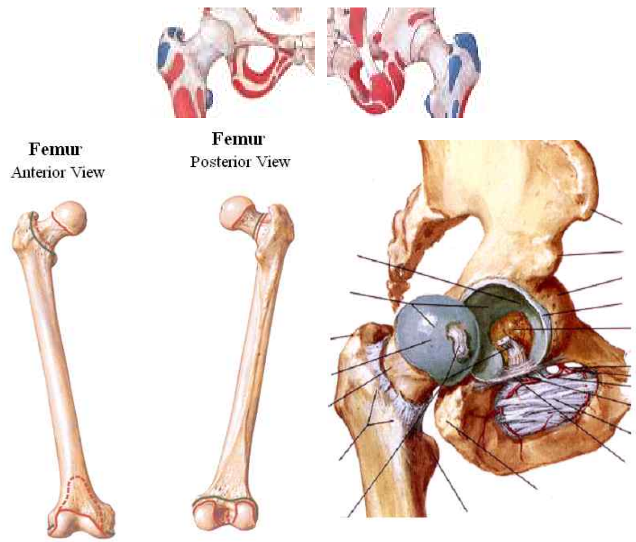




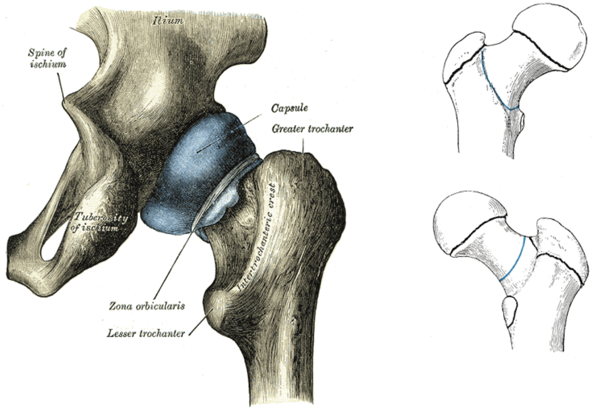

A
B
C
NORMAL HIP
FEMORAL
ANTEVERSION
FEMORAL
RETROVERSION

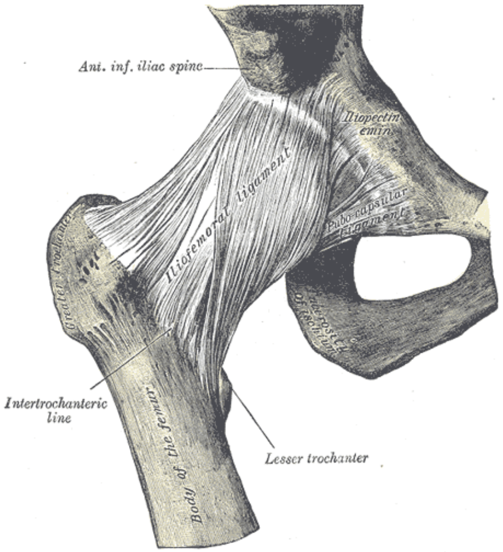

Femur
Anterior View
Femur
Posterior View

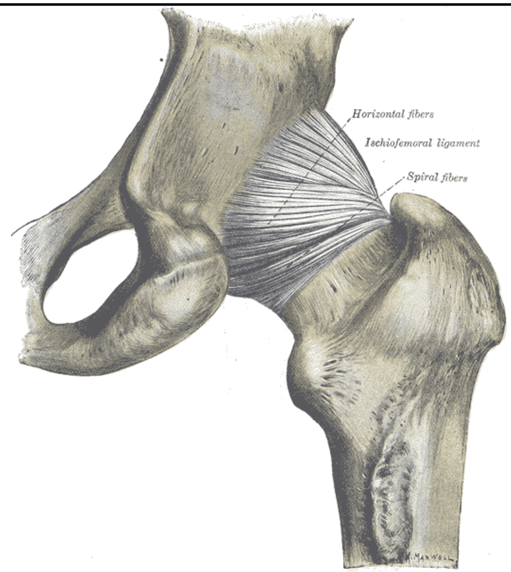

Anterior
Medial
Calcar Femorale

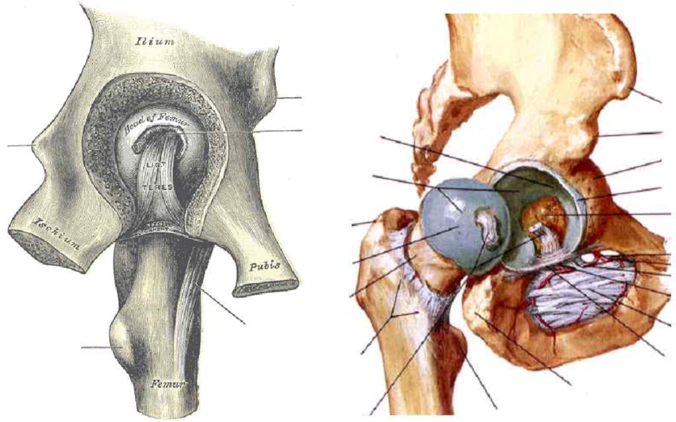

Femur
Anterior View
Femur
Posterior View

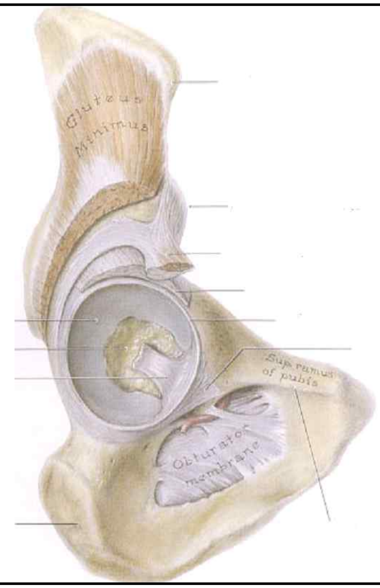
Arthrology


Ilium
Spine of ischium
Capsule
Greater trochanter
Intertrochanteric crest
Zona orbicularis
Lesser trochanter

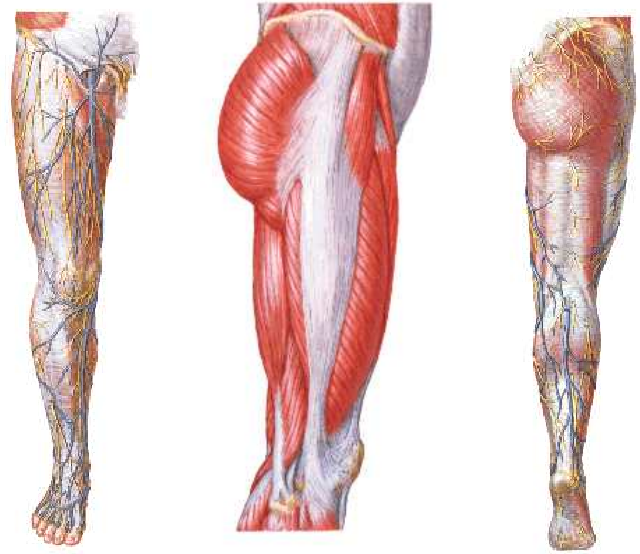

Ant. inf. iliac spine
Iliofemoral ligament
Pubo-capsular ligament
Intertrochanteric line
Body of the femur
Lesser trochanter


Horizontal fibers
Ischiofemoral ligament
Spiral fibers

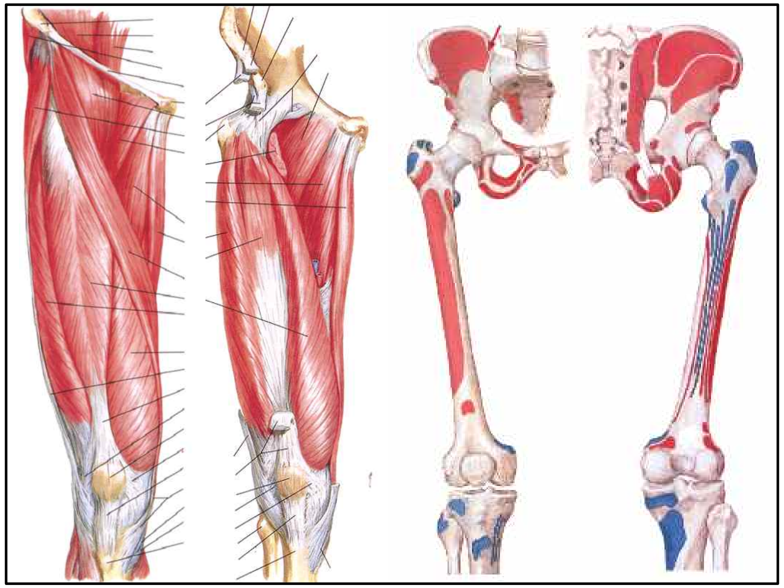

Ilium
Head of Femur
LIG.T
TERES
Ischium
Pubis
Femur

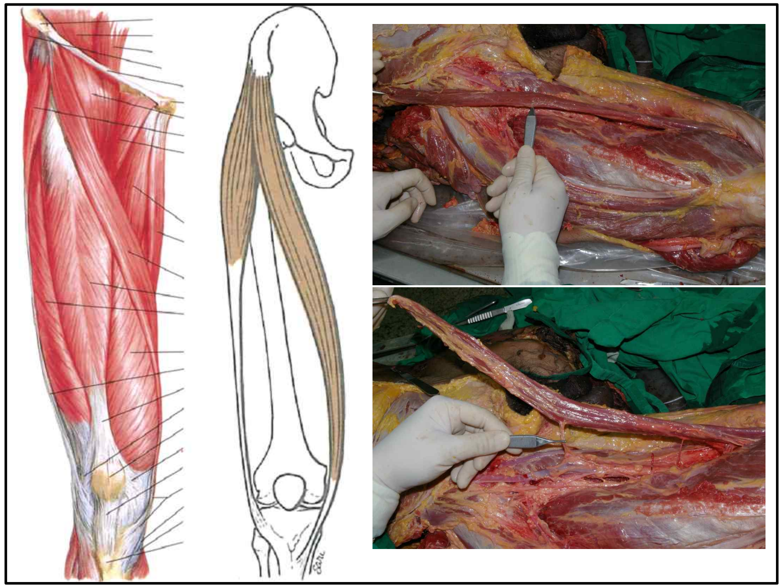

Gluteus
Minimus
Sup. ramus
of pubis
Obturator
membrane

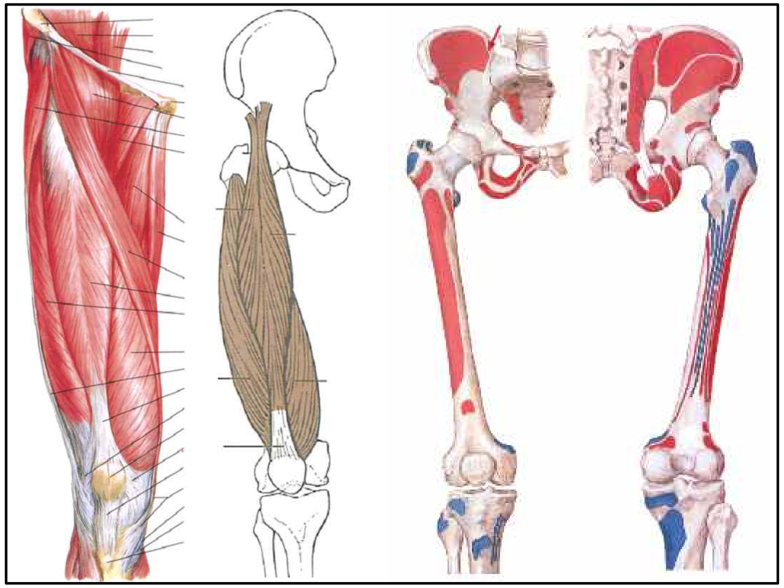
Fascia

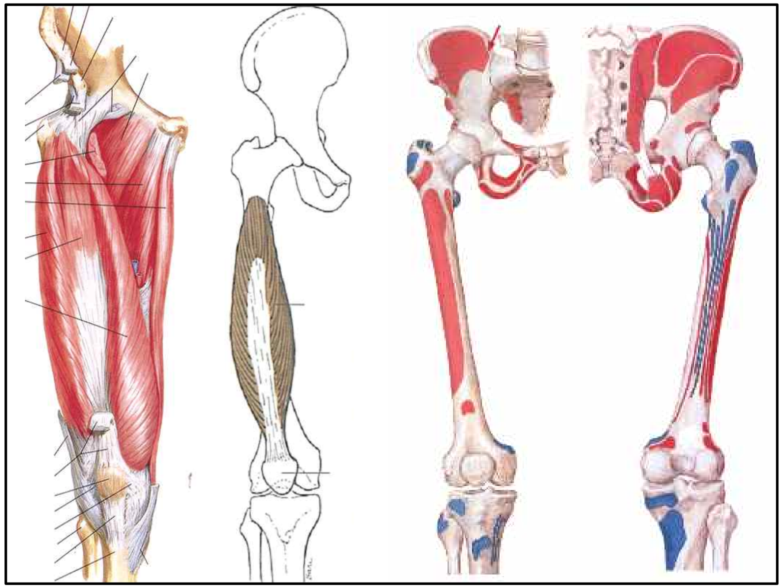


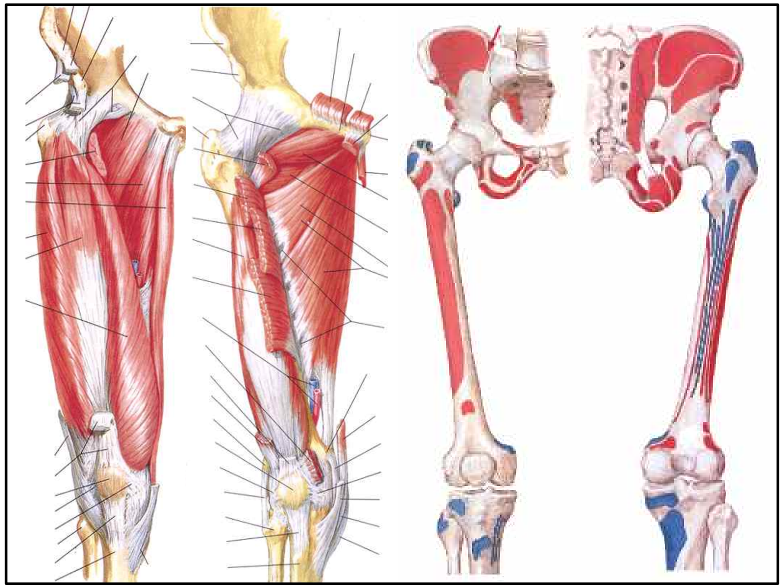
Myology

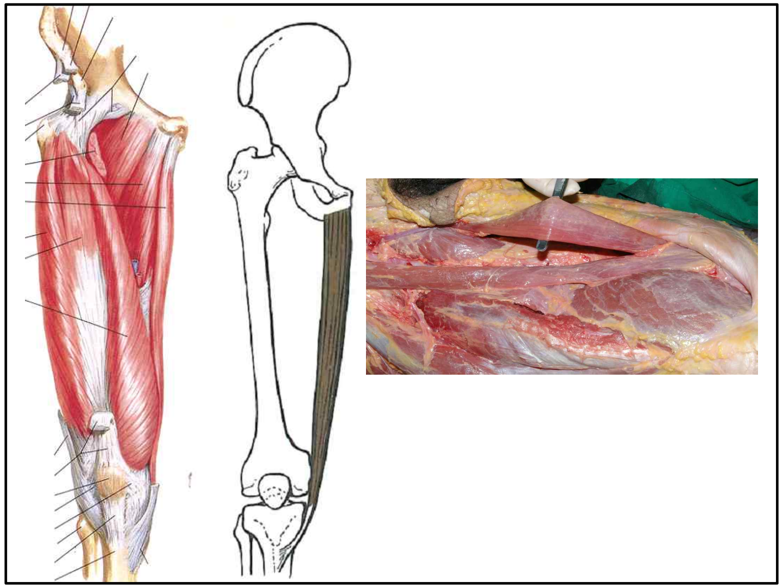


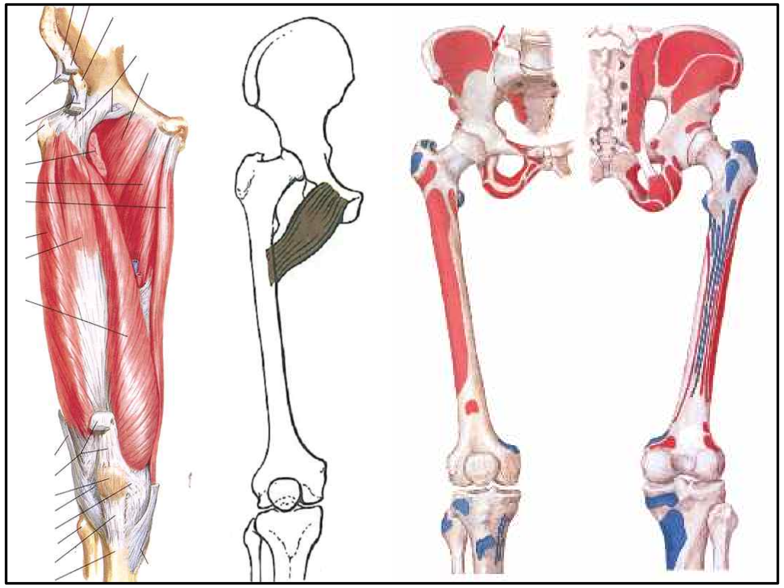


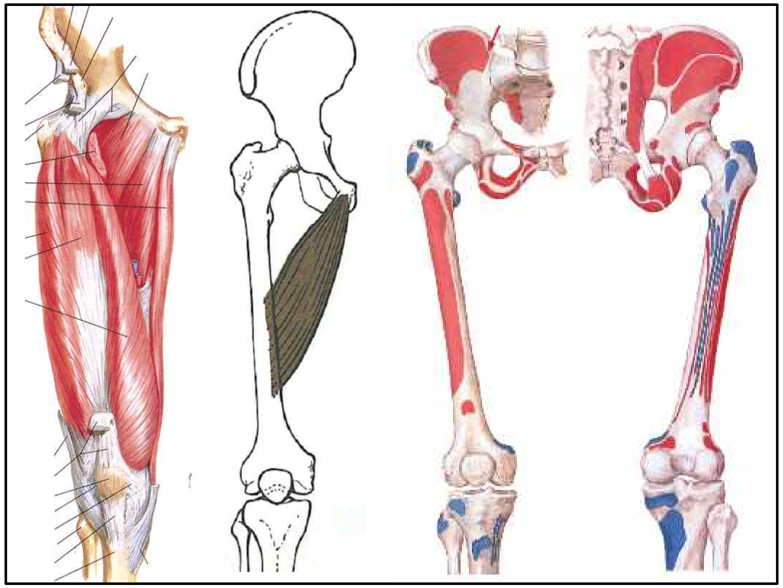


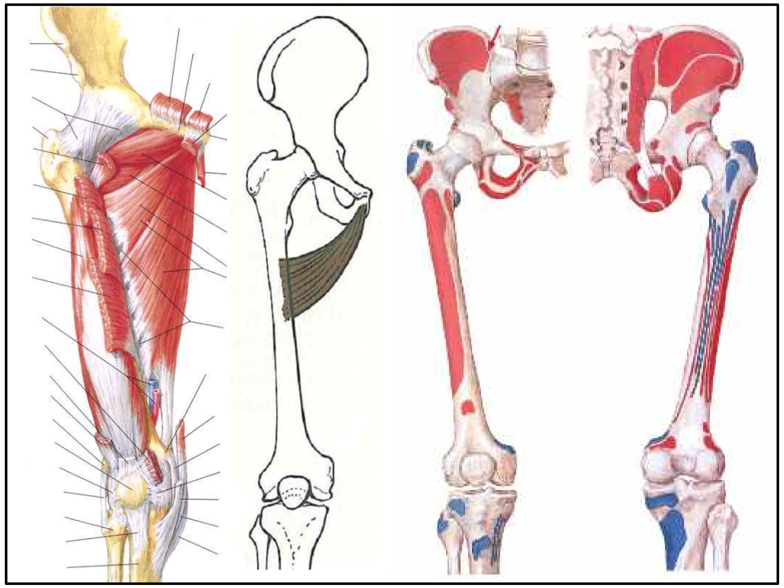


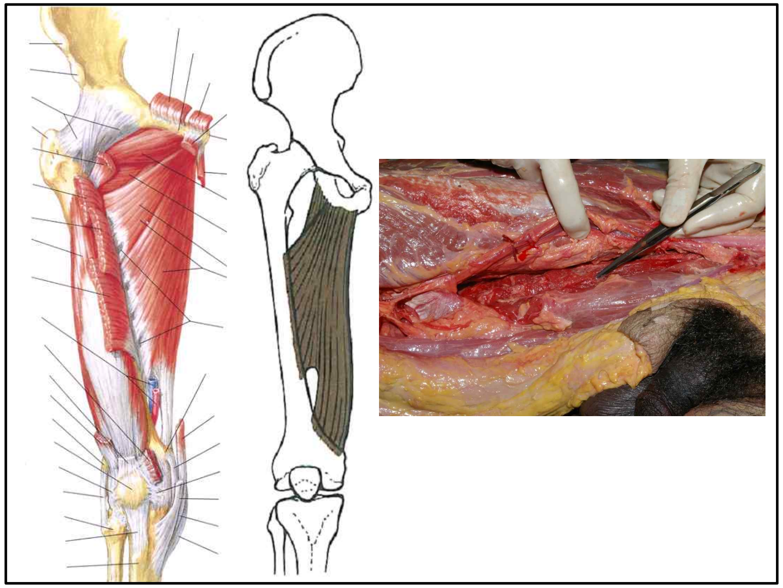


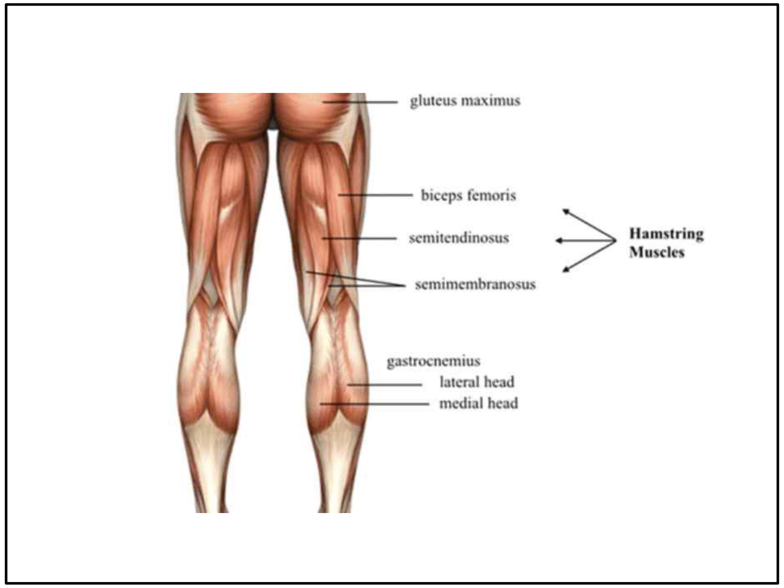


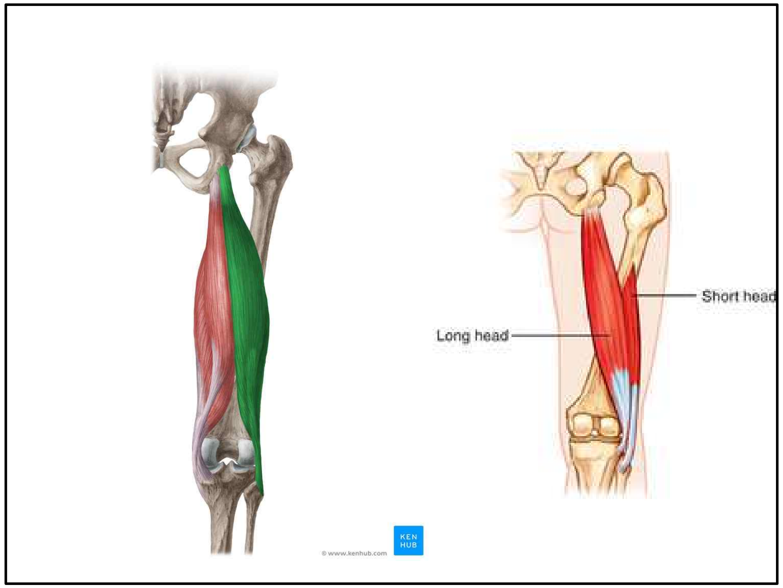


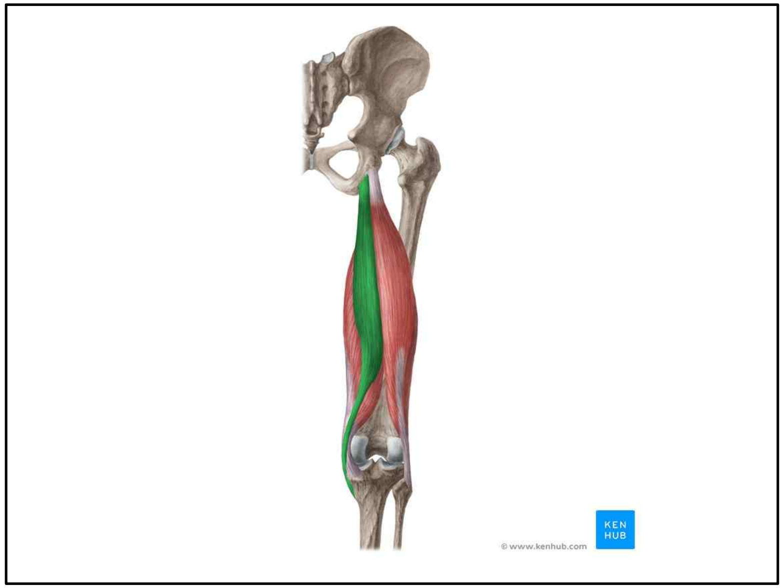


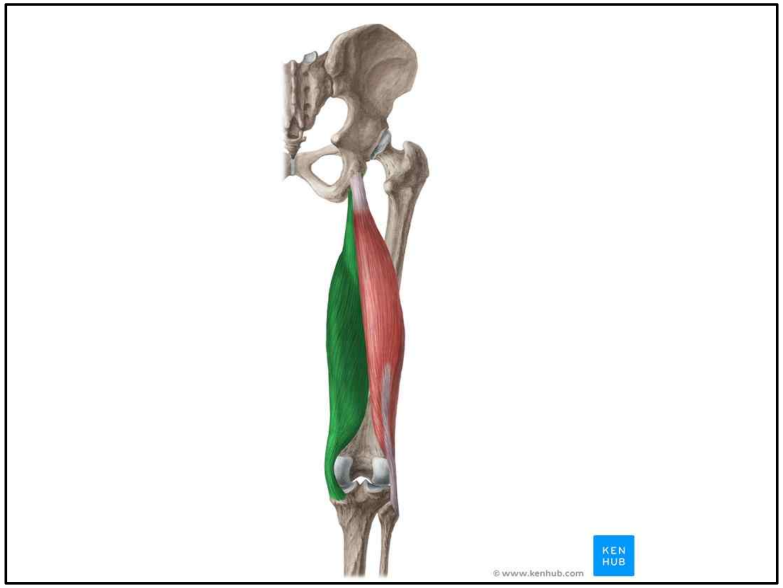





gluteus maximus
biceps femoris
semitendinosus
semimembranosus
Hamstring Muscles
gastrocnemius
lateral head
medial head


Short head
Long head
© www.kenhub.com
KEN HUB


© www.kenhub.com
KEN HUB


© www.kenhub.com
KEN HUB

Revision of THA
Reconstruction of acetabular & femoral deficiencies

명지병원 정형외과

2023.05.02

R4. 이 인 엘

REVISION OF THA

▣ Revision of total hip arthroplasty

▶ 17.5% of all hip arthroplasties performed in the United States (1990 ~ 2002)

▶ Failure of total hip arthroplasty ← one or more technical problems

▶ Revision requires

→ More operative time, more blood loss

→ Incidences of infection, thromboembolism, dislocation, nerve palsy

→ Fracture of the femur ↑

REVISION OF THA

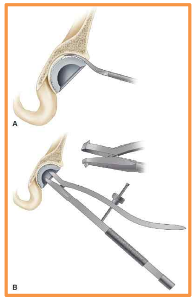
▣ Indication

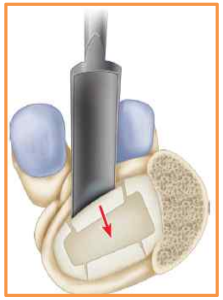
① Painful / aseptic loosening of one or both components (m/c)
② Progressive loss of bone
③ Fracture or mechanical failure of the implant
④ Recurrent or irreducible dislocation
⑤ Infected total hip arthroplasty as a one-stage or two-stage procedure
⑥ Periprosthetic fracture

▣ Relative contraindication

① Painless loss of motion in the hip
② Painless limb lengthening
③ Limping

REVISION OF THA





Remove femoral stem → Remove acetabular cup → Cup change → Remove femoral cement → Femoral stem change

REMOVAL OF CEMENTED FEMORAL COMPONENT

- Stem을 extract 하기 전에 removal을 방해하는 overhanging bone을 GT에서 제거
- Stem에 proximal curvature가 있는 경우 implant의 shoulder에 놓여있는 lateral cement를 제거

FIGURE 3-134 Moreland femoral component extractor. (Redrawn from Johnson & Johnson, DePuy, Warsaw, IN.) SEE TECHNIQUE 3-8.

FIGURE 3-136 Moreland V osteotome for removal of lateral cement over shoulder of implant for stems with proximal curvature. (Redrawn from Johnson & Johnson, DePuy, Warsaw, IN.) SEE TECHNIQUE 3-8.

REMOVAL OF A CEMENTLESS FEMORAL COMPONENT

- Extensively porous-coated implant
- Osteotome → proximal에만 효과, distal 에는 효과 없다

FIGURE 3-137 Moreland specialized, thin, flexible osteotome for disrupting bone ingrowth at proximal end of porous-coated stem. (Redrawn from Johnson & Johnson, DePuy, Warsaw, IN.) SEE TECHNIQUE 3-9.

FIGURE 3-138 Removal of implants with extensive distal bone ingrowth (Glassman and Engh). **A,** Prosthesis is transected with carbide-tipped, metal-cutting burr. **B,** Distal cylindrical portion of stem is removed by reaming over it with trephine reamer. (Redrawn from Johnson & Johnson, DePuy, Warsaw, IN.) SEE TECHNIQUE 3-10.

EXTENDED TROCHANTERIC OSTEOTOMY

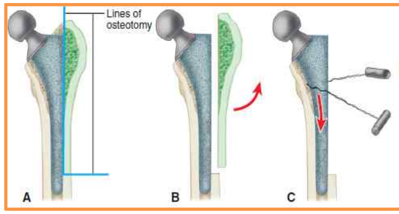


FIGURE 3-140 Extended trochanteric osteotomy for difficult stem removal. **A,** Longitudinal portion of osteotomy follows lateral border of stem and extends distally to predetermined level. **B,** Anterior cortex is divided, and entire lateral cortical segment, with trochanter, is retracted anteriorly, exposing lateral surface of stem. **C,** Bone ingrowth is disrupted with Gigli saw passed down medial side of stem. SEE TECHNIQUE 3-11.

REMOVAL OF A BROKEN FEMORAL COMPONENT

FIGURE 3-141 Collis and Dubrul method for removal of broken stem. **A,** Trephine is used to cut circumferentially around fractured prosthesis; stem acts as drill guide for trephine. **B,** Stem is removed from medullary canal with slide hammer and collet instrumentation. (Redrawn from Collis D, Dubrul W: The removal of fractured prosthetic components from medullary cavities: a new technique, *Contemp Orthop* 8:61, 1984.) SEE TECHNIQUE 3-12.

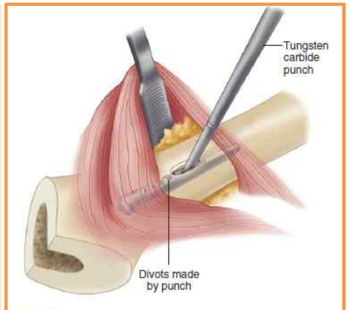


FIGURE 3-142 Method of removal of broken stem described by Moreland, Marder, and Anspach. Small window is made in anterior femoral cortex just distal to break in stem. Carbide punch is used to push prosthesis proximally. (Redrawn from Moreland JR, Marder R, Anspach WE Jr: The window technique for the removal of broken femoral stems in total hip replacement, *Clin Orthop Relat Res* 212:245, 1986.) SEE TECHNIQUE 3-13.

REMOVAL OF FEMORAL CEMENT

▶ THA revision 중 가장 시간이 많이 걸리고 위험한 부분
▶ 일반적으로 acetabular component를 revision 한 후에 시행
→ femoral canal에서 계속 bleeding 되면 acetabular side의 수술 시야를 방해하고 blood loss가 많아지기 때문

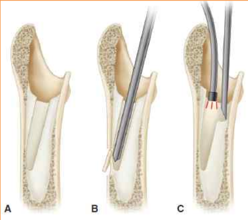


FIGURE 3-143 Removal of cement from femoral canal. **A** and **B**, After removal of varus stem, channel in cement is such that drill or osteotome tends to follow channel and penetrate cortex. **C**, Cement must be removed from medial wall to prevent penetration; fiberoptic light is helpful in this procedure. **SEE TECHNIQUE 3-15.**


FIGURE 3-144 Removal of cement from femoral canal. Longitudinal radial splits are made in proximal cement column. (Redrawn from Johnson & Johnson, DePuy, Warsaw, IN.) **SEE TECHNIQUE 3-15.**

RECONSTRUCTION OF ACETABULAR DEFICIENCIES

▣ Deficiency of the acetabular bone stock

① Osteolysis caused by wear, loosening, infection
② Excessive bone resection at the time of previous surgery especially if the patient has had a resurfacing procedure or previous acetabular revision
③ Pre-existing bone deficit from acetabular fracture or dysplasia that was not corrected at the time of previous surgery
④ Inadvertent destruction of bone during removal of a previous component or cement

RECONSTRUCTION OF ACETABULAR DEFICIENCIES

▣ AAOS Classification of Acetabular Deficiencies

TABLE 3-6 AAOS Classification of Acetabular Deficiencies

Type I	Segmental deficiencies
Peripheral	
Superior	
Anterior	
Posterior	
Central (medial wall absent)	
Type II	Cavitary deficiencies
Peripheral	
Superior	
Anterior	
Posterior	
Central (medial wall intact)	
Type III	Combined deficiencies
Type IV	Pelvic discontinuity
Type V	Arthrodesis

From D'Antonio JA, Capello WN, Borden LS, et al: Classification and management of acetabular abnormalities in total hip arthroplasty, *Clin Orthop Relat Res* 243:126-137, 1989.

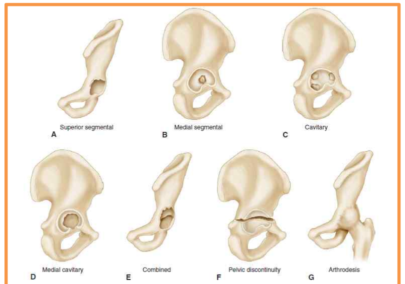


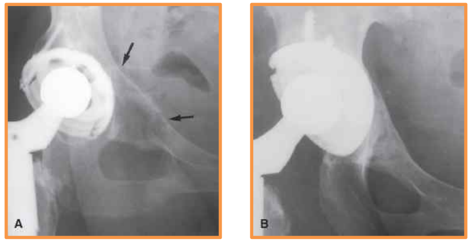
FIGURE 3-153 **A**, Superior segmental defect violates superior supporting rim and part of anterior supporting rim of acetabulum. **B**, Medial segmental defect violates medial supporting rim. **C**, Three cavitary defects involve excavation of bone without violation of superior, posterior, or anterior rim. **D**, Medial cavitary. Excavation of medial wall of acetabulum occurred without violation of medial rim (contained bone defect). **E**, Combined segmental cavitary defects. Superior, anterior segmental lesion combined with superior, anterior, and medial cavitary defects. **F**, Pelvic discontinuity. Interruption of anterior and posterior columns creates rare but unstable defect. **G**, Arthrodesis. Acetabular cavity filled with bone.

MANAGEMENT OF ACETABULAR CAVITARY DEFICITS

▶ Easiest to manage
▶ Ream to a slightly larger size (small size)
to increase the area of host bone in contact with the implant surface
▶ Allo or auto bone cancellous bone graft + large component (large size)

MANAGEMENT OF ACETABULAR SEGMENTAL DEFICITS

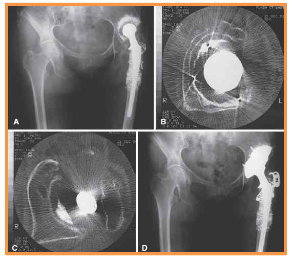
▶ Segmental deficits in
the anterior column usually do not require reconstruction



Anterior segmental deficiency in young woman.
A, Polyethylene wear produced this segmental deficiency in anterior column of acetabulum. Posterior column is intact.
B, Revision accomplished with large-diameter porous implant and cancellous bone grafting. No structural graft was required.

MANAGEMENT OF ACETABULAR SEGMENTAL DEFICITS

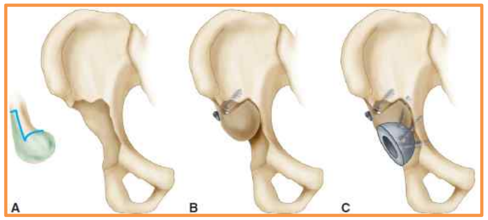
▶ Structural augmentation is needed most commonly for a
large posterior or superior segmental deficiency



Superior segmental deficiency.
A, Elderly woman with two previous revisions for developmental dysplasia. Residual high hip center with superior segmental deficit can be seen.
B, CT scan shows deficient posterior bone stock at high location.
C, Best available posterior bone stock is at level of true acetabulum.
D, Reconstruction with specialized, oblong revision acetabular component.

MANAGEMENT OF ACETABULAR SEGMENTAL DEFICITS

▶ Combined superior and either posterior or anterior segmental deficits usually are too large to be managed with a femoral head allograft

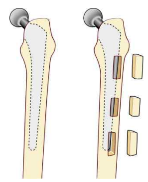


Paprosky "7" graft for segmental acetabular deficiency.
A, Distal femoral allograft is shaped to resemble numeral 7.
B, Graft is shaped to fit acetabular deficiency and fixed as shown, with several screws placed above acetabulum through remaining cortical portion of graft.
C, Graft is reamed, and revision component is implanted

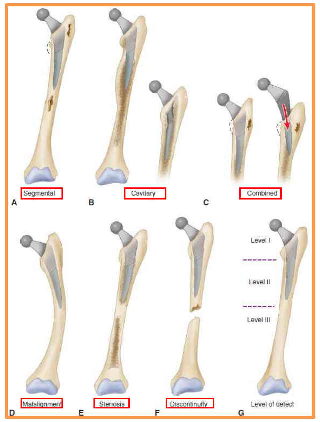
RECONSTRUCTION OF FEMORAL DEFICIENCIES

▣ AAOS Classification of femoral Deficiencies

① Osteolysis caused by loosening, wear, or infection
② Perforation or creation of windows
during removal of the previous stem or other implant
③ Stress shielding from
an excessively stiff or extensively porous-coated implant
④ Pre-existing osteoporosis and thin femoral cortices



RECONSTRUCTION OF FEMORAL DEFICIENCIES



RECONSTRUCTION OF FEMORAL DEFICIENCIES

▣ Two basic types → Segmental / Cavitary

① Segmental deficit
: Any loss of bone in the supporting <u>cortical shell of the femur</u>
partial , complete // anterior, medial, posterior

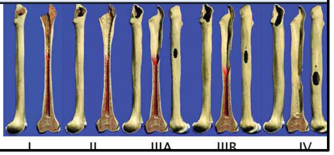
② Cavitary deficit
: Contained lesion representing an excavation of the cancellous or endosteal cortical bone without violation of the cortical shell of the femur.

▶ level I : proximal to the inferior border of LT
▶ level II : from the inferior margin of LT to 10cm distally
▶ level III : distal to level II

Treatment of femoral bone loss

	Definition	Proximal Metaphysis	Diaphysis	Proximal Remodeling	Reconstruction Options
I	Minimal proximal metaphyseal bone loss	Intact	Intact	No proximal remodeling	Cementless fixation; proximal fitting (i.e., SROM) or extensively porous-coated stem
II	Moderate-to-severe proximal metaphyseal bone loss	Absent	Intact	Slight proximal remodeling	Extensively porous-coated stem
III					
A	Severe proximal metaphyseal bone loss with diaphysis intact for some distance	Absent	≥4 cm of isthmus	Significant proximal remodeling	Extensively porous-coated stem if < 19 mm in diameter. If > 19 mm in diameter, then modular tapered stem
B	Severe proximal metaphyseal bone loss with diaphysis intact for some distance	Absent	< 4 cm of isthmus	Significant proximal remodeling	Modular tapered stem
IV	Complete loss of metaphyseal and diaphyseal bone	Absent	Absent	Little proximal remodeling	APC, cemented stem, or impaction grafting + cemented stem

Della Valle and Paprosky classification



Treatment of femoral bone loss

Type I

- Minimal metaphyseal cancellous bone lose

- Tx. : reconstructed with cemented or uncemented primary length stems

Treatment of femoral bone loss

Type II

- Extensive metaphyseal cancellous bone lose to the level of LT
- Tx. : Calcar replacement required to restore limb length
  Extensively porous-coated stem

MANAGEMENT OF FEMORAL SEGMENTAL DEFICITS

A, Patient was referred with failed long-stem cemented revision prosthesis. Large anterolateral cortical window had been created during previous surgery and was filled with cement.
B, Window was used for cement removal. Femur was reconstructed with cementless long stem and allograft cortical strut to restore lateral cortex.

Exercise # 1

▣ 문제 1. 대퇴스템의 시멘트 골절을 보이는 80세 환자에서 인공고관절 재치환술을 계획하려고 한다. 적당한 순서는?

1. 비구컵 제거
2. 비구컵 치환
3. 대퇴스템 제거
4. 대퇴스템 시멘트 제거
5. 대퇴스템 치환

① 1-2-3-4-5
② 1-3-4-2-5
③ 3-1-2-4-5
④ 3-4-1-2-5
⑤ 3-4-5-1-2

Exercise # 1

▣ 문제 1. 대퇴스템의 시멘트 골절을 보이는 80세 환자에서 인공고관절 재치환술을 계획하려고 한다. 적당한 순서는?

1. 비구컵 제거
2. 비구컵 치환
3. 대퇴스템 제거
4. 대퇴스템 시멘트 제거
5. 대퇴스템 치환

① 1-2-3-4-5
② 1-3-4-2-5
③ 3-1-2-4-5
④ 3-4-1-2-5
⑤ 3-4-5-1-2

Revision sequence of cemented THA
1) femoral stem 제거
2) acetabular cup 제거
3) cup change
4) femoral cement 제거
5) femoral stem change

Exercise # 2

▣ 문제 3. 고관절 재치환술 시, 삽입물의 안정성을 위해 구조 골 이식 (structural bone graft)이 자주 필요한 비구결손으로 짝지어진 것은?

① 전방 분절 결손 – 상방 분절 결손
② 전방 분절 결손 – 내측 분절 결손
③ 후방 분절 결손 – 상방 분절 결손
④ 후방 분절 결손 – 내측 분절 결손
⑤ 상방 분절 결손 – 내측 분절 결손

Exercise # 2

▣ 문제 3. 고관절 재치환술 시, 삽입물의 안정성을 위해 구조 골 이식 (structural bone graft)이 자주 필요한 비구결손으로 짝지어진 것은?

① 전방 분절 결손 – 상방 분절 결손
② 전방 분절 결손 – 내측 분절 결손
③ 후방 분절 결손 – 상방 분절 결손
④ 후방 분절 결손 – 내측 분절 결손
⑤ 상방 분절 결손 – 내측 분절 결손

Structural bone grafting
- most common
- for a large posterior or superior segmental deficiency

Reference

▣ Elite
P 533 ~ 551
▣ Campbell
P 264 ~ 286

Back & spine surgical approach

Myong-ji Hospital
Orthopaedics

2023.05.08
R3. 이규환

Anterolateral approach

▶ It provides access to all vertebrae from L1 to the sacrum, whereas the transperitoneal approach is very difficult to use above the level of L4

▶ it allows drainage of an infection, such as a psoas abscess, without the risk of contaminating the peritoneal cavity and causing a postoperative ileitis

▶ it is slightly more difficult to reach the L5-S1 disc space using this retroperitoneal approach, d/t vascular anatomy

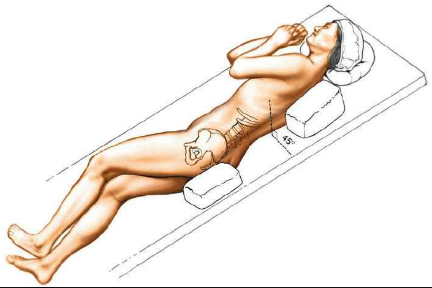
Anterolateral approach

▣ Position

▶ Place the patient on a radiolucent operating table in the semilateral position(45˚ – 90˚)

▶ placing sandbags under the hips and shoulders or by using a kidney rest brace to hold the patient

▶ The angle allows the peritoneal contents to fall away from the incision

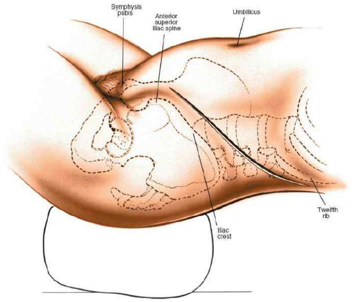


▣ Skin incision

▶ Palpate the 12th rib in the affected flank and the pubic symphysis in the lower part of the abdomen

▶ Palpate the lateral border of the rectus abdominis muscle about 5 cm lateral to the midline

▶ Make an oblique flank incision extending down from the posterior half of the 12th rib toward the rectus abdominis muscle and stopping at its lateral border, about midway between the umbilicus and the pubic symphysis



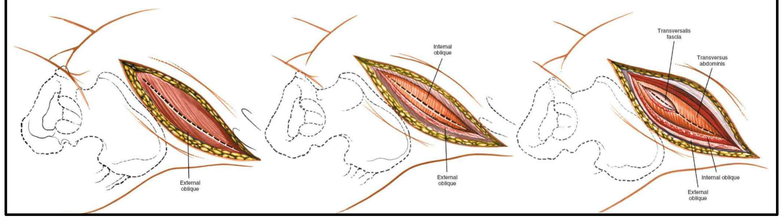
▣ Superficial surgical dissection

▶ Divide the aponeurosis of external oblique muscle in the line of its fibers, which is in line with the skin incision

▶ divide the internal oblique muscle in line with the skin incision which is perpendicular to the line of its muscular fibers

- This division causes partial denervation, but if the muscle is closed properly, postoperative hernias can be avoided

▶ Divide transversus abdominis muscle in line with the skin incision to expose the retroperitoneal space

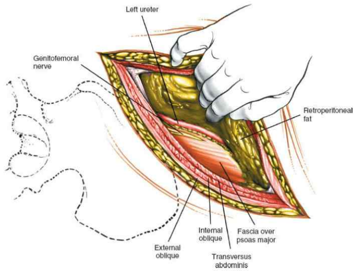


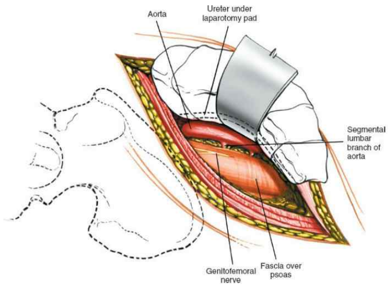
▣ Superficial surgical dissection

▶ Using blunt finger dissection, develop a plane between the retroperitoneal fat and the fascia that overlies the psoas muscle

▶ Gently mobilize the peritoneal cavity and its contents and retract them medially

▶ Place a Deaver-type retractor over the peritoneal contents and retract them to the right upper quadrant. The ureter, which is attached loosely to the peritoneum, is carried forward with it.

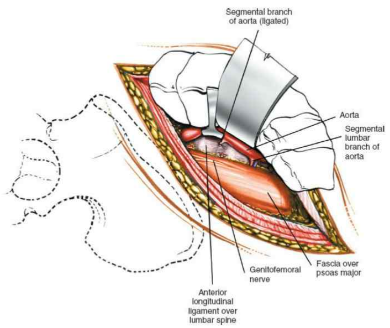




▣ Deep surgical dissection

▶ Follow the surface of the psoas muscle medially to reach the anterior lateral surface of the vertebral bodies.

▶ Place a needle into the involved lumbar vertebra or disc, and take a radiograph to identify the exact location



Posterior approach

▣ Position

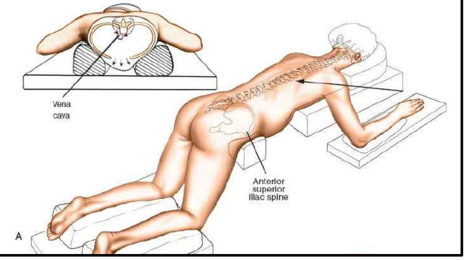
▶ prone position

▶ bolsters are placed longitudinally under the patient's sides

- to reduce venous plexus filling

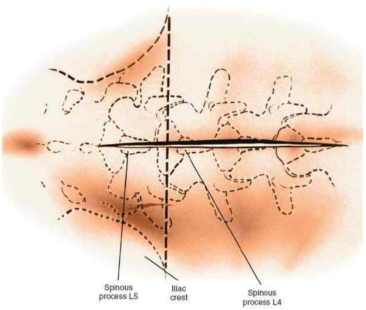
▶ For decompression, flex the hips to create an increase in interlaminar or interspinous distance

▶ For lumbar fusion, place the hips in neutral or slight extension



▣ Skin incision

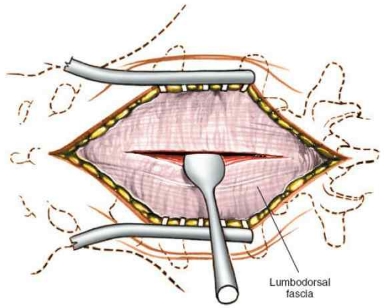
▶ Make a midline longitudinal incision over the spinous processes, extending from the spinous process above to the spinous process below the pathologic level



▣ Superficial surgical dissection

▶ Deepen the incision through fat and fascia in line with the skin incision until the spinous process itself is reached

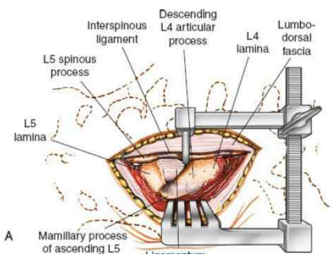
▶ Detach the paraspinal muscles subperiosteally as one unit from the bone, using a dissector, such as a Cobb elevator, or with cautery

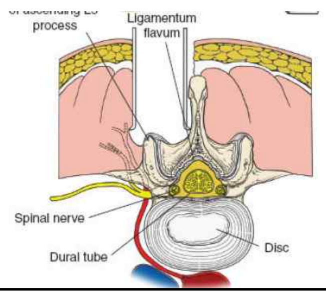


▣ Superficial surgical dissection

▶ Dissect down the spinous process and along the lamina to the facet joint

▶ Continue dissecting laterally, stripping the joint capsule from the descending and ascending facets.

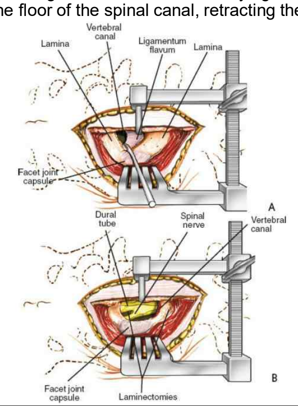


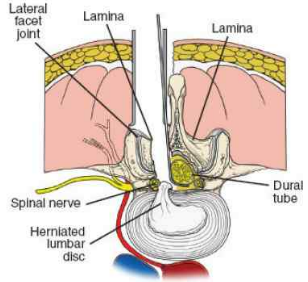


▣ Deep surgical dissection

▶ Remove the ligamentum flavum by cutting its attachments to the superior, or leading, edge of the inferior lamina using either a curette or sharp dissection

▶ Using blunt dissection and staying lateral to the dura, carefully continue down to the floor of the spinal canal, retracting the dura and its nerve root medially

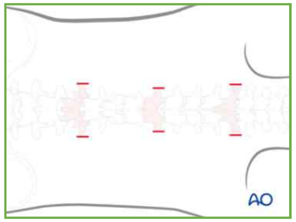


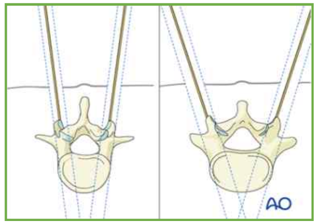


Percutaneous posterior approach for pedicle screw placement

▣ Percutaneous posterior approach for pedicle screw placement

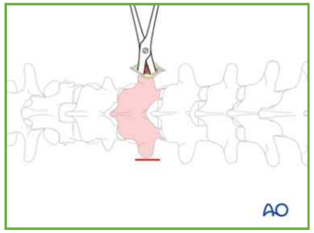
- ▶ Skin incision is lateral to the image projection of the pedicle
- ▶ Distance from the skin incision to the image projection varies depending on the various levels of the spine
- ▶ In the middle thoracic spine, the skin incision is close to the image projection of the pedicle, and in the lumbar spine it is more lateral

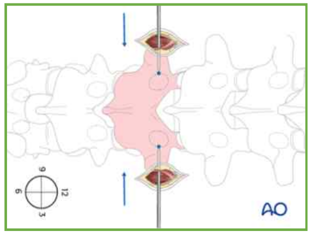




▣ Percutaneous posterior approach for pedicle screw placement

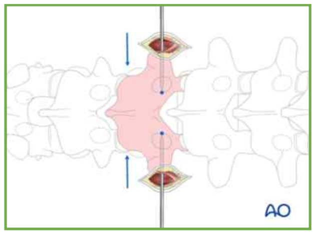
- ▶ Using scissors, a blunt dissection of the subcutaneous tissue, the fascia and the muscles is performed down to the bony structures of the vertebra
- ▶ Cannulated needles are inserted both at a 3 o'clock on the right side and a 9 o'clock position on the left side.

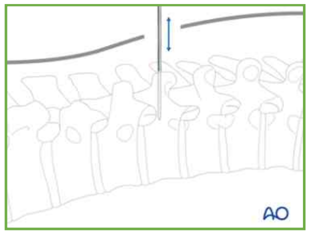




▣ Percutaneous posterior approach for pedicle screw placement

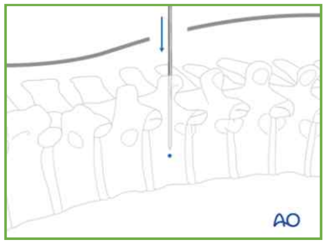
- ▶ The cannulated needles are tapped in until they reach the medial border of the pedicle image projection
- ▶ A lateral X-ray is then performed → If the tip of the needle has not passed the posterior wall of the vertebral body in the lateral projection, retract and reposition the needle

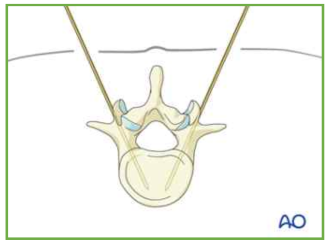




▣ Percutaneous posterior approach for pedicle screw placement

- ▶ If the tip of the needle has passed the posterior wall of the vertebral body in the lateral projection, the needle can be advanced to the center of the vertebral body
- ▶ A K-wire is introduced via the cannulated needle. Then, the cannulated needle is removed leaving the K-wire in place

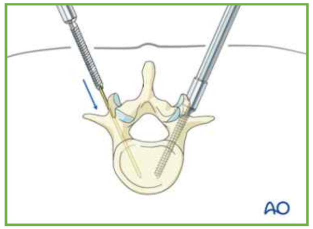




▣ **Percutaneous posterior approach for pedicle screw placement**

▶ After dilatation of the soft tissue,
the cannulated pedicle screw is inserted over the k-wire

▶ These steps are repeated,
depending on the number of vertebrae that have to be instrumented



Reference

▣ Campbell's Operative Orthopaedics,
' Chapter 37. Spinal Anatomy and Surgical Approaches', 14th edition

▣ AO surgery reference
https://surgeryreference.aofoundation.org/

▣ Surgical Exposures in Orthopaedics_ The Anatomic Approach 5th

PCL Diagnosis & Treatment

Myong-ji Hospital
Orthopedics
R2. 김수영

Introduction

▣ Diagnosis
▶ Physical exam
▶ X-ray (Posterior stress radiographs)
▶ MRI
▶ Arthroscope

▣ Treatment
▶ Conservative treatment
▶ Operative treatment

▣ Complications

▣ Rehabilitations

▣ Exercise

Diagnosis

▣ Physical exam

▶ Posterior sagging sign
▶ Quadriceps active test
▶ Posterior drawer test : most accurate test
▶ Dial test, ER recurvatum test, Reverse pivot shift test

▣ X-ray (Posterior stress radiographs)

▣ MRI

▣ Arthroscope

X-ray (Posterior stress)

▣ Plain X-rays
▶ Avulsion fractures with acute injuries
▶ Assess for posterior tibiofemoral subluxation

▣ Posterior stress radiographs
▶ KT 1000 or MRI 보다 더 민감도가 높다
▶ 8mm 이상 후방 전위가 있으면 PCL 완전 파열을 의미한다

X-ray (Posterior stress)

Telos device

Hamstring contracture

Kneeling view

Gravity view

Axial view

Telos: 12.7 ± 3 mm
Hamstring : 11.2 ± 3.2 mm
Kneeling : 14.4 ± 3.8 mm
Gravity : 10.5 ± 2.8 mm
Axial : 19.4 ± 6.9 mm

Pain : Telos, kneeling

Tobias M. Knee Surg Sports Traumatol Arthrosc 2006

X-ray (Posterior stress)

Fig. 3 A line is drawn along the medial tibial plateau. Perpendicular lines are drawn tangential to the midpoint between the most posterior contours of the medial and lateral femoral and tibial condyles. The distance is measured to determine the total posterior displacement (PTD)

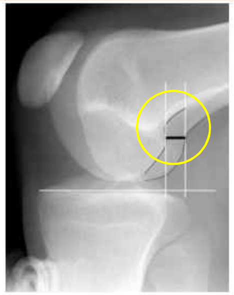


Fig. 4 By directing the vertical x-ray beam to the lateral side of the knee imprecisely, the posterior edges of the medial/lateral femoral condyles are reproduced in a displaced fashion on the x-rays. The distance of the posterior edges indicates the rotational error of the x-ray

Tobias M. Knee Surg Sports Traumatol Arthrosc 2006

MRI

▣ Continuity, Enlarged, Signal
▣ Acute PCL (96 ~ 100% accuracy / 1st Choice of Dx)
▶ Bone bruise located anterior to tibia
▣ Chronic PCL (Residual laxity = PDT / 1st Choice of Dx)
▶ May appear to be normal
→ PCL usually remains contiguous (~70%)
although there may be complete or partial ligamentous disruption

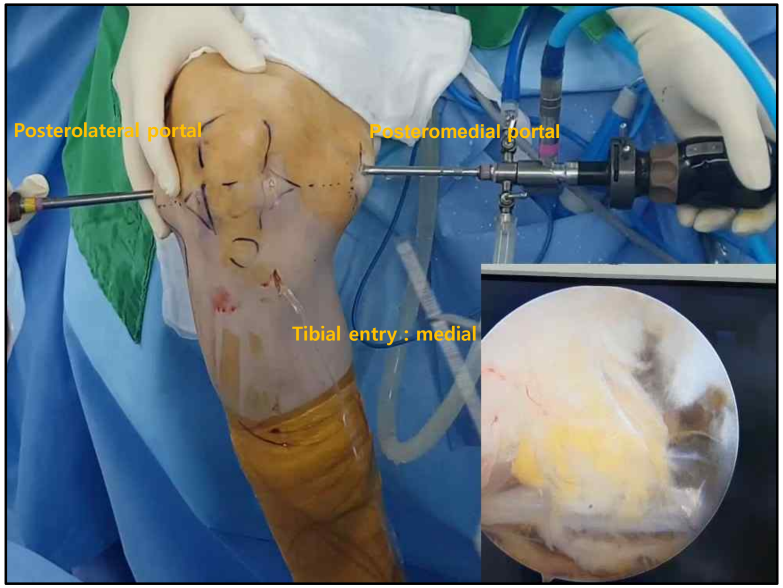
Acute PCL injury

Chronic PCL injury

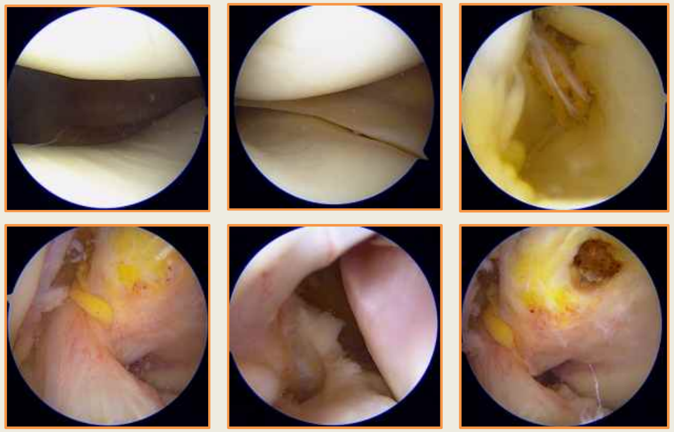
PCL mucoid degeneration

1073168 황O영 M/33

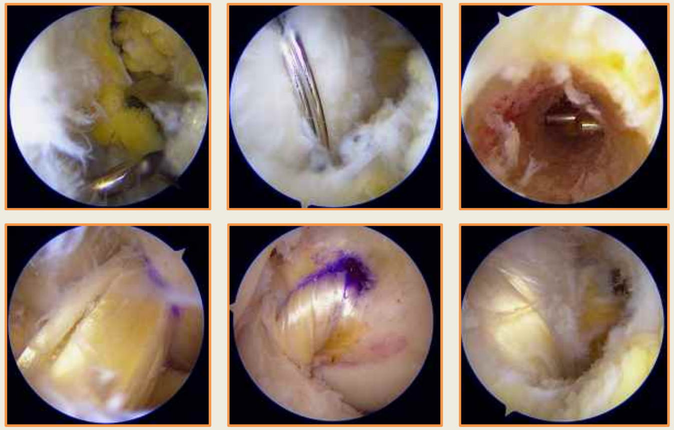
▶ 내원 4개월 전 축구하다 넘어지며 수상
▶ PDT : 11.92 mm (Rt. Knee)



1073168 황O영 M/33



1073168 황O영 M/33



Arthroscope

▣ 출혈, 파열된 섬유, 긴장도 감소, 인대의 위축
▣ ACL pseudolaxity (전방십자인대의 가성 이완)
▣ 후외측 구조물 손상 시, Drive through sign 동반
▶ 외측 구획의 과도한 이완 → 외측 구획의 경골대퇴 간격이 늘어남
▣ Abnormal contact sign
▶ 내측 반월상 연골의 전각이 대퇴골 내과와 접촉
→ 이는 후방 불안정성으로 인하여 근위경골이 후방으로 전위되어
비정상적인 내측 구획의 접촉이 발생
▶ PCL 손상에서 볼 수 있는 간접적인 징후

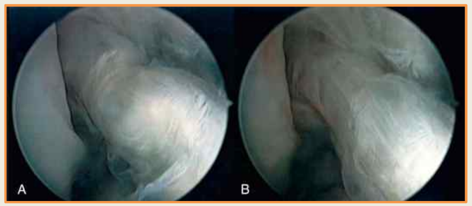


그림 V-86. Drive through sign.

Conservative vs Operative

▣ 활액막에 의해 싸여 있고 혈액 공급이 원활하기 때문에 ACL 보다 자연 치유력 ↑
▶ Extra-articular synovium tissue

▣ Accounting factors
▶ Nature of injury (Acute or Chronic) → 손상의 시기
▶ Type of ligament rupture (avulsion or intra-substance) → 손상의 정도
▶ Degree of laxity (Gr I, II or III)
▶ Pt's symptoms → 환자의 증상
▶ Pt's occupational or athletic demand → 환자의 신체 상태

▣ Isolated, low grade (Gr I, II < 8mm), mild symptomatic, low demand in daily life
▶ Conservative treatment

0 ~ 4 mm	Normal
5 ~ 7 mm	Partial PCL
8 ~ 11 mm	Isolated PCL
≥ 12mm	PCL + PLC

Santiago Pache, MD. Arch Bone Jt Surg. 2018

Conservative Treatment

▣ Indications

▶ Posterior drawer of less than 10 mm (grade II) with the tibia in neutral rotation
→ Posterior drawer excursion decreases with IR of the tibia on the femur

▶ Less than 5 degrees of abnormal rotary laxity (5도 이하의 회전 불안정성)
→ However, abnormal ER of the tibia with the knee flexed 30 degrees, indicating PLRI

▶ No significant valgus-varus abnormal laxity (심한 내반 or 외반 불안정성이 없는 경우)
→ No associated significant ligamentous injury

Conservative Treatment

▣ 2 ~ 3 weeks (Acute phase)

▶ 통증과 염증의 완화, 조직의 치유, 관절 운동의 유지, 조기 체중 부하 및 조기 근육 강화
▶ Clutch와 brace를 사용하여 tolerable weight bearing을 시도하고 ROM은 0 ~ 60도 제한
▶ Quadriceps exercise를 시행하며 hip flexor 강화를 위해 SLR exercise를 시행
→ Quadriceps rehabilitation with a focus on knee extensor strengthening

▣ 3 ~ 4 weeks

▶ Brace off 후 정상 ROM까지 증가시키고 슬건 운동을 시작

▣ 6 ~ 8 weeks

▶ 모든 근력 강화 운동을 계속하고 달리기를 시작하며 근력이 85%에 이르면 스포츠 복귀

Operative Treatment

▣ Indication

▶ PCL 단독 손상
→ PCL avulsion fracture로 전위가 있으며 instability를 동반할 때
→ 후방 전위가 10mm 이상이며 젊고 활동성의 기대치가 높을 때
→ 충분한 재활에도 통증 및 신체 장애가 있을 때

▶ More than 5 degrees of abnormal rotatory laxity
→ 동반 인대 손상, 특히 후외측 불안정성이 동반한 복합 손상

▶ Significant valgus-varus abnormal laxity

▶ 수상 후 1 ~ 3주 이후, 염증 반응의 시기 지나고,
관절 운동 범위 회복 후 시행하는 것을 추천

Repair & Augmentation

- Clinically isolated' acute PCL disruptions are repaired if the ligament is avulsed with a fragment of bone

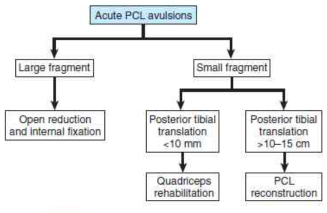


FIGURE 45-136 Treatment algorithm for posterior cruciate ligament (PCL) avulsion fracture. (From Veltri DM, Warren RF: Isolated and combined posterior cruciate ligament injuries, J Am Acad Orthop Surg 1:67, 1993.)

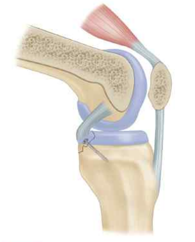


FIGURE 45-137 Screw reattachment of bone fragment avulsed with posterior cruciate ligament from posterior tibia. **SEE TECHNIQUE 45-24.**

Repair & Augmentation

- PCL occasionally will be 'peeled off' from its femoral attachment
- ▶ Surgical repair produces good results
- Repair of lesions at other sites is more controversial
- ▶ Good results achieved with primary repair of bony avulsions
- ▶ Primary repair of mid-substance ruptures are typically not successful
- ▶ Suture alone cannot restore the PCL and is not strong enough to withstand the applied forces on the knee in proximal one-third or mid one-third substance tears → with augmentation

Reconstruction

- Type of Graft : Autograft VS Allograft
- Bundle addressed : Single-bundle VS Double-bundle
- Tibial Graft fixation : Tanstibial tunnel VS Tibial inlay technique

Santiago Pache, MD. Arch Bone Jt Surg. 2018

Reconstruction

- Femoral tunnel : Single bundle
- ▶ Mostly for reconstruction of multiple knee ligaments in knee D/L
- ▶ AL bundle reconstruction (Not PM bundle)
- ▶ Femoral physio-metric point

→ 8 mm proximal to the articular cartilage at the 1-o'clock on the Rt. knee / at the 11-o'clock on the Lt. knee

- ▶ Femoral tunnel in the antero-superior portion of the femoral footprint

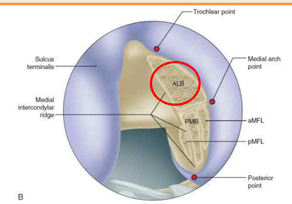


FIGURE 51-51 Arthroscopic view of the tibial attachment (**A**) and femoral attachment (**B**) of the posterior cruciate ligament (PCL) in a right knee, demonstrating pertinent landmarks. ALB, anterolateral bundle; aMFL, anterior meniscofemoral ligament; PMB, posteromedial bundle; pMFL, posterior meniscofemoral ligament. (Redrawn from Anderson CJ, Ziegler CG, Wijdicks CA, et al: Arthroscopically pertinent anatomy of the anterolateral and posteromedial bundles of the posterior cruciate ligament, J Bone Joint Surg 94:1936, 2012.)

Reconstruction

▣ Femoral tunnel : Double bundle

▶ Decrease posterior tibial translation / Rotational stability better than SB

▶ Femoral tunnel location

→ 11 mm and 7 mm diameter tunnels with a 2 mm bone bridge between the ALB and PMB reconstruction tunnels

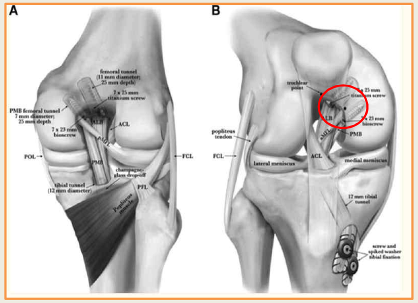


FIGURE 51-53 Ideal sites for positions of femoral tunnels as viewed from side of left knee with lateral femoral condyle removed (Bisson and Clancy). SEE TECHNIQUE 51-23.

Santiago Pache, MD. Arch Bone Jt Surg. 2018

Reconstruction

▣ Femoral tunnel : 4 fiber regions of PCL

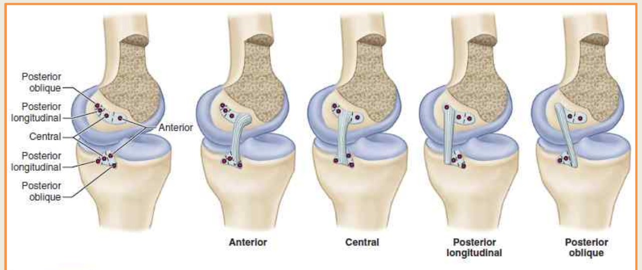
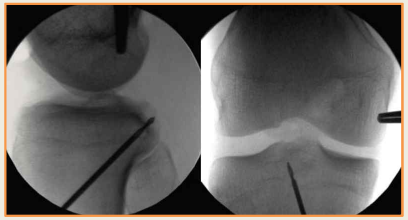


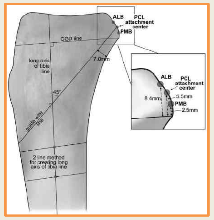
FIGURE 45-141 Four fiber regions of posterior cruciate ligament and their osseous sites of attachment on medial femoral condyle and posterior part of tibia. (From Covey CD, Sapega AA: Injuries of the posterior cruciate ligament, J Bone Joint Surg 75A:1376, 1993.)

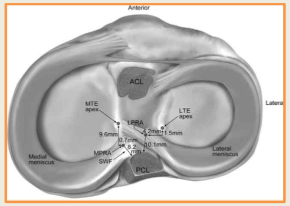
Tightens flexion
Relaxes extension

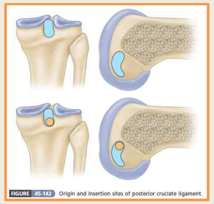
Relaxes flexion
Tighten extension

Reconstruction









Santiago Pache, MD. Arch Bone Jt Surg. 2018

Reconstruction

▣ Tibia tunnel : Transtibial technique

▶ Place the guide tip 10~12 mm below the joint line

▶ Drill guide approximately 60 degrees to the articular surface of the tibia, starting just inferior and medial to the TT

▶ Radiographs of the knee after guide pin insertion confirm that the guide wire exits in the fovea just inferior to the articular margin of the posterior tibia and just lateral to the midline

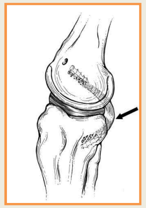
▶ Killer turn : 경골 후방에서 관절내로 이행하는 부위에서 이식물이 급격히 방향을 전환
(경골 근위부 터널의 경계의 날카로운 이식각에 의해 야기되는 graft의 마모)

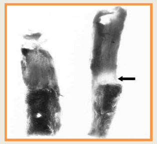
Reconstruction

Transtibial method	
Advantage	Disadvantage
Most popular & traditional procedure	Neurovascular risk with drilling
Supine position	"Killer" turn
Minimal incision (through an anterior approach)	

- ▶ Tibial tunnel rasping
- ▶ Anterolateral tibial tunnel
- ▶ PCL remnant preservation
- ▶ Immobilization & Delayed ROM

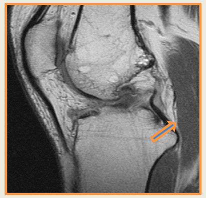
Prevent killer turn

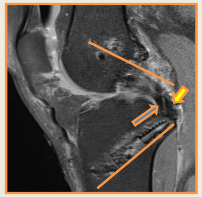




Cushion effect !
Blunt angle !

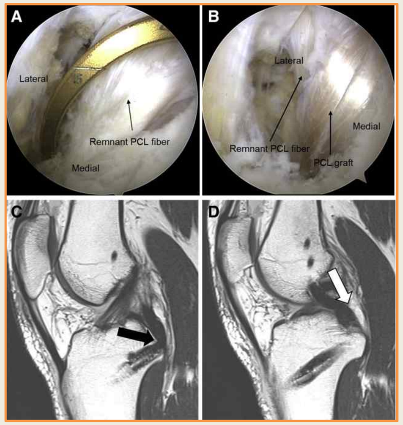
Reserve entire PCL insertion





Blunt angle

Prevent killer turn



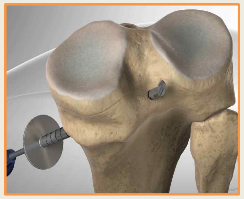
- ▶ Arthroscopic Anatomic Posterior Cruciate Ligament Reconstruction With Remnant Preservation
- ▶ This remnant preservation technique, which spares mechanoreceptors and prevents the killer-turn effect, can contribute to restoration of knee stability, biomechanics, and proprioception

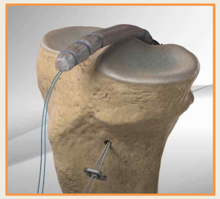
Dhong Won Lee. Arthroscopy: The Journal of Arthroscopic and Related Surgery 2019

Reconstruction

▣ Tibia tunnel : Tibial inlay technique

- ▶ Graft bone plug fixed
- ▶ Tibia footprint of the PCL is placed in the sulcus between the medial and lateral prominences of the posterior tibia
- ▶ Prior to fixation, the graft is pulled through the posterior arthrotomy and into the femoral tunnel using the looped wire
- ▶ After verifying appropriate bone block fitting and graft clearance, the graft is tensioned and definitively secured

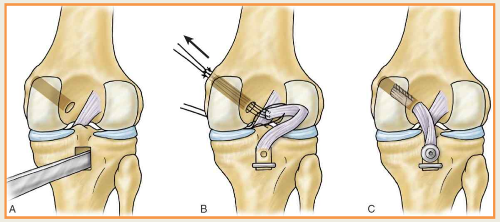




Reconstruction

▣ Tibia tunnel : Tibial inlay technique

▶ Advantage
→ Placing a tibial inlay graft securely into the posterior PCL tibial attachment site
▶ Often selected when only the PCL required reconstruction
▶ Tibial inlay graft provides ideal graft fixation and early healing



Reconstruction

Tibial inlay method	
Advantage	Disadvantage
Avoids the problem of abrasion of the ligament graft	Exposure of the popliteal fossa
Avoid "killer turn"	Prone or lateral decubitus position
Accurate and rigid fixation at tibial insertion	Difficult in approach, revision
Allows the graft to pass easily through the femoral tunnel	

Reconstruction

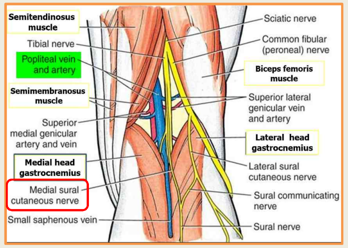
▣ Posterior approach

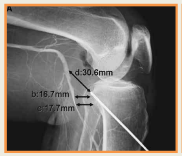
▶ Protect the medial sural cutaneous nerve (posterior cutaneous nerve of the calf),
→ which usually perforates the deep fascia distal to the horizontal limb of the incision

▶ Identify the medial border of the medial gastrocnemius and bluntly develop the interval between it and the semimembranosus tendon
→ exposing the posterior joint capsule

▶ By lateral retraction on the medial head of the gastrocnemius, no tension is directly applied to the motor branch to the medial head of the gastrocnemius, the only motor branch from the tibial nerve in the popliteal fossa that traverses medially

Reconstruction





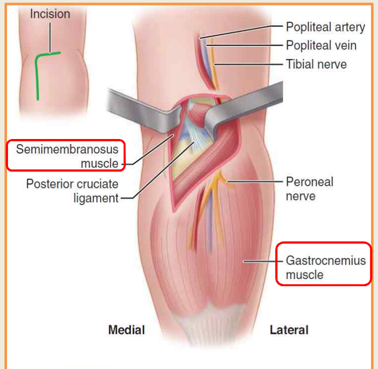


FIGURE 45-150 Posterior approach for reconstruction of posterior cruciate ligament. **SEE TECHNIQUE 45-28.**

Reconstruction

▣ Type of Graft : Autograft VS Allograft

▣ Bundle addressed : Single-bundle VS Double-bundle

▣ Tibial Graft fixation : Tanstibial tunnel VS Tibial inlay technique with remnant preservation

Complications

▣ Loss of motion

▶ Most common problem : Flexion loss is more common than extension loss
▶ Many studies report between 10 ~ 20 degrees loss of flexion, most likely caused by improper graft placement or inadequate rehabilitation
▶ The position of the femoral tunnel is more critical than that of the tibial tunnel
▶ Femoral attachments anterior and distal to the most isometric region result in increased graft tension, with flexion loss resulting from an increase in distance between the femoral and tibial attachment sites
▶ Loss of extension or a flexion contracture most likely is caused by prolonged immobilization in flexion

▶ Results of PCL reconstruction are less successful than with ACL reconstruction and residual posterior laxity often exists

Complications

▣ Failure to obtain objective stability

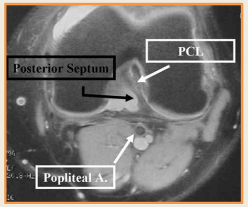
▶ Poor graft selection has been implicated in the failure of reconstructions that use the ITB, the medial head of the gastrocnemius, or the hamstring tendons
→ These tissues may have insufficient strength to prevent posterior sag and drawer

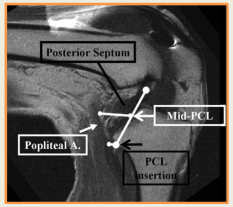
▶ Improper tunnel placement can result in graft abrasion and subsequent failure
→ Femoral tunnel placement posterior and proximal to the most isometric region results in decreased graft tension in flexion secondary to a decrease in distance between femoral and tibial attachment sites
→ This results in graft laxity with an inability to prevent posterior sag and drawer

Complications

▶ Neurologic injuries can result from excessive tourniquet time & manifest as neurapraxia
→ Direct injury to the tibial nerve can result from penetration by either the tibial guide pin or drill and can be avoided by ensuring direct exposure of the tip of the pin and drill during preparation of the tibial tunnel

▶ Vascular complications include laceration, thrombosis, and intimal injury to the popliteal artery
→ Viewing the tip of the guide pin and reamer at all times can prevent this injury





Rehabilitations

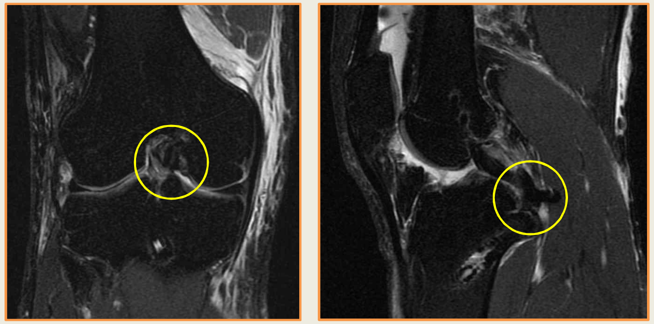
▣ Conservative treatment rehabilitation (대정)

▶ 2 ~ 3주 목발과 보조기 착용 (PWB & ROM 0 ~ 60')
→ 대퇴사두근 운동 및 하지 직거상 운동 시행하여 굴곡근 강화 시행
▶ 3 ~ 4주부터 보조기 제거 후 정상 관절운동범위까지 증가
▶ 6 ~ 8주경 모든 근력강화 운동 시행하고 근력이 85%에 이르면 스포츠 복귀

▣ Operative treatment rehabilitation (대정)

▶ 수술 후 3 ~ 5일부터 수동적 관절운동 → 6주경에 90도까지 굴곡
→ Immobilize in extension early and protect against gravity
→ Early motion should be in prone position
▶ 2주간 장하지 부목 실시하고 이후 보조기 6주 착용 목발 6주 실시 PWB
▶ 수술 후 3개월에 120 ~ 130도, 6개월에 정상 관절운동까지 굴곡

2021.03.15 Postop MRI



POD# 4 Mon OPD f/u

4. Cybex Test Result

UnInvolved 60deg/sec		Involved 60deg/sec		60deg/sec Deficits(%)	
Extesion	164	Extesion	149	Extesion	9
Flexion	72	Flexion	84	Flexion	-15
UnInvolved 180deg/sec		**Involved 180deg/sec**		**180deg/sec Deficits(%)**	
Extesion	111	Extesion	100	Extesion	10
Flexion	77	Flexion	72	Flexion	7

6. Y Balance test

Limb Length 85

Ant.	Rt	49	Post.medial	Rt	94	Post.lateral	Rt	93
	Lt	55		Lt	88		Lt	98
	Different	6		Different	-6		Different	5

Standing leg balance (mCTSIB)

		EOSS	ECSS	EOFS	ECFS
Score	Un	93	82	90	78
	In	91	73	88	76

검사결과 및 교육

주호소 오래걸으면 먹먹한 느낌

가동범위 N

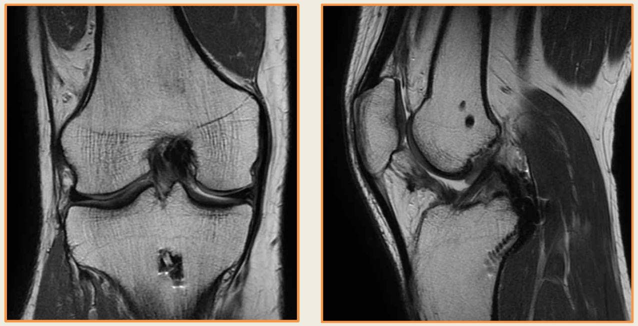
보행상태 N

근력상태 : Extensor deficit 9 %, Flexor deficit -15 %

기능적상태 balance test시 dirrksdml ralgas postion

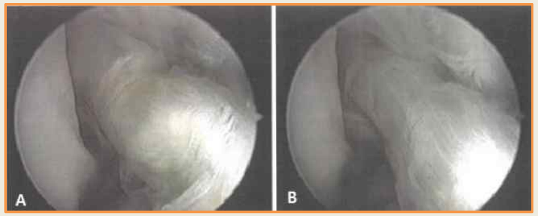
운동기능종합평가 근력 좋아요

2022.03.24 POD # 1 Year



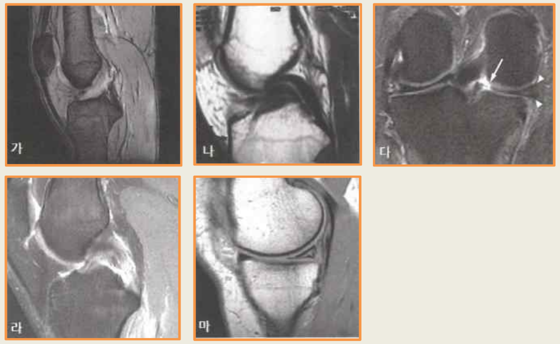
Exercise # 1

▣ 슬관절 불안정성을 호소하는 환자에서 관절경 삽입 직후 (A) 및 경골 전방 전위를 하면서 촬영한 사진 (B)이다. 해당 환자에서 수술 전 예상되는 자기 공명 영상 검사는? (20 B2)



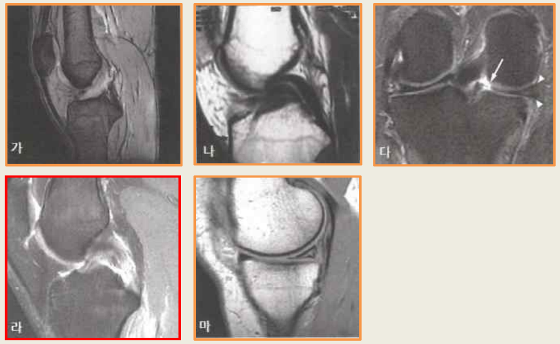
Exercise # 1

▣ 슬관절 불안정성을 호소하는 환자에서 관절경 삽입 직후 (A) 및 경골 전방 전위를 하면서 촬영한 사진 (B)이다. 해당 환자에서 수술 전 예상되는 자기 공명 영상 검사는? (20 B2)



Exercise # 1

▣ 슬관절 불안정성을 호소하는 환자에서 관절경 삽입 직후 (A) 및 경골 전방 전위를 하면서 촬영한 사진 (B)이다. 해당 환자에서 수술 전 예상되는 자기 공명 영상 검사는? (20 B2)



Exercise # 2

▣ 후방 십자인대 견연 골절의 관혈적 정복 및 내고정술에서 후방 도달법을 사용 시, 슬와 신경과 혈관을 보호하기 위해 견인해야 할 근육은? 21B / 16I / 15B

① 슬와근
② 반막양슨
③ 대퇴이두근
④ 비복근 내측두
⑤ 비복근 외측두

Exercise # 2

▣ 후방 십자인대 견연 골절의 관혈적 정복 및 내고정술에서 후방 도달법을 사용 시,
슬와 신경과 혈관을 보호하기 위해 견인해야 할 근육은? 21B / 16I / 15B

① 슬와근
② 반막양손
③ 대퇴이두근
④ 비복근 내측두
⑤ 비복근 외측두

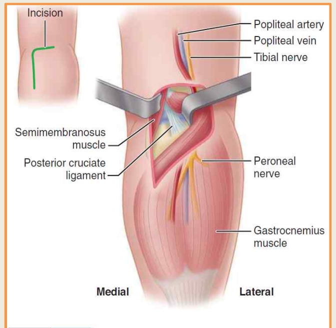


FIGURE 45-150 Posterior approach for reconstruction of posterior cruciate ligament. SEE TECHNIQUE 45-28.

Reference

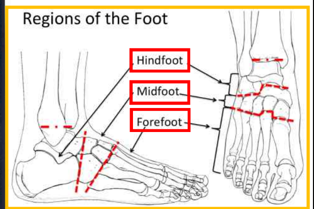
▣ 정형외과학 제 8판
P1363 ~ 1365
▣ Campbell's Operative Orthopaedics,
' Chapter 45. Knee injuries', 13th edition P2238~2239
▣ Stress radiography to measure posterior cruciate ligament insufficiency
: a comparison of five different techniques
Knee Surg Sports Traumatol Arthrosc (2006) 14:1116–1121
▣ Posterior Cruciate Ligament: Anatomy and Biomechanics
Current Reviews in Musculoskeletal Medicine (2018) 11:510–514
▣ Return to Sports and Clinical Outcomes After Arthroscopic Anatomic Posterior Cruciate Ligament Reconstruction With Remnant Preservation Arthroscopy:
The Journal of Arthroscopic and Related Surgery, Vol 35, No 9 (September), 2019: pp 2658-2668
▣ Posterior Cruciate Ligament: Current Concepts Review.
Arch Bone Jt Surg. 2018 Jan; 6(1): 8–18

Anatomy Seminar

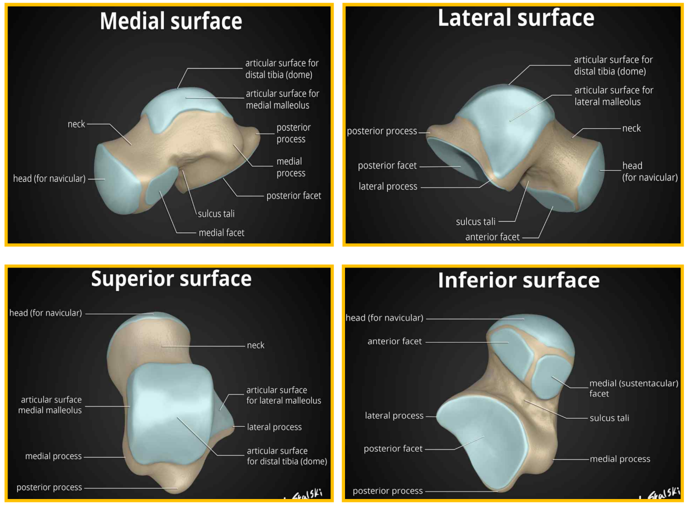
Ankle & Foot

명지병원 정형외과
2022.05.09
R1 정 승 호

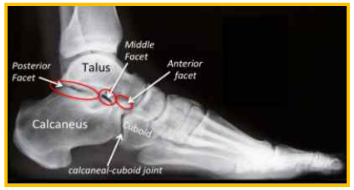
Osteology

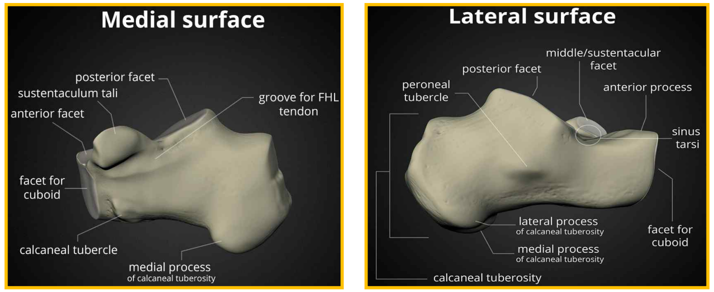


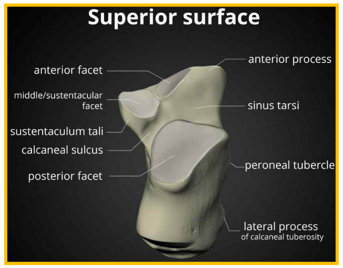
▣ Talus

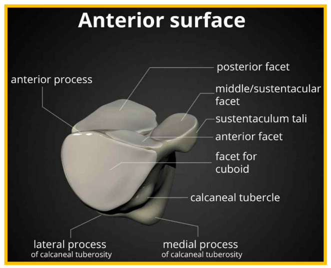


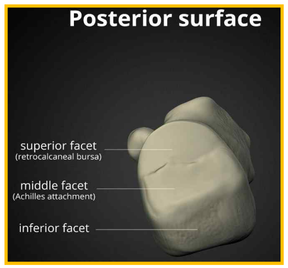
▣ Calcaneus











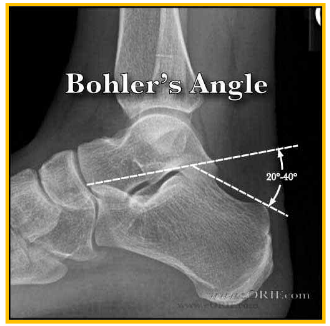
▣ Böhler's angle

→ highest point of the anterior process to the highest point of posterior facet and a line to the superior edge of calcaneal tuberosity

→ Between 20° ~ 40°

→ Decrease

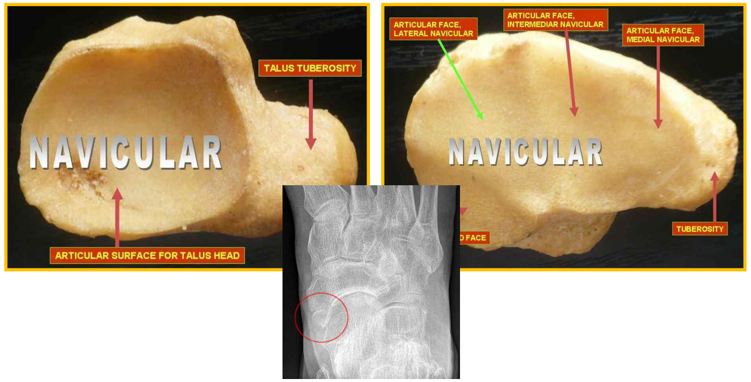
: weight-bearing posterior facet of the calcaneus has collapse, thereby shifting body weight anteriorly



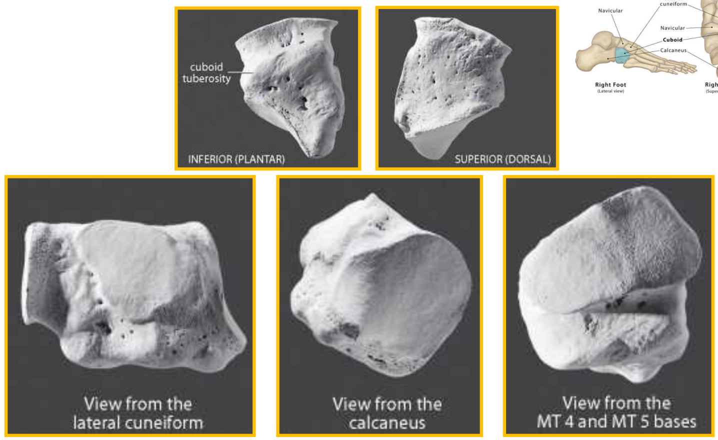
▣ Gissane's angle

→ lines along lateral border of posterior facet and anteriorly to the beak of the calcaneus
→ Between 95° ~ 105°
→ Increased : collapse of the posterior facet

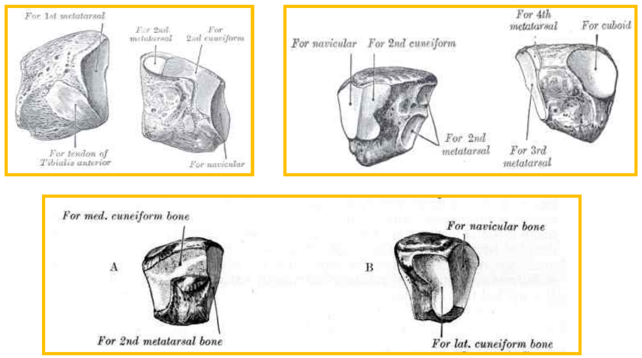
▣ Navicular bone



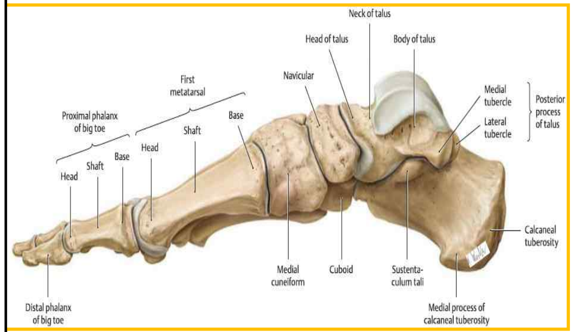
▣ Cuboid bone



▣ Cuneiform bone

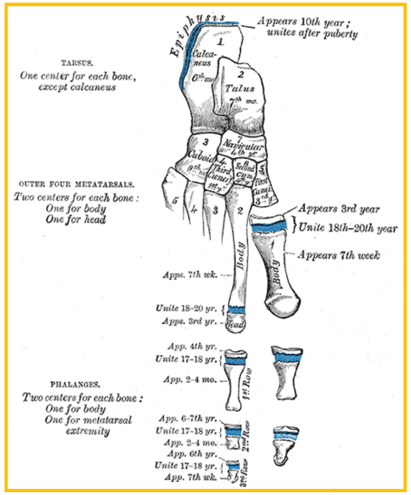


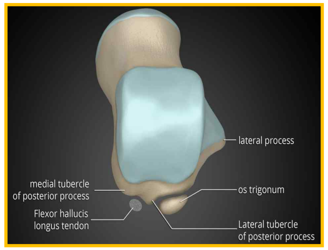
▣ Metatarsal, Phalanx



▣ Metatarsal, Phalanx

Ossification





Arthrology

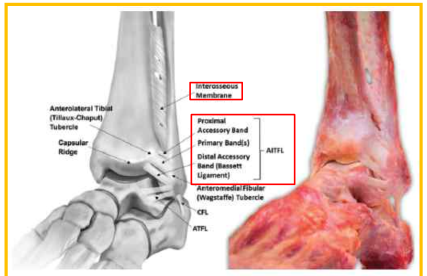
Ankle joint

Syndesmotic ligament

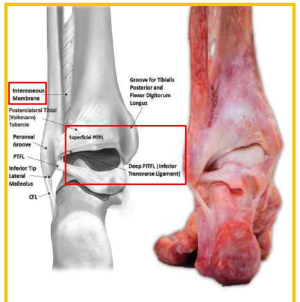
Lateral ligament

Medial ligament (deltoid ligament)

Syndesmotic ligament

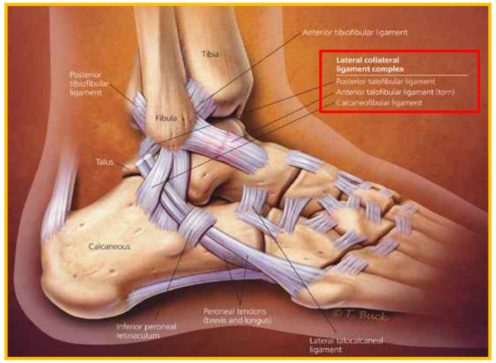


Picture 1. Anterolateral view of left ankle, showing AITFL and interosseous membrane. (Williams 2015, pg 92).

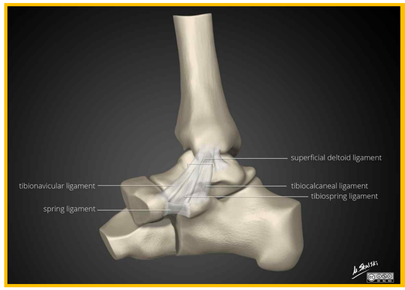


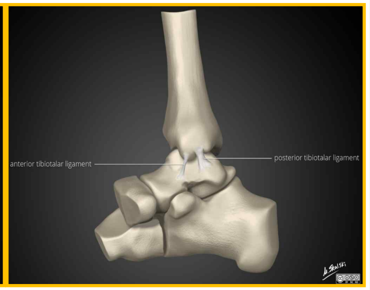
Picture 4. Posterior view of ankle (Williams 2015, pg 94).

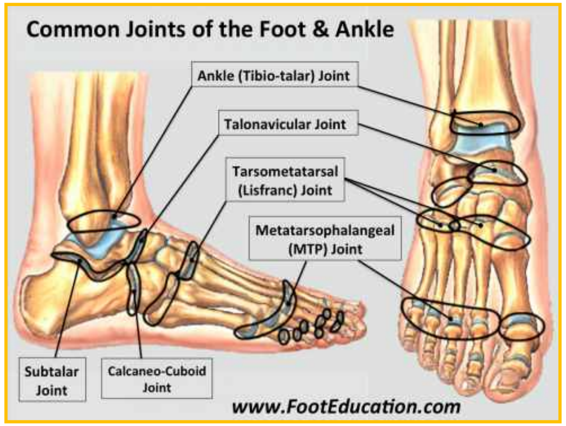
Lateral ligament

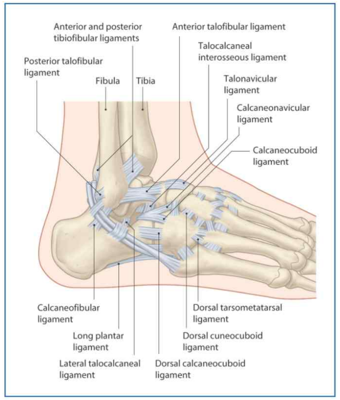


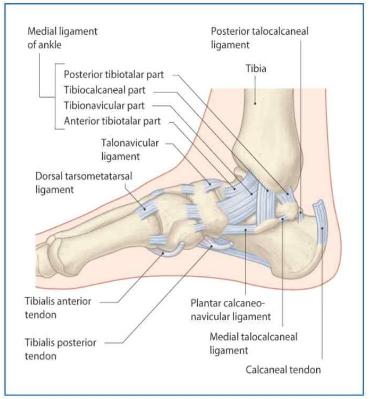
Medial ligament

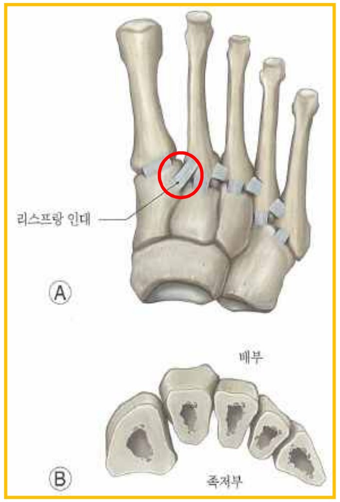


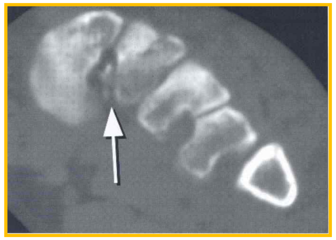




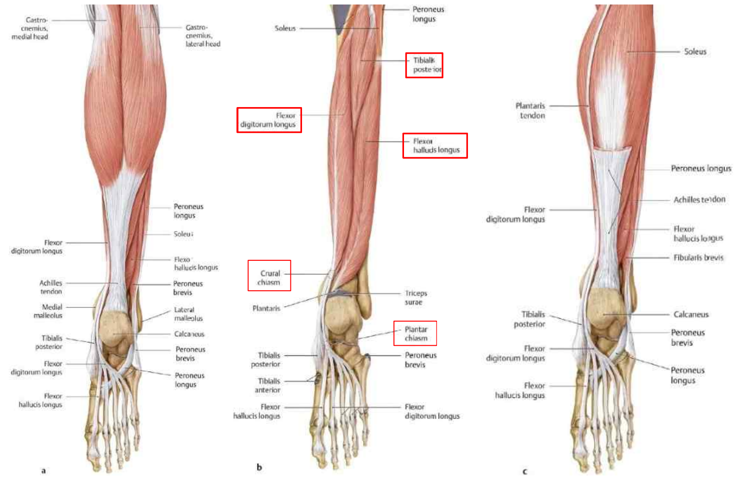




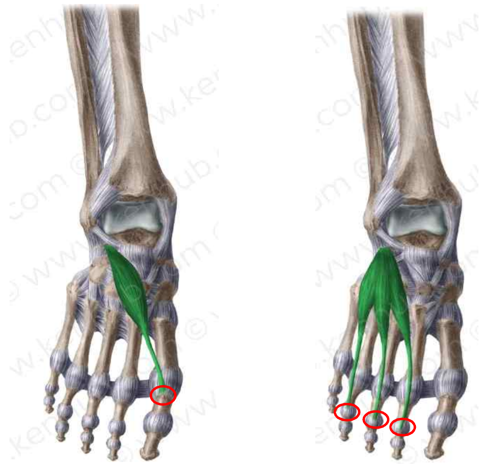




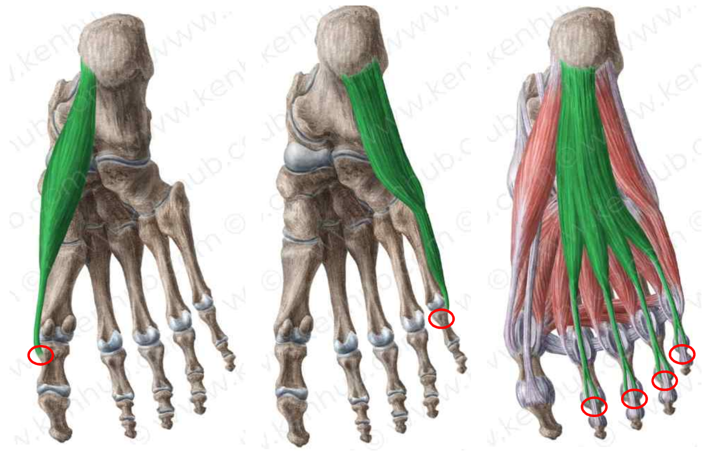
Myology



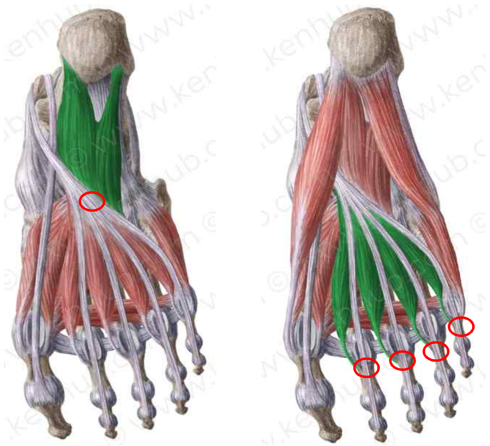
Dorsal Muscle



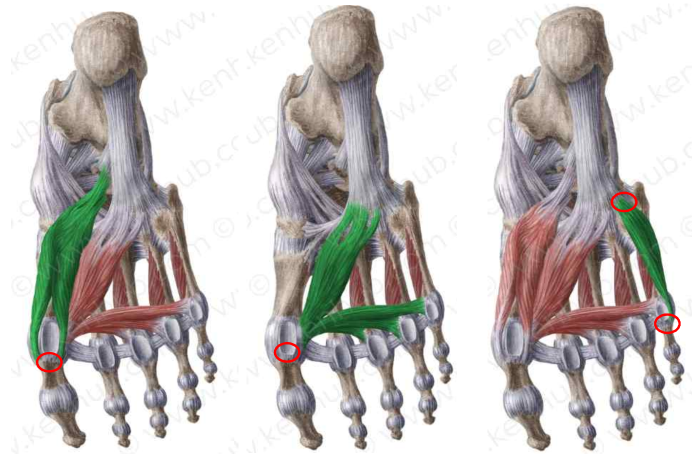
Plantar Muscle 1st layer



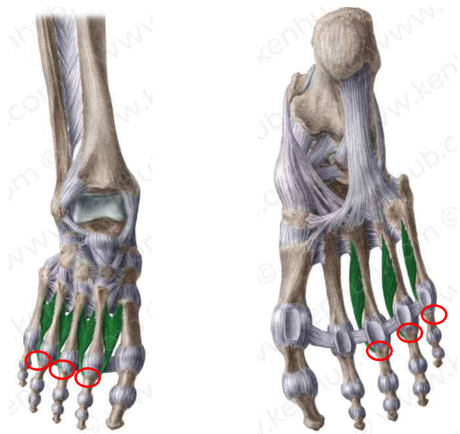
Plantar Muscle 2nd layer



Plantar Muscle 3rd layer



Plantar Muscle 4th layer



J Shoulder Elbow Surg (2023) 32, 374–382

ELSEVIER

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

BASIC SCIENCE

Functional biomechanical comparison of Latarjet vs. distal tibial osteochondral allograft for anterior glenoid defect reconstruction

Alexander Rodriguez[a], John Baumann[a], Will Bezold[a], Conor Smith, MD[a], Dimitri Thomas, MD[b], James L. Cook, DVM, PhD[a], Matthew J. Smith, MD[a,*]

[a]Thompson Laboratory for Regenerative Orthopaedics, Department of Orthopaedic Surgery, University of Missouri, Columbia, MO, USA

[b]University of North Carolina Orthopedics and Sports Medicine at Lenoir, Kinston, NC, USA

Introduction

- Glenohumeral joint stability and functional kinematics are dependent on dynamic musculoskeletal interactions that are influenced by the bony architecture of the glenoid fossa

- The association between the extent of glenoid bone loss and glenohumeral joint stability
  - demonstrating an inverse relationship that markedly diverges after a critical threshold of 21%-25% of anterior glenoid bone loss

- Glenoid bone loss also alters joint loading by decreasing contact area and increasing contact pressures, which can have detrimental effects on joint health

Introduction

- For patients with glenoid bone loss greater than 25%, glenoid bone augmentation procedures are typically necessary for achieving functional outcomes

- Glenoid bone reconstruction procedures are accomplished using osseous or osteochondral autografts or allografts
  - Coracoid process osseous autograft (Latarjet) procedure
  - Distal tibial osteochondral allograft (DTA) procedure

Introduction

- Latarjet
  - availability, and cost advantages
  - soft tissue stabilization through a "sling effect" of the conjoint tendon
  - morbidity of tissue harvest
  - lack of articular cartilage restoration
  - nonanatomic geometry of the graft

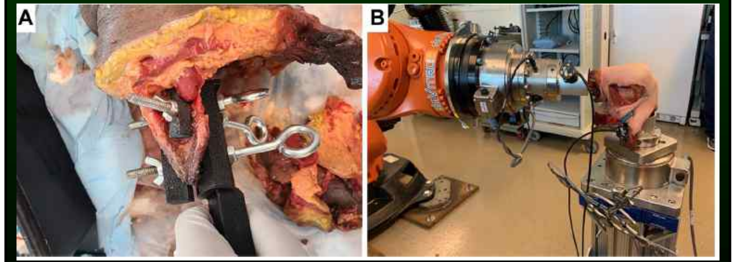
- DTA
  - closely matches the geometry of the native glenoid
  - allograft integration, availability, and costs disadvantage

Purpose

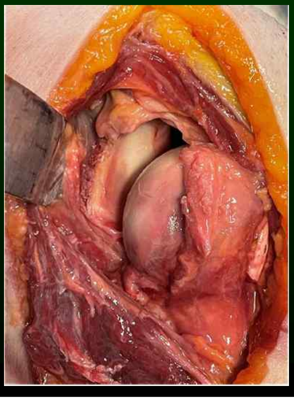
- Latarjet vs. DTA reviewed literature is a cadaveric study : significantly lower peak forces and significantly larger contact areas for DTA reconstructions
  Bhatia et al, AJSM, 2013
- Clinically applicable data for determining the superiority of either of these treatment options for glenoid reconstruction are lacking
- Compare these reconstruction techniques with respect to joint kinematics and cartilage pressure mapping based on preclinical functional assessments using a robotic testing system

Materials and Methods

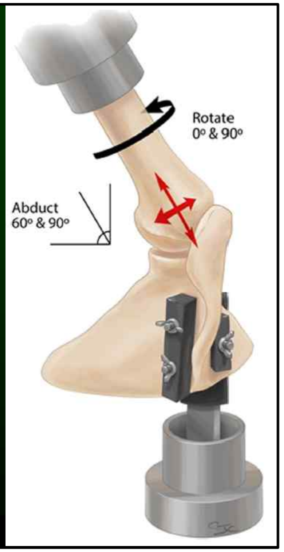
- 4 matched pairs (n =8) of fresh frozen human cadaveric shoulders
- rotator cuff, articular cartilage, and bony anatomy of the glenohumeral joint were grossly normal



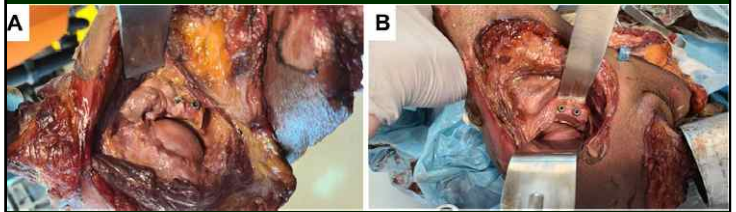
- Each specimen was first tested in its native, intact state
- A defect was then created through a standard deltopectoral approach and subscapularis tenotomy to comprise 25% loss of bone on the anterior glenoid



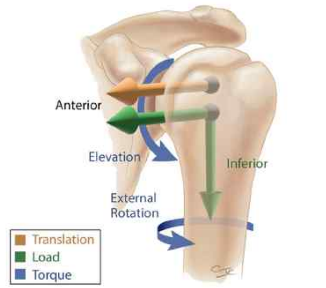
- Each specimen was tested in 3 positions
  - Neutral
  - 60˚ abduction from 0 ˚ - 90 ˚ external rotation
  - 90˚ abduction from 0 ˚ - 90 ˚ external rotation
- Each cycle started and ended with the glenohumeral joint in the neutral position, and each stage consisted of 10 cycles
- Check humeral head translation (mm), load (N), and torque (Nm)



- The tenotomy/arthrotomy was performed in an identical fashion to the Larjarjet and DTA



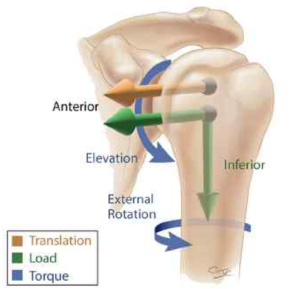
Result



60-90					
DOF	ΔAnterior Change (mm)	ΔInferior Drawer Load (N)	ΔAnterior Drawer Load (N)	ΔNegative Elevation Torque (Nm)	ΔExternal Rotation Torque (Nm)
Native	5.4 ± 2.8	19.2 ± 7.3	25.4 ± 7.5	0.79 ± 0.45	4.5 ± 3.8
Latarjet	3.1 ± 1.6	4.1 ± 1.3	7.6 ± 3.8	0.37 ± 0.26	1.9 ± 1.4
DTA	2.4 ± 0.8	4.6 ± 1.8	4.3 ± 1.3	0.24 ± 0.1	2.2 ± 1.4
p-value	**0.015**	**0.001**	**0.0039**	**0.031**	**0.013**

90-90					
DOF	ΔInferior Drawer Load (N)	ΔAnterior Drawer Load (N)	ΔHorizontal Abduction Torque (Nm)	ΔNegative Elevation Torque (Nm)	ΔExternal Rotation Torque (Nm)
Native	20.2 ± 8.4	19.7 ± 8.8	2.8 ± 1.7	2.7 ± 1.4	6.6 ± 2
Latarjet	7.1 ± 4	6.1 ± 2.4	0.98 ± 1.1	1.2 ± 0.9	2.3 ± 1.7
DTA	5.7 ± 3.7	4.5 ± 2.2	1.6 ± 1.2	0.89 ± 0.5	1.5 ± 1.1
p-value	**<0.0001**	**0.0006**	**0.015**	**0.0052**	**0.013**

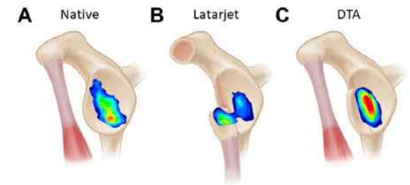
Result



60-90					
DOF	ΔAnterior Change (mm)	ΔInferior Drawer Load (N)	ΔAnterior Drawer Load (N)	ΔNegative Elevation Torque (Nm)	ΔExternal Rotation Torque (Nm)
Native	5.4 ± 2.8	19.2 ± 7.3	25.4 ± 7.5	0.79 ± 0.45	4.5 ± 3.8
Latarjet	3.1 ± 1.6	4.1 ± 1.3	7.6 ± 3.8	0.37 ± 0.26	1.9 ± 1.4
DTA	2.4 ± 0.8	4.6 ± 1.8	4.3 ± 1.3	0.24 ± 0.1	2.2 ± 1.4
p-value	**0.015**	**0.001**	**0.0039**	**0.031**	**0.013**

90-90					
DOF	ΔInferior Drawer Load (N)	ΔAnterior Drawer Load (N)	ΔHorizontal Abduction Torque (Nm)	ΔNegative Elevation Torque (Nm)	ΔExternal Rotation Torque (Nm)
Native	20.2 ± 8.4	19.7 ± 8.8	2.8 ± 1.7	2.7 ± 1.4	6.6 ± 2
Latarjet	7.1 ± 4	6.1 ± 2.4	0.98 ± 1.1	1.2 ± 0.9	2.3 ± 1.7
DTA	5.7 ± 3.7	4.5 ± 2.2	1.6 ± 1.2	0.89 ± 0.5	1.5 ± 1.1
p-value	**<0.0001**	**0.0006**	**0.015**	**0.0052**	**0.013**

Result



Status	Native	Latarjet	DTA	P-value
Compression Max (N) @ 60°	26.9 ± 5.2	35.6 ± 4.1	29.2 ± 4.6	**0.008**
Compression Max (N) @ 90°	31.9 ± 12.3	43.9 ± 4.9	36.3 ± 8.9	0.19

Discussion

- There were significant differences in changes in
  - anterior translation
  - inferior drawer
  - anterior drawer
  - compression loads
  - horizontal abduction
  - negative elevation (adduction)
  - external rotation torques during cyclical testing in 90 ° of external rotation

  with 60 ° and/or 90 ° of abduction when comparing the 2 different glenoid bone reconstruction techniques to native, intact shoulders

- The only significant difference between Latarjet and DTA reconstructions was a significantly higher absolute maximum compressive load for Latarjet compared with DTA at 60 ° of abduction

Discussion

- The significantly smaller change in anterior translation from the neutral position with cyclic 60 ° abduction testing in the reconstructed shoulders compared to the native state is likely associated with anterior constraint related to the anterior glenoid bone augmentation

- The significantly lower compression load, inferior and anterior drawer loads, and torques observed in the reconstruction groups compared with the native group are likely multifactorial and related to the operative procedures that were performed

Discussion

- Latarjet reconstructions were associated with significantly higher maximum joint compression loads when compared with DTA reconstructions

- The higher load after Latarjet reconstruction is possibly related to the nonanatomic, noncartilaginous nature of the coracoid graft, which limits the ability to renew the native forces within the joint

- This explanation is supported by the descriptive pressure distribution findings from the present study, which demonstrated noncentralized asymmetrical, unevenly distributed, bimodal articular contact pressure maps

- This may provide one explanation for the relatively high incidence of degenerative changes reported to occur in shoulders that have undergone Latarjet reconstructions

Conclusion

- Latarjet and DTA of large (25%) glenoid bone defects are associated with significant glenohumeral kinematic differences that largely confer less translation, load, and torque on the joint in abduction when compared to the native state

- These findings suggest that these 2 surgical techniques exhibit similar glenohumeral kinematics such that each provides adequate functional stability following anterior glenoid bone reconstruction

Conclusion

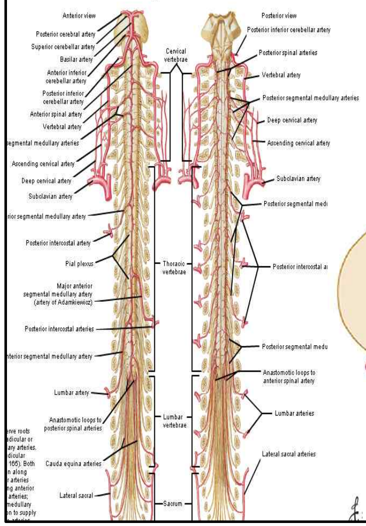
- Joint compression load and articular contact pressure distribution may favor DTA reconstruction for treatment of large (25%) anterior glenoid bone defects associated with shoulder instability

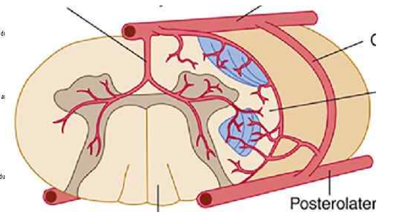
Neurovascular Anatomy

-Spine-

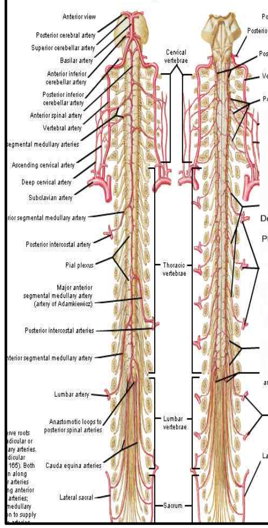
명지병원 정형외과
R2. 김수영

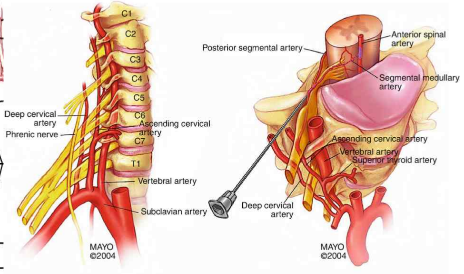
Arteries of Spinal Cord - Schema



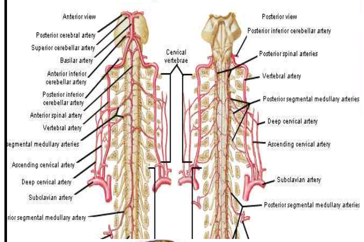


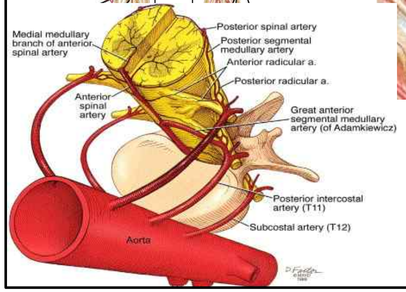
Arteries of Spinal Cord - Schema

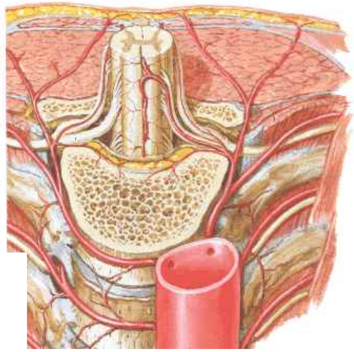


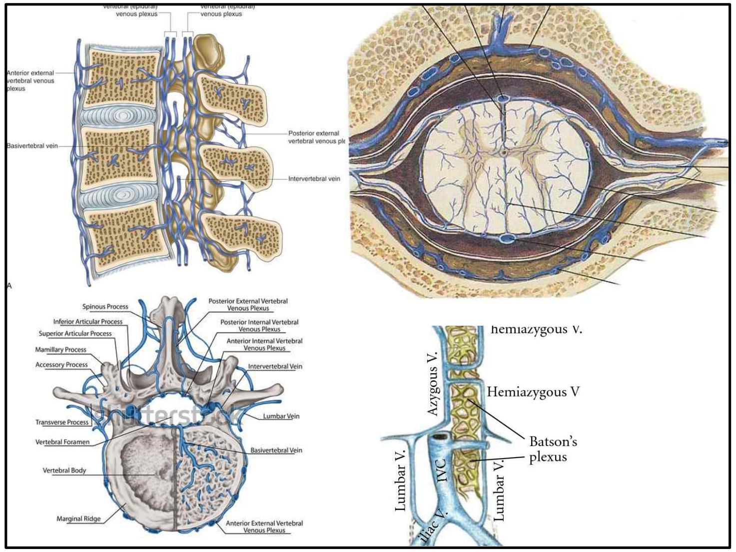


Arteries of Spinal Cord - Schema

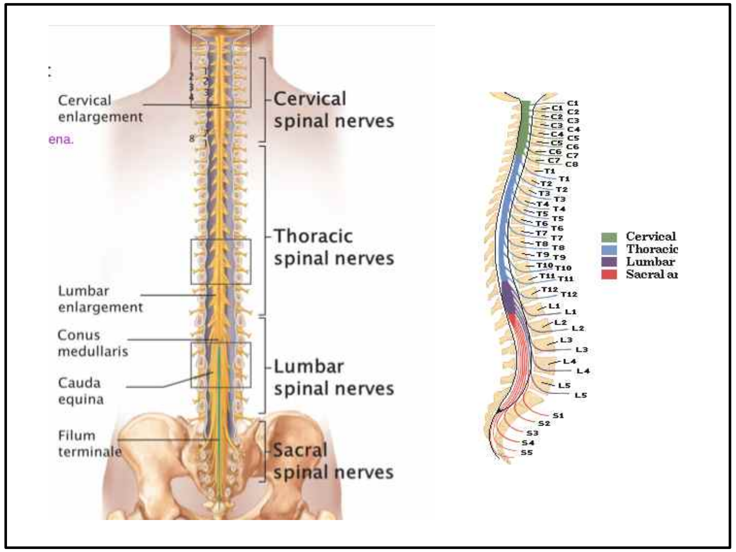




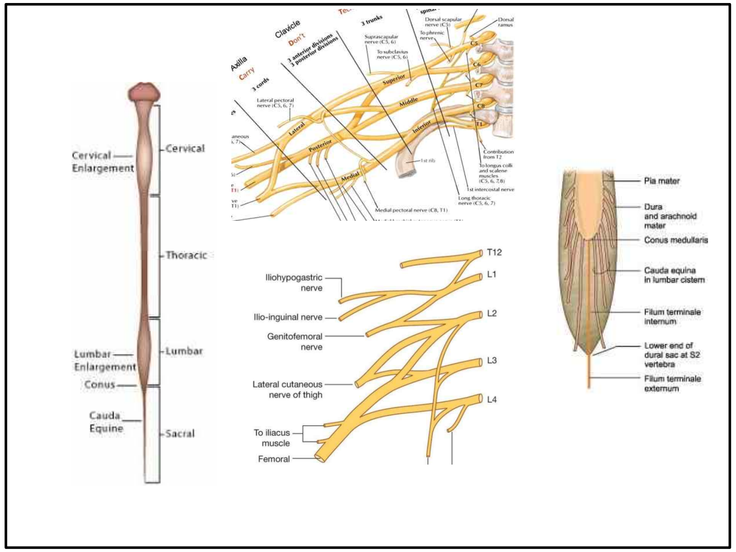




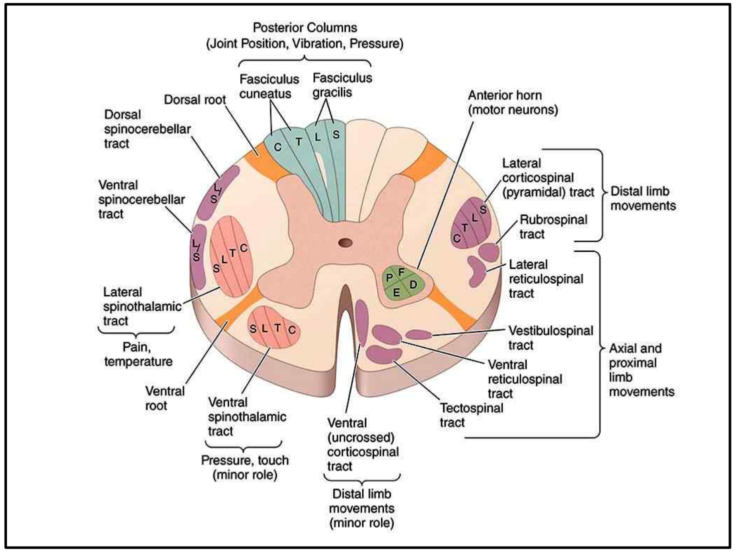
venous plexus
venous plexus
Anterior external vertebral venous plexus
Basivertebral vein
Posterior external vertebral venous plexus
Intervertebral vein
Spinous Process
Inferior Articular Process
Superior Articular Process
Mamillary Process
Accessory Process
Transverse Process
Vertebral Foramen
Vertebral Body
Marginal Ridge
Posterior External Vertebral Venous Plexus
Posterior Internal Vertebral Venous Plexus
Anterior Internal Vertebral Venous Plexus
Intervertebral Vein
Lumbar Vein
Basivertebral Vein
Anterior External Vertebral Venous Plexus
hemiazygous V.
Azygous V.
Hemiazygous V
Batson's plexus
Lumbar V.
IVC
Lumbar V.
iliac V.



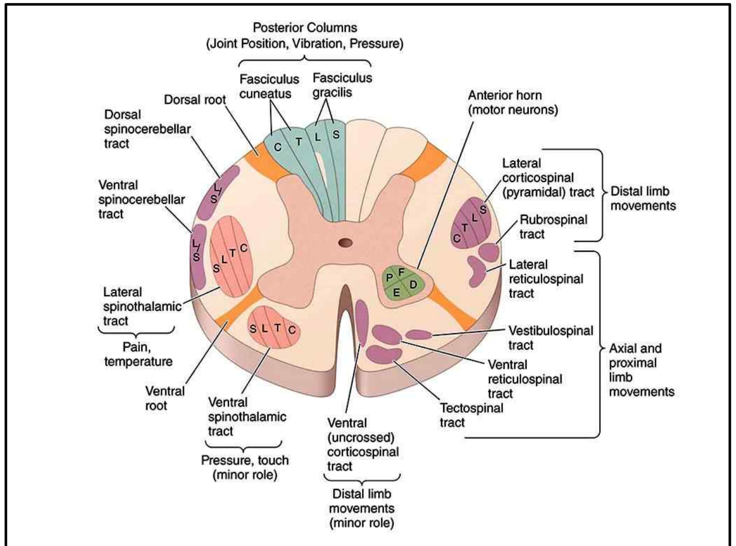
Cervical enlargement
ena.
Cervical spinal nerves
Thoracic spinal nerves
Lumbar enlargement
Conus medullaris
Cauda equina
Lumbar spinal nerves
Filum terminale
Sacral spinal nerves
Cervical
Thoracic
Lumbar
Sacral

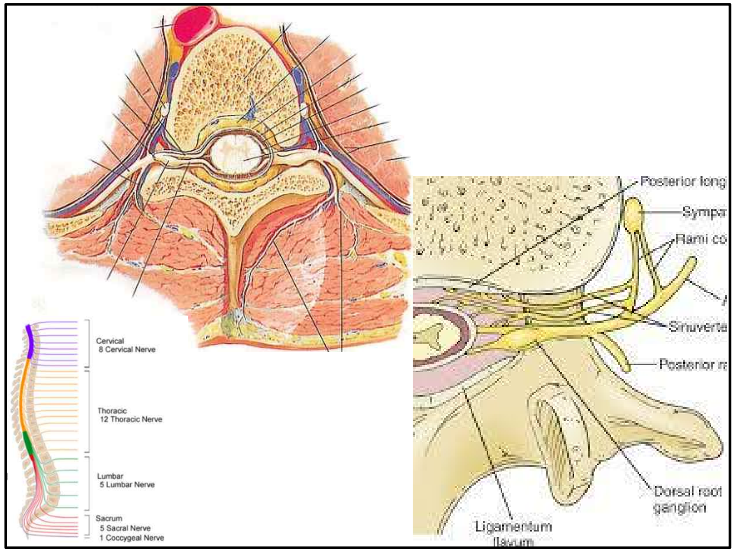


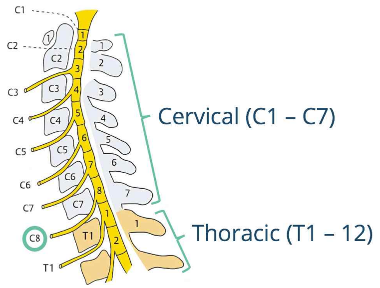
Cervical Enlargement
Cervical
Thoracic
Lumbar Enlargement
Lumbar
Conus
Cauda Equine
Sacral
Axilla
Carry
Clavicle
Don't
3 trunks
Superior
Middle
Inferior
Lateral
Posterior
Medial
T12
L1
L2
L3
L4
Iliohypogastric nerve
Ilio-inguinal nerve
Genitofemoral nerve
Lateral cutaneous nerve of thigh
To iliacus muscle
Femoral
Pia mater
Dura and arachnoid mater
Conus medullaris
Cauda equina in lumbar cistern
Filum terminale internum
Lower end of dural sac at S2 vertebra
Filum terminale externum

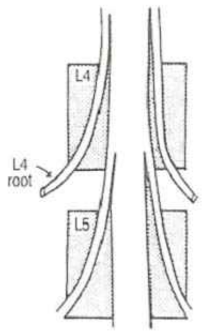


Posterior Columns
(Joint Position, Vibration, Pressure)
Fasciculus cuneatus
Fasciculus gracilis
Dorsal root
Dorsal spinocerebellar tract
Ventral spinocerebellar tract
Lateral spinothalamic tract
Pain, temperature
Ventral root
Ventral spinothalamic tract
Pressure, touch (minor role)
Ventral (uncrossed) corticospinal tract
Distal limb movements (minor role)
Anterior horn (motor neurons)
Lateral corticospinal (pyramidal) tract
Rubrospinal tract
Distal limb movements
Lateral reticulospinal tract
Vestibulospinal tract
Ventral reticulospinal tract
Tectospinal tract
Axial and proximal limb movements


Posterior Columns
(Joint Position, Vibration, Pressure)
Fasciculus cuneatus
Fasciculus gracilis
C T L S
Dorsal root
Dorsal spinocerebellar tract
Ventral spinocerebellar tract
Lateral spinothalamic tract
Pain, temperature
Ventral root
Ventral spinothalamic tract
Pressure, touch (minor role)
Anterior horn (motor neurons)
Lateral corticospinal (pyramidal) tract
Rubrospinal tract
Distal limb movements
Lateral reticulospinal tract
Vestibulospinal tract
Ventral reticulospinal tract
Tectospinal tract
Axial and proximal limb movements
Ventral (uncrossed) corticospinal tract
Distal limb movements (minor role)


Posterior long
Rami co
Sinuverte
Posterior r
Dorsal root ganglion
Ligamentum
Cervical
8 Cervical Nerve
Thoracic
12 Thoracic Nerve
Lumbar
5 Lumbar Nerve
Sacrum
5 Sacral Nerve
1 Coccygeal Nerve


C1
C2
C3
C4
C5
C6
C7
C8
T1
Cervical (C1 – C7)
Thoracic (T1 – 12)


L4
L4 root
L5

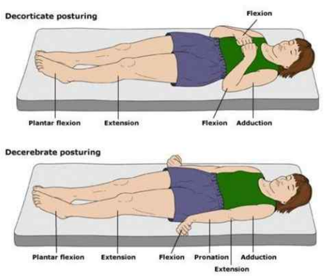
Cervical injury 총론

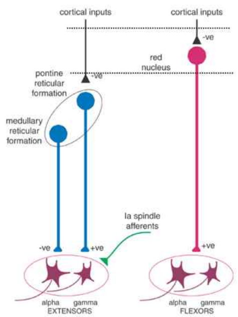
명지병원 정형외과
R1. 김현진

Physical examination

- Head
  - lacerations, contusions, facial fracture 등을 검사
- Ear canals
  - CSF leakage, blood behind tympanic membrane 검사 (suggestive skull fracture)
- Spinous processes
  ① palpated from the upper cervical to the lumbosacral region
  ② Painful spinous process may indicate a spinal injury
  ③ Palpable defects in the interspinous ligaments may indicate disruption of the supporting ligamentous complex
- Careful and gentle retraction of the head may elicit pain however, excessive flexion and extension of the neck should be avoided.
- Elbows flexed posture : spinal cord injury
  cf) Elbow extended posture : higher injury
- penile erection, incontinence of bowel or bladder
  - significant spinal injury
- Quadriplegia
  - flaccid paralysis of the extremities
- Initial BP 감소, PR 감소 (neurogenic shock)

Elbows flexed posture?

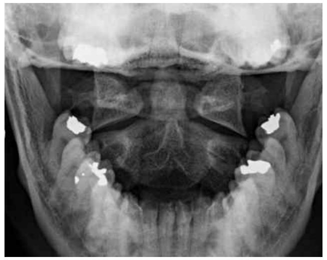


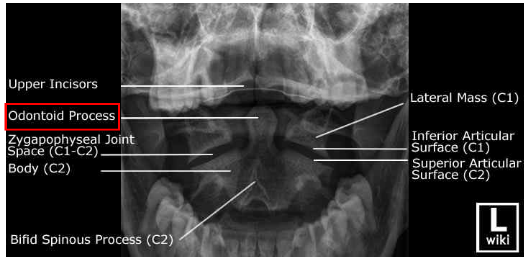


Imaging evaluation

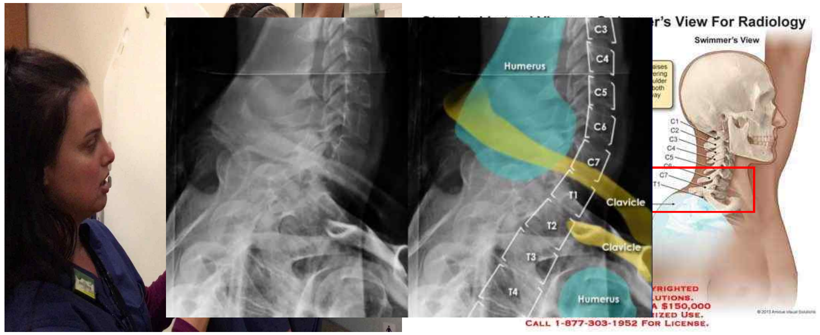
- **Most frequentLy missed C-spine Fx.**
  ① Odontoid process (open mouth view)
  ② cervico-thoracic junction (swimmer's view)

open mouth view



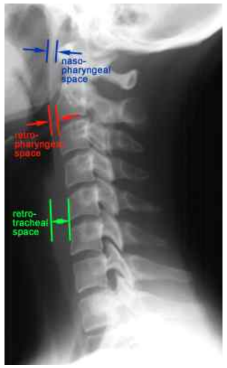


swimmer's view



Imaging evaluation

- **prevertebral soft tissue shadow**
  - **C3의 anteroinferior border에서 5mm 이내가 정상으로, 5mm 이상이면 injury c soft tissue swelling을 강력히 시사**
  - **대정 : C6 아랫면에서 15mm 이상증가 시 retropharyngeal space의 bleeding, hematoma, edema 를 의미**
  - **Rockwood : C2-3 disc space에서 7mm이상, C6-7 disc space에서 21mm 이상 증가시 underlying spinal injury 시사**



Cross table lateral view

- 경추의 외상이 의심되거나 신경 손상이 의심되는 환자
- cross table lateral view를 제일 먼저 촬영
- 경추의 추체 전방, 추체 후방, 추궁판 연결부, 극돌기 끝부분을 연결하는 4개의 선을 확인

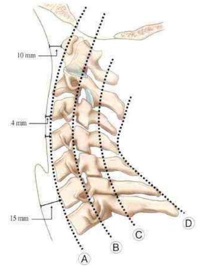
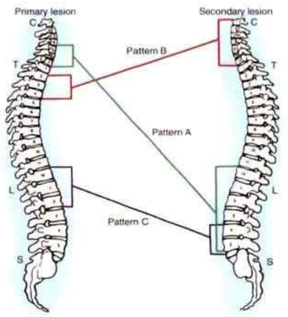


그림 VIII-27. 경추 방사선 측방상에서 관찰이 필요한 4개의 연축선 및 후인두 연부조직의 정상폭. (A) 추체 전방 연결선. (B) 추체 후방 연결선. (C) 추궁판 연결선. (D) 극돌기 끝부분 연결선.

Multiple spinal fractures

- Three patterns of injury
  - primary (C5 - 7) -> 2nd (T12 or L spine)
  - primary (T2 & T4) -> 2nd (C spine)
  - primary (T12-L2) -> 2nd (L4-5)
- Primary lesion의 level에서 fx. identify시 secondary vertebral injury를 suspect 해야함



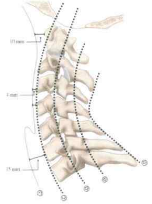
기출문제1

1. 다음 방사선 촬영법의 이름을 적으시오. 08B2

정답 : swimmer's view

기출문제2

1. 경추부 측면 방사선 사진은 경추의 전장을 볼수 있어 외상에 의한 경추부 손상시 응급실에서 필수적으로 촬영한다. 경추 측면상 연속선 중에서 골절, 탈구의 소견이 보이지 않더라도 숨어있는 경추부 손상을 시사하여 보다 정밀한 관찰을 필요로 하는 선은? 17I



㉮ 가
㉯ 나
㉰ 다
㉱ 라
㉲ 마

정답 : 가

C6 아랫면에서 15mm 이 상증가 시 retropharyngeal space의 bleeding, hematoma, edema 를 의미

기출문제3

1. 낙상으로 내원한 30세 남자 환자가 경부 중앙부위 압통 및 사지 불완전 마비를 호소한다. 손상을 파악할 수 있는 가장 빠르고 정확한 검사는 무엇인가? 21B

㉮ C-spine flexion/extension view
㉯ C-spine oblique view
㉰ Multidetector-CT (MD-CT)
㉱ MRI
㉲ whole body bone scan

정답 : 다

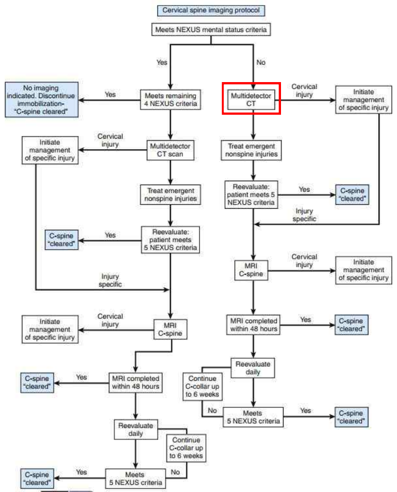


FIGURE 41.1 Cervical spine imaging protocol in patients without spinal cord injury.

NEXUS
(National Emergency X-Radiography Utilization Study)

- Alert and stable
- No focal neurologic deficit
- No altered level of consciousness
- Not intoxicated
- No midline spinal tenderness
- No distracting injury

Posterolateral rotatory instability

명지병원 정형외과
R3. 이 규 환
2023.05.15

Case review

김 O 태 M/46 #01033990

- Chief complaint
  - Rt. knee pain & instability
  - Onset : 2개월 전
- Present illness
  - 46세 남자환자 2개월 전 무릎 굽힌 상태로 미끄러 넘어지며 수상 후 발생한 통증 및 불안정한 증상으로 외래 내원

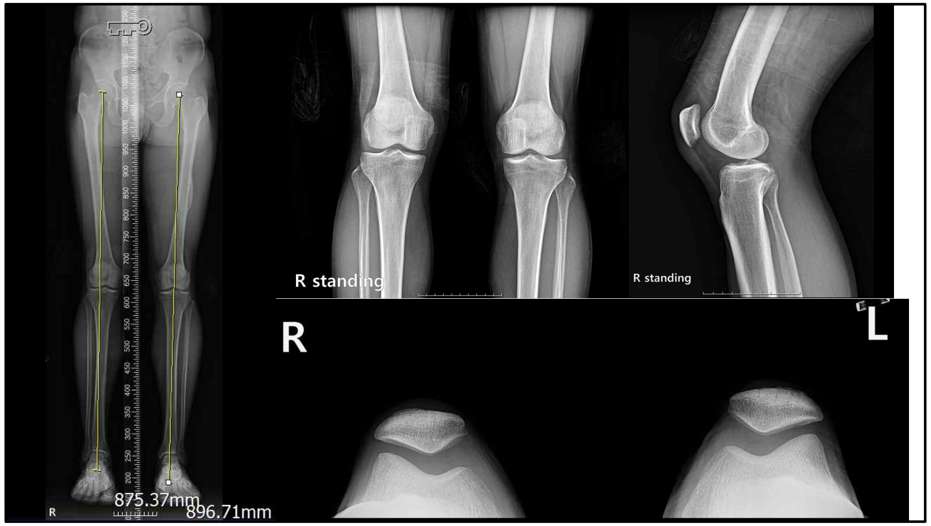
Past history

- Medical history
  - HTN
- Social history
  - Sports activity : moderate activity

Physical examination

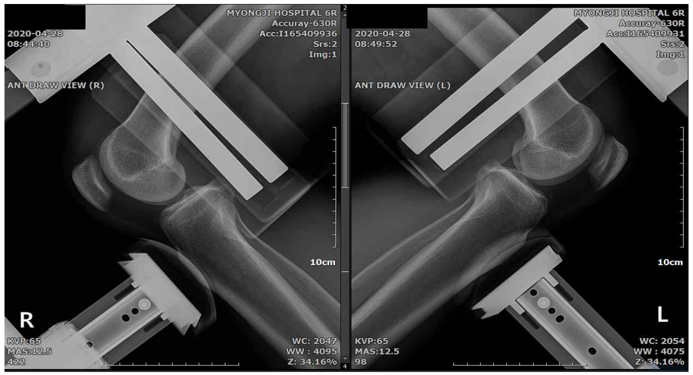
- General
  - 신장 174cm, 체중 68kg
  - BMI : 22.4 (kg/m²)

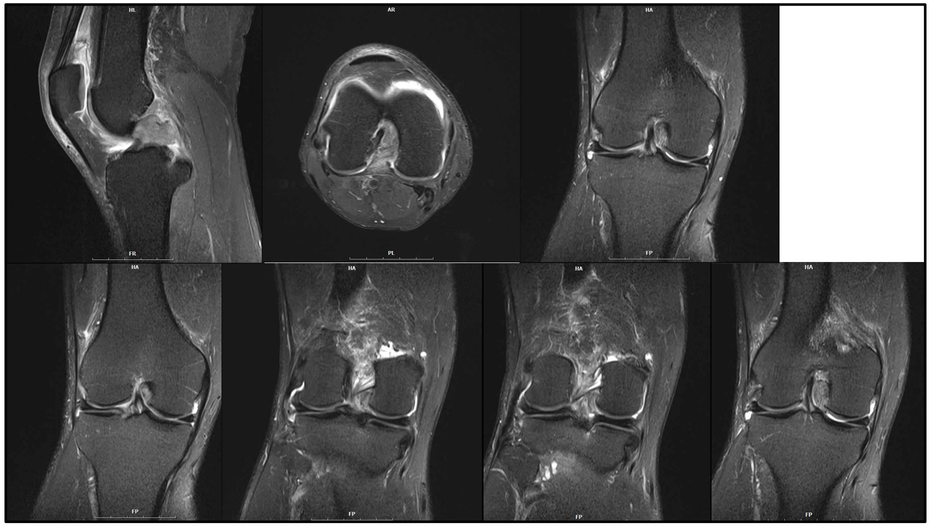
- Physical examination
  - ROM : 0-full
  - McMurray test (-) / Apley test (-)
  - ADT (-) / Lachmann (-)
  - PDT (+)
  - Posterior sagging (+)
  - PLDT (+)
  - Reverse pivot shift test (+)



X ray

- Side to side difference : 18mm

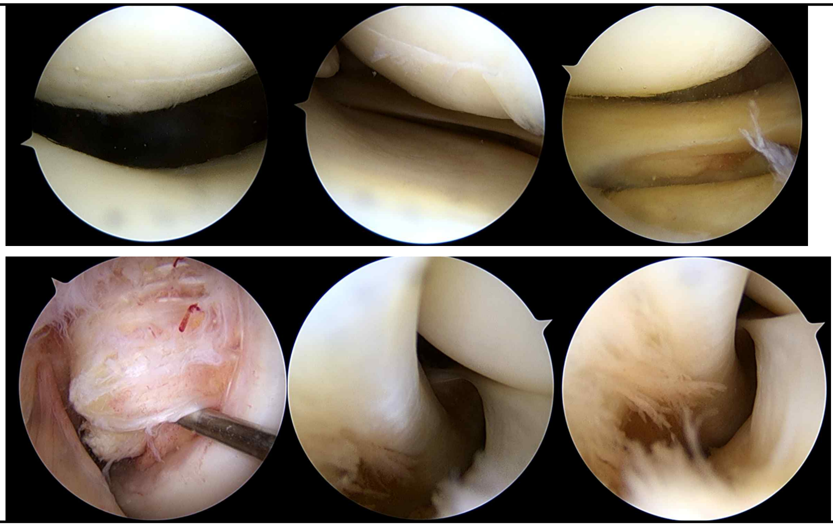


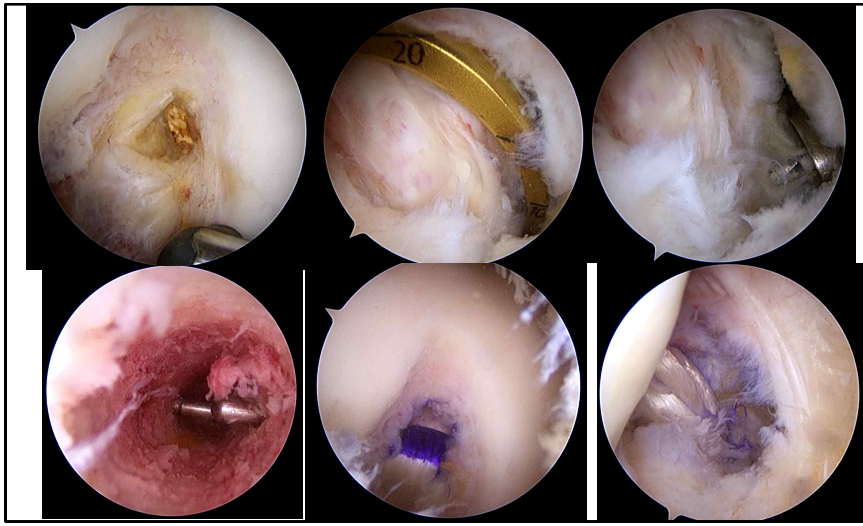


Diagnosis & Plan

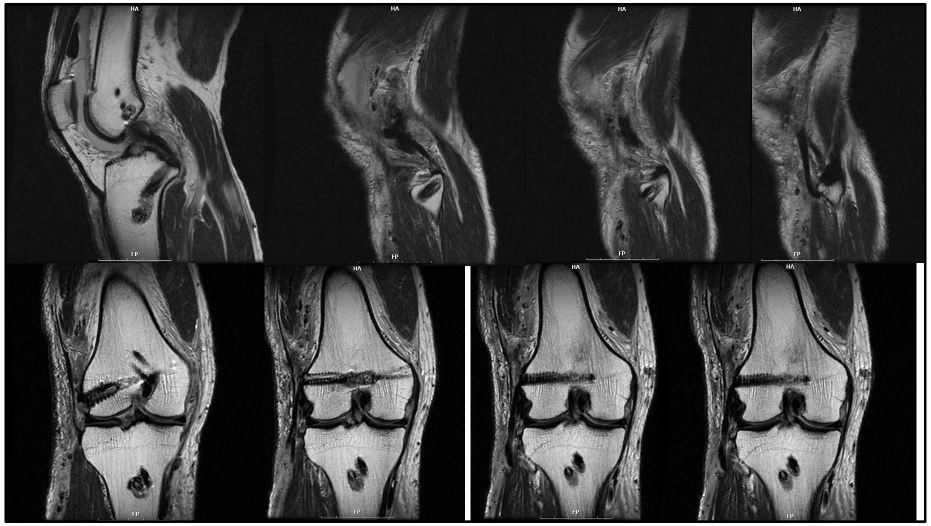
- Diagnosis
  - Rupture, PCL, knee, Rt.
  - PLRI, knee, Rt.
- Plan
  - A/S PCL-R & PLC-R, knee, Rt.

Under anesthesia physical exam





Post OP X-ray



Posterolateral rotatory instability
Topic review

Rotary instability

- Anterolateral complex instability
- Anteromedial complex instability
- **Posterolateral complex instability**
- Posteromedial complex instability

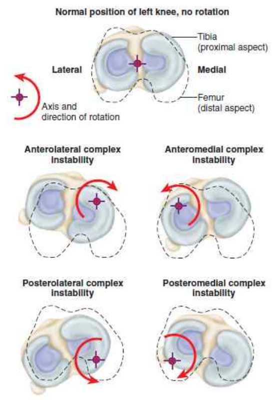


FIGURE 45-66 Demonstration of shift in vertical axis away from center of tibia as tibia shifts excessively and abnormally in relation to femur. Position of femur is designated by *shaded area*.

Posterolateral corner

- Primary restraint to **varus stress** & **posterolateral rotation**
- PLC injury
  - Isolated PLC injuries are <u>rare</u> → **concurrent injuries (ACL, PCL commonly)**
  - Potential source of **residual instability** after intra-articular ligament reconstruction
  - **Missed** PLC injury → common cause of <u>ACL reconstruction failure</u>

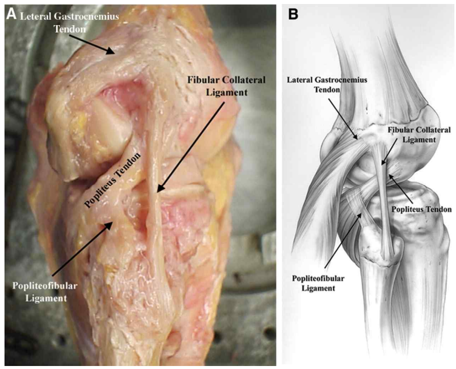
→ High index of suspicion is necessary!!

Posterolateral corner

- Injury mechanism
  - **Adduction, flexion, and ER of the femur on the tibia**
  - <u>Blow to anteromedial knee</u>
  - Varus blow to flexed knee
  - Contact and noncontact hyperextension injuries
  - Knee dislocation

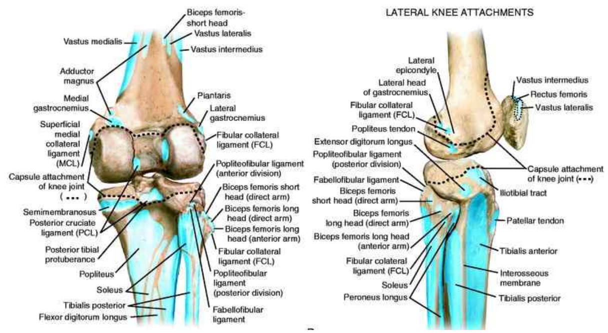
Anatomy

- Static stabilizer
  - Fibular collateral ligament
  - Popliteus tendon
  - Popliteofibular ligament
  - Arcuate ligament
  - Fabellofibular ligament
  - Posterolateral capsule
- Dynamic stabilizer
  - Iliotibial band
  - Biceps femoris tendon
  - Popliteus tendon



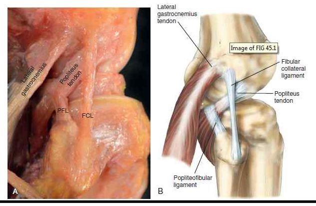
Anatomy

- Static stabilizer
  - Fibular collateral ligament
  - Popliteus tendon
  - Popliteofibular ligament
  - Arcuate ligament
  - Fabellofibular ligament
  - Posterolateral capsule
- Dynamic stabilizer
  - Iliotibial band
  - Biceps femoris tendon
  - Popliteus tendon



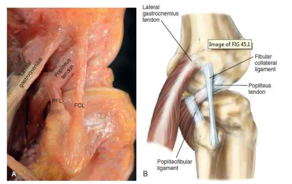
Anatomy

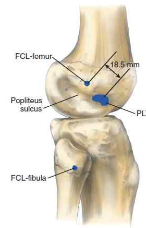
- Fibular collateral ligament
  - 1.4mm proximal, 3.1mm posterior to lateral epicondyle
  - 8.2mm posterior to anterior margin of fibular & 28.4mm distal to tip of fibular styloid
  - **Primary stabilizer to varus stress in extension → less influential as the knee goes flexion**



Anatomy

- Popliteus tendon
  - Courses proximolaterally from its tibia insertion
  - becomes tendinous in the lateral third of the popliteal fossa
  - Course deep to FCL → becomes intra-articular
  - **Static and dynamic stabilizer against ER**

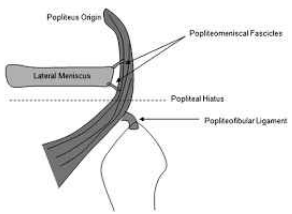


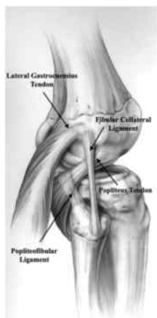


Insall & Scott Surgery of the Knee

Anatomy

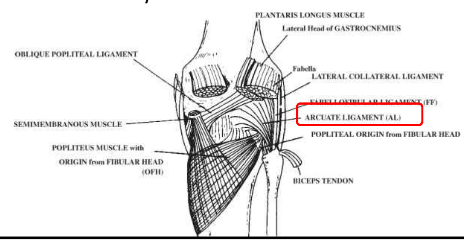
- Popliteofibular ligament
  - Originate from musculotendinous junction of the popliteus muscle
  - Insert to posterior surface of the fibular styloid
  - **Important restraint to ER(primary)**





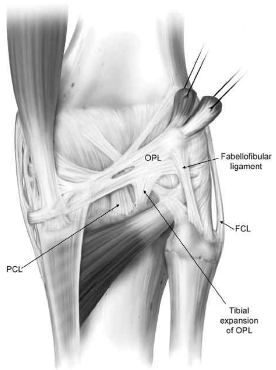
Anatomy

- Arcuate ligament
  - has been variously described
  - Several structures that combine to form an arched, or arcuate, appearance
  - the strongest and most consistent fibers form a triangular sheet that diverges upward from the fibular styloid



Anatomy

- Fabellofibular ligament
  - The fabella (Latin for "little bean") is a sesamoid bone that is found within the lateral gastrocnemius tendon in 30% of individuals
  - If not fully ossified, a cartilaginous analogue is found approximately 66% of the time
  - Thickening of collagen that extends vertically from the fibular styloid to the fabella
  - Important landmark during surgical reconstruction
    - course between the biceps and GCN tendons



Anatomy

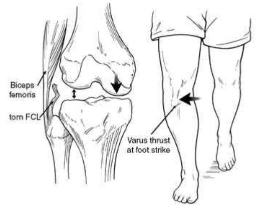
- Iliotibial band
  - Most superficial layer of lateral aspect of knee
  - Tensor fascia lata ~ inserts at Gerdy's tubercle
- Biceps femoris tendon
  - Long head : ischial tuberosity
  - Short head : lateral lip of linear aspera of femur
  - Insertion : Fibular head

Biomechanics of posterolateral knee

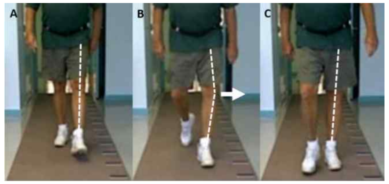
- Varus stress
  - FCL : primary restraint to varus stress
  - PLT : minor primary varus stabilizer
  - Cutting study : FCL sectioned -> varus opening
    FCL intact -> varus stability preserve
- External tibial rotation
  - FCL & popliteus complex : primary restraint
  - PCL : secondary restraint
- Posterior tibial translation
  - PCL : primary restraint
  - PLC : more contribution in lower degree of flexion

History

- Instability & posterolateral pain
- Swelling, ecchymosis
- Tenderness on fibular head
- Varus thrust gait
- Foot drop d/t peroneal nerve distribution
  : 1/3 of PLC injuries can have peroneal nerve injury



Varus thrust gait



- Triple varus
  - stepwise increase in knee varus severity
    - from normal anatomical tibiofemoral varus to weightbearing through to varus thrust gait
  - Primary varus
    - anatomical tibiofemoral varus seen on standing
  - Double varus
    - subsequent opening of the lateral compartment during the stance phase
    - increase in the tension of the lateral ligamentous structures
  - Triple varus(= hyperextension varus)
    - indicates recurvatum of the knee joint during the stance phase
    - the inability of the lateral ligamentous structures to withstand the increased tension in the lateral compartment

Physical examination

- Varus stress test
  - Test with knee at 0' and 30' flexion
  - Varus laxity at 30' flexion
    = PLC injury
  - Varus laxity at full extension
    = PLC + cruciate ligament injury
  - No Varus laxity at full extension with laxity at 30' flexion
    = isolated PLC injury

Physical examination

- Prone external rotation test (Dial test)
  - Measures external rotation restraints(PLT, PFL)
  - ER rotation of tibia at both 30' & 90' knee flexion
  - More than 10' difference in ER is considered pathologic
  - Pathologic at 30' flexion (but not at 90' flexion)
    = suggests isolated PLC injury
  - Pathologic at both 30' & 90' flexion
    = PCL + PLC injury

Dial test probably is not reliable in the presence of medial instability

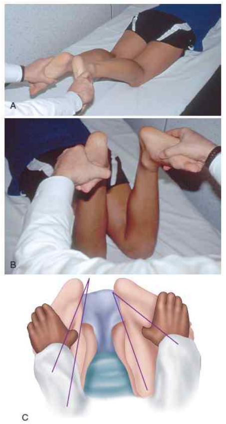


FIGURE 45-64 **A-C,** Prone external rotation test. Increased external rotation at 30 degrees that decreases at 90 degrees indicates isolated injury to posterolateral corner; increased external rotation at both 30 and 90 degrees indicates injury to both posterior cruciate ligament and posterolateral corner.

Knee Surg Sports Traumatol Arthrosc (2010) 18:123–129
DOI 10.1007/s00167-009-0850-9

KNEE

Correlation between the rotational degree of the dial test and arthroscopic and physical findings in posterolateral rotatory instability

Jin Goo Kim · Yong Seuk Lee · Young Jae Kim · Jae Chan Shim · Jeong Ku Ha · Hyun Ah Park · Sang Jin Yang · Soo Jin Oh

Received: 10 January 2009 / Accepted: 9 June 2009 / Published online: 30 June 2009

Table 4 Total number of positive findings

	A group	B group	C group	Total	*P* value for the trend
Total number of positive physical examinations (%) [mean (±SD)]	2.4 (1.0)	3.1 (1.0)	4.4 (0.7)	3.2 (1.3)	<0.001
Total number of positive arthroscopic findings (%) [mean (±SD)]	0.4 (0.7)	1.5 (0.9)	3.0 (1.1)	1.5 (1.4)	<0.001

Physical examination

- External rotation recurvatum test
  - Supine position
  - Grasp both big toe & lift up
  - External rotation & recurvatum & slight varus change

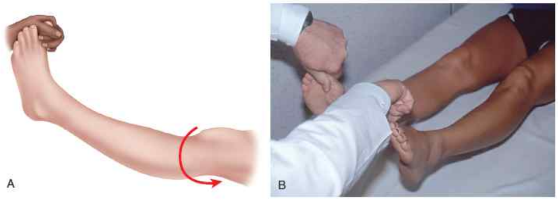
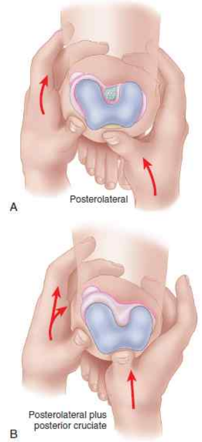


FIGURE 45-62 **A** and **B**, External rotation-recurvatum test (see text). (A courtesy of J.C. Hughston, MD.)

Physical examination

- Posterolateral drawer test
  - Supine, 80' knee flexion, tibia 15' ER, foot fixed
  - External rotation of LTC relative to LFC



Physical examination

- Reverse pivot shift
  - Supine, 90 degree knee flexion(LTC posterior subluxation) → External rotation + valgus stress → knee extension(reduction)
  - Reduction at 35-40 degrees
    - Result of ITB function(change from flexor to extensor)
  - (+) : suggests PCL, arcuate complex, FCL injury

CR TECHNOLOGIES

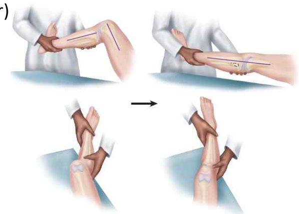
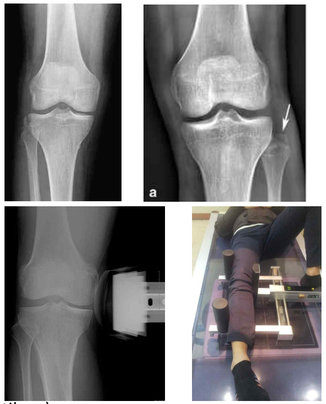


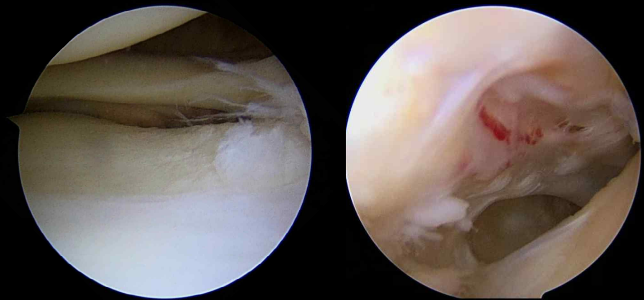
FIGURE 45-63 **Reverse pivot shift sign (see text).** (From Jakob RP, Hassler H, Stäubli HU: Observations on rotatory instability of the lateral compartment of the knee: experimental studies on the functional anatomy and the pathomechanism of the true and the reversed pivot shift sign, Acta Orthop Scand Suppl 191:1, 1981.)

Radiograph

- Plain radiographs
  - Segond fractures
  - Fibular head fractures or avulsions
  - Chronic PLC injuries → Varus malalignment
- Stress radiographs
  - Varus & posterior stress
- MRI
  - Confirm injury
  - Evaluated for associated injuries (meniscus, cartilage)
  - Difficult to determine if operation is recommended
  - **Varus stress radiography is necessary**



Arthroscopic findings



Classification (The Hughston classification)

In knee full extension

- Grade I
  - 0-5mm of lateral opening(or 0-5' rotational instability) and minimal ligament disruption
  - PFL, popliteus injury
- Grade II
  - 5-10mm of lateral opening(or 6-10' rotational instability) and moderate ligament disruption
  - PFL, popliteus, LCL injury
- Grade III
  - >10mm of lateral opening (or >10' rotational instability) and severe ligament disruption and no endpoint
  - PFL, popliteus, LCL, cruciate lig. injury

Treatment

- Non-operative treatment
  - Grade I & II injuries
  - Knee bracing c knee immobilizer or hinged knee brace : 3-6 wks
  - Passive & active prone knee flexion for stiffness
  - After 3-6 wks, consider sports therapy
  - Able to return to play if pain is absent & full ROM
- Operative treatment
  - Grade III injuries, avulsion fractures, multi-ligament injuries
  - PLC injury + ACL or PCL injuries
  - Repair vs reconstruction

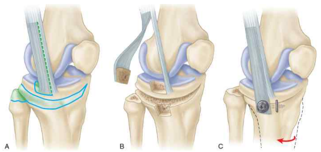


FIGURE 45-100 Valgus high tibial osteotomy for chronic posterolateral instability and varus alignment. **A** and **B**, Iliotibial band is removed with bone block and advanced across osteotomy. **C**, Bone block is secured with cancellous screw distal to osteotomy. (From Veltri DM, Warren RF: Treatment of acute and chronic injuries to the posterolateral and lateral knee, Oper Tech Sports Med 4:174, 1996.) **SEE TECHNIQUE 45-15.**

Treatment

- Repair vs Reconstruction
  - Repair
    - 1-2 wks after injury
    - Direct repair or using transosseous drill holes and sutures

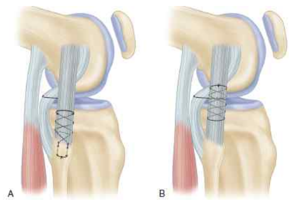
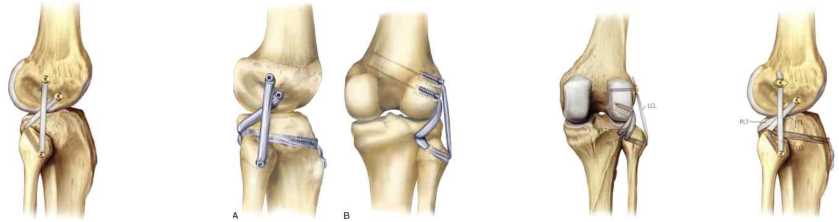


FIGURE 45-88 **A**, Repair of avulsion of fibular attachment of lateral collateral ligament with Bunnell-type suture. **B**, Repair of midsubstance tear of lateral collateral ligament with Bunnell-type suture. **SEE TECHNIQUE 45-10.**

Treatment

- Repair vs Reconstruction
  - Reconstruction
    - Tibialis anterior or tibialis posterior allograft
    - Reconstruction of the PLT / FCL / PFL
    - various technique



Treatment

- Chronic posterolateral corner injury
  - Duration > 3M
  - Standing long-leg AP alignment radiographs are mandatory to evaluate the patient's alignment
  - When varus malalignment occurs, <u>a corrective osteotomy</u> must be performed prior to reconstruction
    - proximal tibial medial opening wedge osteotomy
    - lateral tibial closing wedge osteotomy

Treatment

- Chronic posterolateral corner injury
  - proximal tibial medial opening wedge osteotomy vs lateral tibial closing wedge osteotomy
    - biomechanically validated to decrease both varus motion and external rotation laxity
    - theoretical benefit of tightening the posterior capsule
  - In a knee with a deficient ACL
    - the tibial slope should be decreased
  - In a knee with a deficient PCL
    - the tibial slope should be increased
  - Genu recurvatum can be addressed by increasing the tibial slope
  - Flexion contracture at the knee can be addressed by decreasing the tibial slope

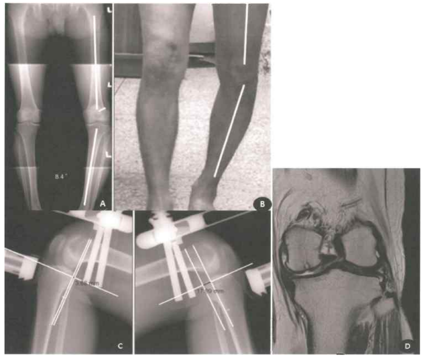
Post operative care

- Immobilization and weight bearing limitation for 6wks
- Q-muscle strengthening immediately
- POD#1-2 wks, initiate ROM
- POD#4M, initiate Hamstring strengthening, sports-specific training
- Normal ROM, normal strength & stability → return to sports

QUIZ#1

- 55세 환자가 6개월 전 발생한 외상 후 지속되는 좌측 슬관절 불안정성을 주소로 내원하였다. 슬관절 신체 검진 및 보행 시 (A,B) 양상과 후방 부하 방사선 사진(C), 촬영한 자기 공명 영상 검사(D)이다. 일차적으로 먼저 시행해야할 치료는? (19B2)

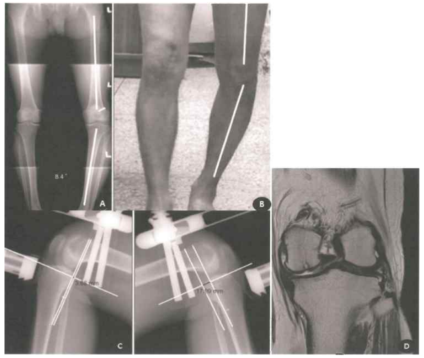
1. 전방십자인대 재건술
2. 후방십자인대 재건술
3. 후외측인대 재건술
4. 근위 경골 외반 절골술
5. 후방십자인대 재건술 + 후외측인대 재건술



QUIZ#1

- 55세 환자가 6개월 전 발생한 외상 후 지속되는 좌측 슬관절 불안정성을 주소로 내원하였다. 슬관절 신체 검진 및 보행 시 (A,B) 양상과 후방 부하 방사선 사진(C), 촬영한 자기 공명 영상 검사(D)이다. 일차적으로 먼저 시행해야할 치료는? (19B2)

1. 전방십자인대 재건술
2. 후방십자인대 재건술
3. 후외측인대 재건술
4. 근위 경골 외반 절골술
5. 후방십자인대 재건술 + 후외측인대 재건술



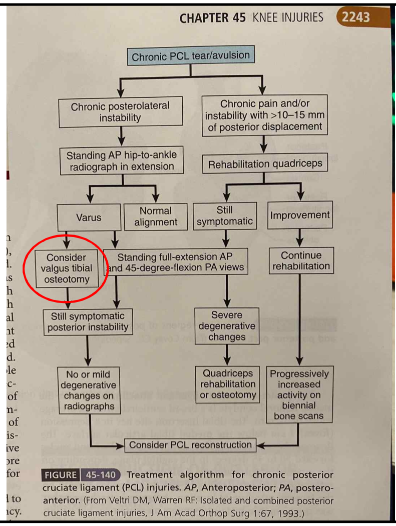
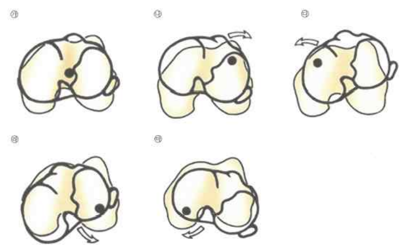


FIGURE 45-140 Treatment algorithm for chronic posterior cruciate ligament (PCL) injuries. *AP*, Anteroposterior; *PA*, posteroanterior. (From Veltri DM, Warren RF: Isolated and combined posterior cruciate ligament injuries, J Am Acad Orthop Surg 1:67, 1993.)

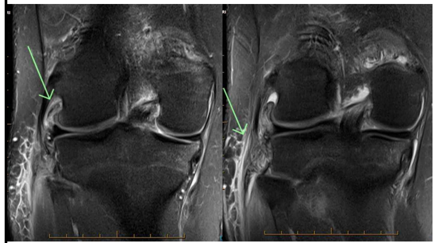
QUIZ#2

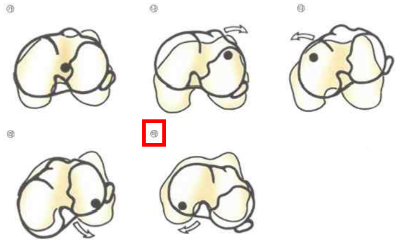
- 25세 남자환자가 스키 손상 후 발생한 우측 슬관절 통증 및 불안정성을 주소로 내원하였다. 진행한 MRI 소견이 다음과 같을때, 발생 가능성이 가장 높은 불안정성의 방향은? (19B2)



QUIZ#2

- 25세 남자환자가 스키 손상 후 발생한 우측 슬관절 통증 및 불안정성을 주소로 내원하였다. 진행한 MRI 소견이 다음과 같을때, 발생 가능성이 가장 높은 불안정성의 방향은? (19B2)





Reference

- Campbell's operative orthopaedics 14th edition
- Insall & Scott surgery of the knee, 4th edition
- *Jin Goo Kim, et al., Correlation between the rotational degree of the dial test and arthroscopic and physical findings in posterolateral rotatory instability, Knee Surg Sports Traumatol Arthrosc., 2010*
- *Oog-Jin Shon, et al., Current Concepts of Posterolateral Corner Injuries of the Knee, Knee surgery & related research., 2017;29(4):256-268*

J Shoulder Elbow Surg (2023) 32, 703–712

ELSEVIER

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

Biomechanical comparison of combined latissimus dorsi and teres major tendon transfer vs. latissimus dorsi tendon transfer in shoulders with irreparable anterosuperior rotator cuff tears

Gyu Rim Baek, BS[a], Jung Gon Kim, MD[b], Daniel Kwak, BA[a], Andrew P. Nakla, BS[a], Min-Shik Chung, BS[a], Michelle H. McGarry, MS[a], Thay Q. Lee, PhD[a,*]

[a]Orthopedic Biomechanics Laboratory, Congress Medical Foundation, Pasadena, CA, USA
[b]Department of Orthopedic Surgery, Yeosu Baek Hospital, Yeosu-si, Jeollanam-do, Republic of Korea

Introduction

- Irreparable anterosuperior rotator cuff tears (IASRCTs) can result in a gradual loss of active elevation and internal rotation, superior and anterior translation of the humeral head, and cuff tear arthropathy.
- However, there are limited joint-preserving treatment options for IASRCTs, especially in young patients, as well as high-demand elderly patients.

Burnier et al, ABJS, 2019

- Several tendon transfer options, such as pectoralis major (PM) or minor and trapezius transfer have been proposed to address this challenging problem in young and active patients with IASRCTs

Paladini et al, JSES, 2013

Introduction

- Although pain is usually improved with PM transfer, the outcomes of active shoulder range of motion, strength, and stabilization of the humeral head translation have been variable, especially in IASRCTs

Elhassan et al, JBJS, 2008

- In recent years, anterior latissimus dorsi (LD) tendon transfer has emerged as an alternative treatment option
- A combined 2-tendon (LD and TM) transfer was reported to have better clinical outcomes than an isolated LD transfer

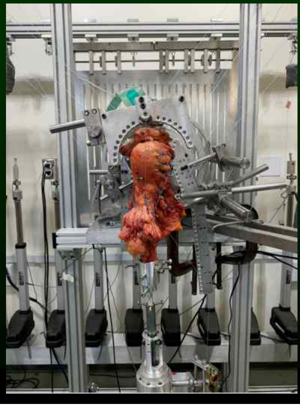
Lichtenberg et al, JSES, 2012

Purpose

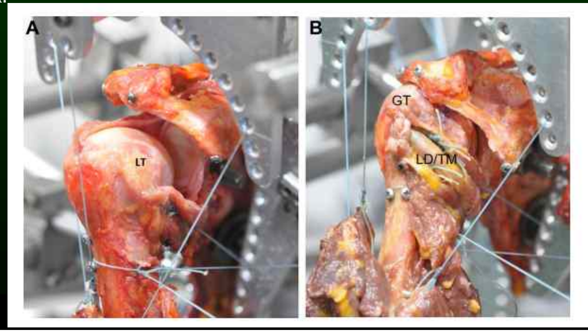
- The aim of the study was to evaluate the biomechanical efficacy of the combined latissimus dorsi and teres major tendon (LDTM) transfer and compare it to an isolated latissimus dorsi (LD) transfer in a cadaveric IASRCT model.
  - Superior and anterior translation of the humeral head
  - Subacromial contact pressure

Materials and Methods

- Controlled laboratory study using 8 fresh frozen shoulders
- All specimens were macroscopically intact, with no history of previous injury or surgery



- All tests were performed at 0 ° ,30 ° , and 60 ° of glenohumeral abduction in the scapular plane and 0 ° ,30 ° ,60 ° , and 90 ° of external rotation.
- Anteroinferior translation was assessed using loads of 20, 30, 40, and 50 N
- Superior translation and subacromial contact pressure were assessed after loading an additional 40 N on the deltoid to create a superiorly directed load.



Result

Table I Superior translation for each testing condition

Testing condition	Superior translation, mm			
	0° ER	30° ER	60° ER	90° ER
0° of abduction				
Intact	1.8 ± 0.4	1.5 ± 0.3	1.7 ± 0.4	2.0 ± 0.6
IASRCT	$5.4 \pm 0.7^{*}$	$5.7 \pm 0.8^{*}$	$6.3 \pm 0.6^{*}$	$7.3 \pm 0.5^{*}$
Combined LDTM transfer (×1)	$5.8 \pm 0.8^{*}$	$5.2 \pm 0.8^{*}$	$5.9 \pm 0.6^{*}$	$6.7 \pm 0.6^{*}$
Combined LDTM transfer (×2)	$4.1 \pm 1.1^{*}$	$3.9 \pm 1.0^{*}$	$3.9 \pm 1.1^{\dagger}$	3.7 ± 1.5
Combined LDTM transfer (×3)	$3.4 \pm 1.0^{\dagger}$	$2.6 \pm 1.0^{\dagger}$	$2.6 \pm 1.2^{\dagger}$	$1.2 \pm 1.4^{\dagger}$
Isolated LD transfer (×1)	$5.8 \pm 0.9^{*}$	$6.1 \pm 0.9^{*}$	$6.9 \pm 0.5^{*}$	$8.3 \pm 0.9^{*}$
Isolated LD transfer (×2)	$5.8 \pm 1.0^{*}$	$5.8 \pm 0.9^{*}$	$6.5 \pm 0.6^{*,\S}$	$7.8 \pm 0.8^{*}$
Isolated LD transfer (×3)	$5.6 \pm 0.9^{*,\|}$	$5.4 \pm 0.9^{*,\|}$	$5.9 \pm 0.7^{*,\|}$	$7.4 \pm 0.8^{*,\|}$
30° of abduction				
Intact	1.8 ± 0.2	1.6 ± 0.2	1.5 ± 0.2	2.2 ± 0.4
IASRCT	$4.6 \pm 0.5^{*}$	$4.6 \pm 0.6^{*}$	$4.9 \pm 0.6^{*}$	$6.6 \pm 0.5^{*}$
Combined LDTM transfer (×1)	3.3 ± 0.8	2.6 ± 1.2	$2.0 \pm 1.2^{\dagger}$	4.3 ± 1.3
Combined LDTM transfer (×2)	$1.4 \pm 0.7^{\dagger}$	$0.5 \pm 1.0^{\dagger}$	$0.1 \pm 1.1^{\dagger}$	$0.3 \pm 1.4^{\dagger}$
Combined LDTM transfer (×3)	$0.0 \pm 0.6^{\dagger}$	$-0.5 \pm 0.8^{\dagger}$	$-0.9 \pm 0.8^{*,\dagger}$	$-1.0 \pm 1.2^{\dagger}$
Isolated LD transfer (×1)	$4.8 \pm 0.5^{*}$	$4.5 \pm 0.6^{*}$	$5.0 \pm 0.6^{*,\ddagger}$	$6.8 \pm 0.6^{*}$
Isolated LD transfer (×2)	$4.3 \pm 0.4^{*,\S}$	$4.2 \pm 0.6^{*,\S}$	$4.7 \pm 0.5^{*,\S}$	$6.3 \pm 0.6^{*,\S}$
Isolated LD transfer (×3)	$3.4 \pm 0.7^{\|}$	$3.3 \pm 0.9^{\|}$	$3.3 \pm 0.9^{\|}$	$4.7 \pm 1.0^{\|}$
60° of abduction				
Intact	0.2 ± 0.3	0.7 ± 0.2	0.8 ± 0.2	0.5 ± 0.1
IASRCT	0.3 ± 0.8	0.5 ± 0.4	1.5 ± 0.5	3.3 ± 0.8
Combined LDTM transfer (×1)	0.2 ± 0.7	-0.9 ± 0.5	$-1.8 \pm 0.5^{*,\dagger}$	$-2.5 \pm 1.1^{\dagger}$
Combined LDTM transfer (×2)	0.1 ± 0.8	$-1.3 \pm 0.5^{*,\dagger}$	$-2.9 \pm 0.5^{*,\dagger}$	$-3.3 \pm 1.2^{\dagger}$
Combined LDTM transfer (×3)	-0.7 ± 0.7	$-2.2 \pm 0.7^{*,\dagger}$	$-4.5 \pm 0.8^{*,\dagger}$	$-4.0 \pm 1.4^{*,\dagger}$
Isolated LD transfer (×1)	0.6 ± 1.1	$0.9 \pm 0.7^{\ddagger}$	$0.9 \pm 0.9^{\ddagger}$	0.8 ± 0.9
Isolated LD transfer (×2)	0.2 ± 1.0	0.2 ± 0.6	$0.1 \pm 0.8^{\S}$	$-0.1 \pm 0.6^{\dagger,\S}$
Isolated LD transfer (×3)	0.8 ± 1.3	$0.1 \pm 0.7^{\|}$	$-0.5 \pm 0.8^{\|}$	$-1.4 \pm 0.7^{\dagger}$

IASRCT, irreparable anterosuperior rotator cuff tear; *LD*, latissimus dorsi; *TM*, teres major; *ER*, external rotation.
Data are given as mean ± standard error.
* $P < .05$ vs. Intact.
† $P < .05$ vs. IASRCT.
‡ $P < .05$ vs. Combined LDTM transfer×1.
§ $P < .05$ vs. Combined LDTM transfer×2.
$^{\|}$ $P < .05$ vs. Combined LDTM transfer×3.

Result

- At 30 ° and 60 ° abduction with all humeral rotation degrees, the combined LDTM transfer condition significantly decreased superior translation compared to the IASRCT condition at double and triple muscle loading (P < .028)
- However, the isolated LD transfer condition failed to significantly decrease superior translation compared with the IASRCT condition at every abduction angle and muscle loading.

Result

Table II Anteroinferior translation for each testing condition

Testing condition	Anteroinferior translation, mm			
	20 N	30 N	40 N	50 N
0° of abduction				
Intact	1.4 ± 0.5	2.4 ± 0.6	4.5 ± 1.3	6.0 ± 1.4
IASRCT	3.6 ± 1.1	9.6 ± 2.3	13.0 ± 2.3*	13.9 ± 2.3
Combined LDTM transfer (×1)	3.0 ± 0.9	7.5 ± 2.3	13.9 ± 2.9*	17.4 ± 3.1*
Combined LDTM transfer (×2)	1.8 ± 0.5	4.1 ± 1.1	9.9 ± 3.7	14.1 ± 4.1
Combined LDTM transfer (×3)	1.3 ± 0.3	2.3 ± 0.6	5.3 ± 1.5†	13.8 ± 4.4
Isolated LD transfer (×1)	5.0 ± 1.9	11.4 ± 2.7*	16.4 ± 3.1*	19.7 ± 3.2*
Isolated LD transfer (×2)	3.4 ± 2.0	10.3 ± 4.0*	13.9 ± 3.8*	21.0 ± 3.5*
Isolated LD transfer (×3)	2.8 ± 2.2	9.2 ± 4.1	13.6 ± 3.8*,‡	21.2 ± 3.2*
30° of abduction				
Intact	1.3 ± 0.3	2.3 ± 0.4	4.2 ± 1.1	5.3 ± 1.2
IASRCT	2.9 ± 0.6	9.7 ± 3.1	12.2 ± 3.2	14.9 ± 3.0*
Combined LDTM transfer (×1)	2.2 ± 0.5	6.6 ± 3.2	12.7 ± 3.4*	16.7 ± 2.5*
Combined LDTM transfer (×2)	1.5 ± 0.4	3.5 ± 0.9	7.9 ± 3.2	14.1 ± 3.8*
Combined LDTM transfer (×3)	1.2 ± 0.3	2.4 ± 0.6†	5.8 ± 2.2	12.6 ± 4.0
Isolated LD transfer (×1)	4.6 ± 2.2	12.3 ± 3.9*	13.4 ± 3.6*	19.8 ± 2.6*
Isolated LD transfer (×2)	4.6 ± 2.1	9.5 ± 4.0	14.7 ± 3.8*	19.3 ± 2.6*
Isolated LD transfer (×3)	2.1 ± 0.8	7.8 ± 3.7	12.7 ± 3.9	15.9 ± 3.5*
60° of abduction				
Intact	1.0 ± 0.2	2.3 ± 0.5	3.8 ± 1.0	6.2 ± 2.0
IASRCT	3.1 ± 0.8	8.4 ± 2.4*	10.3 ± 2.4*	15.6 ± 2.3*
Combined LDTM transfer (×1)	4.9 ± 2.3	7.0 ± 2.4	9.0 ± 2.2*	12.3 ± 2.4*
Combined LDTM transfer (×2)	4.9 ± 2.3	7.2 ± 2.4*	8.2 ± 2.3*	9.4 ± 2.1†
Combined LDTM transfer (×3)	4.1 ± 1.9	6.2 ± 2.1	7.0 ± 2.1	8.0 ± 1.9†
Isolated LD transfer (×1)	6.3 ± 2.9	9.5 ± 2.7*	11.1 ± 2.4*	16.2 ± 1.8*
Isolated LD transfer (×2)	4.9 ± 2.6	8.7 ± 2.6*	9.6 ± 2.5*	12.7 ± 2.2*
Isolated LD transfer (×3)	4.8 ± 1.9	8.6 ± 2.4*	9.3 ± 2.4*	11.0 ± 1.9

IASRCT, irreparable anterosuperior rotator cuff tear; *LD*, latissimus dorsi; *TM*, teres major.
Data are given as mean ± standard error.
* $P < .05$ vs. Intact.
† $P < .05$ vs. IASRCT.
‡ $P < .05$ vs. Combined LDTM transfer×1.

Result

- The IASRCT condition showed a significant increase in anteroinferior translation compared to the intact rotator cuff at 30, 40, and 50 N of anteroinferior loading at 60 ° abduction (P < .021)
- The combined LDTM transfer condition showed a significant decrease in anteriorinferior translation compared to the tear condition at 0 ° abduction with 40 N (P = 0.029) and 60 abduction with 50 N (P = 0.008).
- The isolated LD transfer condition did not demonstrate any significant decrease in anteroinferior translation compared to the IASRCT condition at every abduction angle.

Result

Table III Mean subacromial contact pressure for each testing condition

Condition	Contact pressure, kPa			
	0° ER	30° ER	60° ER	90° ER
0° of abduction				
Intact	96.0 ± 13.4	115.1 ± 11.0	95.6 ± 13.1	25.4 ± 13.3
IASRCT	91.4 ± 22.8	166.9 ± 28.1	218.3 ± 41.5*	105.4 ± 45.4
Combined LDTM transfer (×1)	69.9 ± 22.1	160.2 ± 32.5	162.1 ± 32.3	60.2 ± 24.3
Combined LDTM transfer (×2)	29.7 ± 14.5	91.9 ± 35.0	100.0 ± 34.7†	NA
Combined LDTM transfer (×3)	NA	48.9 ± 25.5*,†	58.7 ± 29.4†	NA
Isolated LD transfer (×1)	87.1 ± 24.8	161.1 ± 31.9	203.7 ± 36.1*	106.9 ± 32.7
Isolated LD transfer (×2)	80.1 ± 29.7	135.2 ± 26.3	173.8 ± 31.7	99.6 ± 31.5
Isolated LD transfer (×3)	56.1 ± 21.0$^{\|}$	115.5 ± 23.7$^{\|}$	143.9 ± 27.6	102.8 ± 40.5
30° of abduction				
Intact	112.0 ± 9.5	100.6 ± 12.1	97.1 ± 10.8	46.9 ± 15.2
IASRCT	151.9 ± 25.6	211.1 ± 23.3*	195.3 ± 20.4*	186.9 ± 35.8*
Combined LDTM transfer (×1)	80.7 ± 14.4†	102.8 ± 31.0†	89.8 ± 34.4†	112.2 ± 36.2
Combined LDTM transfer (×2)	29.5 ± 14.5*,†	35.0 ± 19.4†	19.8 ± 19.8†	21.1 ± 21.1†
Combined LDTM transfer (×3)	21.6 ± 10.9*,†	20.3 ± 13.7†	14.9 ± 14.9†	19.2 ± 19.2†
Isolated LD transfer (×1)	140.5 ± 21.3	194.1 ± 20.8*,‡	206.0 ± 25.7*,‡	180.5 ± 28.2*
Isolated LD transfer (×2)	121.2 ± 19.8§	180.4 ± 24.0§	172.5 ± 27.3§	160.1 ± 29.6*,§
Isolated LD transfer (×3)	72.9 ± 22.9†	115.7 ± 32.2$^{\dagger,\|}$	112.7 ± 36.9$^{\|}$	112.2 ± 40.4
60° of abduction				
Intact	102.7 ± 24.7	147.6 ± 27.4	65.3 ± 23.4	30.6 ± 15.7
IASRCT	122.2 ± 33.4	200.6 ± 30.0	139.9 ± 30.0	167.2 ± 36.9*
Combined LDTM transfer (×1)	60.2 ± 20.3†	75.1 ± 24.5†	67.9 ± 24.1	29.0 ± 15.5†
Combined LDTM transfer (×2)	24.8 ± 16.8*,†	54.0 ± 19.5*,†	62.8 ± 25.0	18.8 ± 12.0†
Combined LDTM transfer (×3)	18.5 ± 12.3*,†	42.3 ± 18.8*,†	41.4 ± 27.1†	15.7 ± 10.1†
Isolated LD transfer (×1)	85.3 ± 16.5	166.0 ± 32.8‡	171.1 ± 31.3*,‡	62.0 ± 13.8†
Isolated LD transfer (×2)	71.6 ± 12.8	133.4 ± 29.9	141.3 ± 23.1	34.3 ± 17.3†
Isolated LD transfer (×3)	61.5 ± 17.0†	114.3 ± 26.4	102.7 ± 13.5	30.1 ± 14.6†

IASRCT, irreparable anterosuperior rotator cuff tear; *LD*, latissimus dorsi; *TM*, teres major; *ER*, external rotation.
Data are given as mean ± standard error.
* $P < .05$ vs. Intact.
† $P < .05$ vs. IASRCT.
‡ $P < .05$ vs. Combined LDTM transfer×1.
§ $P < .05$ vs. Combined LDTM transfer×2.
$^{\|}$ $P < .05$ vs. Combined LDTM transfer×3.

Result

- Mean contact pressure significantly increased in the IASRCT condition compared to the intact rotator cuff condition
- The Combined LDTM transfer significantly decreased contact pressure from the IASRCT condition at all abduction angles (P < .046), whereas isolated LD transfer significantly decreased contact pressure only at 60 ° abduction and at 90 ° external rotation (P < .015)

Discussion

- The combined LDTM transfer condition significantly decreased superior translation, whereas the isolated LD transfer condition failed to significantly decrease superior translation compared to the IASRCT condition
- The combined LDTM condition showed a significantly decreased anterior-inferior translation compared to the IASRCT condition.
- In contrast, the isolated LD transfer condition did not significantly decrease anterior-inferior translation compared to the IASRCT condition at any abduction and muscle loads.

Discussion

- The LDTM transfer was also able to significantly decrease contact pressure from the IASRCT condition at every abduction angle.
- At 30 ° abduction with 30 ° and 60 ° of external rotation, the combined LDTM transfer condition showed significantly decreased contact pressure compared to the isolated LD transfer condition.

Discussion

- It was demonstrated that isolated LD tendon transfer for IASRCTs could not completely restore the superior migration and anterior subluxation of the humeral head.
- Thus, isolated LD tendon transfer is not enough to stabilize the glenohumeral joint

Conclusion

- Combined LDTM transfer decreased superior translation, anteroinferior translation, and subacromial contact pressure compared with the IASRCT condition.
- Isolated LD transfer did not improve glenohumeral translation and subacromial contact pressure.
- Combined LDTM transfer may be a more reliable treatment option than isolated LD transfer in patients with an IASRCT.

Flexor & Extensor tendon injury

명지병원 정형외과
R2. 우창우
2023.05.19

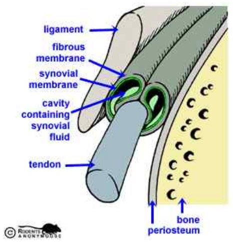
Tendon

- Tendon
  - Fibrous connective tissue connecting muscle & bone
  - Joint motion
  - Cylindrical or flat

Tendon

- Structures of tendon
  - Cellular structures
    - Fibroblast
    - Tenocyte
      - Proteoglycan, glycoprotein, elastin, type I collagen

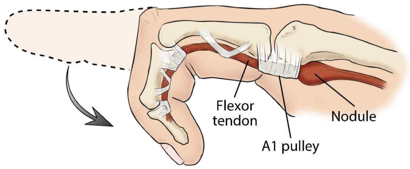
Tendon



- Structures
  - Non cellular structures
    - Paratendon
    - Epitendon
    - Tendon sheath
      - Flexor tendon을 감싸는 부분
        - » 2 layered, tendon taking high mechanical force
          - Fibrous sheath : outer layer
          - Synovial sheath : inner layer

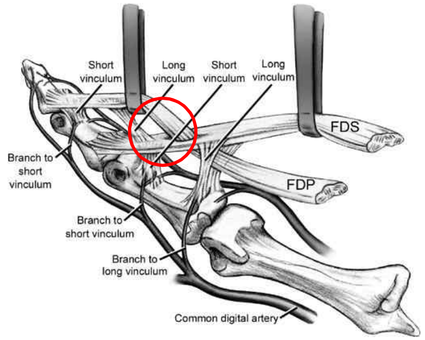
Tendon

- Structures
  - Non cellular structures
    - Pulley
      - Annular pulley
      - Cruciate pulley
      - → Related to flexion & Extension of finger



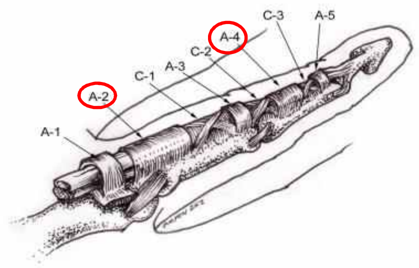
Anatomy of Flexor tendon

- Flexor tendon



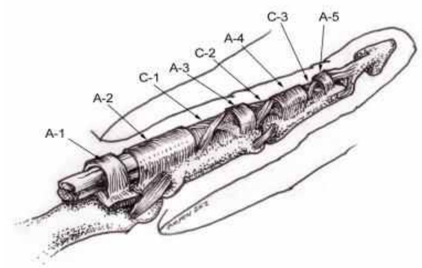
Anatomy of Flexor tendon

- Flexor tendon
  - Pulley



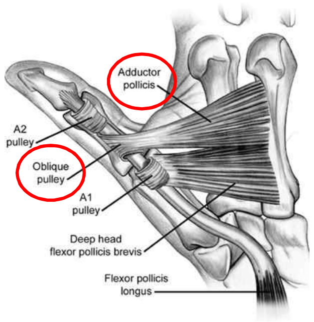
Anatomy of Flexor tendon

- Tendon ischemic area (Avascular zone)
  - FDS beneath A2 pulley
  - FDP beneath A2 & A4 pulley



Anatomy of Flexor tendon

- Flexor tendon
  - Thumb pulley



Flexor tendon

- Tendon nutrition
  - Synovial fluid from tenosynovial sheath (synovial diffusion)
  - Bloody supply from
    - Longitudinal vessels in the paratendon
    - Intraosseous vessel at the tendon insertion site
    - Vincular circulation

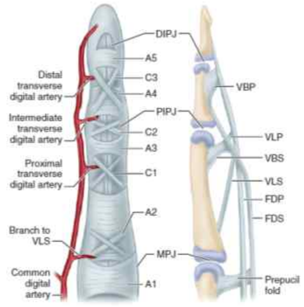


FIGURE 66-1 Vascular supply to flexor tendons is by four transverse communicating branches of digital arteries. DIPJ, distal interphalangeal joint; FDP, flexor digitorum profundus; FDS, flexor digitorum sublimis; MPJ, metacarpophalangeal joint; PIPJ, proximal interphalangeal joint; VBP, vinculum breve profundus; VBS, vinculum breve superficialis; VLP, vinculum longum profundus; VLS, vinculum longum superficialis.

Flexor tendon healing

- Tendon healing mechanism
  - Stage
    - Inflammatory phase (48-72 hrs)
      - Cell infiltration
      - Granulation
      - Growth factors
    - Proliferative phase (5 days to 4 weeks)
      - Fibroblast proliferation
      - Neovascularization & adhesion
    - Remodeling (4 weeks to about 3.5 months)

Flexor tendon healing

- Tendon healing mechanism
  - Extrinsic healing
    - Activity of peripheral fibroblast
    - Scar & adhesion (+)
  - Intrinsic healing
    - Activity of fibroblast derived from the tendon (tenocyte)
    - Scar & adhesion (-)
    - Cyclic tension : promote intrinsic healing
      - » Core suture & circumferential suture

Flexor tendon healing

- Tendon healing mechanism
  - Extrinsic mechanism : peripheral fibroblast
  - Intrinsic mechanism : fibroblast derived from the tendon

  - Adhesion

    not be essential to the tendon repair process itself

    Tendon injury + synovial sheath injury + immobilization

Flexor tendon examination

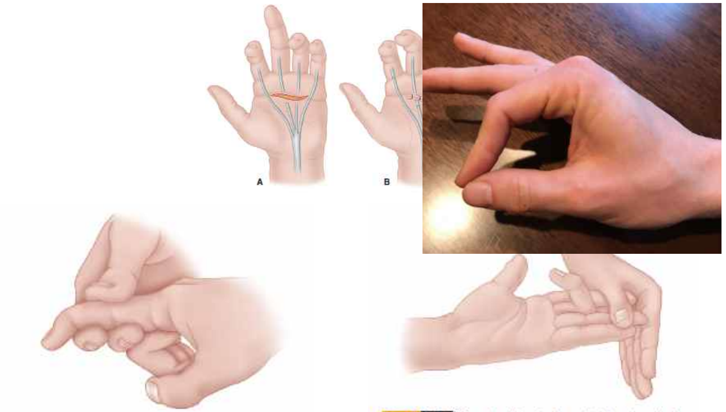


FIGURE 66-3 If distal interphalangeal joint can be actively flexed while proximal interphalangeal joint is stabilized, profundus tendon has not been severed.

FIGURE 66-4 If proximal interphalangeal joint can be actively flexed while adjacent fingers are held completely extended, sublimis tendon has not been severed (see text).

Flexor tendon injury

- Flexor zone of hand
  - Zone I
    - FDP only (A4 pulley)
  - Zone II
    - FDS ~ palmar crease
    - Camper's Chiasm
    - A1~A3 pulley
  - Zone III
    - Carpal tunnel (distal)
    - 9 flexor tendons
  - Zone IV
  - Zone V

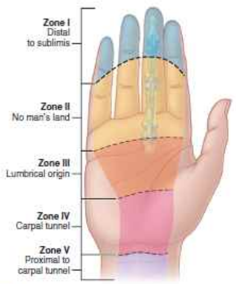
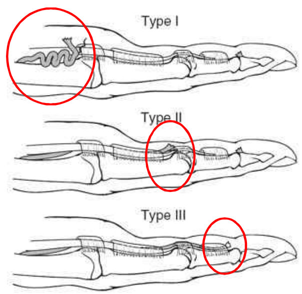


FIGURE 66-32 Flexor zones of hand. Designated zones on flexor surface of hand are helpful because treatment of tendon injuries may vary according to level of severance.

Jersey finger

- 수상 후 10일 이내 - reattach
- 수상 후 10일 이후 – tendon graft



Flexor tendon injury

- Flexor zone of hand
  - Zone I
    - Area at IP joint
    - Insertion of the FPL
  - Zone II
    - MC head and MP joint
  - Zone III
    - MC beneath the thenar m.
  - Zone IV
    - Carpal tunnel
  - Zone V

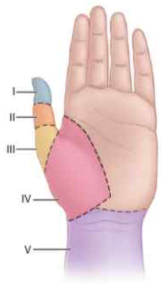


FIGURE 66-44 Anatomical zones of flexor pollicis longus that influence type of repair.

Tendon repair

- End-to-end tendon suture

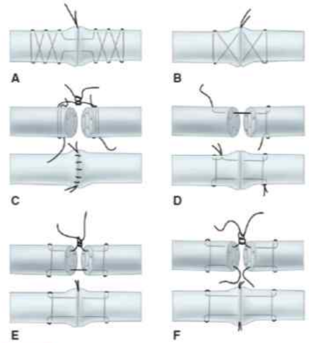


FIGURE 66-7 Commonly used techniques for end-to-end tendon suture. A, Conventional Bunnell stitch. B, Crisscross stitch. C, Mason-Allen (Chicago) stitch. D, Kessler grasping stitch. E, Modified Kessler stitch with single knot at repair. F, Tajima modification of Kessler stitch with double knots at repair site.

Tendon repair

- Fish-mouth end-to-end suture (PULVERTAFT)

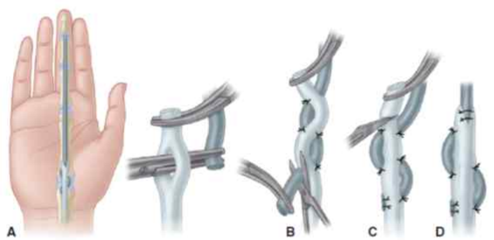


FIGURE 66-23 Pulvertaft technique of suturing tendon of small diameter to one of larger diameter. A, Smaller tendon is brought through larger tendon and anchored with one or two sutures after tension is adjusted. B, Tendon is brought through more proximal hole and is anchored again with one or two sutures after tension is adjusted. C, After excess is cut flush with larger tendon, exit hole can be closed with one or two sutures. D, Excess of larger tendon is trimmed as shown to permit central location of smaller tendon. This so-called fish mouth is closed with sutures.

Tendon repair

- FDP insertion site

FIGURE 66-26 Tendon-to-tendon su

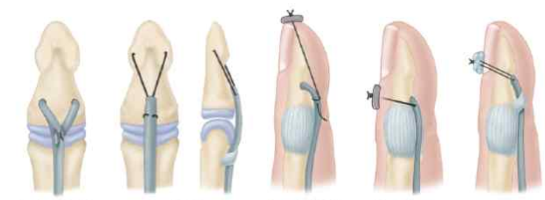


FIGURE 66-27 Tendon-to-bone attachment.

Tendon repair

- Zone 1 injury

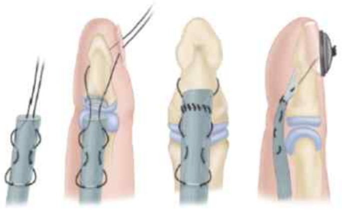


FIGURE 66-30 Zone I injury. Profundus tendon is advanced and reinserted into distal phalanx using pull-out wire suture and tie-over button. SEE TECHNIQUE 66-8.

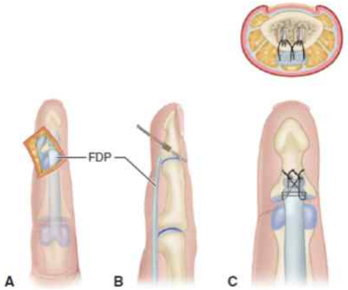


FIGURE 66-31 Suture anchor tendon attachment. Volar (A) and lateral (B) views showing avulsed flexor digitorum profundus tendon and surgical exposure. C, Volar and cross-sectional views showing suture anchor placement in the distal phalanx and suture technique.

Tendon repair

- Zone 2 injury (Strickland technique)

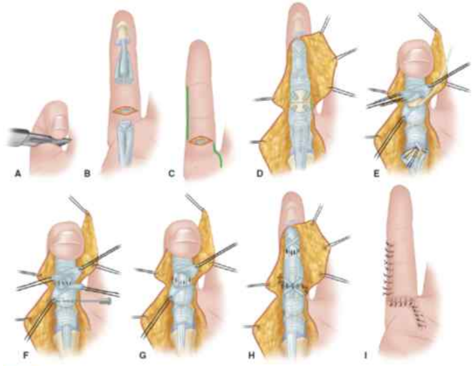


FIGURE 66-39 Strickland technique of flexor tendon repair in zone II. A, Knife laceration through zone II with digit in full flexion.

Tendon repair

- Flexor digitorum sublimis spiral

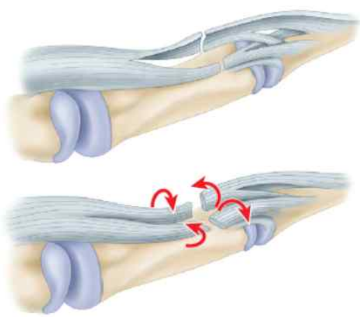


FIGURE 66-35 Flexor digitorum sublimis spiral. Flexor digito-

Tendon repair

- Postoperative mobilization techniques

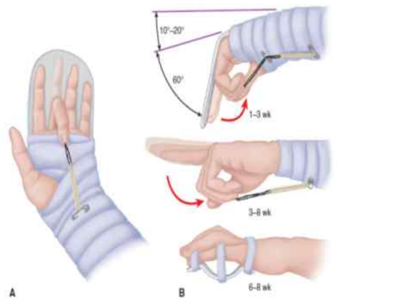


FIGURE 66-40 A, After primary flexor tendon repair or flexor tendon graft, wrist and hand are held in posterior plaster splint. Additionally, involved finger is held in flexion by elastic band attached at wrist level and at fingernail by wire through nail or glued-on garment hook. This permits active finger extension and protected passive flexion. B, Immediate controlled mobilization of repaired flexor tendon is achieved with extension block splint and proper rubber band traction, allowing proximal interphalangeal joint extension against traction and flexion of 40 to 60 degrees. At 3 to 8 weeks, rubber band is attached to elastic bandage cuff at wrist. After removal of rubber band traction, night splinting can be used at 6 to 8 weeks if necessary. SEE TECHNIQUE 66-10.

Extensor tendon

Anatomy

Compartment 4
Extensor indicis
Extensor digitorum

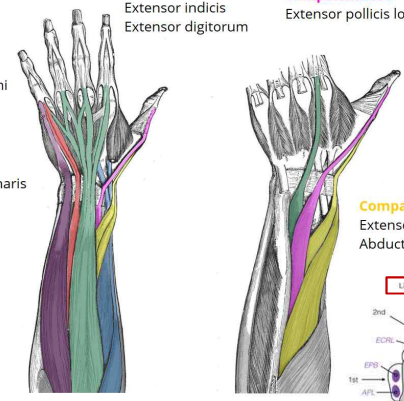
Compartment 3
Extensor pollicis longus

Compartment 5
Extensor digiti minimi

Compartment 2
Extensor carpi radialis brevis
Extensor carpi radialis longus

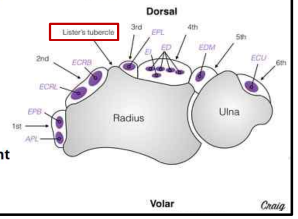
Compartment 6
Extensor carpi ulnaris

Compartment 1
Extensor pollicis brevis
Abductor pollicis longus



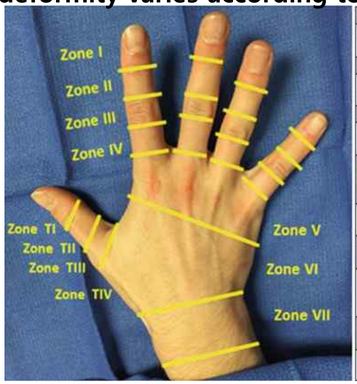
Superficial Compartment

Deep Compartment



Anatomy

- **The type of injury, surgical approach, potential deformity varies according to the zone**

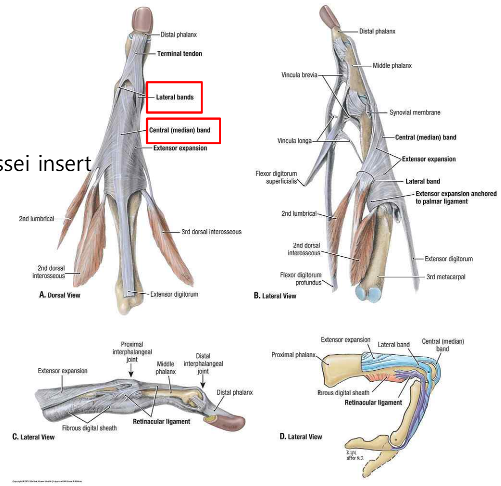


Zone I	Injury is distal to the DIP joint
Zone II	Injury is overlying the middle phalanx
Zone III	Injury is over the PIP joint
Zone IV	Injury is overlying the proximal phalanx
Zone V	Injury is over the MCP joint
Zone VI	Injury is over the metacarpal Most common zone of injury
Zone VII	Injury to the tendon and retinaculum over the wrist joint
Zone VIII	Injury to the muscle belly in the distal forearm
Zone TI	Injury is distal to the IP joint of the thumb
Zone TII	Injury is overlying the proximal phalanx of the thumb
Zone TIII	Injury is over the MCP joint of the thumb
Zone TIV	Injury is over the CMC joint of the thumb

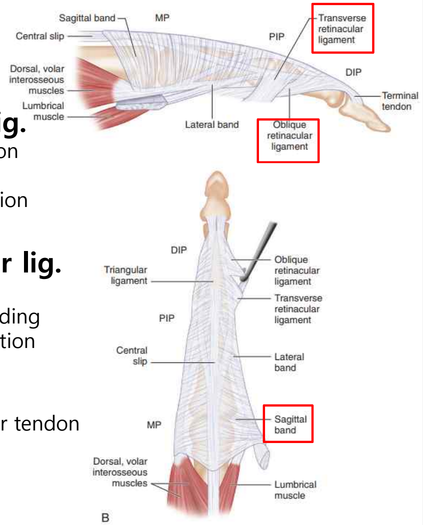
Anatomy

- **Lateral band**
  distal phalanx
  lumbricals, EI, interossei insert
  DIP extension

- **Central band**
  middle phalanx base
  PIP extension



Anatomy



- **Oblique retinacular lig.**
  prox. phalanx base flexor tendon
  terminal extensor tendon
  coordination of PIP & DIP motion

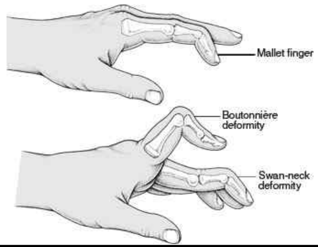
- **Transverse retinacular lig.**
  flexor tendon fiber
  lateral slip, central slip surrounding
  prevent lateral slip ant. Dislocation

- **Sagittal band**
  prevent subluxation of extensor tendon
  in MCP joint

Examination

- Laceration, Open wound
- Inspection : phalanx deformity

- DIP in flexion-> Mallet finger
- PIP in flexion, DIP in hyperextension-> Boutonniere deformity
- PIP in hyperextension, DIP in flexion -> Swan neck deformity



Extensor tendon repair

Zone I

- DIP joint area

- Avulsion from its insertion into the distal phalanx (mallet finger)

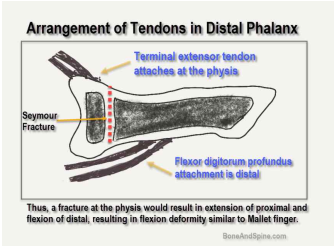
- **Nonoperative Tx.**
  Hyperextension on a splint for 6 to 8 wks
  Night only for 2 to 4 additional wks

Table 10-1 Classification of Mallet Finger

Type		Definition
I		Closed injury
II		Associated with overlying skin laceration
III		Associated with tendon and loss of overlying skin (deep abrasion)
IVA		Transphyseal injury in skeletally immature digit
IVB		Associated with avulsion fracture involving 20%-50% of articular surface
IVC		Associated with avulsion fracture involving >50% of articular surface

Zone I

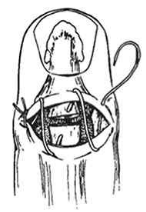
- **Mallet finger deformities in children**
  Caused by traumatic separation of the epiphysis
  Usually allows straightforward reduction
  with DIP hyperextension
  Splint for 3 to 4 wks
  Growth disturbance is rare



Zone I

- **Chronic mallet finger(secondary repair)**
  Splint Tx. is successful Tx. until 12wks after injury
  After 12wks, if still exist severe drop and
  DIP passive extension possible consider operation

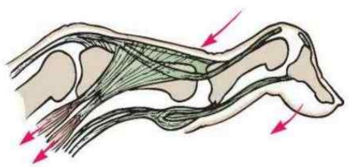
- **Acute transection of extensor tendon**
  Tendon repaired with roll stitch or
  dermotenodermal suture c K-wire

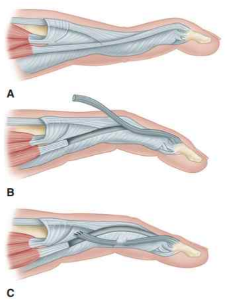


Zone I

- Correction of **old mallet finger deformity** by tendon transfer or tendon graft

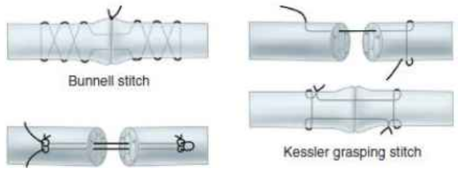
- **Lateral band transferring or ORL reconstruction by using PL**

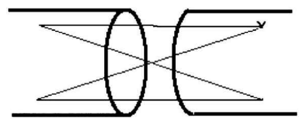




Zone II

- middle phalanx area
- Laceration involve the triangular lig.
- The Kleinert modification of the **Bunnell suture** and **modified Kessler sutures** were stronger than a figure of 8 or mattress suture

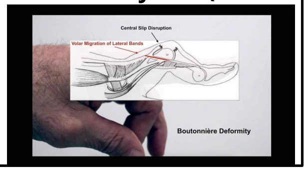




Zone III

- **PIP joint area**

- **Deformity process**
  - **Central slip injury but lateral band, triangular ligament intact**
  - **If untreated (2~3weeks)**
  - **Lat. Band volar side로 subluxation**
  - **>lat. Band becoming a flexor of the PIP joint (PIP extensor x.)**
  - **> Boutonniere deformity**

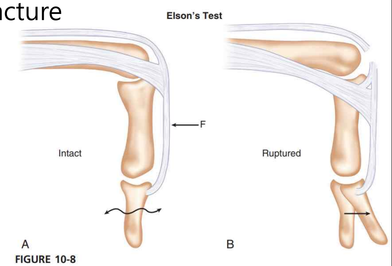


Zone III

- **Elson's Test**
- **Chronic Boutonniere deformity needs secondary repair & reconstruction**

  Restoration of central slip

  Release associated contracture



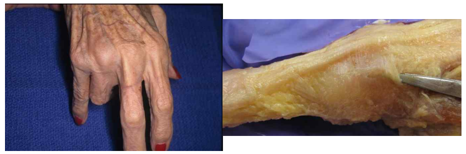
Zone IV

- prox. phalanx area

- If full active PIP joint extension is present, closed treatment with splint 3-4 wks may sufficient

- If PIP joint is limited, exploration is needed to determine the extent of injury

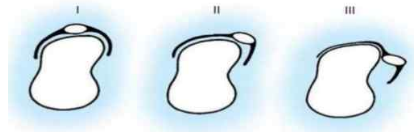
Zone V



- **MCP joint area**
- **Traumatic D/L of extensor tendon**

  M/C occurs at long finger

  ulnar side injury d/t radial **sagittal band** rupture
- **Rayan and Murray classification**



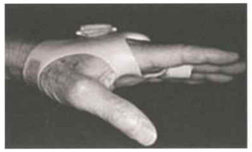
Type I show no extensor instability
Type II extensor tendon subluxation
Type III extensor tendon dislocation

Zone V

- Conservative Tx.
  If seen within the first few days
  Extension splint for 3-4 wks,
  following 3-4 wks for buddy taping

- Sagittal band repair
  After 3wks from injury & failure of conservative Tx.

- Sagittal band reconstruction

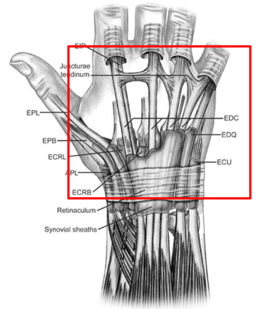


Zone VI

- Metacarpal area

- **May not always result in loss of the extension** at the MCP joint (**d/t juncturae tendinum & proprius tendon**)

- Wounds should be explored in patients who cannot hyperextend the MCP joint even though weak active extension may be present



Zone VII

- Area of the wrist under extensor retinaculum

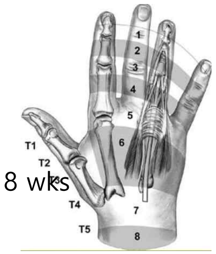
- Access to the tendons may require elevation of the extensor retinaculum

Zone VIII, IX

- Area of the distal forearm, proximal to the extensor retinaculum

- The tendinous portion of the musculotendinous unit can be sutured to the muscle belly

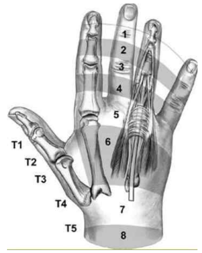
Zone TI, TII



- Closed injury of EPL
  Splinting involving finger tip more than 8 wks
- Associated fractures of the distal phalanx involving more than 50% of the joint or fractures with distal fragment subluxation usually require operation
  direct or secondary repair

Zone TIII, TIV TV

- TIII : MCP joint , TIV : the thumb MC
- EPL, APL, EPB tendons injury
- Repairs to all injured tendons
- Tendon transfer using PL or EIP



1. 6주전 주먹으로 벽을 친 후 제 3 중수지 관절 통증과 주먹을 쥐었을 때 탄발음(snapping)이 있는 24세 환자의 동영상 소견이다. 가장 적절한 치료는? (동영상 1개) 18B2/15I

㉮ 경과 관찰
㉯ 시상대(sagittal band) 봉합
㉰ 중수수지관절 신전 상태로 부목고정
㉱ 충양건 절단술
㉲ 중수골간 인대(intermetacarpal ligament) 봉합

1. 우측 수부 인지의 단추 구멍 변형(button hole deformity)을 주소로 내원한 환자로 3주일 전 우수 인지 근위 지간 관절의 배측의 개방성 창상을 입었다고 한다. 방사선 사진상 골절이나 탈구는 관찰되지 않았다. 가장 적절한 치료는? 13I
㉮ 경과 관찰
㉯ 신전 부목
㉰ 근위지간관절 고정술
㉱ 외측지대(lateral band) 유리술
㉲ 중앙신건(central extensor tendon) 봉합

답: ㉲

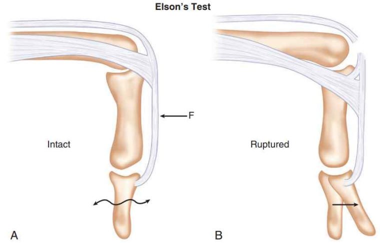


FIGURE 10-8

Reference

- Campbell's operative orthopedics 13th edition, Vol. IV. P.3348-3364

- 정형외과학 7판, 제 1권. P.702-711

Ankle & Foot
<Surgical approach>

명지병원 정형외과

R3. 이준우

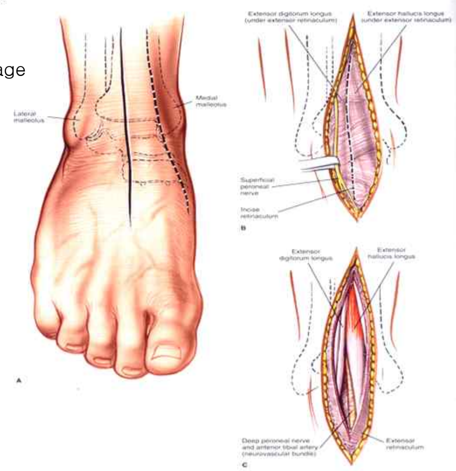
Anterior Approach to the Ankle

Ix>1.ankle joint arthrodesis

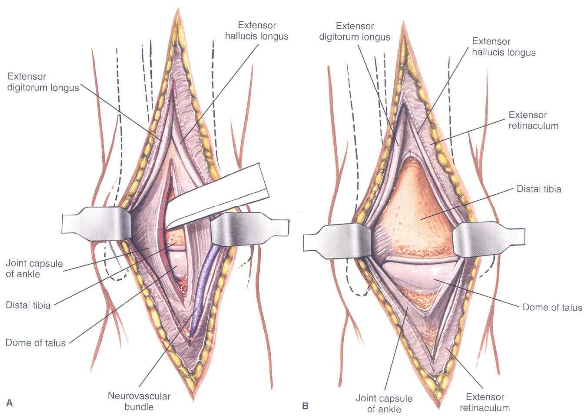
2.ankle joint infection시 drainage

3.loose body removal

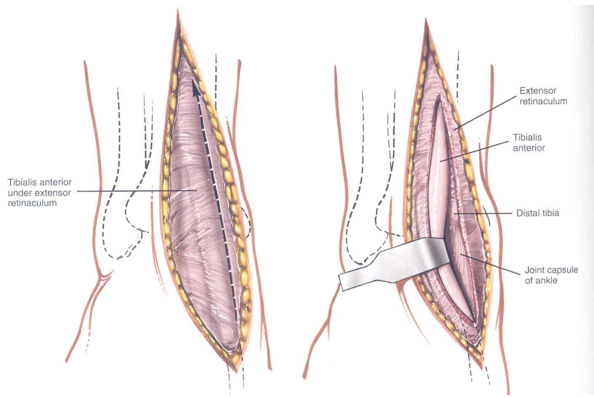
4. pilon Fx.



Anterior Approach to the Ankle

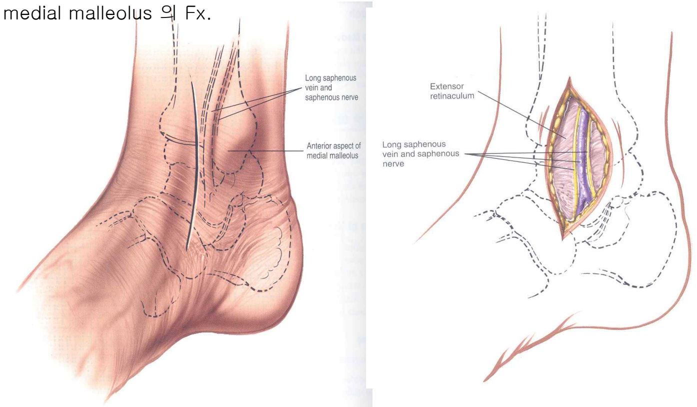


Anterior Approach to the Ankle

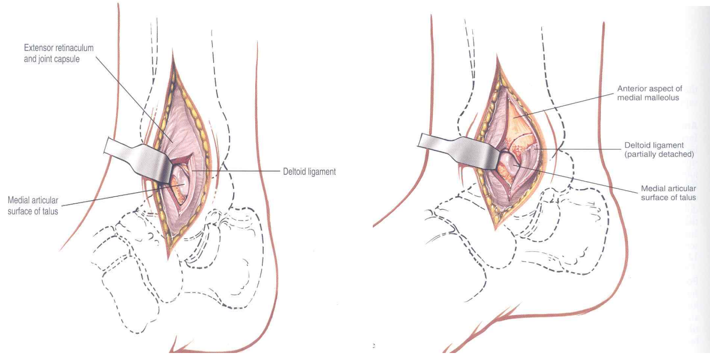


Ant. Approach to medial malleolus

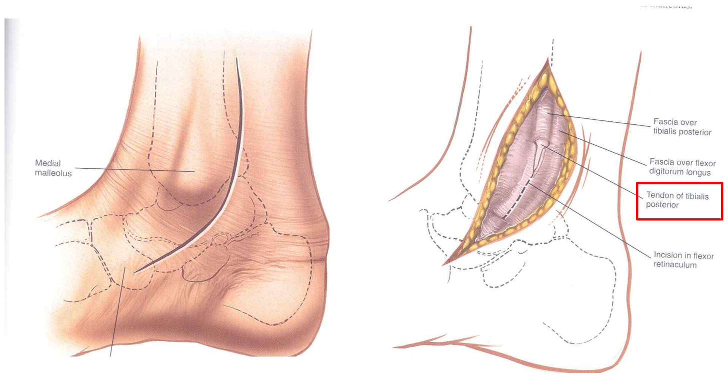
medial malleolus 의 Fx.



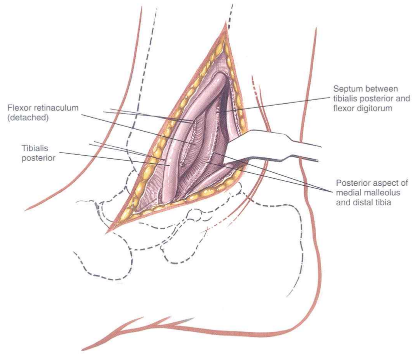
Ant. Approach to medial malleolus



Post. Approach to medial malleolus



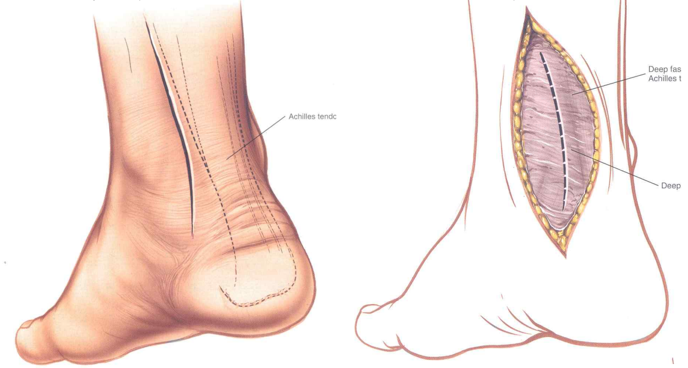
Post. Approach to medial malleolus



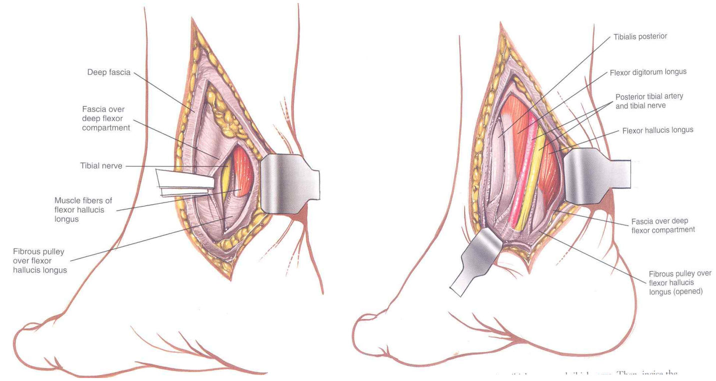
Posteromedial Approach to Ankle

1>medial malleolus 뒤쪽의 tendon 과 neurovascular 의 exposure

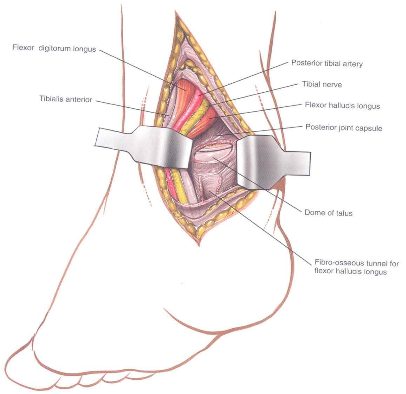
2>ankle joint posterior malleolus Fx.의 한 direct technique



Posteromedial Approach to Ankle



Posteromedial Approach to Ankle

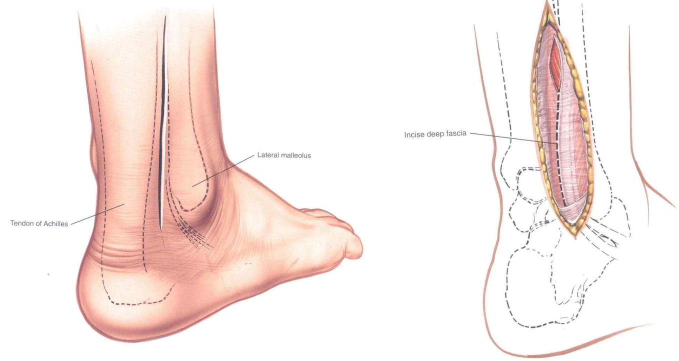


Posterolateral Approach to Ankle

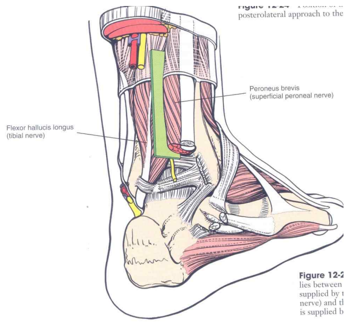
Ix>1. posterior malleolus Fx.의 ORIF

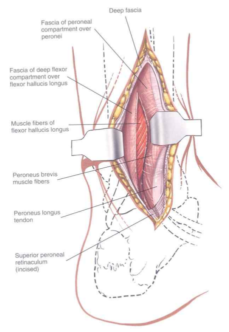
2. distal tibia 와 ankle j. posterior aspect

3.subtalar j. 의 posterior facet을 arthrodesis

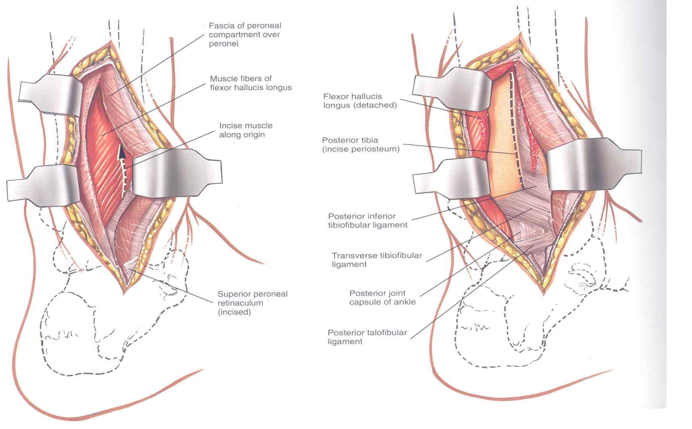


Posterolateral Approach to Ankle

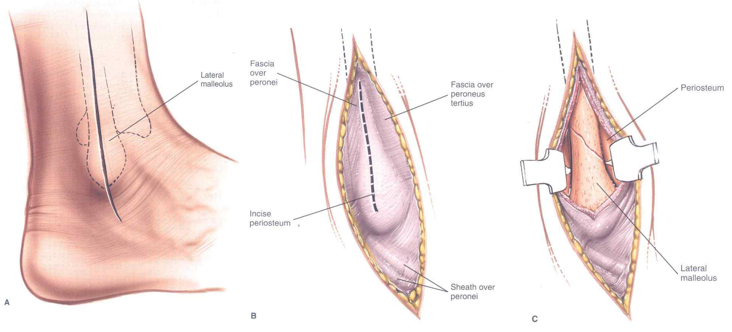




Posterolateral Approach to Ankle



Approach to Lateral Malleolus



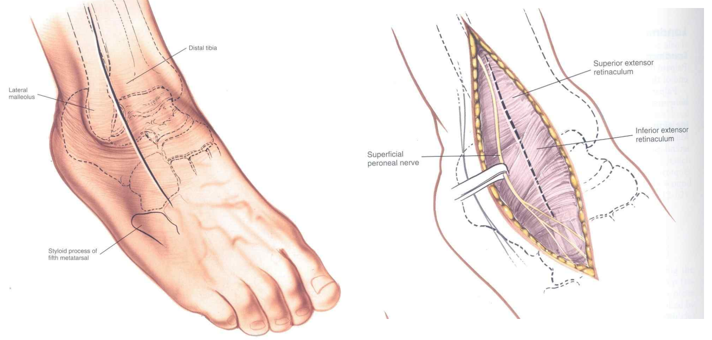
Anterolateral Approach to Ankle

1>ankle arthrodesis

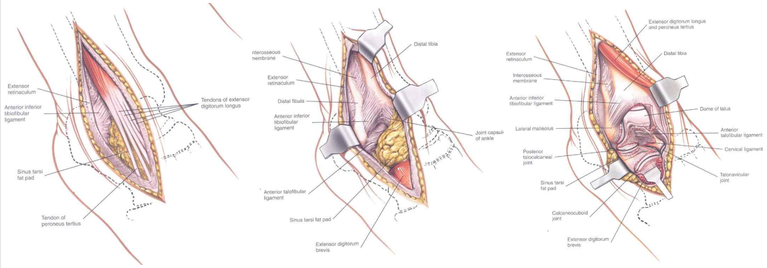
2> triple arthrodesis

3>subtalar arthrodesis

4> talus 의 D/L 의 reduction



Anterolateral Approach to Ankle

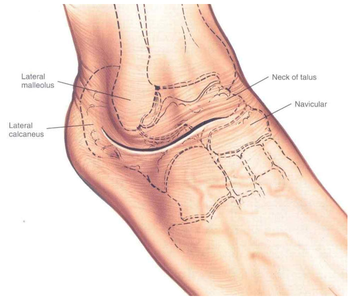


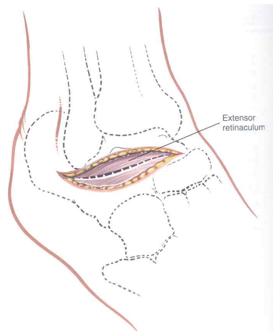
Lateral Approach to Hindfoot

Ix>1.talocalcan, talonavicular 의 expose

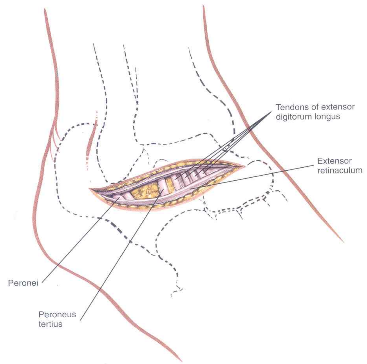
2.posterior talocalcaneal joint

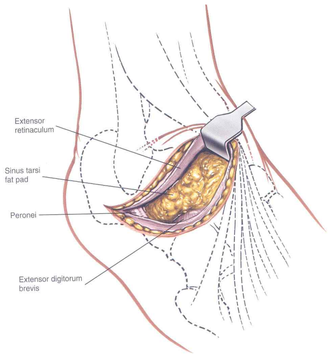
3.calcaneocuboid joint



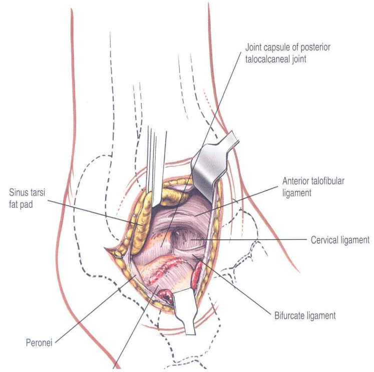


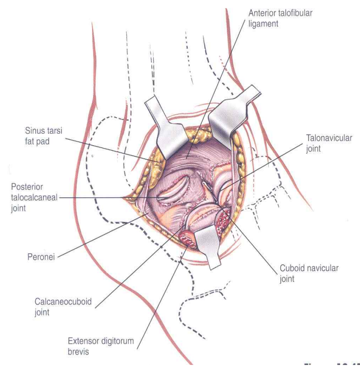
Lateral Approach to Hindfoot



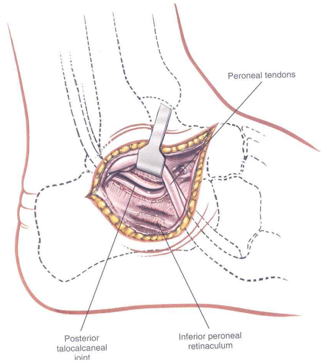


Lateral Approach to Hindfoot

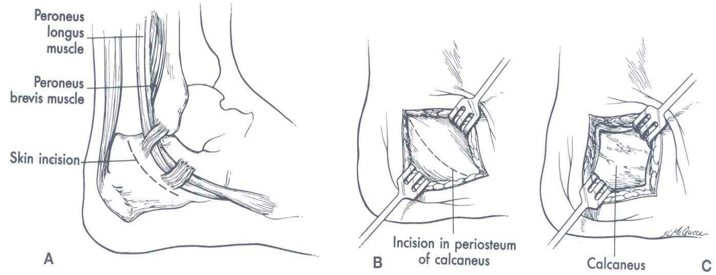




Lateral Approach to Hindfoot



Lateral Approach to Calcaneus

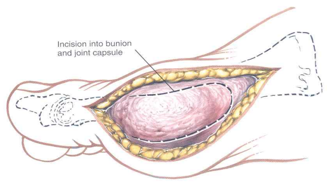


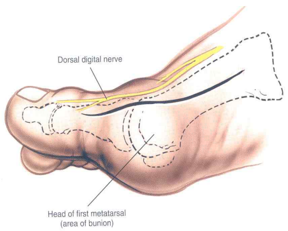
Dorsomedial Approach to MP joint of Great Toe

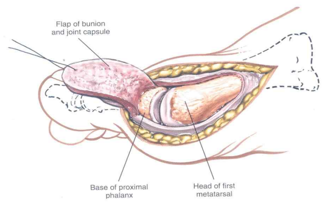
Ix>1.metatarsal head 의 extension

2.prox. phlanx 의 prox. part의 excision

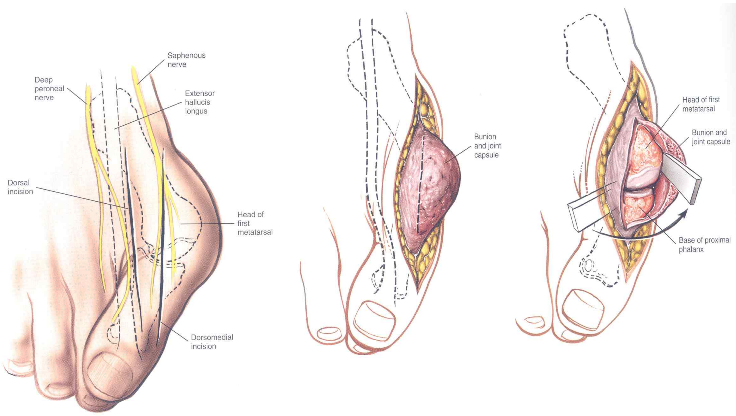
3.bunionectomy







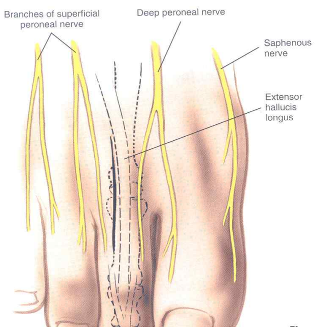
Dorsal Approach to MP joint of Great Toe

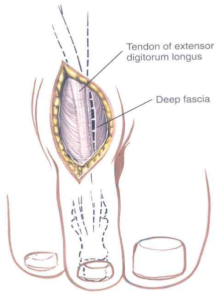


Dorsal Approach to MP joint of 2nd–5th Toes

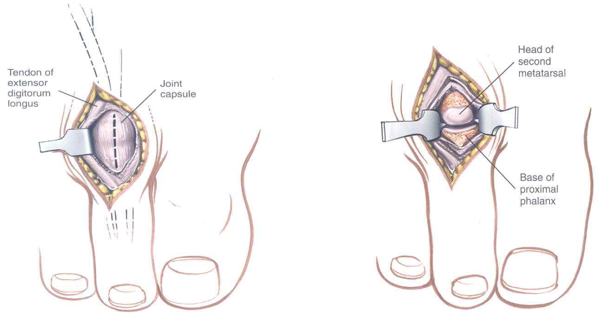
Ix> 1.metatarsal head excision

2. dorsal metatarsal osteotomy

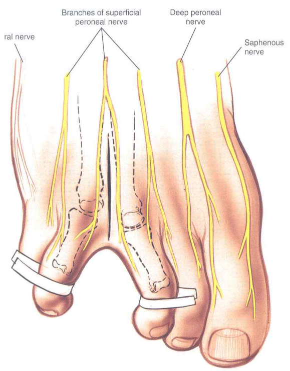


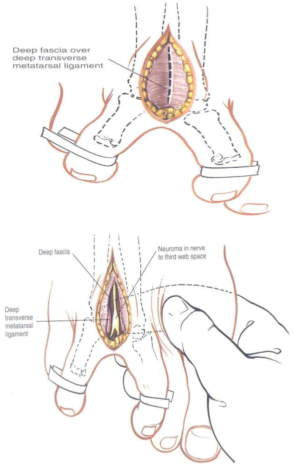


Dorsal Approach to MP joint of 2nd–5th Toes



Approach to Dorsal Web space



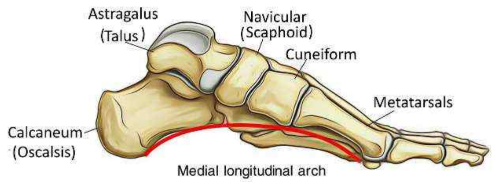


Flat foot

Date : 2023-05-26
R2. 김수영

Definition

- Flat foot = Pes planus
- Foot with no or very low medial longitudinal arch



Characteristics

- Hindfoot valgus
- Midfoot abduction at the midtarsal joint
- Forefoot pronation, primarily at the midtarsal joint

FIGURE 83.1 **A,** Patient with asymmetric pes planus. **B,** Talus slides distally, medially, and plantarward with loss of posterior tibial tendon and probable insufficiency of plantar calcaneonavicular ligament. **C,** Long-standing deformity. Achilles tendon contracture exacerbates heel valgus. **D,** In sitting position, when asked to hold foot in plantarflexion-inversion after being placed there passively by examiner, patient unconsciously used anterior tibial tendon. Also note increased supination (forefoot varus relative to longitudinal axis of calcaneus).

원인 및 병적 기전

- 발의 발달 과정
  - 출생 시 : 두꺼운 지방층, 관절의 과유연성으로 편평함
  - 2~3세 : 활발이 걷기 시작하면서 내측 세로 궁 발달
  - 4~5세 : 내측 세로 궁 자발적 형성

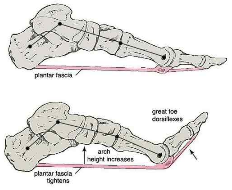
  **5~20% 성인될 때 까지 편평족으로 남는다

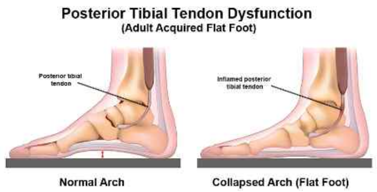
- 원인
  - 대부분 알 수 없다
  - 소아 : 족근골 결합, 부 주상골, 선천성 수직 거골, 대부분 flexible
  - 성인 : 어릴때 발생한 편평족 변형이 남은 경우
    외상 후 변형, 후 경골 건 기능 부전, 류마티스 관절염, 아킬레스건 단축, 소아마비, 중추신경계 손상, 신경근육성 질환, 당뇨에 의한 신경성 관절증

Classification

세로 궁의 유연성에 따라

- 유연성 (flexible) : 체중 부하 시 세로 궁이 소실되지만 제 1족지 배굴시킬 때 감아올림 기전(windlass mechanism) → 세로 궁 형성
  : Functioning posterior tibial tendon
- 강직성 (rigid) : 체중 부하와 관계없이 항상 족저부가 편평함





Symptoms & Diagnosis

- Inspection
  - Hindfoot valgus
  - Midfoot abduction at the midtarsal joint
  - Forefoot pronation, primarily at the midtarsal joint
  - Loss of medial longitudinal arch
- Foot & ankle fatigue
- Pain : medial at first but localizes laterally
  - Anterior surface of the lateral process of the talus impinges on the floor of the sinus tarsi

Symptoms & Diagnosis

- **Single heel rise test**
- Examiner should have the patient toe-stand while holding on to the examiner or the examining table for balance only and not support
- Gradually rising on only the affected foot to the tip-toe position
- Inverting the heel at the end stage without concomitant external support is not possible for a patient with complete loss of continuity of the tendon

Radiologic findings

- Weight bearing x-rays
- Foot series , ankle series
- CT
- MRI

- In a normal foot : the talus–first metatarsal angle is 0 to 10 degrees on a standing lateral view : An increased angle indicates loss of the medial longitudinal arch
- Overlapping metatarsals or loss of height of the medial cuneiform also indicates depression of the medial longitudinal arch
- Loss of the calcaneal pitch angle : indicate both loss of the longitudinal arch and contracture of the gastrocsoleus complex
- The standing lateral tibial-calcaneal angle has been found to be significantly increased in adults with flatfeet and Achilles tendon contracture

FIGURE 83.6 Measurement of standing lateral tibial-calcaneal angle (see text). (From Arangio GA, Wasser T, Rogman A: The use of standing lateral tibial-calcaneal angle as a quantitative measurement of Achilles tendon contracture in adult acquired flatfoot, *Foot Ankle Int* 27:685, 2006.)

FIGURE 83.7 Incongruency angle is determined by drawing line joining lateral extent of talar articular surface *(point A)* and lateral extent of navicular surface *(point B)*. Second line is drawn between lateral aspect of talar neck at its narrowest segment *(point C)* and lateral extent of talar articular surface *(point A)*. Distal and lateral interval between these two lines forms incongruency angle. **A,** Incongruency angle in normal foot. **B,** Incongruency angle in type IIb flatfoot deformity. (From Ellis SJ, Yu JC, Williams BR, et al: New radiographic parameters assessing forefoot abduction in the adult acquired flatfoot deformity, *Foot Ankle Int* 30:1168, 2009.)

FIGURE 83.8 Depiction of hindfoot alignment angle measurements taken on a patient with flatfoot **(A)** and normal control patient **(B)**. (From Williamson ERC, Chan JY, Burket JC, et al: New radiographic parameter assessing hindfoot alignment in stage II adult-acquired flatfoot deformity, *Foot Ankle Int* 36:417, 2015.)

MRI

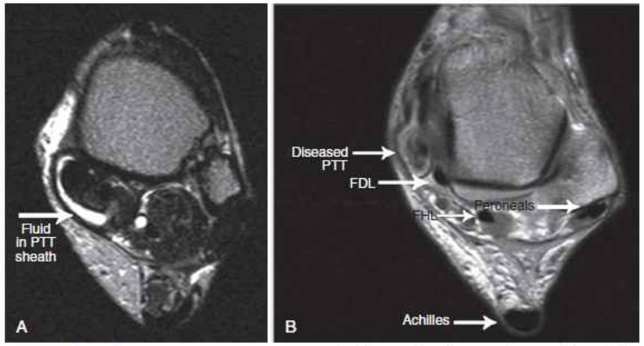


FIGURE 83.9 Magnetic resonance imaging is helpful to identify peritendinous effusion (A) and degeneration within the tendon (B).

Treatment

– 3~4세 : 치료 불필요
– 3~9세 : 경과관찰
– 10~14세 : 증상 있을 시 원인에 따라 수술 고려 가능

증상이 없는 경우는 교정신발, 내재근 강화 운동

치료

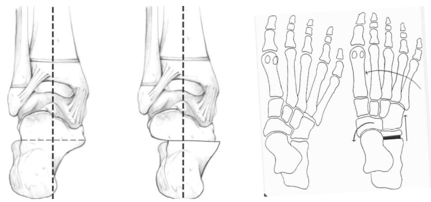
- 증상이 있는 유연성 편평족

보존적 치료 : 주상골패드 착용, 정형화된 보조기(UCBL)

치료

- 증상이 있는 유연성 편평족

수술적 치료 :
– 종골 내측 전위 골절술(medial sliding calcaneal osteotomy)
  : 종골 결절을 내측으로 이동시켜 체중 부하의 축을 재정렬
– Evans의 종골 연장술(lateral column legthening osteotomy)
  : 거골하 관절의 전방과 중간 소관절 사이에서 절골술
– 관절 유합술
  : 변형 교정에 효과적이나 인접 관절의 퇴행성 관절염 발생 등의 문제



치료

- 강직성 편평족 : PTT insufficiency
  - 관절염과 변형을 동반한 경우 많다
  - 관절 유합술(삼중 관절 유합술) 많이 사용

TABLE II Myerson Modification of Johnson and Strom Classification of Adult-Acquired Flatfoot Deformity

Stage	Description
I	Mild medial pain and swelling with no deformity, can perform heel-rise test but demonstrates weakness on repetition, tenosynovitis on pathology with normal tendon length
II	Moderate pain with or without lateral pain, flexible deformity, unable to perform heel-rise test, elongated tendon with longitudinal tears
IIA	<30% talar head uncoverage
IIB	>30% talar head uncoverage
III	Severe pain, fixed deformity, unable to perform heel-rise test, visible tears on pathology
IV	Lateral talar tilt
IVA	Flexible ankle valgus without severe arthritis
IVB	Fixed ankle valgus with or without arthritis

치료

- 보존적 치료
  - 1기, 2기는 깔창사용, 6~8주간 부목고성
  - 재활운동(비골건의 강화운동, 아킬레스 건 신연 운동)

- 수술적 치료
  - 1기 : 후경골 건 부전 : 경골 건의 할액막 절제술 (tenosynovectomy)
  - 2A : 종골 내측 전위 절골술
  - 2B : 외측 주 연장술 (controversal)
  - 3기 : 관절 유합술(Triple arthrodesis)
  - 4기 : 인공관절 전치환술 혹은 관절 유합술

1. 14세 남아로 족부의 통증과 변형을 주수로 내원하였다. 환아는 주상골 부위 통증으로 2개월간 보조기 착용을 한 과거력이 있었다. 단순 방사선 사진에서 주상골 부위에 0.6cm 크기의 부골이 있었으며 이부위의 통증을 호소하였다. 이 환아의 치료로 가장 적절한 것은? 20B/16B

㉮ 부주상골 제거술 + 후경골 근건 재고정술
㉯ 부주상골 제거술
㉰ 경과관찰
㉱ 보조기 치료 지속
㉲ 부주상골 유합술

2022 ELITE OS BOARD GUIDE Vol. VII (족부) 89

1. 14세 남아로 족부의 통증과 변형을 주수로 내원하였다. 환아는 주상골 부위 통증으로 2개월간 보조기 착용을 한 과거력이 있었다. 단순 방사선 사진에서 주상골 부위에 0.6cm 크기의 부골이 있었으며 이부위의 통증을 호소하였다. 이 환아의 치료로 가장 적절한 것은? 20B/16B

㉮ 부주상골 제거술 + 후경골 근건 재고정술
㉯ 부주상골 제거술
㉰ 경과관찰
㉱ 보조기 치료 지속
㉲ 부주상골 유합술

Lower cervical injury classification & treatment

명지병원 정형외과
R2. 우창우

Lower cervical spine injury

- 척추의 손상 → 관찰되는 골절 그 자체로서보다는 해당 운동 분절의 인대 손상을 나타내주는 의미가 크다.
- 경추의 손상은 대부분 간접적 외력에 의하여 발생한다.
  - 외상이 가해지는 방향과 자세에 따라 점차 진행되어 일정한 양상의 손상에 이른다.

Lower cervical spine injury

- Instability
  - Horizontal translation
  : lateral flexion – extension view 상 3.5mm 이상의 translation

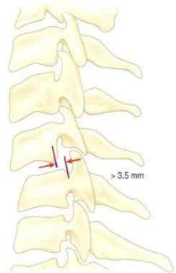
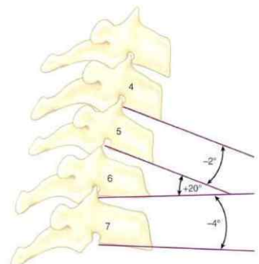


FIGURE 41.27 Sagittal plane translation of more than 3.5 mm suggests clinical instability. (Redrawn from White AA, Johnson RM, Panjabi MM: Biomechanical analysis of clinical stability in the cervical spine, *Clin Orthop Relat Res* 109:85, 1975.)

Lower cervical spine injury

- Instability
  - Horizontal translation
  : 11도 이상의 angulation of one vertebra to another



$$\left.\begin{array}{r}\text{Abnormal}\\ \text{angle}\end{array}\right\}\begin{array}{l}= 20 - (-2) = 22\\ = 20 - (-4) = 24\end{array}\Big\} > 11^\circ$$

FIGURE 41.28 Significant sagittal plane rotation (>11 degrees) suggests instability. (Redrawn from White AA, Johnson RM, Panjabi MM: Biomechanical analysis of clinical stability in the cervical spine, *Clin Orthop Relat Res* 109:85, 1975.)

Lower cervical injury classification

- Stretch test
  - Used for determining clinical instability in lower cervical spine
  - Contraindicated in obviously unstable injury
  - Consistent feedback for neurological examination

  - Apply traction through gardner well tong
  - Lat. X-ray check
  - Initial 10 pound / add 3-5 pound
  - Check neurologic status

BOX 8-16 End Points for Stretch Test

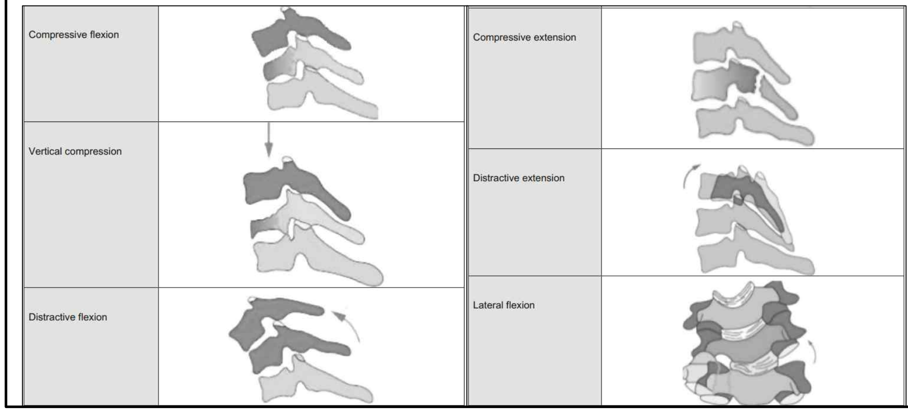
- Change in neurological status
- Increase of 1.7 mm between adjacent vertebral at any level
- Angulatory change of 7.5 degrees at any disc level
- Reaching one third of body weight or weight limit for tongs, whichever is less

Lower cervical injury classification

- Allen & Ferguson's classification
  - 6가지로 분류
  - 손상의 기전과 구조물 예측하는데 도움이 되나,
    많은 경우 정확한 정의에 맞지 않는 경우가 있다.

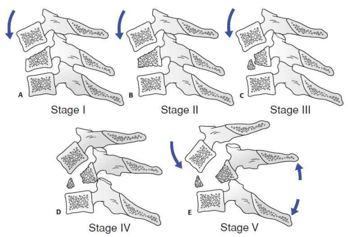
- Subaxial Injury Classification (SLIC) scoring system
  - 최근 사용되는 classification scoring system

Allen & Ferguson's lower cervical injury classification



Allen & Ferguson's lower cervical injury classification

<Compression flexion injuries>



- CF stage 1: Blunting of the anterosuperior vertebral body margin.

- CF stage 2: Beak appearance of the anterosuperior vertebral body margin; a sagittal vertebral body split may also be present.

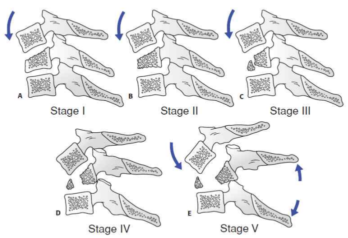
→ 전방 추체의 구조적 안정성이 유지되면서 후방 인대군의 손상이 없는 안정 손상

→ 8-12주간 경성 경추 보조기 or Halo vest

→ 고정을 제거한 후 불안정성 (+) : 후방 고정술

Allen & Ferguson's lower cervical injury classification

<Compression flexion injuries>

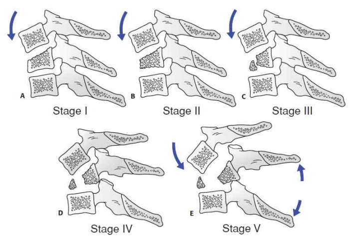


• CF stage 3: Oblique primary fracture line that extends from the anterior vertebral body to the inferior endplate. (This has been subsequently described by other authors as a so-called teardrop fracture.)

→ 잠재적 불안정 손상이 있어 MRI
  → 후방 인대군 손상 (-) : Halo vest
  → 후방 인대군 손상 (+) : 후방 유합술
→ 신경손상 있으면 전방 감압술 및 고정술

Allen & Ferguson's lower cervical injury classification

<Compression flexion injuries>

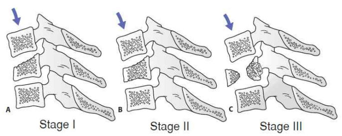


• CF stage 4: In addition to stage 3 features, posterior translation of the upper vertebra measuring less than 3 mm.
→ 신경손상 (-) : 후방 고정술
→ 신경손상 (+) : 전방 감압술 및 고정술
→ 후방인대군 손상 심할 경우 후방 고정술 및 유합술 추가

• CF stage 5: Posterior translation of the upper vertebra measuring 3 mm or more, facet gapping indicating anterior and posterior ligamentous injury.
→ 전방 감압술 및 고정술 + 후방 고정술 및 유합술

Allen & Ferguson's lower cervical injury classification

<Vertical compressive injuries>



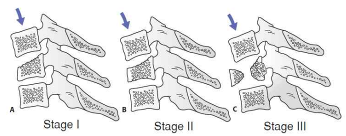
• VC stage 1: Central superior or inferior endplate fracture.

• VC stage 2: Superior and inferior endplate fractures, sometimes with vertebral body fracture lines that give the appearance of a quadrangular fracture fragment.

→ ant. column의 부분적 손상
→ 후방 인대군 손상 (-)
→ 6-8주간 경성 경추 보조기

Allen & Ferguson's lower cervical injury classification

<Vertical compressive injuries>

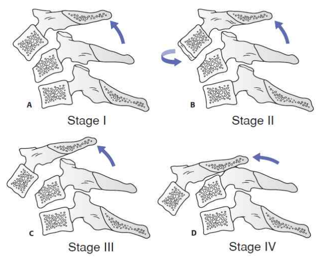


• VC stage 3: Vertebral body comminution, with or without retropulsion of fragments, with or without kyphotic (late flexion type), or translational (late extension type) deformity.

→ ant. column의 붕괴 및 후방 인대군 손상 (+)
→ 신경 손상 (-) :
  전방 감압술 및 고정술 or 후방 고정술 및 유합술
→ 신경 손상 (+) :
  전방 감압술 및 고정술 + 후방 고정술 및 유합술

Allen & Ferguson's lower cervical injury classification

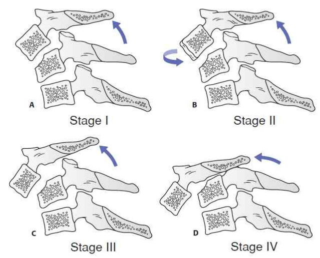
<Distractive flexion injuries>



- m/c type
- 의식 (+) & 전신 상태 안정적 : closed reduction
- 의식 (-) : closed reduction 금기
  - 54~80% 급성 추간판 탈출증이 동반되어 있음
  - MRI 먼저 시행하여 추간판 탈출 없는 경우 C/R
  - 추간판 탈출 있을경우 전방도달법을 이용하여 탈출된 추간판 제거 후 관혈적 정복술 시행

Allen & Ferguson's lower cervical injury classification

<Distractive flexion injuries>



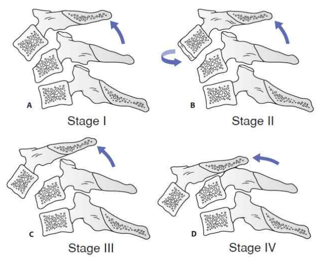
• DF stage 1: Facet subluxation, gapping of the spinous processes, indicating failure of the PLC, with or without blunting of the anterosuperior vertebral body

• DF stage 2: Unilateral facet dislocation, usually PLC is intact, rotational deformity.

→ Reduction 후 경성 경추 보조기 or Halo vest (8-12wks)
→ 고정을 제거한 후 불안정성 (+) :
전방 유합술 or 후방 극돌기간 고정술 및 유합술

Allen & Ferguson's lower cervical injury classification

<Distractive flexion injuries>



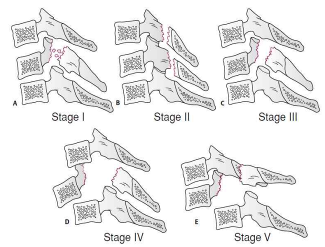
• DF stage 3: Bilateral facet dislocations, 50% translation of the upper vertebral body over the lower vertebral body.

• DF stage 4: 100% translation of the upper vertebral body over the lower vertebral body. (Appearance of a so-called floating vertebra.)

- 신경 손상 (-) : 후방 유합술
- 추간판 탈출 or 신경 손상 (+) : 전방 추간판 제거술 및 유합술
- C/R 실패한 경우 : 후관절 절제술 후 후방 유합술
- 전위 정도 및 인대 손상 정도 고려하여 전/후방 유합술 병행

Allen & Ferguson's lower cervical injury classification

<Compressive extension injuries>



• CE stage 1: Posterior arch fracture that may be a facet, pedicle, or lamina fracture, with or without rotation that can result in mild anterior translation. (These are more commonly referred to as lateral mass fractures.)

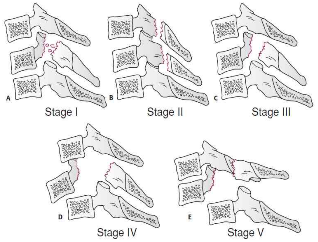
Transverse facet appearance : pedicle + articular process Fx.

• CE stage 2: Bilateral lamina fractures can occur at multiple levels.

→ 경성 경추 보조기 or Halo vest (8-12 잔)

Allen & Ferguson's lower cervical injury classification

<Compressive extension injuries>



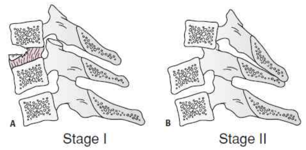
• CE stage 3: Bilateral lamina, facet, and pedicle fractures without vertebral body displacement. This injury is more often described as a floating lateral mass fracture.

• CE stage 4: As for CF stage 3, with partial anterior vertebral body displacement.
→ 후방 구조물 골절이 있어 강선을 이용한 후방 고정술 불가능
→ Lat. mass screw 또는 Pedicle screw 고정술 및 유합술
→ Lat. Mass 또는 Pedicle에 골절 있는 경우 원칙적으로 전방 연 부조직의 파열이 있어 전방 고정술을 시행

• CE stage 5: As for CE stage 3, with 100% anterior vertebral body displacement.
→ 전/후방 구조물 모두 손상 있어 전/후방 유합술 및 고정술
→ 전위된 추체 사이의 추간판 제거술 후 금속판을 이용한 전방 고정술 시행하고 추가적인 후방 lat. mass screw 고정

Allen & Ferguson's lower cervical injury classification

<Distractive extension injures>



• DE stage 1: Abnormal widening of the disc space may be associated with avulsion fractures of the anterior vertebral body margin. No evidence of posterior translation.

→ MRI 또는 Flexion-Extension 상에서 전방 인대군 손상 (-) : 경성 경추 보조기 or Halo vest (8-12wks)
→ 고정을 제거한 후 불안정성 (+) : 전방 유합술 및 고정술

• DE stage 2: DF stage 1 with posterior translation.

→ 전후방 구조물 모두 손상 (+) : 전후방 고정술

Allen & Ferguson's lower cervical injury classification

<Lateral flexion injures>

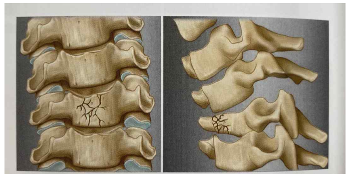


그림 54. 측굴곡 손상의 두 단계.

• LF stage 1: Unilateral uncovertebral fracture or asymmetric vertebral body compression.

• LF stage 2: Vertebral body, or posterior arch fractures, with lateral translation or unilateral facet gapping, coronal angular deformity is noted on an AP radiograph or coronal CT scan.

→ 골견인을 통해 정복을 한 후 halo vest
→ 정복의 유지가 어렵거나 각 변형 등 진행성 병변이 오는 경우 전방 추체 제거술 및 고정술

Subaxial Injury Classification (SLIC) scoring system

Subaxial Injury Classification (SLIC) Scale

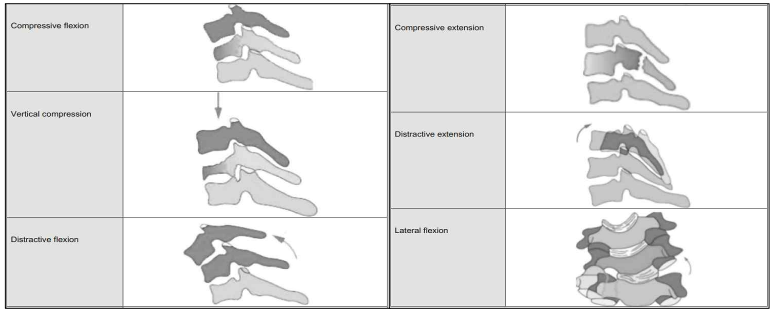
	POINTS
MORPHOLOGY	
No abnormality	0
Compression + burst	1+1 = 2
Distraction (e.g., facet perch, hyperextension)	3
Rotation or translation (e.g., facet dislocation, unstable teardrop, or advanced stage flexion compression injury)	4
DISCOLIGAMENTOUS COMPLEX	
Intact	0
Indeterminate (e.g., isolated interspinous widening, magnetic resonance imaging signal change only)	1
Disrupted (e.g., widening of anterior disc space, facet perch, or dislocation)	2
NEUROLOGIC STATUS	
Intact	0
Root injury	1
Compete cord injury	2
Incomplete cord injury	3
Continuous cord compression (neuro-modifier in the setting of a neurologic deficit)	+1

From Dorak M, Fisher CG, Fehlings MG, et al: The surgical approach to subaxial cervical spine injuries, Spine 32:2620, 2007.

• 점수가 높을수록 심한 손상
• 기존의 분류법에 비하여 신경학적 손상의 정도와 불안정성을 반영하여 점수화
• 4점 미만 = 비수술적 치료
• 4점 이상 = 외과적 감압술 및 고정술 고려

Take home message

<Allen & Ferguson's subaxial cervical spine injury classification>



Subaxial Injury Classification (SLIC) scoring system

Subaxial Injury Classification (SLIC) Scale	
	POINTS
MORPHOLOGY	
No abnormality	0
Compression + burst	1+1 = 2
Distraction (e.g., facet perch, hyperextension)	3
Rotation or translation (e.g., facet dislocation, unstable teardrop, or advanced stage flexion compression injury)	4
DISCOLIGAMENTOUS COMPLEX	
Intact	0
Indeterminate (e.g., isolated interspinous widening, magnetic resonance imaging signal change only)	1
Disrupted (e.g., widening of anterior disc space, facet perch, or dislocation)	2
NEUROLOGIC STATUS	
Intact	0
Root injury	1
Compete cord injury	2
Incomplete cord injury	3
Continuous cord compression (neuro-modifier in the setting of a neurologic deficit)	+1

From Dorak M, Fisher CG, Fehlings MG, et al: The surgical approach to subaxial cervical spine injuries, Spine 32:2620, 2007.

4점 미만 = 비수술적 치료

4점 이상 = 외과적 감압술 및 고정술 고려

COLLATERAL LIGAMENT FUNCTIONAL ANATOMY, INJURY MECHANISM & DIAGNOSIS

명지병원 정형외과
R1. 정 승 호

MEDIAL LIGAMENTOUS INJURIES OF THE KNEE

STRUCTURES FOR MEDIAL STABILITY

Static structure

- Superficial medial collateral ligament (sMCL)
- Deep medial collateral ligament (dMCL)
- Posterior oblique ligament (POL)
  - Posteromedial capsule

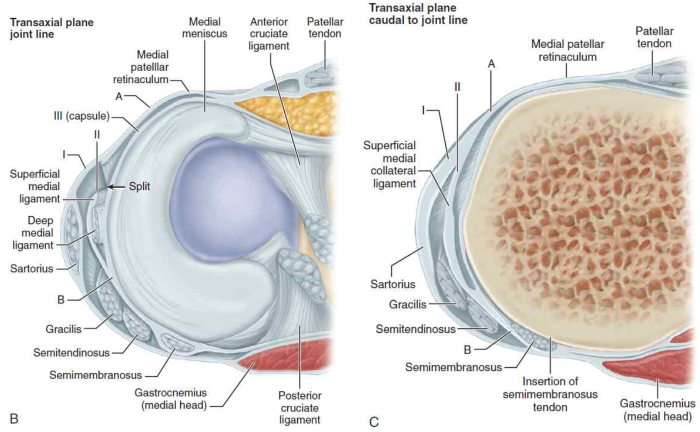
Dynamic structure

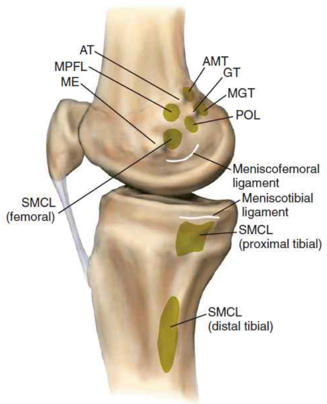
- Semimembranosus tendon

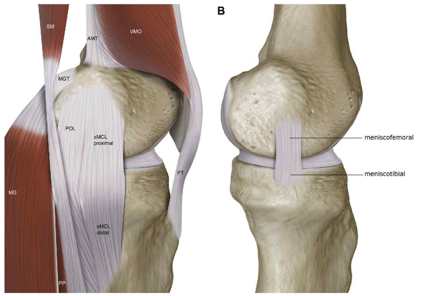
ANATOMY

- Medial side of the knee
  - a spatial concept of three distinct layers
  - Layer 1
    - Crural fascia of the knee
      - Present from the patella anteriorly to the popliteal fossa posteriorly
    - Sartorius fascia
      - Blends with the crural fascia anteriorly as it attaches to the tibia
    - The gracilis (G) and semitendinosus tendons
      - Between layers 1 and 2

- Medial side of the knee
  - Layer 2
    - Superficial medial collateral ligament (SMCL)
      - 3.2 mm proximal and 4.8 mm posterior to the medial epicondyle
      - Two division of tibial attachment
  - Layer 3
    - Consists of the knee joint capsule
    - Deep medial collateral ligament (dMCL)
      - Distinct component of the capsule deep to the SMCL
      - Meniscofemoral and meniscotibial attachment
    - Posterior oblique ligament (POL)
      - Thickening of the posterior medial capsule in this region
      - Importance in medial stability
      - Attaches proximal and posterior to the attachment site of the SMCL
      - Have 3 portion
        - Superficial, central, and capsular arm







...ial and posteromedial ligament anatomy of the knee. (A) superficial and (B) deep. AMT, adductor magnus tendo...

BIOMECHANICS

- Robinson et al
  - Anterior aspect of the sMCL
    - Remained taught throughout motion
  - pMCL
    - Consistently loosened in flexion
    - Tightened in full extension and internal rotation
- Griffith et al
  - Both divisions of the sMCL
    - Primary restraints to valgus load and external rotation
    - Degree of knee flexion affecting the load response
  - POL
    - Restraint to <u>internal rotation</u> and <u>valgus</u>
    - Approaching full extension

BIOMECHANICS

- Proximal division of the sMCL
  - Primary stabilizer to valgus stress
- Distal division of the sMCL
  - Primary stabilizer to external rotation at 30 degrees of flexion
- **Single functional unit**
  - **sMCL**
    - Primary restraint to valgus and internal rotation (at all flexion angle)
    - External rotation at 30 degrees of flexion
  - **POL**
    - Primary restraints to internal rotation
  - dMCL
    - Contribution to flexion dependent internal rotation stability

INJURY MECHANISM

4 mechanism

① Abduction + flexion + internal rotation of the femur

② Adduction + flexion + external rotation of the femur

③ Hyperextension

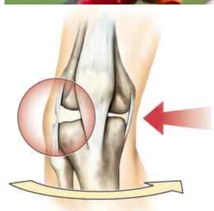
④ Anteroposterior displacement

① Abduction + flexion + internal rotation of the femur

- **Most common mechanism**
  - Femur is rotated internally by the shift of the body weight
    - Injury on the medial side of the knee
      - Medial collateral ligament
      - Medial capsular ligament
  - Medial meniscus may be trapped between the condyles of the femur and the tibia
  - The unhappy triad of O'Donoghue

② Adduction + flexion + external rotation of the femur

- **Much less common**
- **Produces the primary disruption laterally**
  - Lateral collateral ligament usually disrupted initially
    - Capsular ligaments
    - Arcuate ligament complex
    - Popliteus
    - Iliotibial band
    - Biceps femoris
    - Common peroneal nerve



DIAGNOSIS

- History
  - Describe the injury by patient
  - Isolated MCL injuries occur
    - Valgus moment across a flexed knee
  - Rotational mechanisms
    - more commonly result in multiple ligament damage
- Physical exam
  - Inspection of knee alignment & soft tissue envelope
  - Localized swelling or hemathrosis
  - Neurovascular status
  - Pain along the expanse of the ligament
  - Standard cruciate exam
  - *Evaluation of the lateral structures*

DIAGNOSIS

- **Injury grade (valgus stress test)**
  - **The amount of joint line opening with valgus stress at 0 and 30 degrees**
  - Compared with uninjured knee
  - Grade I
    - less than 5 mm of increased opening
  - Grade II
    - 5 to 10 mm
  - Grade III
    - more than 10 mm
  - Placing a finger along the joint line
  - Comparing to the uninjured knee

DIAGNOSIS

- POL injury
  - Increased laxity in full extension
  - often indicates a combined ligament injury
    - most commonly an anterior cruciate ligament (ACL) tear
- Grade III MCL tears
  - 80% incidence of combined ligament injury
- Increased rotational motion
  - Suspicion of injury to PMC complex
    - Anteromedial rotatory instability : MCL & POL injury

IMAGING

- Standard radiographs
  - AP, lateral, and sunrise patella views
  - Potential for fracture and to joint malalignment
  - Indicating multiligament injury
    - Widening of the joint space
    - non–weight-bearing films
  - The chronically injured knee
    - Weight-bearing radiographs
    - Rosenberg view to assess the amount of joint wear
  - Stress radiography
    - Quantify the amount of laxity compared with the uninjured knee
    - Confirm the diagnosis of a medial side injury

IMAGING

- Magnetic resonance
  - Invaluable tool to assess the
  - **Can define the location an**
  - Evaluation for meniscal lesic other ligaments
  - Ligament and meniscal dam
    - diagnostic sensitivity anc
  - Two or more structures were
    - values decreased to 88%
- Ultrasonography
  - Identify intact and injured me
  - Deep and superficial MCL, F

FIG 44.6 Coronal MRI of a distal MCL rupture.

LATERAL COLLATERAL LIGAMENT INJURIES

ANATOMY

Lateral collateral ligament (LCL)

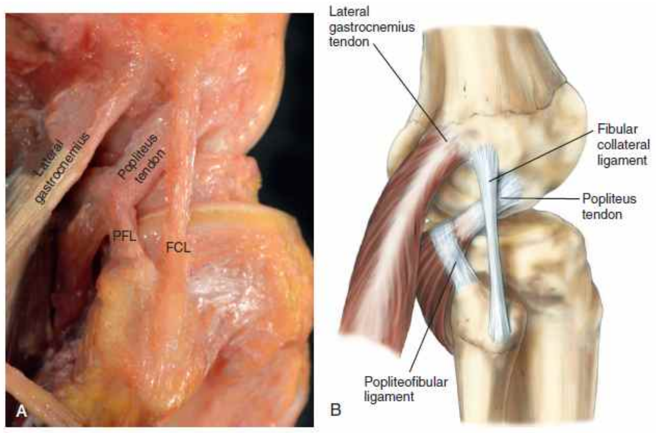
(1) Lateral collateral ligament

- Proximal : 1.4 mm proximal / 3.1mm Posterior to the lateral epicondyle
- Distal : 8.2 mm posterior to the anterior aspect of the fibular head
  : 28.4mm distal to the tip of the fibular styloid

(2) Function : Prime importance in stabilizing the knee against varus stress (with the knee in extension)

** As the knee goes into flexion

- Lateral collateral ligament becomes less influential as a varus-stabilizer



Popliteus tendon

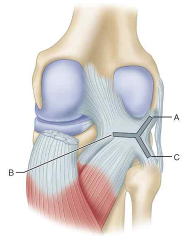


FIGURE 45-2 Popliteus muscle with its tripartite origin. Main tendon attached to lateral condyle of femur (A). Attachment to posterior horn of lateral meniscus (B). Attachment to fibular head (C).

(1) Three origin
- ① Lateral femoral condyle : the strongest
- ② Fibula : popliteofibular lig.
- ③ Posterior horn of LM

(2) Oblique Y-shaped ligament

(3) Function
- ① Prime medial rotator of the tibia during the initial stages of flexion
- ② Also acts to withdraw the meniscus during flexion
  ** lateral meniscus is mobile
- ③ Supplies rotary stability to the femur on the tibia

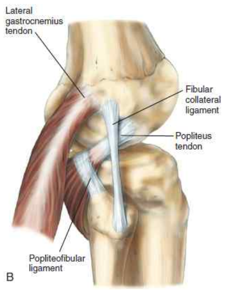
Popliteo-fibular ligament

(1) Connects the fibula to the femur through the **popliteal tendon**

(2) Originates from the posterior part of the fibula
& posterior to the biceps insertion

(3) Joins the popliteal tendon
- Just proximal to its musculotendinous junction

(4) Important in resisting
- Posterior translation
- Varus rotation
- External rotation (internal rotation of femur)



** Lateral three layer

(1) Layer I
- Iliotibial tract and its expansion anteriorly
- Superficial portion of the biceps femoris and its expansion posteriorly
- Peroneal nerve lies on the deep side of layer I

(2) Layer II
- Retinaculum of the quadriceps
- Patellofemoral ligaments
- Patellomeniscal ligament

(3) Layer III (deep layer of LCL)
- Capsule → outer edge of lateral meniscus(Coronary ligament)
- Popliteus tendon : passes through a hiatus
- Fabello-fibular ligament (superficial lamina)
- Arcuate ligament (deep lamina)

INJURY MECHANISM

Injury mechanism of LCL

- **Direct blow to the medial knee**
- Non contact hyperextension (less)
- Non contact varus stress injuries (less)

- 40% of PLC injurieis are sports-related injury
- Isolated PLC injuries : approximately 25%

DIAGNOSIS

- **History**
  - Details of the accident
  - Previous surgeries
  - Review of the patient's past history
- **Clinical symptom**
  - Pain
  - Subjective side to side instability
  - Difficulty with stairs or uneven ground
  - Swelling
  - Ecchymosis
  - Varus thrust gait
  - Peroneal nerve distribution / foot drop

DIAGNOSIS

Physical examination

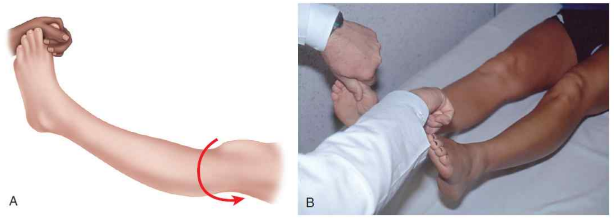
- **Varus stress test**
  - Knee position
    - Full extension
    - 30 degrees of flexion
  - Lateral knee joint line is palpated by the examiner's finger
    - The amount of lateral compartment gapping is assessed.
  - Interpretation
    - Opening of the lateral compartment
      - Knee flexed to 30 degrees
        - Isolated injury of the FCL
      - If the varus instability persists in full extension
        - Combined FCL, PLC, and cruciate ligament injury

- **Dial test**
  - Position : prone
    - Knee flexed to 30◦ & 90 ◦
  - External rotation of the tibia relative to the femur

  - Interpretation
    - More than 10 ◦ of external rotation compared with the uninvolved
    - Knee flexion 30 (+) + knee flexion 90 (-) : Isolated PLC injury
    - Knee flexion 30 (+) + knee flexion 90 (+) : PLC + PCL injury
    - * PCL : secondary stabilizer of external rotation

External Rotation recurvatum test

- Position
  - Supine position
  - Big toe is grasped and the leg lifted
    - Gentle pressure applied to the proximal knee
- Wide variation of the sensitivity of this test has been reported.
- ** Test for PCL, PLRI, LCL injury



Posterolateral drawer test

- Position : supine, 90 degrees knee flexion

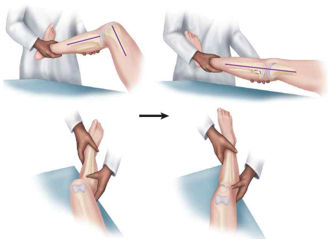
- Posteriorly directed force is applied
- Tibia in external rotation
- Increase in translation with external rotation
  - Suggests an injury to the PLC

Reverse pivot shift test

- Position : supine position , knee flexion 90 degrees

- Knee flexion 90 degrees with external rotation of tibia
- Valgus force
- Slowly extended with maintaining valgus stress
- Reduction of the tibia at 35-40 degrees of flexion

(+) : PCL, arcuate complex, LCL tear



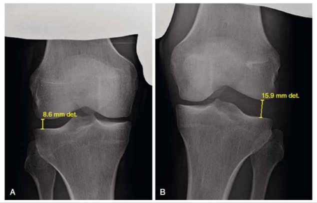
DIAGNOSIS

Plain radiographs

- Standing AP, Lateral, patellofemoral view
  - Ex) Presence of Segond fractures
    Tibial spine avulsions
    Fibular head fractures or avulsions (arcuate sign)

Stress radiograph

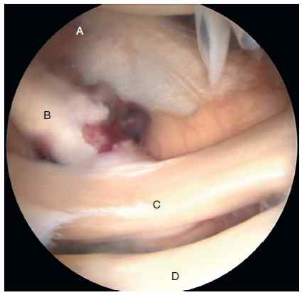
- **Varus stress radiograph**
  - Helpful to definitively characterize the severity and resultant laxity.
  - Contralateral radiograph should be obtained.
  - Sensitive and reproducible test
    - Laprade et al : cadevaric test revealed that



Magnetic resonance imaging (MRI)

- **Evaluating structures of the PLC**
  - Especially in acute injuries
- **Sensitive, specificity : over 90%**
  - Intra-articular structure : ACL, PCL, meniscus, cartilage
  - ITB / biceps femoris tendon / FCL
  - MRI is essential for evaluation of ligamentous injuries

Diagnostic arthroscopy



- **Intra and extra articular structures**
  - Popliteal tendon
  - Meniscofemoral ligament
  - Coronary ligament
  - Lateral meniscus
  - Meniscotibial ligament
- **Laprade et al '**
  - Grade III PLC injury : concomitant injuries are frequent
  - 63% ACL injury / 23 % PCL injuries / LM injury 22%

REFERENCE

13th edition, Campbell Vol.3 Chapter 45. Knee injuries. p.2156-2170

정형외과학 제 **7판,** 대한정형외과학회**, p.1034-1037**

Atlas Fractures & Transverse Ligament Injuries

명지병원 정형외과
R1. 정승호

Epidemiology

- Incidence
  - make up ~7% of cervical spine fractures
  - atlas fractures make up to 25% of the injuries of the craniovertebral junction
  - 1-3% of all spinal injuries
  - commonly missed due to inadequate imaging of occipitocervical junction

Epidemiology

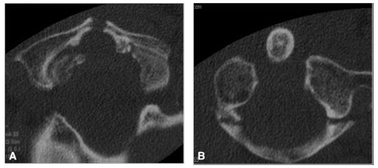
- Demographics
  - bimodal age distribution
    - early adulthood (20-30s)
      - high-energy axial loading mechanism
    - elderly
      - low-energy, ground-level fall
      - predisposed to injury from
        - osteoarthritic bone changes
        - limited mobility
        - gait imbalance

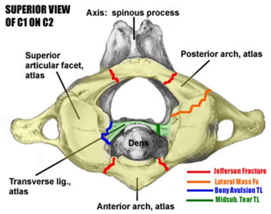
Etiology

- Associated conditions
  - spine fracture
    - 50% have an associated spine injury
    - 40% associated with axis fx
  - closed head injuries
  - neurologic injury
    - risk of neurologic injury is low
    - due to large space for the spinal cord at this level
    - injuries tend to increase the area available for spinal cord at C1

Landells Atlas Fractures Classification

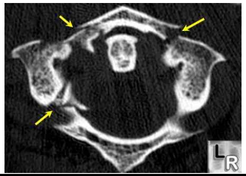
- Type 1
  - Isolated anterior or posterior arch fracture
  - Most common injury pattern
  - "Plough" fracture is an isolated anterior arch fracture caused by a force driving the odontoid through the anterior arch.
  - Stable injury
  - Treat with hard collar

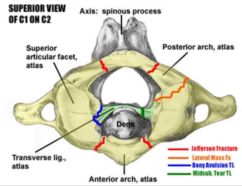




Landells Atlas Fractures Classification

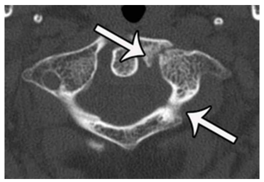
- Type 2
  - Jefferson burst fracture with bilateral fractures of anterior and posterior arch resulting from an axial load.
  - Stability determined by the integrity of transverse ligament.
  - If intact, treat with a hard collar.
  - If disrupted, halo vest (for bony avulsion) or C1-2 fusion (for intrasubstance tear)

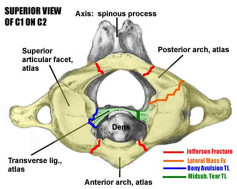




Landells Atlas Fractures Classification

- Type 3
  - Unilateral lateral mass fx.
  - Stability determined by the integrity of the transverse ligament.
  - If stable, treat with a hard collar.
  - If unstable, halo vest.

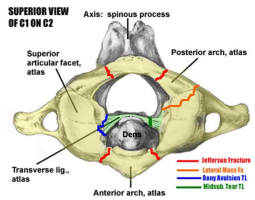




Dickman Transverse Ligament Injuries Classification

- Type 1
  - Intrasubstance tear.
  - Treat with C1-2 fusion.

- Type 2
  - Bony avulsion at tubercle on C1 lateral mass.
  - Treat with halo vest (successful in 75%)



Presentation

- History
  - high-energy injury
    - MVC
    - fall from ladder
  - ground level fall
    - elderly patients

Presentation

- Symptoms
  - neck pain
  - cervical spinal muscle spasms
  - limited neck motion
  - C2 nerualgia/palsy
    - occipital neuralgia
    - occipital numbess
    - occipital alopecia (rare)
  - vertebral artery dissection
    - loss of consciousness
    - double vision
    - vertigo

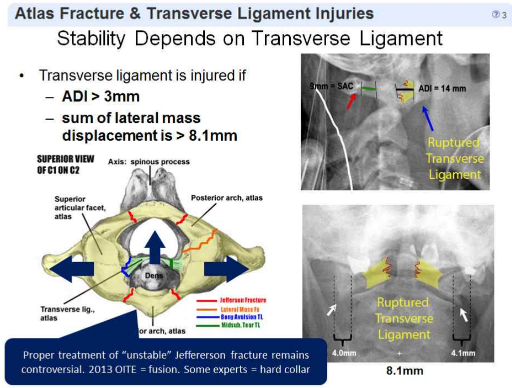
Presentation

- Physical exam
  - neuro deficits uncommon in isolated C1 fractures
  - vertebral artery injury
    - vertigo
    - diplopia
    - blindness
    - ataxia
    - bilateral weakness
    - dysphagia
    - nausea
  - C2 nerve palsy
    - decreased sensation in the occipital region
    - neck flexion and extension weakness

Imagaing

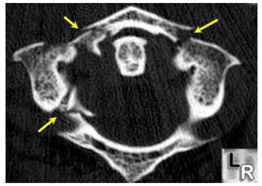
- Radiographs
  - lateral radiographs
    - atlantodens interval (ADI)
    - measured on lateral radiographs and flexion-extension views
    - < 3 mm = normal in adult (< 5mm normal in child)
    - 3-5 mm = injury to transverse ligament with intact alar and apical ligaments
    - > 5 mm = injury to transverse, alar ligament, and tectorial membrane
  - oblique radiographs
  - open-mouth odontoid
    - sum of lateral mass displacement (LMD)
    - if sum of lateral mass displacement is > 6.9 mm (rule of Spence) or 8.1mm with radiographic magnification (rule of Heller) then a transverse ligament rupture is assured and the injury pattern is considered unstable

Imagaing



Imagaing

- CT
  - fractures involving the anterior and posterior ring
  - lateral mass fractures
  - increased radial displacement of the C1 fracture fragments (unstable)
  - bone avulsion injuries of the tubercle (TAL insertion)
  - sagittal split fractures of the lateral mass



Imagaing

- MRI
  - TAL injuries
    - increased T2 signal intensity in the TAL on the sagittal and coronal views
  - spinal cord injury
    - edema
      - increased T2 signal intensity in the spinal cord
    - hematoma
      - depends on age of injury
  - prevertebral soft tissue swelling
    - increased prevertebral soft tissue T2 signal intensity at C1-2

Treatment

- Nonoperative
  - **hard collar vs. halo immobilization for 6-12 weeks**
    - indications
      - stable Type I fx (intact transverse ligament)
      - stable Jefferson fx (Type II) (intact transverse ligament)
      - stable Type III (intact transverse ligament)
      - Dickman type II TAL injuries

      - hard cervical collar
        - typically used in stable fracture patterns with intact transverse ligament
      - halo vest
        - typically used in the transverse ligament is compromised

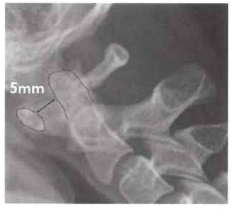
Treatment

- Operative
  - **posterior C1-C2 fusion / occipitocervical fusion**
    - indications
      - unstable Type II (controversial)
      - unstable Type III (controversial)
      - Dickman type I TAL injuries
      - combined C1 and C2 fractures

Treatment

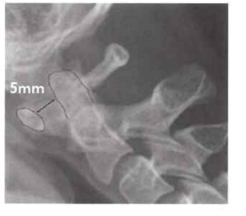
- Operative
  - **C1 internal fixation**
    - indications
      - C1 lateral mass split fractures (controversial)
    - preserves C1-2 motion
    - further randomized trials needed to ascertain role of this treatment

1. 제1경추 방출성 골절의 보존적 치료로 골절의 유합은 이루어졌으나, 경추부 굴곡 시 사지 마지 증세가 나타났다. 굴곡-신전 방사선 소견상 굴곡 시 다음과 같은 영상 검사 소견이 관찰되었다. 손상을 의심하여야 할 구조물을 고르시오. 21B2/09B2



㉮ 첨 인대(apical ligament)
㉯ 익 인대(alar ligament)
㉰ 횡 인대(transverse ligament)
㉱ 전종 인대(anterior longitudinal ligament)
㉲ 후종 인대(posterior longitudinal ligament)

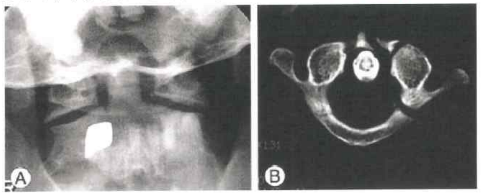
1. 제1경추 방출성 골절의 보존적 치료로 골절의 유합은 이루어졌으나, 경추부 굴곡 시 사지 마지 증세가 나타났다. 굴곡-신전 방사선 소견상 굴곡 시 다음과 같은 영상 검사 소견이 관찰되었다. 손상을 의심하여야 할 구조물을 고르시오. 21B2/09B2



㉮ 첨 인대(apical ligament)
㉯ 익 인대(alar ligament)
㉰ 횡 인대(transverse ligament)
㉱ 전종 인대(anterior longitudinal ligament)
㉲ 후종 인대(posterior longitudinal ligament)

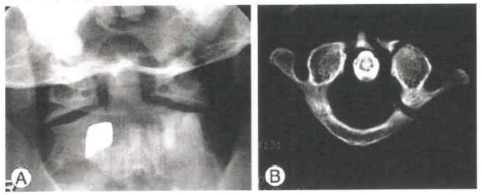
Acute traumatic rupture of transverse atlantal ligament의 방사선 소견
1) Neutral lateral view : Anterior ADI가 4mm 이상
2) Flexion lateral view : Anterior ADI가 5mm 이상
3) Open mouth view : lat. mass의 전위의 합이 7mm 이상

1. 외상 후 내원한 환자의 영상 검사 소견이다. 가장 적절한 치료는? 12B2/08B2



㉮ soft collar brace
㉯ Halo traction
㉰ Halo vest
㉱ Brooks and Jenkins fusion
㉲ Gallie fusion

1. 외상 후 내원한 환자의 영상 검사 소견이다. 가장 적절한 치료는? 12B2/08B2



㉮ soft collar brace
㉯ Halo traction
㉰ Halo vest
㉱ Brooks and Jenkins fusion
㉲ Gallie fusion

환자의 problem
- 일측성으로 발생한 환추 전궁 및 후궁 골절
- 엄밀한 의미에서 전궁 과 후궁에 각각 2개의 골절선이 없으므로 Jefferson 골절이라 할 수 없으나 mechanical significance는 동일하며 치료 원칙은 같다
- lat. mass 전위가 되지 않은 stable Fx.
-> 경성 경추 보조기 또는 halo vest (8-12wks)

2023 Intraining 문제풀이

32.

- 3세 7개월 Scoliosis 아이, cobb's angle 82도 VEPTR, GR insertion시행한상태로 전후방 교정술 및 석고 고정술에 비해서 장점?

1. 반복적인 수술
2. 신경 증상 감소
3. 폐기능 악화 방지
4. 변형 지속 방지
5. Crankshaft Effect 방지

마) 성장형 금속봉 및 확장 흉곽 성형술
(Growing rod and expansion thoracoplasty)

조기 유합 수술에 따른 척추와 흉곽 성장의 제한 및 폐기능 발달의 저하를 피하고자 척추와 흉곽의 성장을 유지 할 수 있는 성장형 금속봉과 인공확장형 금속 늑골을 이용한 수술을 시행할 수 있다. 인공확장형 금속 늑골은 선천성 척추측만증에 동반된 흉곽 발육의 저하로 폐기능 저하나 흉곽 부전 증후군(thoracic insufficiency syndrome)이 동반된 환아에서 유용하다. 그러나 인공 확장형 늑골은 환아의 척추 크기에 비하여 내고정 기구가 커서 피부 문제를 일으키기도 하고 흉곽 출구 증후군을 일으키기도 한다.

33.

- Pelvic incidence 는 일생동안 변하지 않은 값으로 알려져있다. 다만 다음과 같은 수술을 진행하는 경우(L1-5 fusion) pelvic incidence 가 증가하는 것으로 알려져 있다. 이에 대한 원인으로 올바른 것은?

1. 골반의 후굴
2. 대퇴골의 전방 아탈구
3. 요추5번-천추1번 간의 추간판 전단력
4. 요추5번-천추1번 간의 후관절 전단력
5. 천장관절의 전단력

Clinical Trial > Eur Spine J. 2016 Nov;25(11):3707-3714. doi: 10.1007/s00586-015-4199-0.
Epub 2015 Aug 20.

Is pelvic incidence a constant, as everyone knows? Changes of pelvic incidence in surgically corrected adult sagittal deformity

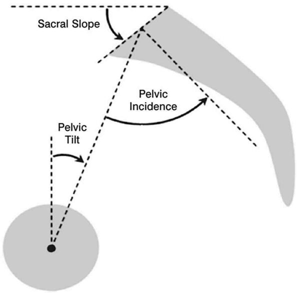
Jung-Hee Lee [1], Ki-Ho Na [2], Jin-Hyok Kim [3], Ho-Yeon Jeong [1], Dong-Gune Chang [4]

Affiliations + expand

PMID: 26289634 DOI: 10.1007/s00586-015-4199-0

Abstract

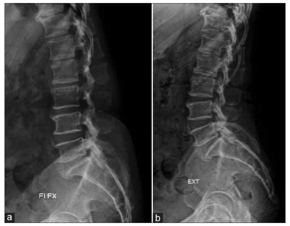
Purpose: Previous investigations have recognized the critical role of pelvic parameters in the setting of a fixed sagittal deformity. Pelvic incidence (PI) is a constant, as everyone knows. However, PI might change reciprocally because of increased shear force on the sacroiliac joint, following surgical correction of fixed lumbar lordosis (LL). The disparity in PI after surgery according to the surgical method, and its impact on final follow-up, has not been reported. This study was undertaken to analyze the disparity of PI before and after surgery, and to evaluate its impact on final sagittal alignment in surgically corrected lordosis when there is immediate postoperative normal alignment following correction of adult sagittal deformity.



34.

- 80세 환자, 6개월 전부터 양측 하지 통증 및 우측 하지 위약감, 1개월 전부터 대소변 장애 발생하였다. 굴곡 방사선 검사(no instability)와 MR(L2-3-4-5 central stenosis) 소견이 다음과 같을 때 적절한 처치는?

1. 경막외 스테로이드 주사
2. 사측방 요추체간 유합술 및 경피적 고정술
3. 신경성형술
4. 약물치료
5. 후방감압술



- Instability
  - Horizontal translation
  : lateral flexion – extension view 상 3.5mm 이상의 translation

- Instability
  - Horizontal translation
  : 11도 이상의 angulation of one vertebra to another

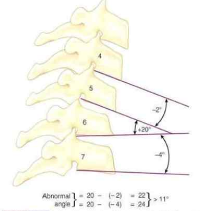


FIGURE 41.28 Significant sagittal plane rotation (>11 degrees) suggests instability. (Redrawn from White AA, Johnson RM, Panjabi MM: Biomechanical analysis of clinical stability in the cervical spine, *Clin Orthop Relat Res* 109:85, 1975.)

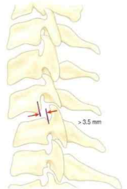


FIGURE 41.27 Sagittal plane translation of more than 3.5 mm suggests clinical instability. (Redrawn from White AA, Johnson RM, Panjabi MM: Biomechanical analysis of clinical stability in the cervical spine, *Clin Orthop Relat Res* 109:85, 1975.)

2) Operative treatment

(1) 수술 Ix (대정)
① 보존적 치료에도 불구하고 악화되어 참을 수 없는 통증
② 회복되지 않아 심한 일상생활 및 보행장애가 있는 경우
③ 마미신경총 증후군과 같은 심각한 신경마비를 초래한 경우 (즉각적인 수술)

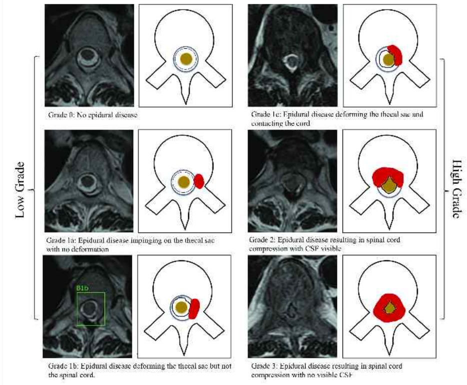
(2) Principles of spinal stenosis surgery
- decompression by laminectomy or a fenestration procedure
: TOC for lumbar spinal stenosis

(3) fusion이 필요 없는 경우
① elderly pt.
② already decreased activity level
③ disc space narrowing at the operated level
④ an absence of motion at this level preoperatively

(4) fusion이 필요한 경우
① 60세 미만 c instability by loss of articular process on one side
② 55세 미만 c midline decompression for deg. SPLT
③ 50세 미만 c isthmic SPLT
④ 한쪽 facet를 제거하거나 양쪽 facet의 50%이상 제거한 경우

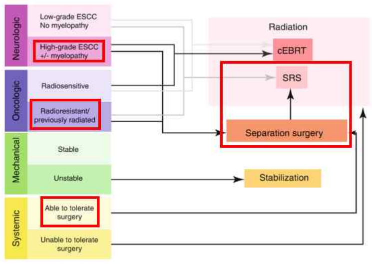
35.

- 신장암 있는 74세 환자 di
  부터 하지근력 약화되었습
  적절한 치료는?



1. 고식적 방사선치료
2. 정위적 방사선치료
3. 척추전절제술
4. 경피적 후방고정술
5. seperation surgery 후 정위적 방사선 치료

NOMS framework

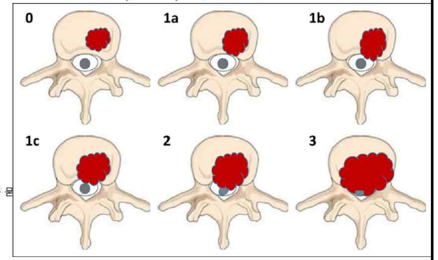


(해설)
74세 renal cancer 환자의 spine metastasis에서 NOMS framewor에 따른 치료 방법 결정을 묻는 문제.
Neurologic - 3일 전부터 하지 근력 약화 / 제시된 MRI 상 cord compression 된 소견으로
high-grade ESCC + myelopathy
Oncologic – renal cancer ; **radioresistant cancer**
Mechanical
Systemic – 다른 장기 전이 없고 tolerate surgery condition 으로 생각

종합하면 **separation surgery + SRS**

ESCC grade

Grade		Description
Low Grade	0	Bone only disease
	1 a	Epidural impingement, without deformation of thecal sac
	1 b	Deformation of the thecal sac, without spinal cord abutment
	1 c	Deformation of the thecal sac, with spinal cord abutment, without cord compression
High Grade	2	Spinal cord compression, with cerebrospinal fluid (CSF) visible around the cord
	3	Spinal cord compression, no CSF leak visible around the cord



36

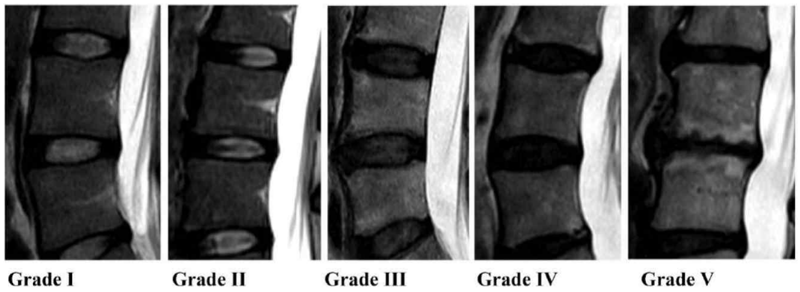
- 54세 여환 , 1달전부터 악화되는 고관통증 및 요통 신체진찰상 고관절 굴곡 구축 및 통증 호소 하였다. 이와 연관있는 해부학적 구조물은?

1. 장요근 농양
2. 경막외농양
3. 추간판 높이감소
4. 추체 골경화 및 용해

37

- 8개월 전부터 지속되는 요통을 주소로 내원한 53세 여자의 MRI 검사 결과이다. 시행한 혈액학적 검사상 WBC 7,700 CRP 0.16 dl/mg (정상 0.5)소견 확인되었다. 적절한 진단은?

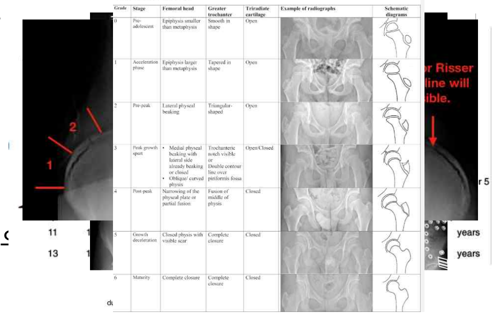
1. 감염성척추염
2. 척추관절병증
3. 척추전이암
4. 퇴행성 추간판 장애, Modic type 1
5. 퇴행성 추간판 장애, Modic type 2



38

- 12세 여자, 초경 한달전 이며 X-ray가 주어졌다. 다음 그림에서 해당되는 위치를 고르시오

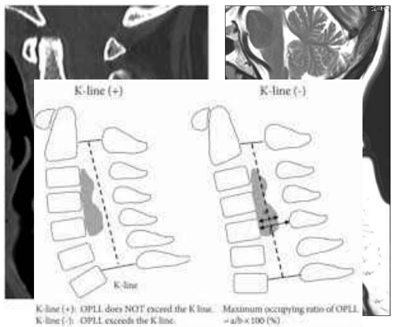
1. A(1번 위치로 표시)
2. B(2번 위치로 표시)
3. C(3번 위치로 표시)
4. D(4번 위치로 표시)
5. E(4번의 우측 꼭지 점의

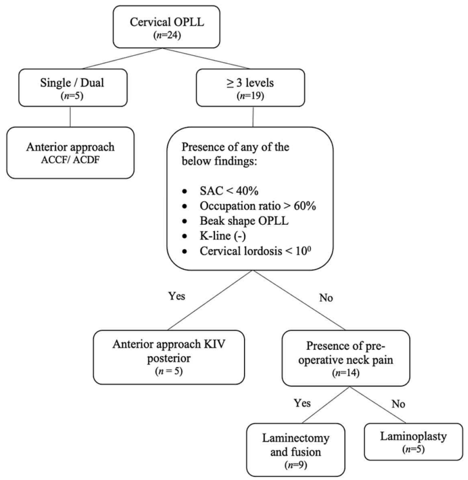


39

- 경추 척수증이 환자에서 하지 마비 발생함. 어떤 치료를 해야할 지?

1. 내시경적 전방 감압술
2. 전후방 감압 및 유합
3. 후궁 절제
4. 후궁 성형
5. 후방 감압 및 유합

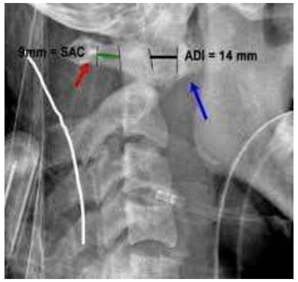




40

- 52세 ra 환자 14년간 ra 치치료시행중으로 2달전부터 손쓰는게 불편 1달 전부터 걷는게 불편함. 최근 방사선학적으로 운동의 악화를 설명할 수 있는것은?

1. Anterior atlantodental interval
2. Posterior atlantodental interval
3. subaxial subluxation
4. cervical lordosis
5. cervical sagittal vertical alignment



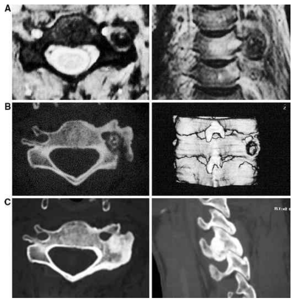
Radiography

Radiographs should include anteroposterior, lateral, odontoid, and lateral flexion and extension views. Instability and potential for neurologic sequelae are correlated best with the posterior atlantodens interval, which is determined by measuring the distance between the ventral surface of the lamina of C1 and the dorsal aspect of the odontoid; the interval should be more than 14 mm. This measurement is 97% sensitive for the presence of paralysis. In patients with preoperative paralysis caused by atlantoaxial subluxation, recovery is not expected if the spinal canal diameter is less than 10 mm. If basilar impression is coexistent, significant recovery occurs only if the space available for the cord is at least 13 mm. Therefore when patients have a posterior atlantodens interval of 14 mm or less, decompression must be considered because of the risk of paralysis from their atlantoaxial instability. Remember that the posterior atlantodens interval measured on a radiograph does not represent the actual space available for the cord because the soft tissues are not included in the measurement.

41

- 18세 여자 / 1년전부터 발생한 좌측 뒷목에 뻐근한 통증 / 밤에 더 심해지는 통증이며 / NSAID 복용시 증상 조절 됨

1. 생검
2. 병소절제
3. C4-5-6 추간판절제술 및 전방유합술
4. C4-5-6 후방관절 차단술
5. C5, 6 신경차단술



5. Osteoid osteoma

출제된 내용 미리 보기
5-1. 특성 - 16B
5-2. 진단 - 19B/12B2

<교과서 내용 정리하기>

1) 특성

(1) young male에 흔함. 10-30대. 남자
(2) 호발 부위 : lower extremity (30%에서 femur, tibia), prox. femur가 가장 흔함
(3) 대부분 골 피질에 발생, 드물게는 해면골에서 발견되기도 함
(4) no malignant change
(5) Sx : night pain, aspirin으로 Sx relief
(6) 척추 발생시 scoliosis 초래

2) 진단

(1) x-ray : distinct sclerosis의 중심부에 nidus (뚜렷한 골경화 중심부에 1~1.5cm의 nidus)
(2) CT : best study to identify the nidus and confirm the diagnosis

<그림 참고, FIGURE 25-1, Campbell 14th>

(3) bone scan : double density sign

3) 치료 : nidus를 완전히 remove 해야 한다.

(1) en bloc resection of the nidus
 - 단점 : risk of fracture 증가
(2) burr-down technique.
 ① power burr를 이용하여 reactive bone을 shaving 하고 nidus를 curet 한다.

42

- 45세 남자 fall down hx. / Bulvocarvernous reflex (+), 배꼽 밑으로 sensory & motor (-) Asia scale 및 TLICS 은?

1. Spinal shock / 9
2. ASIA A / 8
3. ASIA E / 9
4. ASIA A/ 9
5. ASIA E / 8

ASIA Impairment Scale		
A	Complete	No motor, no sensory, no sacral sparing
B	Incomplete	No motor, sensory only
C	Incomplete	50% of muscles LESS than grade 3 (can't raise arms or legs off bed)
D	Incomplete	50% of muscles MORE than grade 3 (can raise arms or legs off bed)
E	Normal	Motor and sensory function are normal

TABLE · 8-18 Thoracolumbar Injury Classification and Severity Score•

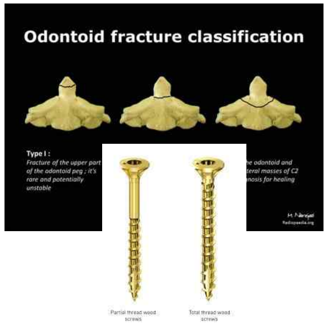
	POINTS
FRACTURE MECHANISM	
Compression fracture	1
Burst fracture	1
Translation/rotation	3
Distraction	4
NEUROLOGICAL INVOLVEMENT	
Intact	0
Nerve root	2
Cord, conus medullaris, incomplete	3
Cord, conus medullaris, complete	2
Cauda equina	3
POSTERIOR LIGAMENTOUS COMPLEX INTEGRITY	
Intact	0
Injury suspected/indeterminate	2
Injured	3

•Score of ≤ 3—nonoperative treatment; score of ≥ 5—operative treatment; score of 4—either nonoperative or operative treatment, depending on qualifiers such as comorbid medical conditions and other injuries.

43.

- Odontoid process fx 시에 screw 고정이 필요한 타입(사진 제공)과 screw 유형(사진 제공) 고르시오

1. Type 1 + full thread screw
2. Type 2 + partial thread screw
3. Type 2 + full thread screw
4. Type 2 + partial thread screw
5. Type 3 + full thread screw



(obliquity of fracture)에 따라 전사방(anterior oblique), 후사방(posterior oblique), 수평방(horizontal)으로 세분할 수 있으며, 골절선의 경사 방향은 전방 나사못 고정술을 시행할 때 중요하다. 전위가 없는 제 II형 골절의 경우 윤 조끼 보조기로 12주 간 고정을 하는데 견고한 외고정에도 불구하고 약 30% 정도에서 불유합이 발생할 수 있다. 따라서 최초 5 mm 이상의 전위 또는 10도 이상의 각 형성을 보이는 경우, 후방 전위가 있는 경우, 나이가 50세 이상인 제 II형 골절의 경우에는 조기에 수술을 시행하는 것이 바람직하다. 제 IIA형 골절은 도수정복 또는 견인으로 만족스러운 정복이 힘들고 외고정으로 유합을 얻기 어렵기 때문에 조기에 환추-축추 유합술을 시행하는 것이 바람직하다.

수술을 시행할 경우 골절선의 경사 방향, 연부조직의 부종 또는 피질골 경계에 의한 급성 여부 및 환추 골절의 동반 여부에 따라 적절한 수술 방법을 선택하여야 한다. 수술 방법에는 환추-축추 후방 강선 고정술(posterior C1-2 wiring), 전방 나사 못 고정술(anterior screw fixation), 환추-축추 횡관절 나사못 고정술(transarticular C1-2 screw fixation) 및 환추-축추 분절 고정술(C1-2 segmental fixation) 등이 있다.

전방 나사못 고정술은 환추-축추 후방 유합술에 비해 환추-축추 관절의 회전 운동을 보존할 수 있다는 장점이 있다. 하나 또는 두 개의 cannulated screw를 사용하여 고정할 수 있으며 나사선 끝이 반드시 골절선을 통과하여 lag screw 효과를 얻도록 해야 한다. 후사방 제 II형 골절의 경우 나사못이 골절선을 90도 방향으로 통과할 수 있어 유합 성공률이 높은 반면, 전사 방 제 II형 골절의 경우에는 나사못 방향과 골절선 방향이 평행 하거나 비슷하여 골절 편이 전위되거나 유합 성공률이 떨어지게 된다. 따라서 골절선이 후사방(posterior oblique) 또는 수평방(horizontal)인 경

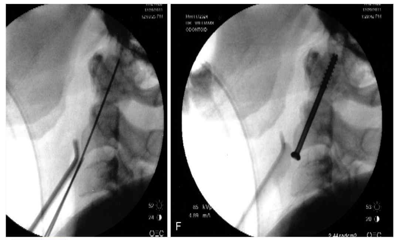


FIGURE 41.19 Odontoid fracture. **A,** Patient positioned with traction applied and image intensifiers for open-mouth and lateral images in position. **B,** Wire held in place while lateral view is obtained to indicate level of incision placement. **C,** Image with wire held in place. **D,** Open-mouth view. **E,** Lateral view after placement of first guidewire. **F,** Bicortical screw placement. **SEE TECHNIQUE 41.8.**

PCL Anatomy & Biomechanics

2023.05.01
R1. 김현진

Introduction

▣ Posterior cruciate ligament

▶ Restraint of Posterior tibial translation relative to the femur
▶ Secondary restraint to resist Varus, Valgus, External rotation

▶ Less common than ACL injuries
▶ Occur from a posterior force directed on the tibia
most common with the knee in a flexed position

▶ Innervated by branches of the Tibial nerve

▶ Vascular supply comes from the Middle geniculate artery

Knee Surgery, Sports Traumatology, Arthroscopy (2021) 29:672–681
https://doi.org/10.1007/s00167-020-06357-y

KNEE

Evolving evidence in the treatment of primary and recurrent posterior cruciate ligament injuries, part 1: anatomy, biomechanics and diagnostics

Philipp W. Winkler[1,2] · Bálint Zsidai[3] · Nyaluma N. Wagala[2] · Jonathan D. Hughes[2] · Alexandra Horvath[4] · Eric Hamrin Senorski[5] · Kristian Samuelsson[3,6] · Volker Musahl[2]

Received: 16 September 2020 / Accepted: 26 October 2020 / Published online: 17 November 2020

Radiographic Landmarks for Tunnel Positioning in PCL Reconstructions

[1]Johannsen, A J; [1]Westcott, D J; [1]LaPrade, R F; +[1]Wijdicks, C A; [2]Engebretsen, L
+[1]Steadman Philippon Research Institute, Vail, Colorado, [2]Oslo University Hospital, Oslo, Norway
cwijdicks@sprivail.org

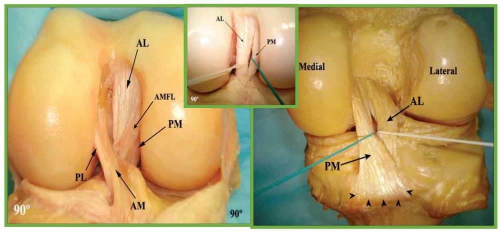
PCL Anatomy

▣ Length : 36~38 mm

▣ Cross-sectional area : 40~60 mm^2 at midsubstance level

▣ Thickness : 2 times than ACL

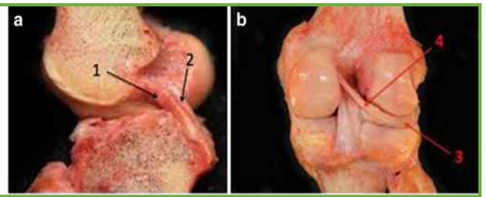
▣ Composed of two major parts → ALB & PMB



PCL Anatomy

▶ ALB, PMB는 굴곡 & 신전에서 서로 상호 보완적으로 긴장과 이완
▶ ALB이 PMB보다 3배 강한 인장 강도
▶ 슬관절 굴곡 시, ALB 긴장되어 후방 안정성에 기여
▶ 슬관절 신전 시, PMB 긴장되어 후방 안정성에 기여
▶ PCL → Posterolateral corner의 구조물과 함께 상호보완적으로 knee joint stability 기여
(대정 P1042)

Fig. 1 (a) Anatomy of the PCL with the knee extended showing the anterolateral (1) and posteromedial (2) bundles, including the femoral and tibial footprints and (b) anterolateral and posteromedial bundles of the PCL relative to the lateral meniscus (3) and meniscofemoral ligament of Wrisberg (4) (Courtesy of Jorge Chahla, MD, PhD)



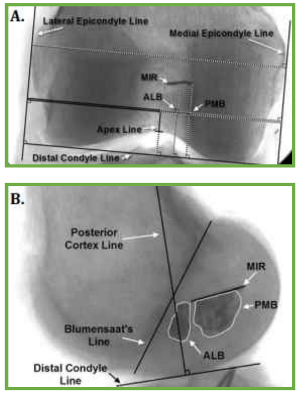
Anterolateral Bundle

▣ Length : 31.79 mm
▣ Diameter : 6.50 mm^2

▣ Femoral attachment of the ALB
▶ 4.8 mm posteroinferior
parallel to Blumensaat's line
▶ 14.1mm superior to distal joint line

▣ Tibial attachment of the ALB
▶ Medially & Posteriorly by the PMB

▣ Tensile strength of the PCL : 739~1627 N
▶ ALB : 1620 N



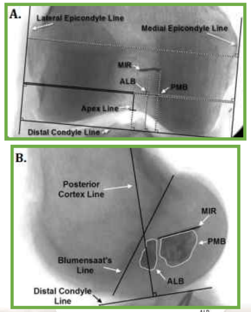
Posteromedial Bundle

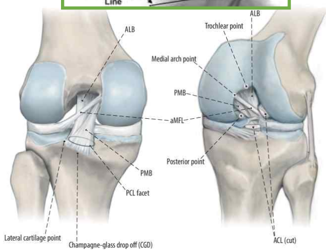
▣ Length : 32.42 mm
▣ Diameter : 5.62 mm^2

▣ Femoral attachment of the PMB
▶ 10.6 mm posteroinferior
parallel to Blumensaat's line
▶ 15mm superior to distal joint line

▣ Tibial attachment of the PMB
▶ Anterior meniscofemoral ligament(ligament of Humphrey) distally
▶ 3.1 mm lateral from the medial groove of the medial tibial plateau
articular surface and 4.4 mm anterior to the champagne glass drop-off of the posterior tibia

▣ Tensile strength of the PCL : 739 ~ 1627 N
▶ PMB : 258 N

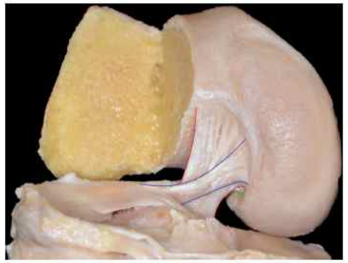


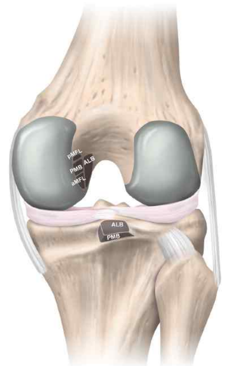


Femoral attachment site

▣ Anterolateral aspect of the MFC within the notch
▶ Medial intercondylar ridge

▣ Femoral footprint : 190-230 mm^2

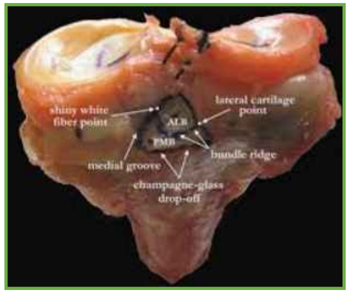


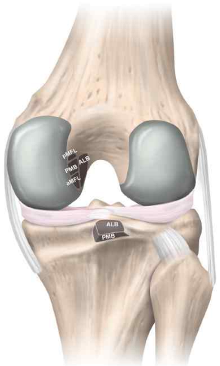


Tibial attachment site

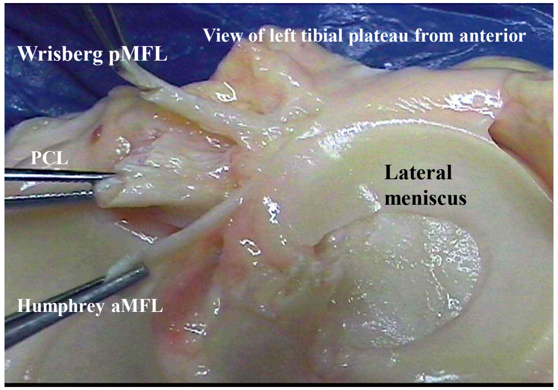
▣ Posterior aspect of the tibial plateau (1~1.5cm distal to the joint line)
▶ Posterior horn of the medial meniscus → anterior border of PCL facet

▣ Tibial footprint : 243 mm²

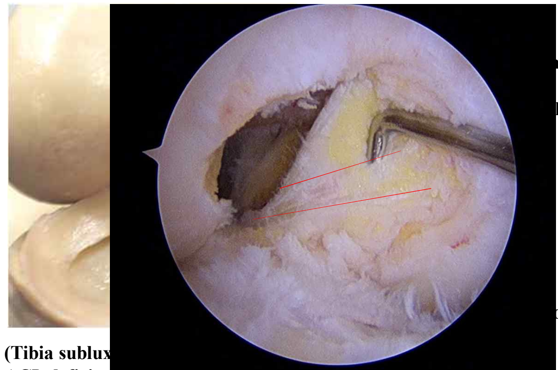




Anatomy of the MFL



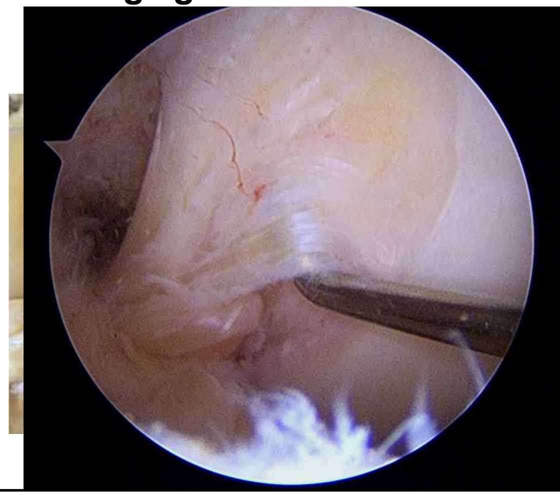
Humphrey ligament AMFL



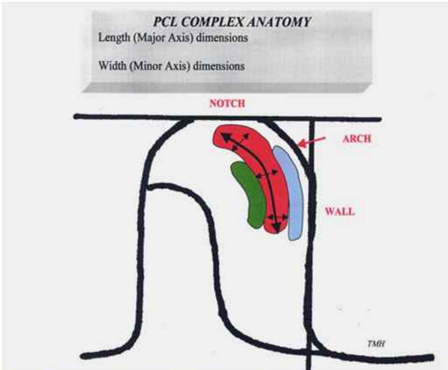
PCL and
hment
vertical
or

(Tibia sublux
ACL deficient knee)

Wrisberg ligament PMFL



l to
horn



	Length(mm)	Width(mm) Notch	Arch	Wall	Circumference(mm)	Area mm2
PCL	17.4	8.1	8.1	6.5	50.3	131.4 (SD 19.0)
Hum	9.5	3.3	3.1	3.0	22.9	27.9 (SD 12.3)
Wris	8.5	3.3	3.8	3.3	24.3	29.0 (SD 10.2)

Area contribution

PCL 70%
aMFL 15%
pMFL 15%

Knee Surg Sports Traumatol Arthrosc (2003) 11 : 271–281
KNEE
DOI 10.1007/s00167-003-0410-7

A. A. Amis
A. M. J. Bull
C. M. Gupte
I. Hijazi
A. Race
J. R. Robinson

Biomechanics of the PCL and related structures: posterolateral, posteromedial and meniscofemoral ligaments

- Significant increase in laxity when the MFLs were cut, in both the PCL intact knee and in the PCL deficient knee

-Intact knee : MFLs contributed 28 percent of the resistance to posterior draw

-PCL deficient : Increase to 70 percent of the resistance to posterior draw

→ Preserve MFL

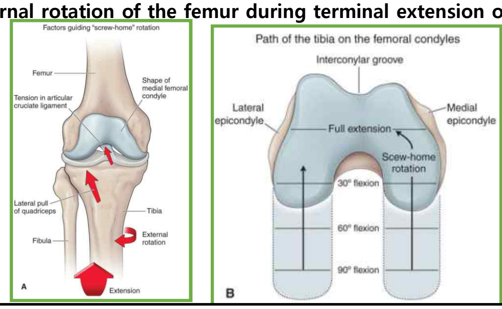
PCL biomechanics

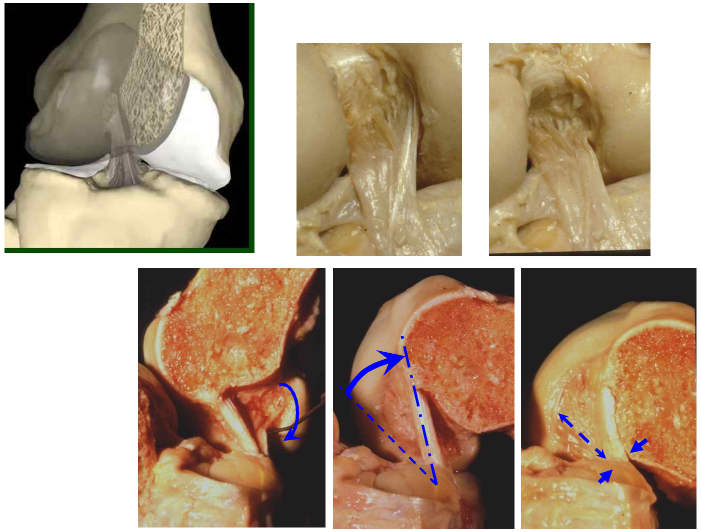
▣ Restraint to Posterior tibial translation
▣ Restraint to Excessive rotation
(Specifically 90°~120° of knee flexion)
▣ Two bundles functioned independently
(Acting in Flexion → ALB / in Extension → PMB)

▣ Two bundles function synergistically
▶ Isolated tear of either bundle does not result in a clinically significant increase in posterior translation of the tibia

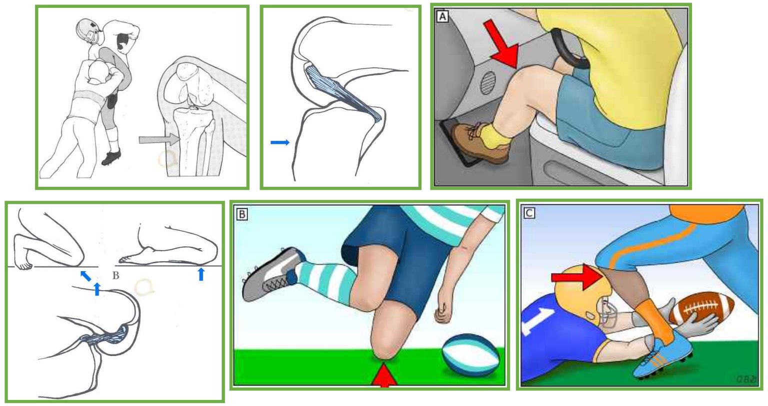
PCL biomechanics

▣ Rotational axis to guide the screw home mechanism
▶ PCL is more vertically than obliquely oriented
▶ PCL is the axis around which rotation of the knee occurs
▶ It appears to guide the “screw-home” mechanism on internal rotation of the femur during terminal extension of the knee





Injury mechanism



Injury mechanism

▣ Isolated tears of the PCL

▶ Fall on the flexed knee

▶ Striking of the flexed tibia on the dashboard in a motor vehicle

→ 이 때 내반 or 외회전력 동반

→ 외측 or 후외측 구조물 손상 (대정 P 1042)

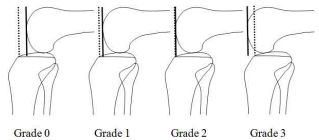
▶ Upper tibia driven posteriorly with the knee flexed

→ PCL disruption as the only clinically detectable instability

→ Isolated PCL disruptions can be difficult to diagnose acutely unless a <u>fragment of bone is avulsed</u>

Injury mechanism

▣ Posterolateral corner injury



▶ Posterior tibial translation

▶ Tibiofemoral contact shifts anteriorly

▶ Medial meniscus posterior horn unloaded

▶ Force in the PLC ↑

→ Dial test

Physical exam

▣ Popping, 파열되는 느낌을 받지 못하는 경우가 흔함

▣ 동반 손상이 있을 경우, 불안정이 더 심한 편

▣ 만성으로 진행 시, 불안정성 보다는 신체 장애 호소

Physical exam

▣ Posterior sagging

▶ 경골 내과의 anterior margin은
대퇴 내과의 anterior margin 보다 전방으로 1cm 정상적으로 돌출

▶ Absent or posteriorly-directed tibial step-off indicates a positive sign

Physical exam

▣ Quadriceps active test

Physical exam

▣ Posterior drawer test

Physical exam

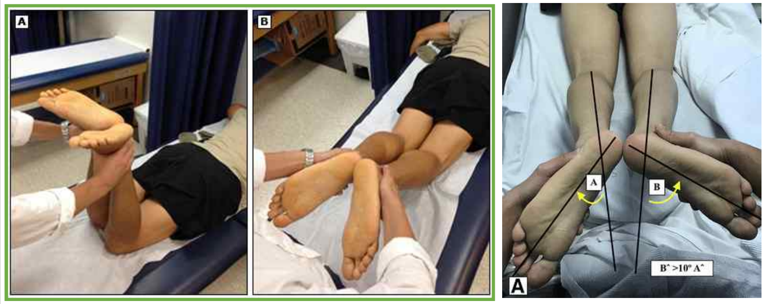
▣ Posterolateral drawer test

Physical exam

▣ External rotation recurvatum test

Physical exam

▣ Dial test



- 양쪽이 10도 이상 차이나면 → Pathologic
- 30도 굴곡 시 +, 90도 굴곡 시 – → isolated posterolateral corner injury
- 30도, 90도 굴곡 모두에서 + → both PCL & posterior corner injury

Knee Surg, Sports Traumatol, Arthroscopy (1996) 3:252–255

Knee Surgery
Sports Traumatology
Arthroscopy

A biomechanical analysis of joint contact forces in the posterior cruciate deficient knee

P. MacDonald, A. Miniaci, P. Fowler, P. Marks, B. Finlay
University Hospital, London, Ontario, Canada

Received: 10 October 1995; accepted: 21 January 1996

The purpose of this study
- the static forces in the medial and lateral compartments of the knee before and after cutting the PCL in a cadaveric knee model.

Methods and materials

- Nine cadaveric knee specimens
  - Under 45 years of age
  - No history of knee pathology
- Loading was then commenced to 1500 N with a 1min ramp time, a 1min load and a 1min unloading ramp time.
- The loading process was carried out at 0°, 30° and 60° of knee flexion.

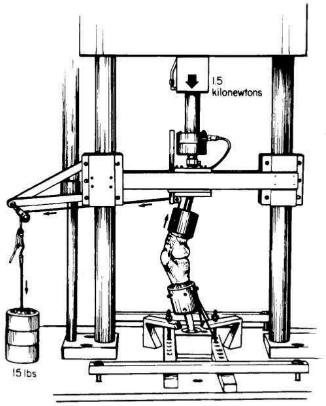
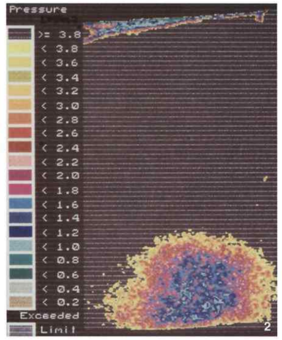


Fig. 1. Loading apparatus

Results



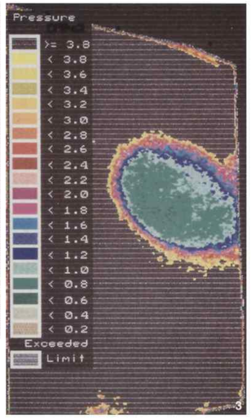


Fig. 2. Film imprint from medial compartment at 60° flexion prior to cutting PCL. *Colours on lower end of scale*, higher pressure value; *top line* references anterior tibial margin

Fig. 3. Film imprint from medial compartment at 60° flexion after cutting PCL. *Top line* references anterior tibial margin. Note increase in pressure value and concentration as well as anterior subluxation (compare Fig. 2)

Results

Table 1. Mean test values (medial vs lateral compartment)

	Medial	Lateral	No samples
Dist. (pixels)			
PCL present	146.9	168.7	27
PCL cut	99.8*	143.1	27
Pres. (Pa)			
PCL present	81.5	79.6	27
PCL cut	99.28*	87.4	27
Length (pixels)			
PCL present	173.8	18.9	27
PCL cut	167.3	168.7	27

*$P < 0.05$, PCL present vs. PCL cut

Table 2. Change in pressure values with changing angle of knee flexion

	0°	30°	60°
Mean pressure (Pa)	74.18	85.27	102.71*
Pres/Length or Con.	0.4426	0.5363	0.7275*,**
Dist. (pixels)	121.05	144.16	98.05**

*$P < 0.05$ vs. 0°, **$P < 0.05$ vs. 30°

Conclusions

- We have also shown with the static model in vitro that medial compartment pressures and pressure concentrations rise significantly at 60° in the posterior cruciate deficient knee.
- The importance here is a relative increase seen on the medial side compared to the lateral side.
- These findings support the clinical observations of the high incidence of degenerative changes on the medial femoral condyle with time

(607)

CURRENT CONCEPTS REVIEW

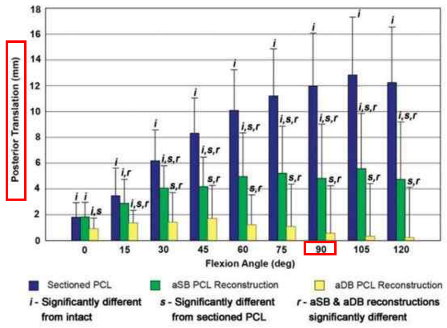
Cutting-Edge Posterior Cruciate Ligament Reconstruction Principles

Foley J. Schreier, BS[1,2]; Mark T. Banovetz, BS[1,3]; Ariel N. Rodriguez MS[1,4]; Robert F. LaPrade MD, PhD[1]
Research performed at Twin Cities Orthopedics, Edina, MN, 55435 U.S.A

Received: 23 June 2021 *Accepted: 25 September 2021*

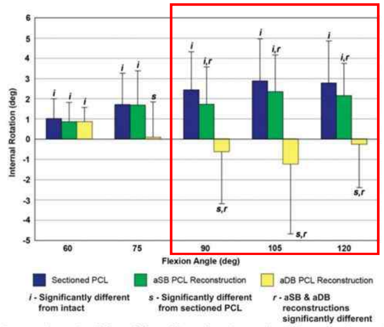
Table 1. Key Points – Effects of Posterior Cruciate Ligament (PCL) Deficiency on the Knee Joint
• The medial and patellofemoral joint compartments have increased compression forces
• The medial tibial plateau is posteriorly subluxed at all flexion angles
• The PCL has intrinsic healing ability, but can often heal in a lax position, leading to altered knee kinematics over time
• PCL deficiency can lead to progressive degeneration of the articular cartilage of the medial femoral condyle and patella

Biomechanics



- Anatomic DB PCLR had significantly less PTT at 90° of flexion than an anatomic SB PCLR

Biomechanics



Figures 3 and 4. Increases in posterior tibial translation and internal rotation at various flexion angles after complete sectioning of posterior cruciate ligament (PCL), anatomic single-bundle PCL reconstruction, and anatomic double-bundle PCL reconstruction. Reproduced with permission from AJSM Vol. 41 Issue 12, pp. 2839-2848.

- At flexion angles greater than 90° there is a significant increase in internal rotation in a SB PCLR compared to a DB PCLR

Grading of PCL injury

Table 3. Grading of PCL injuries based on the degree of posterior tibial translation as found on posterior drawer exam and kneeling stress radiograph measurement of side to side difference.

Grade	Clinical finding with posterior drawer exam	Kneeling stress radiograph measurement SSD
I	0-5 mm PTT	0-7 mm PTT
II	5-10 mm PTT	8-11 mm PTT → compete isolated PCL tear
III	>10 mm PTT; MTP posterior to MFC; posterior sag	≥12 mm PTT → combined PCL tear

PCL – posterior cruciate ligament; SSD – side-to-side difference; PTT – posterior tibial translation; MTP – medial tibial plateau; MFC – medial femoral condyle

Kneeling stress radiograph

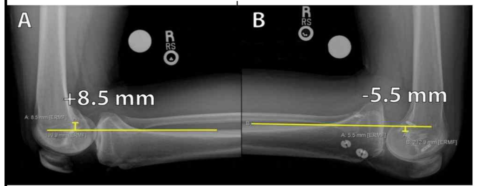


Figure 7. Posterior tibial stress radiographs to measure PTT. Identify a point on the PTC about 15 cm distal to the joint line and draw a line parallel to the PTC. Perpendicular to this line, find the distance between the PTC and the posterior-most aspect of Blumensaat's line. A SSD of 14.0 mm is shown above in a patient who also presented with a concomitant PLC injury. PTT – posterior tibial translation; PTC – posterior tibial cortex; SSD – side-to-side difference; PLC – posterolateral corner

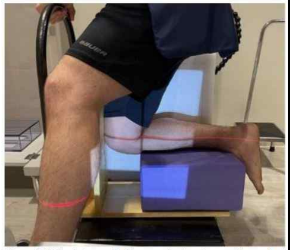


Figure 8. Patient demonstrating a posterior stress radiograph of the right knee. The patient is instructed to bear their full weight on the anterior aspect of the tibia with femoral condyles overhanging the padded support.

Reference

▣ 정형외과학 제 7판
- 대한정형외과학 – P1042~1043

▣ Campbell's Operative Orthopaedics,
' Chapter 45. Knee injuries', 13th edition P2238~2239

▣ Posterior Cruciate Ligament: Anatomy and Biomechanics
Current Reviews in Musculoskeletal Medicine (2018) 11:510–514

▣ Radiographic Landmarks for Tunnel Positioning
in PCL Reconstructions

▣ A biomechanical analysis of joint contact forces
in the posterior cruciate deficient knee

▣ Cutting-Edge Posterior Cruciate Ligament
Reconstruction Principles

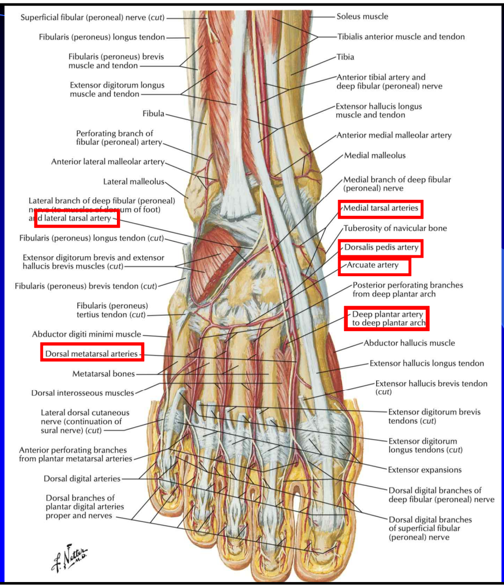
Neurovascular anatomy
– foot & ankle

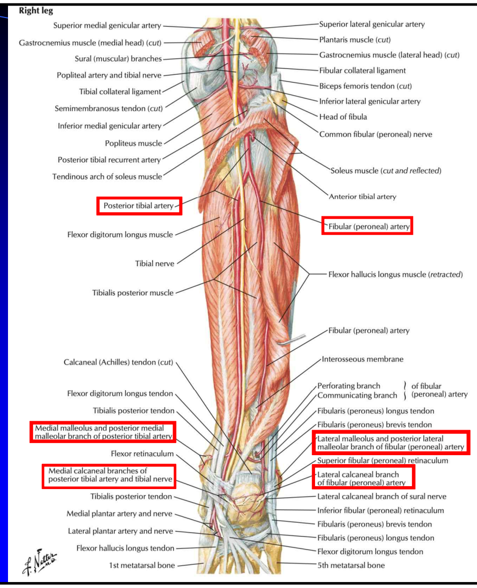
명지병원 정형외과

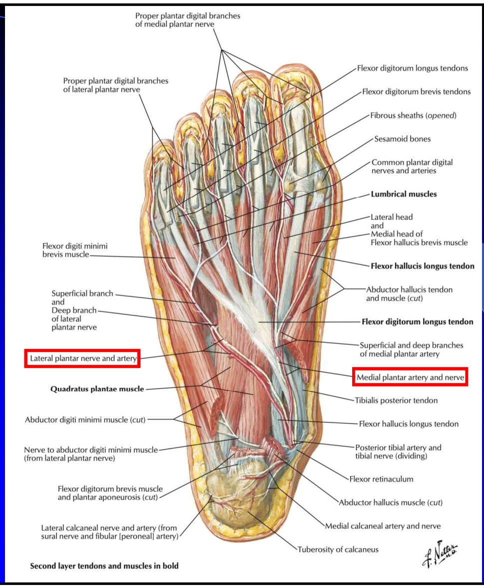
2023.05.02

R2. 우창우

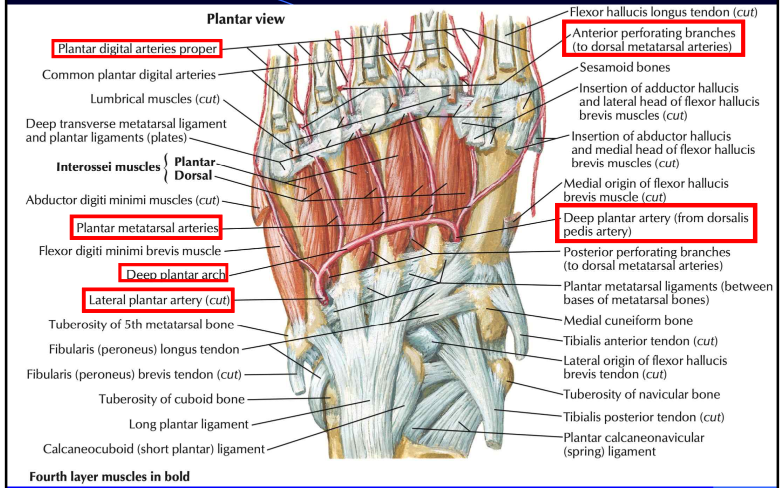
Angiology



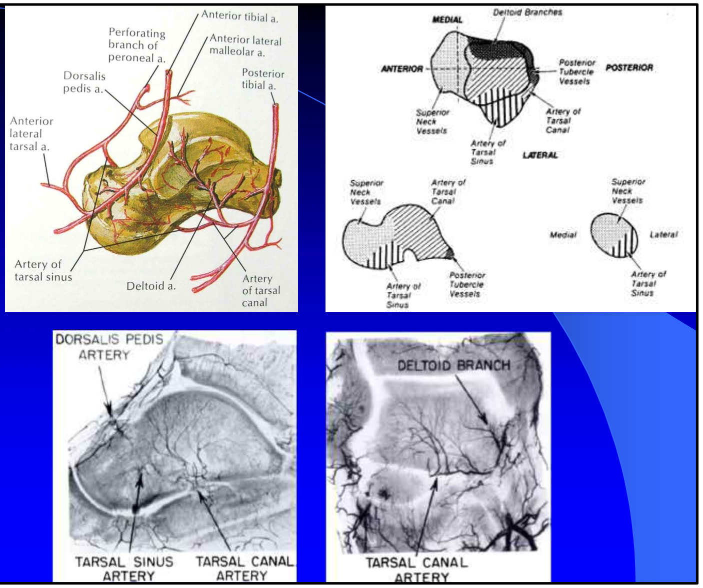




Proper plantar digital branches of medial plantar nerve
Proper plantar digital branches of lateral plantar nerve
Flexor digitorum longus tendons
Flexor digitorum brevis tendons
Fibrous sheaths (opened)
Sesamoid bones
Common plantar digital nerves and arteries
Lumbrical muscles
Lateral head and Medial head of Flexor hallucis brevis muscle
Flexor hallucis longus tendon
Abductor hallucis tendon and muscle (cut)
Flexor digitorum longus tendon
Superficial and deep branches of medial plantar artery
Medial plantar artery and nerve
Tibialis posterior tendon
Flexor hallucis longus tendon
Posterior tibial artery and tibial nerve (dividing)
Flexor retinaculum
Abductor hallucis muscle (cut)
Medial calcaneal artery and nerve
Tuberosity of calcaneus
Flexor digiti minimi brevis muscle
Superficial branch and Deep branch of lateral plantar nerve
Lateral plantar nerve and artery
Quadratus plantae muscle
Abductor digiti minimi muscle (cut)
Nerve to abductor digiti minimi muscle (from lateral plantar nerve)
Flexor digitorum brevis muscle and plantar aponeurosis (cut)
Lateral calcaneal nerve and artery (from sural nerve and fibular [peroneal] artery)
Second layer tendons and muscles in bold

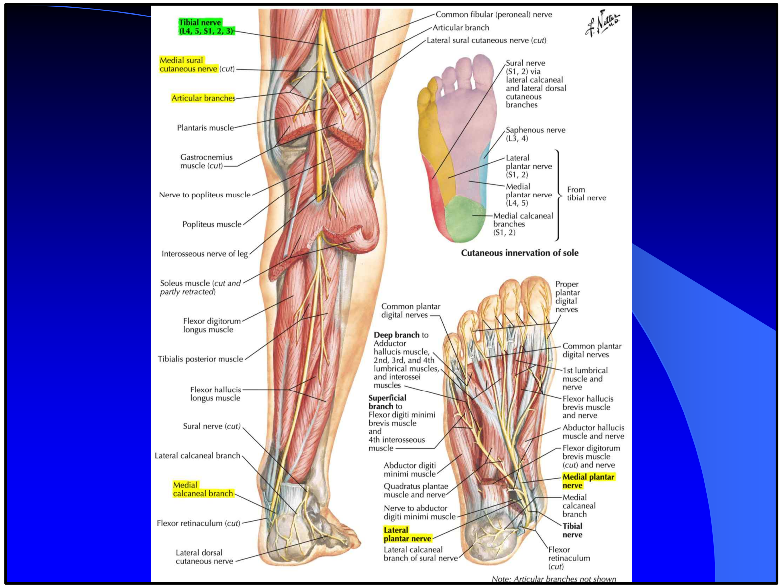


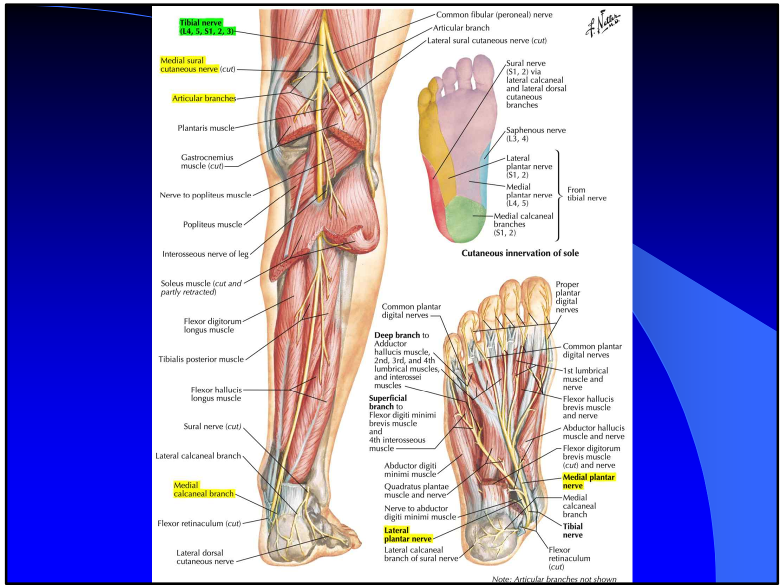
Plantar view
Plantar digital arteries proper
Common plantar digital arteries
Lumbrical muscles (cut)
Deep transverse metatarsal ligament and plantar ligaments (plates)
Interossei muscles
Plantar
Dorsal
Abductor digiti minimi muscles (cut)
Plantar metatarsal arteries
Flexor digiti minimi brevis muscle
Deep plantar arch
Lateral plantar artery (cut)
Tuberosity of 5th metatarsal bone
Fibularis (peroneus) longus tendon
Fibularis (peroneus) brevis tendon (cut)
Tuberosity of cuboid bone
Long plantar ligament
Calcaneocuboid (short plantar) ligament
Flexor hallucis longus tendon (cut)
Anterior perforating branches (to dorsal metatarsal arteries)
Sesamoid bones
Insertion of adductor hallucis and lateral head of flexor hallucis brevis muscles (cut)
Insertion of abductor hallucis and medial head of flexor hallucis brevis muscles (cut)
Medial origin of flexor hallucis brevis muscle (cut)
Deep plantar artery (from dorsalis pedis artery)
Posterior perforating branches (to dorsal metatarsal arteries)
Plantar metatarsal ligaments (between bases of metatarsal bones)
Medial cuneiform bone
Tibialis anterior tendon (cut)
Lateral origin of flexor hallucis brevis tendon (cut)
Tuberosity of navicular bone
Tibialis posterior tendon (cut)
Plantar calcaneonavicular (spring) ligament
Fourth layer muscles in bold

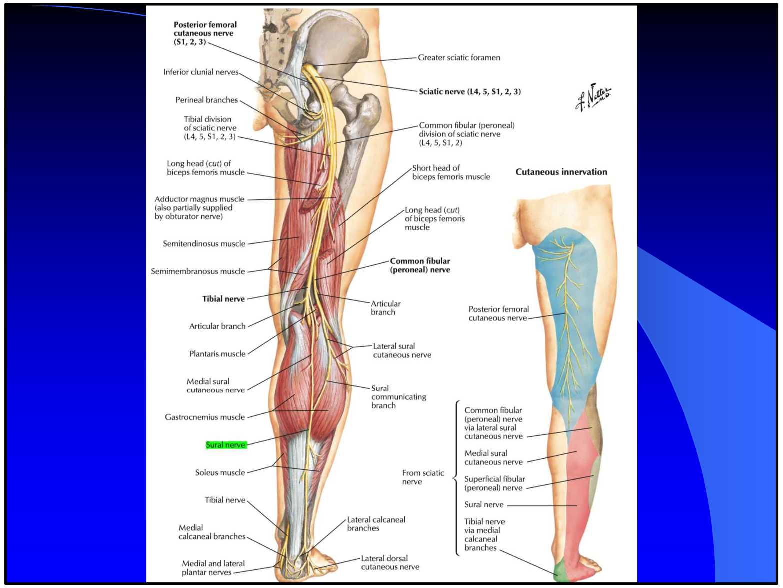


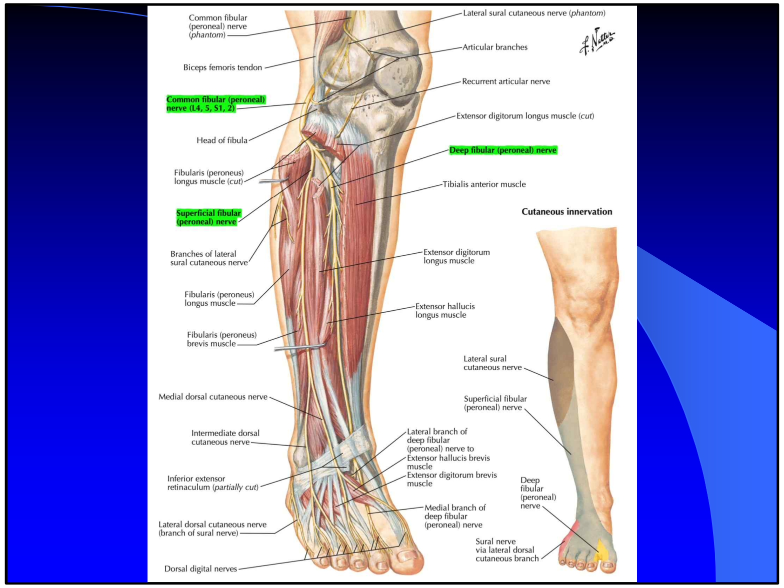
Anterior tibial a.
Perforating branch of peroneal a.
Anterior lateral malleolar a.
Dorsalis pedis a.
Posterior tibial a.
Anterior lateral tarsal a.
Artery of tarsal sinus
Deltoid a.
Artery of tarsal canal
MEDIAL
Deltoid Branches
ANTERIOR
Posterior Tubercle Vessels
POSTERIOR
Superior Neck Vessels
Artery of Tarsal Canal
Artery of Tarsal Sinus
LATERAL
Superior Neck Vessels
Artery of Tarsal Canal
Posterior Tubercle Vessels
Artery of Tarsal Sinus
Medial
Lateral
Superior Neck Vessels
Artery of Tarsal Sinus
DORSALIS PEDIS ARTERY
TARSAL SINUS ARTERY
TARSAL CANAL ARTERY
DELTOID BRANCH
TARSAL CANAL ARTERY

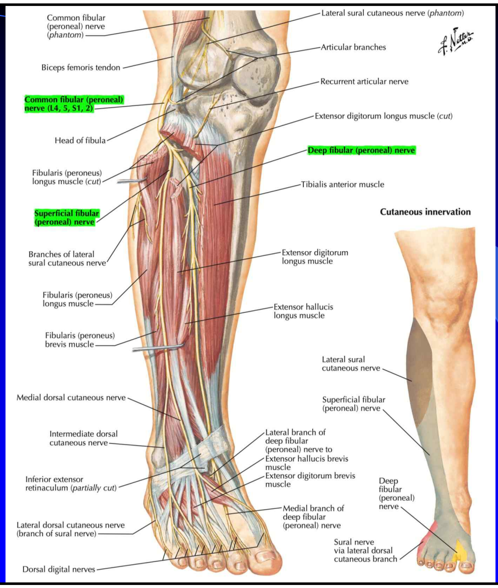
Neurology


Tibial nerve (L4, 5, S1, 2, 3)
Medial sural cutaneous nerve (cut)
Articular branches
Plantaris muscle
Gastrocnemius muscle (cut)
Nerve to popliteus muscle
Popliteus muscle
Interosseous nerve of leg
Soleus muscle (cut and partly retracted)
Flexor digitorum longus muscle
Tibialis posterior muscle
Flexor hallucis longus muscle
Sural nerve (cut)
Lateral calcaneal branch
Medial calcaneal branch
Flexor retinaculum (cut)
Lateral dorsal cutaneous nerve
Common fibular (peroneal) nerve
Articular branch
Lateral sural cutaneous nerve (cut)
Sural nerve (S1, 2) via lateral calcaneal and lateral dorsal cutaneous branches
Saphenous nerve (L3, 4)
Lateral plantar nerve (S1, 2)
Medial plantar nerve (L4, 5)
Medial calcaneal branches (S1, 2)
From tibial nerve
Cutaneous innervation of sole
Proper plantar digital nerves
Common plantar digital nerves
Deep branch to Adductor hallucis muscle, 2nd, 3rd, and 4th lumbrical muscles, and interossei muscles
Superficial branch to Flexor digiti minimi brevis muscle and 4th interosseous muscle
Abductor digiti minimi muscle
Quadratus plantae muscle and nerve
Nerve to abductor digiti minimi muscle
Lateral plantar nerve
Lateral calcaneal branch of sural nerve
Common plantar digital nerves
1st lumbrical muscle and nerve
Flexor hallucis brevis muscle and nerve
Abductor hallucis muscle and nerve
Flexor digitorum brevis muscle (cut) and nerve
Medial plantar nerve
Medial calcaneal branch
Tibial nerve
Flexor retinaculum (cut)
Note: Articular branches not shown


Tibial nerve (L4, 5, S1, 2, 3)
Medial sural cutaneous nerve (cut)
Articular branches
Plantaris muscle
Gastrocnemius muscle (cut)
Nerve to popliteus muscle
Popliteus muscle
Interosseous nerve of leg
Soleus muscle (cut and partly retracted)
Flexor digitorum longus muscle
Tibialis posterior muscle
Flexor hallucis longus muscle
Sural nerve (cut)
Lateral calcaneal branch
Medial calcaneal branch
Flexor retinaculum (cut)
Lateral dorsal cutaneous nerve
Common fibular (peroneal) nerve
Articular branch
Lateral sural cutaneous nerve (cut)
Sural nerve (S1, 2) via lateral calcaneal and lateral dorsal cutaneous branches
Saphenous nerve (L3, 4)
Lateral plantar nerve (S1, 2)
Medial plantar nerve (L4, 5)
Medial calcaneal branches (S1, 2)
From tibial nerve
Cutaneous innervation of sole
Proper plantar digital nerves
Common plantar digital nerves
Deep branch to Adductor hallucis muscle, 2nd, 3rd, and 4th lumbrical muscles, and interossei muscles
Superficial branch to Flexor digiti minimi brevis muscle and 4th interosseous muscle
Abductor digiti minimi muscle
Quadratus plantae muscle and nerve
Nerve to abductor digiti minimi muscle
Lateral plantar nerve
Lateral calcaneal branch of sural nerve
Common plantar digital nerves
1st lumbrical muscle and nerve
Flexor hallucis brevis muscle and nerve
Abductor hallucis muscle and nerve
Flexor digitorum brevis muscle (cut) and nerve
Medial plantar nerve
Medial calcaneal branch
Tibial nerve
Flexor retinaculum (cut)
Note: Articular branches not shown


Posterior femoral cutaneous nerve (S1, 2, 3)
Inferior clunial nerves
Perineal branches
Tibial division of sciatic nerve (L4, 5, S1, 2, 3)
Long head (cut) of biceps femoris muscle
Adductor magnus muscle (also partially supplied by obturator nerve)
Semitendinosus muscle
Semimembranosus muscle
Tibial nerve
Articular branch
Plantaris muscle
Medial sural cutaneous nerve
Gastrocnemius muscle
Sural nerve
Soleus muscle
Tibial nerve
Medial calcaneal branches
Medial and lateral plantar nerves
Greater sciatic foramen
Sciatic nerve (L4, 5, S1, 2, 3)
Common fibular (peroneal) division of sciatic nerve (L4, 5, S1, 2)
Short head of biceps femoris muscle
Long head (cut) of biceps femoris muscle
Common fibular (peroneal) nerve
Articular branch
Lateral sural cutaneous nerve
Sural communicating branch
Lateral calcaneal branches
Lateral dorsal cutaneous nerve
Cutaneous innervation
Posterior femoral cutaneous nerve
Common fibular (peroneal) nerve via lateral sural cutaneous nerve
Medial sural cutaneous nerve
Superficial fibular (peroneal) nerve
Sural nerve
Tibial nerve via medial calcaneal branches
From sciatic nerve


Common fibular (peroneal) nerve (phantom)
Biceps femoris tendon
Common fibular (peroneal) nerve (L4, 5, S1, 2)
Head of fibula
Fibularis (peroneus) longus muscle (cut)
Superficial fibular (peroneal) nerve
Branches of lateral sural cutaneous nerve
Fibularis (peroneus) longus muscle
Fibularis (peroneus) brevis muscle
Medial dorsal cutaneous nerve
Intermediate dorsal cutaneous nerve
Inferior extensor retinaculum (partially cut)
Lateral dorsal cutaneous nerve (branch of sural nerve)
Dorsal digital nerves
Lateral sural cutaneous nerve (phantom)
Articular branches
Recurrent articular nerve
Extensor digitorum longus muscle (cut)
Deep fibular (peroneal) nerve
Tibialis anterior muscle
Extensor digitorum longus muscle
Extensor hallucis longus muscle
Lateral branch of deep fibular (peroneal) nerve to Extensor hallucis brevis muscle Extensor digitorum brevis muscle
Medial branch of deep fibular (peroneal) nerve
Cutaneous innervation
Lateral sural cutaneous nerve
Superficial fibular (peroneal) nerve
Deep fibular (peroneal) nerve
Sural nerve via lateral dorsal cutaneous branch



Common fibular (peroneal) nerve (phantom)
Biceps femoris tendon
Common fibular (peroneal) nerve (L4, 5, S1, 2)
Head of fibula
Fibularis (peroneus) longus muscle (cut)
Superficial fibular (peroneal) nerve
Branches of lateral sural cutaneous nerve
Fibularis (peroneus) longus muscle
Fibularis (peroneus) brevis muscle
Medial dorsal cutaneous nerve
Intermediate dorsal cutaneous nerve
Inferior extensor retinaculum (partially cut)
Lateral dorsal cutaneous nerve (branch of sural nerve)
Dorsal digital nerves
Lateral sural cutaneous nerve (phantom)
Articular branches
Recurrent articular nerve
Extensor digitorum longus muscle (cut)
Deep fibular (peroneal) nerve
Tibialis anterior muscle
Extensor digitorum longus muscle
Extensor hallucis longus muscle
Lateral branch of deep fibular (peroneal) nerve to
Extensor hallucis brevis muscle
Extensor digitorum brevis muscle
Medial branch of deep fibular (peroneal) nerve
Cutaneous innervation
Lateral sural cutaneous nerve
Superficial fibular (peroneal) nerve
Deep fibular (peroneal) nerve
Sural nerve via lateral dorsal cutaneous branch

Osteonecrosis of Femoral Head

명지병원 정형외과
R1. 정승호

Cause

- **Idiopathic (primary) : 10-20%**
- **Secondary :**
  trauma, steroid use, alcohol abuse, smoking, hemoglobinopathies, coagulation disorders, myeloproliferative disorders, HIV infection, pregnancy, rheumatoid disorders, sarcoma, drug intoxication…

Mechanism

- **Infarction :**
  어떤 원인에 의해 골두 공급 혈관이 막히면서 골두의 전외측에 wedge 모양의 괴사가 생기고, 이곳에 혈류가 재생성되면서 괴사 골이 흡수되고 신생 골이 만들어지는데, 이 과정에서 골이 역학적으로 약해져서 함몰된다는 이론.

Mechanism

- **Fat embolism :** 대퇴 골두의 괴사 부위나 연골 하 골부위에 지방 색전이 관찰되는 것을 근거로 함.
- **Accumulative cell stress :** 여러 원인 인자에 의해 병적 상태에 빠진 골 조직에 추가로 스트레스가 가해지거나, 혹은 잦은 스트레스가 쌓여 선을 넘게 되면 괴사가 일어남.

Mechanism

- **Progressive ischemia :** 단단한 피질골 내 압력이 높아지면서 혈관이 압박되어 혈류가 감소된다는 이론.

- **Coagulopathy :** 골 내의 상대적으로 압력이 낮은 모세혈관에서 시작되는 intravascular coagulation에 의해 괴사가 진행된다는 이론.

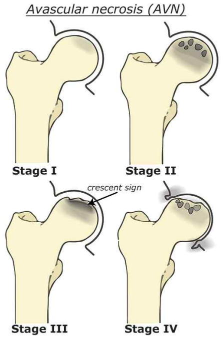
Mechanism

- **Hereditary :** 염색체 12q13에 위치한 제 2형 콜라겐 (COL2AII)과 Vitamin D receptor (VDR) 유전자 이상으로 발생한다는 이론.

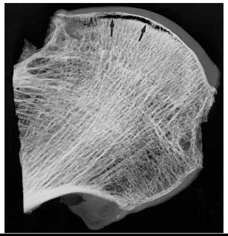
Diagnosis

- **P/Ex. :**
  initially asymptomatic
  groin pain on ambulation
  pain attack when FH(Femoral Head) collapse occur
  Patrick test +
  LOM + **(abduction, IR)**

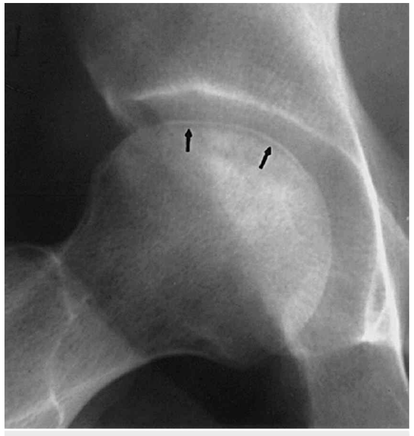
Diagnosis



- **XR :**
  increased density or lucency in the FH
  pathognomonic **Crescent sign** is visible
  FH collapse
  severe arthritic changes

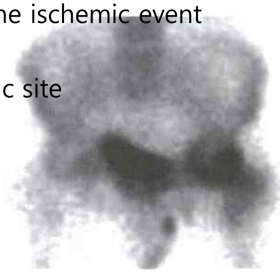


Diagnosis



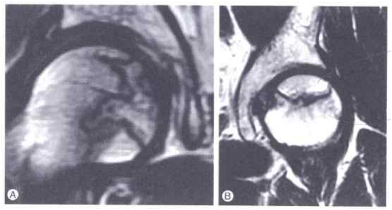
Diagnosis

- **Bone scan :**
  identify multiple joints involvement
  initial screening test
  Cold in hot lesion
    usually seen 7-10 days after the ischemic event
    cold lesion at necrotic site
    hot lesion surrounding necrotic site



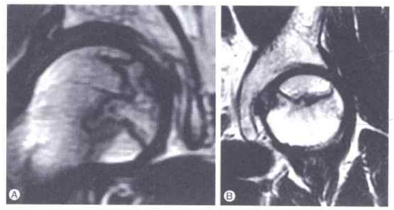
Diagnosis

- **MRI :**
  determine exact stage
  most accurate diagnostic modality
    T1W : decreased marrow signal at necrotic site &
    low-signal band at boundary
    T2W : double line sign



Diagnosis

- **MRI :**
    T2W : double line sign
    inner : high
    -> hyperemic reparative zone (granular tissue)
    outer : low -> normal bone



Differential diagnosis

- Transient osteoporosis
- Stress fractures

Differential diagnosis

- Transient osteoporosis
  XR : diffuse osteopenia c joint preservation
  MR : diffuse edema (T1 low, T2 high)

Differential diagnosis

- Stress fractures

	대퇴골두 연골하 피로 골절	대퇴골두 무혈성 괴사
발생률	드묾	15,000례/연 (미국 통계)
위험 인자	피로 누적형: 갑작스런 활동량 증가 부전 골절형: 골다공증	알코올, 스테로이드, 외상, 장기 이식, 겸상 적혈구증, 고셔병 등
양측성	발생하나 빈도는 알려져 있지 않음	50% 이상에서 양측성
골두 함몰 후 진행	저절로 증상 소실됨	대개 고관절 파괴로 진행
MRI 소견	연골하 골절선(+) 병변과 정상 부위 사이의 반응선(-) 골절선까지 골수 부종(+)	연골하 골절선(+) 병변과 정상 부위 사이의 반응선(+) 괴사 외측에만 골수 부종(+)

no low-signal band & double line sign

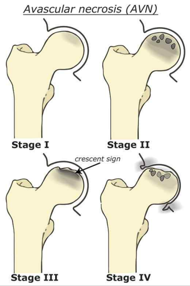
Classification

표 4-1 Ficat and Arlet Classification of Osteonecrosis of the Femoral Head

STAGE	SYMPTOMS	RADIOGRAPHY	BONE SCAN	PATHOLOGICAL FINDINGS	BIOPSY
0	None	Normal	Decreased uptake?		
1	None/mild	Normal	Cold spot on femoral head	Infarction of weight-bearing portion of femoral head	Abundant dead marrow cells, osteoblasts, ostogenic cells
2	Mild	Density change in femoral head Sclerosis or cysts, normal joint line, normal head contour	Increased uptake	Spontaneous repair of infarcted area	New bone deposited between necrotic trabeculae
3	Mild to moderate	Loss of sphericity, collapse	Increased uptake	Subchondral fracture, collapse, compaction and fragmentation of necrotic segment	Dead bone trabeculae and marrow cells on both sides of fracture line
4	Moderate to severe	Joint space narrowing, acetabular changes	Increased uptake	Osteoarthritic changes	Degenerative changes in acetabular cartilage

Classification

- **Ficat & Arlet :**
  I : 일반 촬영 상 정상 소견
  II : 골두 내 경화, 낭종 형성 있으나 연골하 골절 소견 없음
  III : 연골하 골절로 인한 대퇴골두 함몰 소견
  IV : 병변이 비구까지 확장, 고관절 파괴



Treatment

- 질병의 진행을 arrest 하는 방법은 없다
- 예후에서 **stage, size, location**이 중요하다
- 치료방법을 결정하는데 있어서 가장 중요한 것은 **질병의 진행 시기**

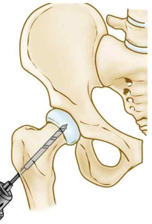
Treatment

- **Observation indications**
  asymptomatic or mild pain
  without FH collapse or less than 2mm collapse at medial or central region
- **Medications**
  bisphosphonate (TOC)
  enoxaparin, warfarin, clofibrate…

Treatment

- **Operative tx.**
  core decompression
  bone grafting(non-vascularized)
  vascularized fibular grafting
  transtrochanteric rotational osteotomy(Sugioka)
  resurfacing arthroplasty
  THA

Treatment

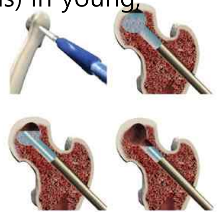


- **Core decompression**

  decrease intraosseous pressure
  improvement of vascularity
  slowing the progression of the disease

  Indications

  Ficat stage I & IIA(small central lesions) in young,
  who are not taking steroids



Treatment

- Bone grafting
- **Vascularized fibular grafting**

  Indications

  age < 50 yrs
  Ficat stage II, III, IV
  doesn't matter taking steroids

그림 IV-27. 혈관 부착 생비골 이식술의 수술 전, 수술 직 후, 수술 후 11년의 단순방사선 사진. 수술전의 연골 하 골절을 동반한 광범위한 괴사의 소견을 보이나 11년 후에 골두의 함몰이나 퇴행성 변화가 없다.

Treatment

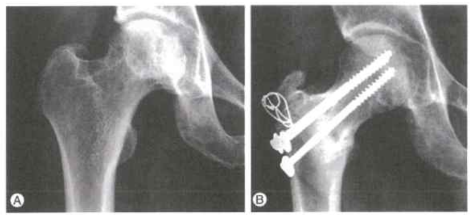
- **Compared with THA**

  healed FH may allow more activity
  no risk of the presence of foreign body
  possibility of survival of a viable FH
  a longer recovery period (post. Op 6mo partial WB)
  less uniform and less complete relief of pain

Treatment

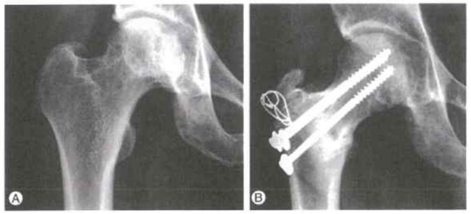
- **Transtrochanteric rotational osteotomy(Sugioka)**

  reposition necrotic part to non-weight bearing part
  rotated anteriorly around its longitudinal axis
  weight bearing force is transmitted to
  the posterior articular surface of FH



Treatment

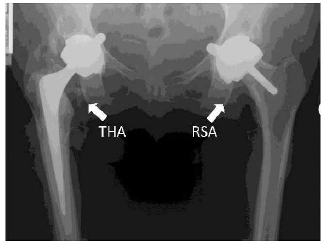
- **Transtrochanteric rotational osteotomy(Sugioka)**
  Indications
  Ficat stage I, II
  age < 55 yrs
  intact posterior articular surface > 0.3



Treatment

- **Resurfacing arthroplasty**
  attractive alternatives for young with advanced necrosis, but recommended only if the avascular segment constitutes **usually < 50%**

- **THA**



Examples

1. 65세 여자가 보존적 치료에 반응하지 않는 고관절 동통을 주소로 내원하였다. 단순 방사선 사진은 다음과 같다. 다음 중 가장 적절한 치료는? 16B2

㉮ 정기적 방사선 검사 추시
㉯ 다발성 천공술
㉰ 근위 대퇴골 절골술
㉱ 인공 고관절 반치환술
㉲ 인공 고관절 전치환술

Examples

1. 65세 여자가 보존적 치료에 반응하지 않는 고관절 동통을 주소로 내원하였다. 단순 방사선 사진은 다음과 같다. 다음 중 가장 적절한 치료는? 16B2

㉮ 정기적 방사선 검사 추시
㉯ 다발성 천공술
㉰ 근위 대퇴골 절골술
㉱ 인공 고관절 반치환술
㉲ 인공 고관절 전치환술

Examples

1. 대퇴골 두 무혈성 괴사의 치료에 대한 설명으로 옳지 않은 것은?

㉮ 질병진행의 rate와 course는 예측 불가능하여 방사선 소견과 임상증상은 일치하지 않을 수도 있다
㉯ 예후에서 staging, size, location이 가장 중요하다
㉰ 치료방법을 결정하는데 있어서 가장 중요한 것은 환자의 나이다
㉱ size가 커짐 (femoral head 면적의 50% 이상 involve)에 따라 83% 이상이 symptomatic ONFH로 간다
㉲ 함몰이 심하고 퇴행성 변화까지 있는 경우는 인공관절 치환술이 도움이 된다

Examples

1. 대퇴골 두 무혈성 괴사의 치료에 대한 설명으로 옳지 않은 것은?

㉮ 질병진행의 rate와 course는 예측 불가능하여 방사선 소견과 임상증상은 일치하지 않을 수도 있다
㉯ 예후에서 staging, size, location이 가장 중요하다
㉰ 치료방법을 결정하는데 있어서 가장 중요한 것은 환자의 나이다
㉱ size가 커짐 (femoral head 면적의 50% 이상 involve)에 따라 83% 이상이 symptomatic ONFH로 간다
㉲ 함몰이 심하고 퇴행성 변화까지 있는 경우는 인공관절 치환술이 도움이 된다

- 치료방법을 결정하는데 있어서 가장 중요한 것은 **질병의 진행 시기**

Paralytic hand

명지병원 정형외과
R3. 이 규 환

Hand function

- Positional changes and delicate movements(pinch, grasp, hook)
  - Joints of the 29 & 50 muscles that act as motors and stabilizers
- The normal upper extremity can rhythmically position the hand through varied concerted extrinsic and intrinsic phasic muscle activity
- Some patterns of muscle group movement act in such endless coordinated repetition that they are said to be synergistic
  - The wrist extensors, finger flexors, and digital adductors
  - the wrist flexors, finger extensors, and digital abductors

Paralytic hand

- A condition in which certain muscles of the hand are paralyzed due to damage to central or peripheral nerves, losing the power to perform certain functions, and the harmony and balance of the muscles are irreversibly disrupted
- Unopposed antagonist muscle contraction often leads to fixed contractures. Although contractures may increase the stability of the hand, they usually increase its disability

Paralytic hand

- Spastic & flaccid type
  - Spastic type
    - 이환된 근육이 약하지만 긴장되어 있고 강직되어 있어 이완되지 않음. → 주기적 근육의 강직이 근긴장을 증가 → 정상적으로 조절이 되지않아 기능장애 초래
    - 주로 CNS 손상 (ex. Cerebral palsy, stroke, etc)
  - Flaccid type
    - 이완되어 있고 자극에도 반응하지 않음. → 길항근이 계속 작용하고 있으므로 이로 인해 길항근의 작용 방향으로 근육 단축, 구축을 일으킴.
    - Anterior horn cell, PNS 손상

대한정형외과학 제 7판

Principle of tendon transfer

- Tendon transfers are useful in restoring hand and upper extremity functions
- Muscles to be transferred must be expendable and have sufficient strength and appropriate amplitude of excursion
- Muscle should be synergistic, have appropriate alignment, and perform one function
- Ideal timing of tendon transfers should consider the condition of the soft tissue and the mobility of adjacent joints
- Transfers are best performed after reaching favorable soft-tissue conditions (not in the context of severe swelling or scarring) and after restoring passive motion of adjacent joints

Evaluation of muscle for tendon transfer

- Considering muscle expendability and its strength
- A muscle usually loses strength by one grade when transferred and should be good or normal

Grade	Muscle Power
0 - Zero	No muscle contraction is seen
1 - Trace	Flicker or Trace of contraction is seen
2 - Poor	Active movement only with gravity eliminated
3 - Fair	Active movement against gravity but not resistance
4 - Good	Active movement against gravity with some resistance
5 - Normal	Active movement against gravity with full resistance

- Synergy and the amplitude of excursion
  - Rehabilitation of a muscle whose tendon has been transferred is less difficult when the transfer is synergistic

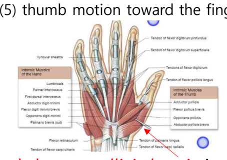
  (e.g., a wrist flexor transfer to restore finger extension)

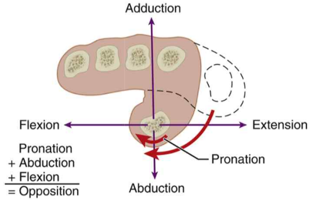
Timing of tendon transfer

- Transferred tendons must be surrounded by fat to prevent them from adhering to raw bone or subcutaneous scar
  - scar tissue has been satisfactorily replaced
  - a flap or graft containing fat is necessary to replace scar
- A satisfactory range of passive joint motion is also necessary before the transfer
  - Stiffness or contracture of joints cannot be corrected by tendon transfers alone
  - If left uncorrected, stiffness or contracture prevents a transferred tendon from moving at the proper time
- Malalignment of bone must be corrected by osteotomy, and any necessary bone grafting must be accomplished before transfer
- Necessary operations to restore any loss of sensibility should also precede tendon transfer

Restoration of pinch

- Thumb opposition is a complex motion made by coordination
  - (1) abduction of the thumb from the palmar surface of the index finger
  - (2) flexion of the metacarpophalangeal joint
  - (3) internal rotation or pronation
  - (4) radial deviation of the proximal phalanx
  - (5) thumb motion toward the fingers



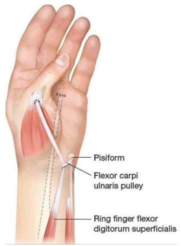


- The abductor pollicis brevis is the most important single muscle that participates in this complex movement
  - IR and abducts the thumb away from the 2nd MC
  - IR and abducts the proximal phalanx of the thumb on 1st MC
  - assists the EPL in extending the interphalangeal joint of the thumb

Tendon transfer to restore opposition

- The direction in which the transferred tendon approaches the thumb usually has been from the ulnar side of the wrist or palm

- Tendon
  - 1st - 4th FDS (muscle of choice)
    - strong enough & FDP is strong enough alone to flex the finger
  - 2nd - 3rd FDS (2nd choice)
  - ------------
  - 3rd - EIP
  - 4th - ECU
  - 5th – PL or ECRL



- Wrist extensor should be transferred only if the other wrist extensors are strong and have not been or will not be transferred elsewhere.

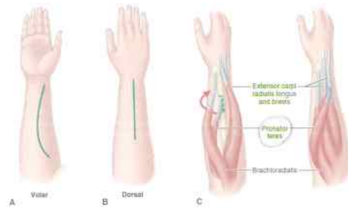
Radial nerve palsy

1. Low radial nerve palsy (PIN마비)
   - Involved muscle - Digital extensors, APL, EPL, EPB
   - Radial wrist extensor & brachioradialis m. → spare (High radial nerve palsy와 DDx.)

<restore해야 하는 basic function>
- all digit extensor(EDC) → FCR로 tendon transfer
- radial abduction of thumb(EPL) → PL로 tendon transfer

2. High radial nerve palsy
   - low + radial wrist extensor + brachioradialis

- Commonly used TT
  - PT to ECRB
  - FCR to EDC
  - PL to EPL

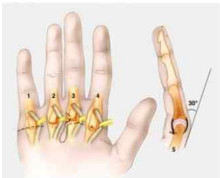


Ulnar nerve palsy

1. Low ulnar nerve palsy
   - Weakness of pinch, grip, clawing of 4,5 finger (d/t FDP function save)

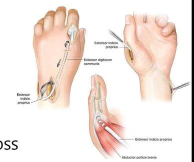
- Adductor pollicis paralysis
  - Adduction만 불능 → brachioradialis or ECRB TT
  - Adduction + Opposition 안될 때 → 4^{th} FDS로 single TT

- Clawing finger
  - EIP TT. → intrinsic m. function restore
  - Zancolli capsulodesis



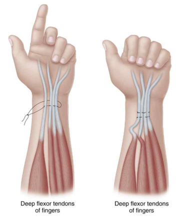
2. High ulnar nerve palsy
   - low ulnar n. palsy + weakness of $4,5^{th}$ FDP + FCU
   - $4,5^{th}$ FDP → 3^{rd} FDP에 suture
   - ECRL to 3,4,5 FDP TT

Median nerve palsy



1. Low median nerve palsy
   - loss of opposition of thumb + radial 3 finger sensation loss
   - Tx : Opponensplasty

2. High median nerve palsy
   - low median n. palsy+ loss of pronation forearm + loss of flexion of wrist & 1,2,3rd fingers



- Restoration
  - Thumb opposition
    - EIP TT
  - 2,3rd FDP
    - attached to ulnar innervated FDP by side by side suture
  - Flexion of thumb
    - brachioradialis to long thumb flexor at wrist level

Quiz #1

- 전완 근위부 후방의 종양 수술을 받은 환자가 수술 후 무지와 수지의 신전이 되지 않았다. 신경 이식술을 시행했으나 신경 회복이 되지 않아 건이전술을 고려할 때 수지 신전 재건을 위해 가장 적절한 공여근은?
  - Palmaris longus
  - Pronator quadratus
  - FCR
  - ECRB
  - ECRL

Quiz #1

- 전완 근위부 후방의 종양 수술을 받은 환자가 수술 후 무지와 수지의 신전이 되지 않았다. 신경 이식술을 시행했으나 신경 회복이 되지 않아 건이전술을 고려할 때 수지 신전 재건을 위해 가장 적절한 공여근은?
  - Palmaris longus
  - Pronator quadratus
  - **FCR**
  - ECRB
  - ECRL

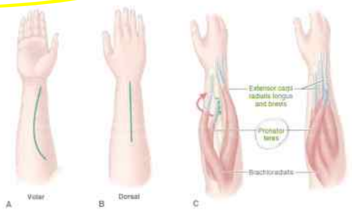
Radial nerve palsy

1. Low radial nerve palsy (PIN마비)
   - Involved muscle - Digital extensors, APL, EPL, EPB
   - Radial wrist extensor & brachioradialis m. → spare (High radial nerve palsy와 DDx.)

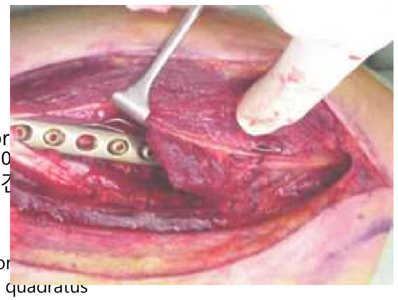
<restore해야 하는 basic function>
- all digit extensor(EDC) → FCR로 tendon transfer
- radial abduction of thumb(EPL) → PL로 tendon transfer

2. High radial nerve palsy
   - low + radial wrist extensor + brachioradialis

- Commonly used TT
  - PT to ECRB
  - FCR to EDC
  - PL to EPL



Quiz #2

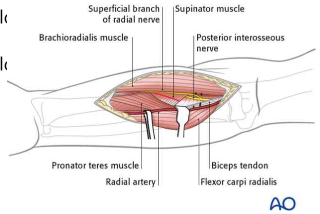


- 전완부 골절로 Henry appr 하던 중 다음 그림의 신경이 였으나 회복이 되지 않아 건 조합은?
  - Palmaris longus + pronator
  - Pronator teres + pronator quadratus
  - Pronator teres + palmaris longus + FCR
  - Palmaris longus + FCR
  - Pronator teres + palmaris longus

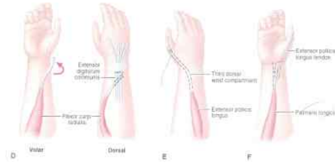
Quiz #2

- 전완부 골절로 Henry appr
  하던 중 다음 그림의 신경0
  였으나 회복이 되지 않아 간
  조합은?

  - Palmaris longus + pronator
  - Pronator teres + pronator
  - Pronator teres + palmaris l
  - **Palmaris longus + FCR**
  - Pronator teres + palmaris l



Radial nerve palsy

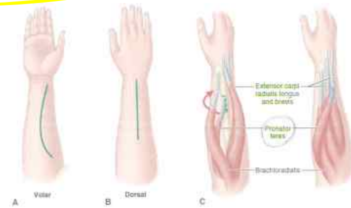


1. Low radial nerve palsy (PIN마비)
   - Involved muscle - Digital extensors, APL, EPL, EPB
   - Radial wrist extensor & brachioradialis m. → spare (High radial nerve palsy와 DDx.)

<restore해야 하는 basic function>
- all digit extensor(EDC) → FCR로 tendon transfer
- radial abduction of thumb(EPL) → PL로 tendon transfer

2. High radial nerve palsy
   - low + radial wrist extensor + brachioradialis

- Commonly used TT
  - PT to ECRB
  - FCR to EDC
  - PL to EPL



Superior Capsule Reconstruction Using Acellular Dermal Allograft Secured at 45° of Glenohumeral Abduction Improves the Superior Stability of the Glenohumeral Joint in Irreparable Massive Posterosuperior Rotator Cuff Tears

Burak Altintas, M.D., Hunter W. Storaci, M.S., Lucca Lacheta, M.D., Grant J. Dornan, M.Sc., Joseph J. Krob, M.D., Zachary S. Aman, B.A., Nicole Anderson, B.A., Samuel I. Rosenberg, B.A., and Peter J. Millett, M.D., M.Sc.

Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 39, No 4 (April), 2023: pp 922-930

Myongji Hospital
Department of Orthopedics
R3. Joon Woo Lee

Introduction

- Irreparable rotator cuff tears (RCTs) present a particularly complex and difficult challenge.
- The prevalence of full-thickness RCTs in the general population is approximately 22% and increases with patient age.
- Tissue inelasticity, poor tendon quality, adhesions, muscle atrophy, and fatty infiltration can all contribute to irreparability.
- Some treatment options exist for these tears, including partial repair, patch-augmented repair, bridging rotator cuff reconstruction with a graft, latissimus dorsi tendon transfer, and arthroscopic superior capsule reconstruction (SCR).

Introduction

- Arthroscopic SCR was first reported by Mihata et al.
  - effective for reducing superior humeral head translation.
  - minimally invasive surgical technique for the treatment of irreparable superior RCTs.
  - limited number of published biomechanical studies on SCR using acellular dermal allograft (ADA).
  - no consensus regarding the graft fixation angle to enhance glenohumeral stability without sacrificing range of motion or risking graft tear.

Introduction

- Despite the significant improvement following SCR,
  - the high rate of graft tears with ADA remains concerning and raises questions regarding the adequate graft fixation angle → due to the importance of maintaining appropriate graft tension at 90° abduction and preventing graft tears at 0° abduction.

Introduction

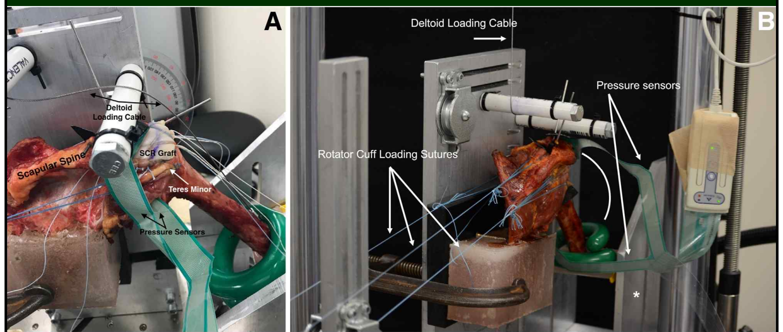
- Purpose of this study
  - to determine the effect of graft fixation angle on shoulder biomechanics following SCR
  - to assess which commonly used fixation angle (30° vs 45° of abduction) results in superior glenohumeral biomechanics
- Hypothesis
  - SCR will reduce humeral head superior translation, glenohumeral contact pressure and subacromial contact pressure of the native state.
  - Graft fixation at 45° of abduction will show increased glenohumeral stability compared to fixation at 30° of abduction.

Materials & methods

- Twelve fresh-frozen male cadaveric shoulder specimens
  - No osteoarthritis, osteoporosis, prior injury or surgery to the shoulder
- Specimen preparation
  - Each specimen underwent a diagnostic arthroscopy
    → excluded if labral or rotator cuff pathologies existed.
  - All soft tissues were removed except for the teres minor, infraspinatus, supraspinatus, and subscapularis muscle bodies and their respective insertions
  - The inferior portion of the scapula was potted in a rectangular mold filled with PMMA (polymethyl methacrylate)
  - The humeral shaft was transected 6 cm distal to the deltoid tuberosity and fixed in a half cylindrical mold filled with PMMA to allow controlled abduction during testing

Materials & methods

- Testing setup

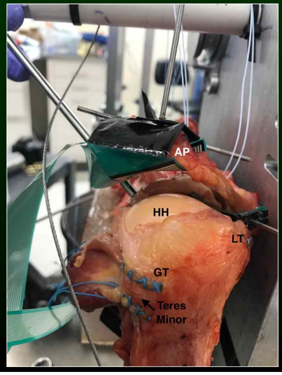


Materials & methods

- Testing setup
  - Physiological rotator cuff muscle forces were simulated by loading the intact musculature with free weights suspended by a pulley system
    - Sutured using high-strength sutures (#2 FiberWire)
    - Rotator cuff loading protocol
      - 6.7 N, supraspinatus
      - 15.6 N, infraspinatus and teres minor
      - 24.5 N, subscapularis
  - A pulley system was used to approximate the anatomical pull of the deltoid muscle.
    - 8.9-N force on the distal aspect of the humerus to approximate the weight of the arm

Materials & methods

- Testing setup
  - Two-pronged pressure sensor was carefully fixed on the surface of the glenoid fossa and on the undersurface of the acromion
    - Secured the sensors using screws



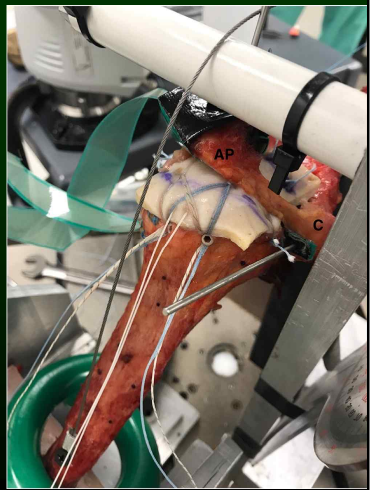
Materials & methods

- Surgical technique
  - Open SCR using an ADA (40 x 70 x 3.0 mm ArthroFLEX, Arthrex)
  - The supraspinatus and infraspinatus muscles and tendons were removed completely. The long head of the biceps was detached at its insertion to the superior labrum
  - Three 3 x12.4 mm PEEK suture anchors (SutureTak, Arhtrex) → to the superior glenoid.
    - sutures passed through the graft in a horizontal mattress fashion
  - Four biocomposite 4.75 x 19.1 mm knotless suture anchors (SwiveLock) → to the humeral side fixation
    - Following the first fixation at 30° or 45° of abduction and subsequent testing, the lateral row anchors were removed, and the graft was retensioned for the second fixation at the respective angle of abduction before the lateral row anchors were reinserted

Materials & methods

- Additional sutures passed through the lateral portion of the graft and were connected to a dynamometer
  → to fix the graft using the same tension for all specimens
  → to minimize variability as the graft can be tightened differently

- Reconstruction was completed by suturing the allograft to the subscapularis and infraspinatus tendons in a side-to-side fashion using high strength suture



Results

Table 1. Intact-subtracted Superior Translation by State

	State	EM Mean (mm)		95% CI
Group Averages	Massive RCT	1.59		0.82 - 2.35
	SCR at 30°	0.29		−0.48 - 1.05
	SCR at 45°	0.53		−0.24 - 1.31
	Comparison	**Mean Difference (mm)**	**95% CI**	***P* Value**
Pairwise Comparisons	Massive RCT vs SCR at 30°	1.30	0.68 - 1.91	<.0001
	Massive RCT vs SCR at 45°	1.06	0.44 - 1.67	.0006
	SCR at 30° vs SCR at 45°	−0.24	−0.86 - 0.37	.3923

Group averages and pairwise between-state comparisons. Results are derived from 2-factor linear mixed-effects models with tested abduction angle assumed constant.
EM Mean, estimated marginal mean; 95% CI, Holm-adjusted 95% confidence intervals.

Table 2. Subacromial Peak Pressure Results by State

	State	EM Mean (kPa)	95% CI
Group Averages	Intact	430	191 - 670
	Massive RCT	580	341 - 819
	SCR at 30°	546	307 - 786
	SCR at 45°	584	344 - 823

	Comparison	Mean Difference (kPa)	95% CI	*P* Value
Pairwise Comparisons	Intact vs Massive RCT	−150	−400 - 101	>.999
	Intact vs SCR at 30°	−116	−366 - 135	>.999
	Intact vs SCR at 45°	−153	−404 - 97	>.999
	Massive RCT vs SCR at 30°	34	−217 - 284	>.999
	Massive RCT vs SCR at 45°	−4	−254 - 247	>.999
	SCR at 30° vs SCR at 45°	−38	−288 - 213	>.999

Group averages and pairwise between-state comparisons.
EM Mean, estimated marginal mean; 95% CI, Holm-adjusted 95% confidence intervals.

Table 3. Glenohumeral Peak Pressure Results by State

	State	EM Mean (kPa)	95% CI
Group Averages	Intact	547	394 - 699
	Massive RCT	814	661 - 967
	SCR at 30°	760	607 - 913
	SCR at 45°	718	565 - 871

	Comparison	Mean Difference (kPa)	95% CI	*P* Value
Pairwise Comparisons	Intact vs Massive RCT	−68	−246 - 110	.014
	Intact vs SCR at 30°	−213	−391 -35	.063
	Intact vs SCR at 45°	−172	-350 -6	.164
	Massive RCT vs SCR at 30°	54	−124 - 232	>.999
	Massive RCT vs SCR at 45°	96	−82 - 274	.731
	SCR at 30° vs SCR at 45°	42	−136 - 220	>.999

Group averages and pairwise between-state comparisons.
EM Mean, estimated marginal mean; 95% CI, Holm-adjusted 95% confidence intervals.

Discussion

- The main finding of this study
  - SCR decreased the superior translation of the humeral head following irreparable posterosuperior RCT
  - The fixation at 45° of glenohumeral abduction provided better restoration of glenohumeral contact pressure than did the fixation at 30°
    → According to Mihata et al., further evidence in SCR's benefit in reducing subacromial joint impingement and improving overall joint stability in cases of irreparable supraspinatus tears.
    → Since SCR is used more frequently for massive irreparable RCTs rather than tears of the supraspinatus alone, the current study analyzed the effect of SCR for an irreparable tear that involved both the supraspinatus and infraspinatus tendons.

Discussion

- According to El-shaar et al.,
  - SCR with an LHB autograft in a cadaveric massive rotator cuff tear model showed biomechanically equivalent to SCR with a TFL autograft in the prevention of superior humeral migration. To superiorly translate a humerus for 1.5 cm, LHB autografts required significantly more stress for superior translation compared to TFL autografts.
    → The results of the present study are in line with the previously published literature showing a positive biomechanical effect of SCR on glenohumeral stability in the coronal plane.

Discussion

- The optimal tensioning angle for SCR remains unclear.
  - Mihata et al. reported that fixation of the TFL graft with a glenohumeral abduction of 10° versus 30° at time of reconstruction showed similar results in restoring the stability
  - Moreover, the ideal placement to counteract strain without excessive graft slack was determined to be a humeral orientation of 25° abduction and 20° internal rotation.
    → This is very important as the graft fixation angles in the reported clinical outcome studies vary widely between neutral abduction to 70° of elevation and 10° of abduction.

Discussion

- The present study showed that graft fixation at 45° of abduction provided better improvement of glenohumeral contact pressure.
  - Determining the optimal graft fixation angle is crucial in getting the most consistent improvement in shoulder function without early graft failure after SCR.

Table 3. Glenohumeral Peak Pressure Results by State

	State	EM Mean (kPa)	95% CI
Group Averages	Intact	547	394 - 699
	Massive RCT	814	661 - 967
	SCR at 30°	760	607 - 913
	SCR at 45°	718	565 - 871

	Comparison	Mean Difference (kPa)	95% CI	*P* Value
Pairwise Comparisons	Intact vs Massive RCT	−68	−246 - 110	.014
	Intact vs SCR at 30°	−213	−391 -35	.063
	Intact vs SCR at 45°	−172	-350 -6	.164
	Massive RCT vs SCR at 30°	54	−124 - 232	>.999
	Massive RCT vs SCR at 45°	96	−82 - 274	.731
	SCR at 30° vs SCR at 45°	42	−136 - 220	>.999

Group averages and pairwise between-state comparisons.
EM Mean, estimated marginal mean; 95% CI, Holm-adjusted 95% confidence intervals.

Limitation

- Effects of various tension angles on long-term stability is not known.
- While fixation at 45° better improved glenohumeral contact pressure, fixation at lower abduction angles might result in better clinical function or graft incorporation.
- Controlling abduction while fixing the other elements may limit the clinical translation of the results.
- The multiple testing conditions may have produced certain laxity in the surrounding soft tissue structures including the ADA.

Conclusion

- SCR improved the superior stability of the glenohumeral joint when the graft was attached at 30° or 45° of glenohumeral abduction.
- The fixation at 45° of glenohumeral abduction provided more stability than did the fixation at 30°.

J Shoulder Elbow Surg (2023) 32, 1420–1431

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Clinical and radiological outcomes in lateralized versus nonlateralized and distalized glenospheres in reverse total shoulder arthroplasty: a randomized control trial

Brendan R. Southam, MD[a], Yehia H. Bedeir, MD[b], Brian M. Johnson, MD[a,*], Kimberly A. Hasselfeld, MS[a], Michael A. Kloby, MS[a], Brian M. Grawe, MD[a]

[a]Department of Orthopaedic Surgery, University of Cincinnati Academic Health Center, Cincinnati, OH, USA
[b]Department of Orthopaedic Surgery, Alexandria University, Alexandria, Egypt

2023.06.20
명지병원 정형외과
R2. 김수영

Introduction

- Reverse Total Shoulder Arthroplasty (RTSA): Established treatment for shoulder pathologies, especially rotator cuff tear (RCT) arthropathy
- Historical RTSA designs : lateralized center of rotation (COR) and glenoid component neck
  - Unwanted shear force, rotation torque on glenoid-implant surface
- Paul Grammont : introduced new concepts in RTSA design
  - Medialized COR and glenosphere without a neck
  - Medial shift of the COR minimized undesired forces on the glenoid-implant interface
  - Decreased deltoid force required for abduction due to longer moment arm

Introduction

- Despite improved results, Grammont-style prostheses faced challenges
  - Scapular notching, instability - inadequate soft-tissue tensioning
  - Loss of external and internal rotation, loss of shoulder contour
- Advances in implant materials, glenoid fixation methods, and surgical techniques have allowed the reintroduction of some lateralization of the center of rotation (COR)
- This lateralization aims to overcome the disadvantages of Grammont-style prostheses while maintaining glenoid component fixation and stability.

Introduction

- Lateralization of the COR offers potential benefits
  - Minimizing impingement and notching, improving range of motion (ROM) and stability, More anatomical shoulder contour
- Recent studies have investigated different approaches to lateralization, including through the humerus, glenosphere, or a combination of both
- Some studies have reported improved ROM and reduced scapular notching with lateralization techniques
- However, other studies have found no significant differences in ROM, scapular notching, or patient-reported outcome scores

Introduction

- Advantages of lateralization can be achieved through lateralizing the humerus, but glenoid (COR) lateralization offers additional benefits.
  - Restore and/or lateralize the joint line, reducing peripheral impingement and notching more effectively than humeral lateralization.
  - Positions the COR closer to the anatomical shoulder's COR
- Glenoid lateralization can be achieved either by the design of the implant, by bone graft, or by a combination of bone graft and augmentation
  - Van de Kleut et al : found no difference between bony or metallic glenoid lateralization
  - By implant : decreased surgical time and more accurate control of the amount of lateralization

Introduction

- Although multiple implants are currently used with varying designs, the appropriate method and degree of lateralization are without consensus.
  - Greiner et al : randomized trial - 10-mm bony-increased offset (BIO) vs standard RTSA
  - Significant improvement in external rotation was found in the BIO RTSA group only when patients with degenerative changes of the teres minor were excluded
- Randomized controlled trial comparing nonlateralized with implant-lateralized RTSA has not been previously reported in the literature

Purpose

- Compare clinical and radiographic outcomes of RTSA using a lateralized vs. a nonlateralized and distalized eccentric glenosphere.
- Primary hypothesis : patients who receive a lateralized glenosphere implant would have significantly better functional outcomes and ROM, particularly with external rotation.
- Secondar hypothesis : Patients who receive a lateralized glenosphere implant would have significantly better radiographic outcomes and fewer complications.

Method

- prospective randomized controlled trial
- Single institution between November 2017 and November 2021
- Inclusion : All adult patients (>18 years of age) who underwent RTSA for RCT arthropathy, irreparable RCTs, glenohumeral arthritis, avascular necrosis of the humeral head, proximal humerus fracture malunion/nonunion, and revision arthroplasty for a failed hemiarthroplasty, anatomic arthroplasty, or reverse arthroplasty or resurfacing in a single fellowship-trained surgeon's practice were considered eligible for enrollment in the study.
- Exclusion
  - Nonelective procedures : Infection, acute fracture, and tumor

Method

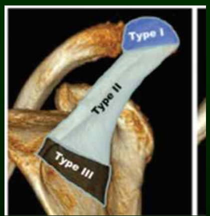
- Clinical outcome assessment : enrollement, 3, 6, 12, and 24 months
  - American Shoulder and Elbow Surgeons (ASES)
  - Patient-Reported Outcomes Measurement Information System Physical Function Upper Extremity (PROMIS PF UE) Computer Adaptive Test
  - Activities of Daily Living Requiring Active External and Internal Rotation (ADLEIR) questionnaire
  - Shoulder ROM : active forward flexion, active abduction, and active external rotation with the arm at both 0 and 90 of abduction

Method

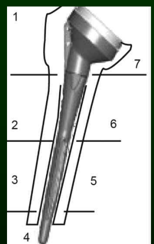
- Radiology assessment
  - Scapular notching, presence of heterotopic ossification
  - Presence of acromion fracture (Levy classification system)
  - Radiolucent lines around the glenoid screws, around the peg, or below the glenoid baseplate (by Melis et al.)
  - Loosening : component migration, shift, tilt or subsidence, or if complete radiolucency > 2 mm was present in each zone.
  - Humeral radiolucent lines were assessed in 7 zones (by Gruen et al)
  - Humeral Implant loosening : Displacement of the humeral component between the time of the initial postoperative radiograph and the most recent follow-up, or if radiolucency > 2 mm was present in more than 3 zones.
  - Lateralization shoulder angle and distalization shoulder angle (Boutsiadis et al)

Method

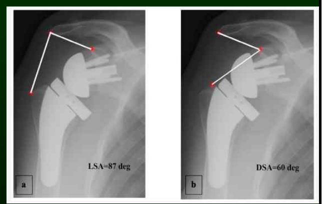
- Radiology assessment



(Levy classification system)



(Gruen et al.)



(Boutsiadis et al)

Results

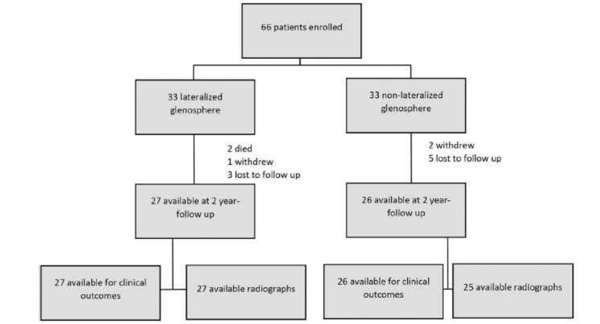


Figure 1 Study flowchart.

Results

Table I Indications for surgery in the lateralized and nonlateralized glenosphere groups

Indication	Lateralized glenosphere (n = 27)	Nonlateralized glenosphere (n = 26)
RCT arthropathy	21 (77.8)	20 (76.9)
Massive RCT	–	2 (7.7)
Avascular necrosis	1 (3.7)	–
Glenohumeral arthritis	1 (3.7)	–
Post-traumatic osteoarthritis	1 (3.7)	–
Failed hemiarthroplasty	1 (3.7)	–
Failed anatomic TSA	1 (3.7)	1 (3.8)
Failed reverse TSA	–	1 (3.8)
Humeral head fracture malunion	1 (3.7)	1 (3.8)
Proximal humerus nonunion	–	1 (3.8)

RCT, rotator cuff tear; *TSA*, total shoulder arthroplasty.
Data are presented as n (%).

Results

Table II Patients' demographics and preoperative measures

Variable	Lateralized glenosphere (n = 27)	Nonlateralized glenosphere (n = 26)	*P* value
Age (yr)	66.1 ± 7.1	73.0 ± 8.4	.002*
Female:male ratio	14:13	15:11	.669
ADLEIR	17.1 ± 9.6	18.5 ± 8.5	.579
ASES	31.0 ± 17.6	36.3 ± 20.7	.267
PROMIS PF UE	28.2 ± 7.1	27.5 ± 9.3	.789
Forward flexion (°)	80 ± 58	72 ± 50	.607
Abduction (°)	57 ± 41	58 ± 40	.966
ER at 0° (°)	10 ± 20	25 ± 23	.013*
ER at 90° (°)	25 ± 27	39 ± 31	.180
Internal rotation (°)	6.4 ± 1.2	6.2 ± 1.6	.647

ADLEIR, Activities of Daily Living Requiring Active External and Internal Rotation questionnaire; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *PROMIS PF UE*, Patient-Reported Outcomes Measurement Information System Physical Function Upper Extremity Computer Adaptive Test; *ER*, external rotation.
Data are presented as mean ± standard deviation.
* Statistical significance.

Results

Table III Preoperative and 2-year postoperative outcome and range of motion measures within each group and a comparison between groups

Variable	Lateralized glenosphere (n = 27)			Nonlateralized glenosphere (n = 26)			Postoperative between-group comparison (*P* value)
	Preoperative	Postoperative	*P* value	Preoperative	Postoperative	*P* value	
ADLEIR	17.1 ± 9.6	30.6 ± 5.1	<.001*	18.5 ± 8.5	31.4 ± 5.3	<.001*	.581
ASES	31.0 ± 17.6	69.4 ± 25.4	<.001*	36.3 ± 20.7	77.1 ± 20.7	<.001*	.229
PROMIS PF UE	28.2 ± 7.1	38.1 ± 10.0	<.001*	27.5 ± 9.3	41.3 ± 10.8	<.001*	.271
Forward flexion (°)	80 ± 58	136 ± 39	<.001*	72 ± 50	145 ± 35	<.001*	.384
Abduction (°)	57 ± 41	101 ± 29	<.001*	58 ± 40	107 ± 29	<.001*	.439
ER at 0° (°)	10 ± 20	41 ± 24	<.001*	25 ± 23	43 ± 22	.010*	.736
ER at 90° (°)	25 ± 27	47 ± 28	.017*	39 ± 31	48 ± 24	.379	.875
Internal rotation	6.4 ± 1.2	5.2 ± 1.3	.001*	6.2 ± 1.6	4.5 ± 1.6	.001*	.158

ADLEIR, Activities of Daily Living Requiring Active External and Internal Rotation questionnaire; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *PROMIS PF UE*, Patient-Reported Outcomes Measurement Information System Physical Function Upper Extremity Computer Adaptive Test; *ER*, external rotation.
Data are presented as mean ± standard deviation.
* Statistical significance.

Results

Table IV Change in preoperative and 2-year postoperative outcomes and range of motion measures between groups

Variable	Lateralized glenosphere (n = 27)	Nonlateralized glenosphere (n = 26)	*P* value
Δ ADLEIR	13.5 ± 9.5	12.9 ± 9.2	.818
Δ ASES	38.4 ± 26.7	40.8 ± 24.4	.737
Δ PROMIS PF UE	9.9 ± 11.4	13.7 ± 10.3	.208
Δ Forward flexion (°)	58 ± 54	73 ± 54	.268
Δ Abduction (°)	43 ± 45	49 ± 54	.676
Δ ER at 0° (°)	32 ± 21	18 ± 34	.092
Δ ER at 90° (°)	26 ± 23	11 ± 49	.283
Δ Internal rotation (°)	−1.2 ± 1.4	−1.4 ± 2.3	.766

ADLEIR, Activities of Daily Living Requiring Active External and Internal Rotation questionnaire; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *PROMIS PF UE*, Patient-Reported Outcomes Measurement Information System Physical Function Upper Extremity Computer Adaptive Test; *ER*, external rotation.
Data are presented as mean ± standard deviation.

Results

Table V Comparison of 2-year postoperative outcome and range of motion measures between groups only in patients receiving treatment for rotator cuff arthropathy

Variable	Lateralized glenosphere (n = 21)	Nonlateralized glenosphere (n = 20)	*P* value
ADLEIR	30.3 ± 5.5	32.3 ± 4.5	.231
ASES	71.2 ± 26.6	75.6 ± 22.9	.575
PROMIS PF UE	38.1 ± 11.2	41.6 ± 10.6	.307
Forward flexion (°)	141 ± 37	151 ± 21	.277
Abduction (°)	101 ± 31	107 ± 25	.492
ER at 0° (°)	43 ± 23	45 ± 23	.744
ER at 90° (°)	46 ± 28	53 ± 23	.352
Internal rotation (°)	5.0 ± 1.4	4.3 ± 1.6	.125

ADLEIR, Activities of Daily Living Requiring Active External and Internal Rotation questionnaire; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *PROMIS PF UE*, Patient-Reported Outcomes Measurement Information System Physical Function Upper Extremity Computer Adaptive Test; *ER*, external rotation.
Data are presented as mean ± standard deviation.

Results

Table VI Comparison of 2-year postoperative outcome and range of motion measures between patients who received subscapularis or LTO repair and those who did not

Variable	LTO or subscapularis repair (n = 23)	No LTO or subscapularis repair (n = 30)	*P* value
ADLEIR	31.9 ± 5.0	30.3 ± 5.2	.273
ASES	75.3 ± 24.8	71.6 ± 22.4	.568
PROMIS PF UE	41.5 ± 11.1	38.2 ± 9.9	.267
Forward flexion (°)	146 ± 35	136 ± 38	.335
Abduction (°)	107.4 ± 32.6	101 ± 26	.428
ER at 0° (°)	51 ± 23	35 ± 21	.012*
ER at 90° (°)	51 ± 28	44 ± 25	.388
Internal rotation (°)	4.5 ± 1.5	5.1 ± 1.5	.184
Variable	**LTO or subscapularis repair (nonlateralized group) (n = 12)**	**No LTO or subscapularis Repair (nonlateralized group) (n = 14)**	***P* value**
ADLEIR	33.3 ± 2.7	29.8 ± 6.4	.088
ASES	76.0 ± 23.3	78.1 ± 19.1	.811
PROMIS PF UE	39.0 ± 12.4	37.4 ± 8.4	.291
Forward flexion (°)	153 ± 22	139 ± 43	.332
Abduction (°)	110 ± 38	104 ± 30	.621
ER at 0° (°)	53 ± 24	35 ± 18	.030*
ER at 90° (°)	55 ± 23	41 ± 24	.138
Internal rotation (°)	4.4 ± 1.3	4.7 ± 1.9	.636
Variable	**LTO or subscapularis repair (lateralized group) (n = 11)**	**No LTO or subscapularis repair (lateralized group) (n = 16)**	***P* value**
ADLEIR	30.4 ± 6.5	30.8 ± 4.0	.827
ASES	75.5 ± 27.5	65.8 ± 24.1	.391
PROMIS PF UE	41.5 ± 11.1	38.2 ± 9.9	.696
Forward flexion (°)	139 ± 45	134 ± 35	.727
Abduction (°)	107 ± 32	101 ± 25	.585
ER at 0° (°)	48 ± 24	36 ± 24	.184
ER at 90° (°)	46 ± 33	47 ± 25	.870
Internal rotation (°)	4.7 ± 1.8	5.4 ± 1.0	.180

LTO, lesser tuberosity osteotomy; *ADLEIR*, Activities of Daily Living Requiring Active External and Internal Rotation questionnaire; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *PROMIS PF UE*, Patient-Reported Outcomes Measurement Information System Physical Function Upper Extremity Computer Adaptive Test; *ER*, external rotation.
Data are presented as mean ± standard deviation.
* Statistical significance.

Results

Table VII Two-year postoperative radiographic analysis

Variable	Lateralized glenosphere (n = 27)	Nonlateralized glenosphere (n = 25)	*P* value
Scapular notching (n)	7	4	.385
Heterotopic ossification (n)	6	4	.569
Acromial stress fracture (n)	1	0	.332
Radiolucent lines (n)			
Glenosphere			
Screws	1	0	.332
Peg	0	0	–
Baseplat	0	0	–
Humeral stem, n (%)			
Zone 1	4 (14.8)	5 (20.0)	.624
Zone 2	4 (14.8)	2 (8.0)	.441
Zone 3	1 (3.7)	1 (4.0)	.952
Zone 4	0	0	–
Zone 5	0	0	–
Zone 6	0	0	–
Zone 7	2 (7.4)	1 (4.0)	.596

Discussion

- External rotation
- No significant differences in external rotation at 2-year follow-up between patients who received a lateralized or a nonlateralized and distalized glenosphere.
- In addition, regardless of lateralization status, there was no concomitant loss of internal rotation when external rotation was improved.
- Previous retrospective analyses : demonstrated that metallic lateralization of the glenosphere results in significantly greater external rotation and lower rates of scapular notching when compared with standard RTSA

Discussion

- Patient-reported functional outcome measures, ROM other than external rotation, and radiographic findings.
- Both groups - statistically significant improvement in their ASES, ADLEIR, and PROMIS PF UE values from their preoperative assessment to their 2-year postoperative assessment.
- No significant difference between the groups at their 2-year assessment with regard to their functional outcomes.
- Kirzner et al : recent meta-analysis comparing standard RTSA with implants using metallic lateralization and osseous lateralization were not found to have significant differences in ASES scores between the groups at the final follow-up.

Discussion

- No difference in the rates of scapular notching or acromial stress fractures between patients receiving lateralized or nonlateralized and distalized glenospheres.
- Glenosphere lateralization has previously been shown in the literature to lower rates of scapular notching : Only grade 1 notching
  - Low grade scapular notching has not been shown to negatively influence clinical outcomes.
- It will be important to monitor these patients in the long term to better understand this radiographic finding and its influence on long-term outcomes and potential need for future revision surgery.

Discussion

- Strength
- Prospective randomized control trial performed by a single surgeon
- Used both established and novel patient-reported outcome measures to assess patient outcomes after surgery

Limitations

- Indications for surgery were somewhat heterogeneous and this may have influenced the results.
- Despite the randomization, there was a preoperative difference in age and external rotation between the 2 groups
- 2 patients who were revised for glenosphere dissociation were converted from a lateralized to a nonlateralized glenosphere
- Not enough patients

Conclusion

- At a minimum 2-year postoperative follow-up, patients in both groups had a significant improvement in their functional outcome scores with no significant difference observed between the groups.
- Similarly, patients in both groups had similar ROM at 2-year postoperative followup regardless of lateralization status.
- There were no statistically significant differences in the rates of scapular notching or acromial stress fractures between the 2 groups.
- Long-term follow-up will be necessary to assess the effects of metallic glenosphere lateralization with regard to late complications, clinical outcomes, and implant survival.

Long Head of the Biceps Autograft Performs Biomechanically Similar to Human Dermal Allograft for Superior Capsule Reconstruction After Rotator Cuff Tear

Pranav Krishnan, B.A., Nicholas Maassen, M.D., Cody Lee, M.D., Hayden Baker, M.D., Jason Koh, M.D., Farid Amirouche, Ph.D., and Aravind Athiviraham, M.D.

From the University of Chicago Pritzker School of Medicine (P.K.); Department of Orthopaedic Surgery, University of Chicago (N.M., C.L., H.B., A.A.); Department of Orthopaedic Surgery, Northshore University Health System (J.K., F.A.); and Department of Orthopaedics, University of Illinois at Chicago (F.A.), Chicago, Illinois, U.S.A.

The authors report the following potential conflicts of interest or sources of funding: J.K. reports payment or honoraria for lectures, presentations, speakers' bureaus, manuscript writing or educational events from Smith & Nephew; leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid: AAOS, American Shoulder and Elbow Surgeons, ACL Study Group, Arthroscopy Association of North America, American Orthopaedic Society for Sports Medicine, International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine, Herodicus Society, Illinois Association of Orthopaedic Surgeons, International Patellofemoral Study Group, and Orthopaedic Journal of Sports Medicine/AOSSM Patellofemoral Foundation; and stock or stock options from Acuitive and Marrow Access Technologies. A.A. reports payment or honoraria for lectures, presentations, speakers' bureaus, manuscript writing or educational events from Arthrex; and leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid: AAOS, American Orthopaedic Association, American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America, Arthroscopy, and Video Journal of Sports Medicine. ICMJE author disclosure forms are available for this article online, as supplementary material.

Received May 10, 2022; accepted October 20, 2022.

Address correspondence to Aravind Athiviraham, M.D., Department of Orthopaedic Surgery, University of Chicago, 5841 S Maryland Ave., MC 3079, Chicago, IL 60637. E-mail: aathiviraham@bsd.uchicago.edu

0749-8063/22616/$36.00
https://doi.org/10.1016/j.arthro.2022.10.023

Introduction

- Irreparable massive rotator cuff tear
  - tears with a diameter greater than 5 cm
  - inability to anatomically reduce the tear without placing excessive strain
  - greater than 50% fatty infiltration of the rotator cuff muscles
  - glenohumeral stability and function can be compromised
    → leading to symptoms of pain and weakness that interfere with activities of daily life
- Have historically had limited treatment options in the young and active patient population
  - debridement
  - partial rotator cuff repair
  - subacromial balloon spacer
  - reverse total shoulder arthroplasty (rTSA)
- Yet limitations remain with each option, either due to limited outcomes, high complication rates, or circumscribed patient indications

Introduction

- Initially described by Mihata et al., superior capsule reconstruction (SCR) was developed as an alternative for younger patients with irreparable rotator cuff tears
  - the use of a tensor fascia lata autograft to reconstruct the superior capsule
  - restore glenohumeral stability in both biomechanical and clinical studies by reducing superior translation of the humeral head
  - potential risk of donor-site morbidity
- Human dermal allograft (HD) and long head of the biceps tendon (LHBT) autograft have emerged as viable options for SCR
  - HD allograft remains one of the most popular alternatives, having been shown to consistently decrease humeral head migration
  - tendency for the HD allograft to elongate by approximately 15% after experimental testing, raising potential concerns of graft failure

Introduction

- This finding might be avoided with the LHBT autograft due to its similar or even improved ultimate strength, strain, and strain energy density compared with other rotator cuff tendons
- Like both the fascia lata autograft and HD allograft, the LHBT autograft has been shown to significantly reduce superior migration of the humeral head compared with the torn rotator cuff

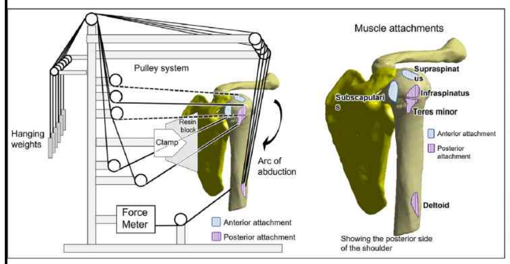
Purpose

- As the choice of using an autograft versus an allograft for SCR currently remains unclear, this study aimed to provide a biomechanical comparison between HD allograft and LHBT autograft with and without posterior side-to-side suturing for SCR

- Hypothesis
  - SCR with HD allograft would increase functional abduction force and decrease superior translation of the humeral head compared with that in SCR with LHBT autograft
  - LHBT with side-to-side suturing would lead to improved glenohumeral stability compared with LHBT without side-to-side suturing

Materials and Methods

- 8 fresh frozen human cadaveric shoulders
- Preserve the glenohumeral joint capsule, and coracoacromial and coracohumeral ligaments



- Each shoulder was tested in 5 conditions
  - (1) intact
  - (2) complete supraspinatus tear
  - (3) LHBT autograft
  - (4) LHBT with side-to-side suturing
  - (5) HD allograft with side-to-side suturing

- 0˚, 30 ˚, 60 ˚, and 90˚ of abduction
- 3 separate trials were recorded

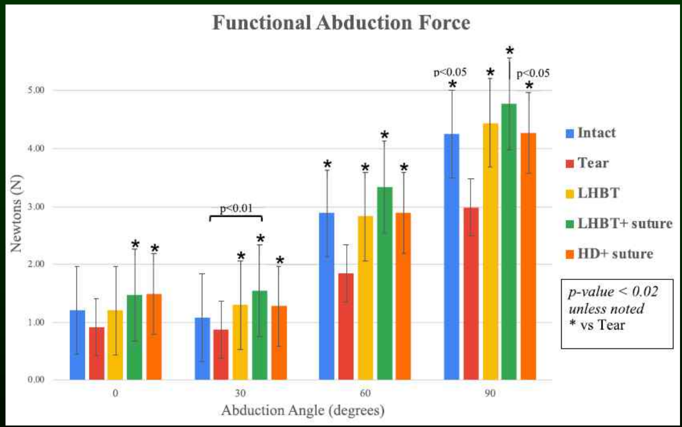
- Functional abduction force
- Superior translation of the humeral head
- Maximal rotational range of motion

- LHBT was tenotomized just underneath the bicipital groove, leaving its attachment to the superior labrum intact

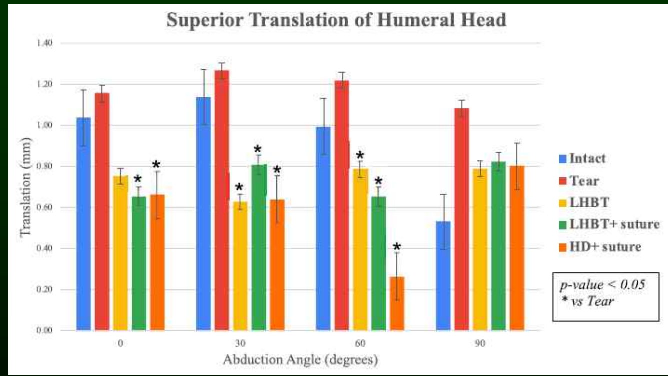
- A punch was used to create a hole at the greater tuberosity, biased towards the posterior portion of the supraspinatus footprint

- The graft was then tenodesed with a single SwiveLock anchor(Arthrex)

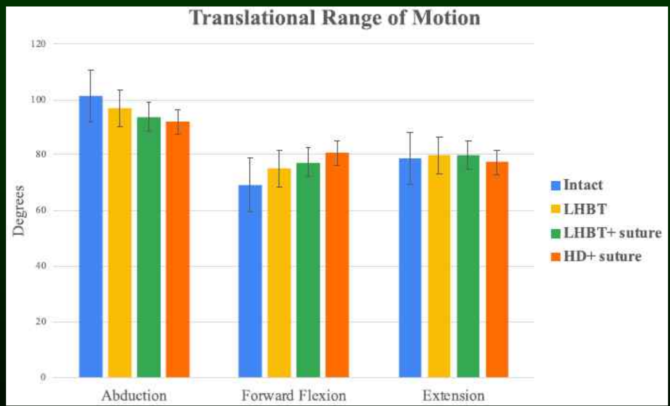
Result



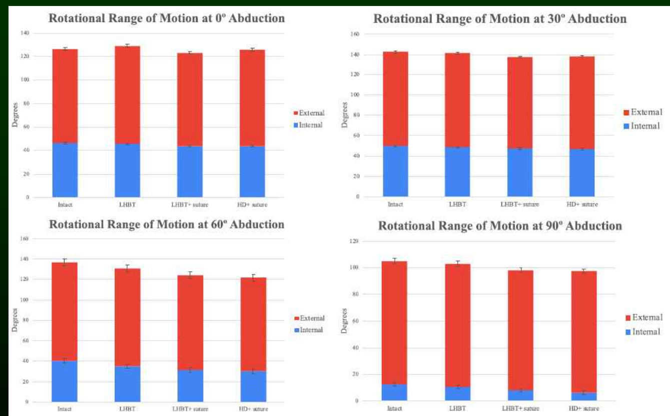
Result



Result



Result



Discussion

- LHBT, LHBT + suture, and HD + suture can all restore functional abduction force to intact levels after a supraspinatus tear
- Functional abduction force
  - not as commonly studied as subacromial pressure
  - an important consideration in biomechanics research, as it has strong clinical correlates
  - active shoulder elevation is a vital outcome often measured to assess the efficacy of operative treatment intervention, in contrast to subacromial contact pressure, which would be difficult to measure in a clinical setting
- Align with the reported data in that SCR with HD allograft was shown to restore functional abduction force to intact levels

Discussion

- Builds on previous research by directly comparing SCR with a dermal allograft and a biceps tendon autograft
- Berthold et al.
  - finding a single-stranded design without side-to-side suturing to be similar to both a box and V-shaped configuration
  - As the result of its described efficacy and relative operative ease, the single-stranded LHBT seemed an ideal candidate to represent the LHBT autograft in a comparison with the HD allograft
- Chose to also incorporate posterior side-to-side suturing with the single-stranded LHBT due to previous studies showing its effect on enhancing SCR's efficacy

Discussion

- LHBT, LHBT + suture, and HD + suture each significantly decreased superior translation compared with the torn supraspinatus condition, in line with previous studies investigating SCR with the LHBT autograft and HD allograft
- No significant differences in superior translation between all 3 reconstructive techniques
  - While it was hypothesized that the HD allograft with its increased surface area would provide more of a resistive force compared with LHBT, the LHBT acted as a stable humeral head depressor to improve shoulder kinematics at a statistically identical level
- Rybalko et al.
  - decreased rotational range of motion at both 60˚ and 90 ˚ of abduction attributing it to the tethering effects of the anterior and posterior side-to-side suturing securing the SCR dermal graft
- Our findings are similar to Mihata et al. who reported no difference in rotational range of motion between SCR both with and without posterior side-to-side suturing

Discussion

- Question of using a LHBT autograft or HD allograft for SCR remains relevant
- LHBT
  - healthy, functional LHBT may preclude
  - its relatively new status, it has not been studied as much as the HD allograft
  - lower cost
  - its relative technical ease leading to a potentially shorter operative time
  - a smaller implant footprint
- Dermal allografts
  - reported higher complication
  - deform during biomechanical studies, with one study detailing a 15% elongation of the dermal graft after shoulder testing

Discussion

- Some patients who receive SCR with HD allograft may require a conversion to rTSA due to graft failure

- Given this likelihood, it may be prudent to account for the relative disruption to local structures inherent in any surgical procedure
  - As LHBT involves fewer suture anchors than HD, and thus entails reduced disruption of the glenoid and proximal humerus, it may allow for more flexibility in planning a rTSA, if ultimately necessary

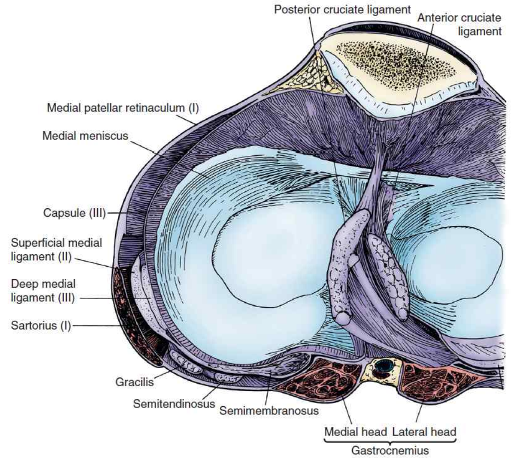
Conclusion

- SCR with LHBT autograft $\pm$ posterior side-to-side suturing, and HD allograft with posterior side-to-side suturing all equivalently restore functional abduction force and decrease superior translation of the humeral head after a complete supraspinatus tear

MEDIAL LIGAMENTOUS INJURIES OF THE KNEE

명지병원 정형외과

R3 조형인

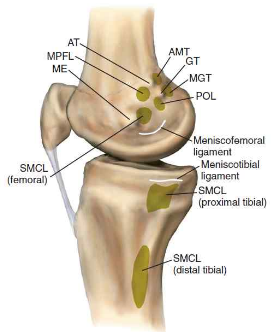


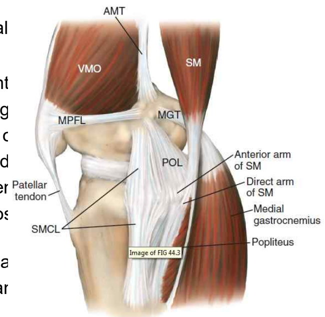
ANATOMY

- Medial side of the knee
  - a spatial concept of three distinct layers
  - Layer 1
    - crural fascia of the knee
      - present from the patella anteriorly to the popliteal fossa posteriorly
    - sartorius fascia
      - blends with the crural fascia anteriorly as it attaches to the tibia
    - The gracilis (G) and semitendinosus tendons
      - between layers 1 and 2

- Medial side of the knee
  - Layer 2
    - superficial medial collateral ligament (SMCL)
      - 3.2 mm proximal and 4.8 mm posterior to the medial

tibial
joint
ral lig
nent c
l and
amer
e pos
nedia
nal ar





- superficial, central, and capsular arm

TREATMENT

- ISOLATED MEDIAL COLLATERAL LIGAMENT INJURY
  - robust healing response
    - its blood supply
    - relatively wide surface area
    - association with other secondary stabilizers
    - extra-articular location
  - The mainstay of treatment of isolated MCL
    - **nonoperative** with an expectation of good outcomes

- Lundberg and Messner
  - Reported patients treated nonoperatively with grade I or II MCL injury
  - good return of function, normal to near-normal stability, and no increased risk of osteoarthritis at 10-year follow-up
- Indelicato et al
  - followed 21 athletes for a mean of 46 months with isolated grade III MCL injuries
  - nonoperatively
  - demonstrated 95% good and excellent result
  - The average return
    - 9.2 weeks after injury for the group

- Rehabilitation protocol
  - no standardized
  - several basic tenants of treatment
    - ① **the knee is stabilized in a brace**
      to protect against a second valgus insult
    - ② **early motion and weight bearing**
      is encouraged and improves the rate and quality of the healing response
    - ③ **quadriceps and hamstring strengthening are started early in the process**
      to prevent deconditioning and optimize the function of the knee's dynamic stabilizers

TREATMENT

- COMBINED INJURIES

1. **Anterior Cruciate Ligament and Medial Collateral Ligament**
   - Appropriate treatment of patients with combined ACL and MCL injuries continues to evolve
   - The ACL
     - acts as a secondary stabilizer to valgus stress
     - contributes to the innate healing potential of the MCL
     - Loss of a functional ACL
       - diminish the capacity of the MCL to heal with nonoperative treatment

- Zaffagnini et al
  - compared the immediate postoperative stability of combined ACL/MCL injuries
    - reconstruction of both ligaments
    - reconstruction of the ACL injury only
    - ACL alone led to greater immediate postoperative laxity than did reconstruction of both ligaments
  - minimum 3-year follow-up
    - no significant valgus laxity and no difference in AP stability
- Grant et al
  - nonoperative treatment of the MCL while regaining motion prior to ACL reconstruction
  - failing to heal the MCL with persistent valgus instability
  - concomitant reconstruction could take place

- **Halinen et al**
  - prospective randomized trial
  - evaluating knee range of motion and quadriceps power
  - In group 1
    - treated with early ACL reconstruction and MCL repair
  - In group 2
    - ACL reconstruction only
  - group 2 saw both variables return more quickly
  - No differences were seen in motion, power, instrumented stability, Lysholm, IKDC score
  - **recommended nonoperative treatment of combined injuries when the ACL was reconstructed**
- Noyes and Barber-Westin
  - operative treatment of the medial structures in ACL/MCL injuries
  - increased rate of flexion loss and patellofemoral pain

TREATMENT

- **COMBINED MULTI-LIGAMENT INJURY AND KNEE DISLOCATION**
  - Treatment protocols **vary among surgeons**
  - Some surgeons prefer reconstruction/repair of all injured ligaments
  - Some prefer to brace for 4 to 6 weeks to regain motion and reconstruct the cruciates alone
    - if valgus stability is restored
  - others prefer to address the MCL and PCL acutely
    - reconstruct the ACL if needed later
  - Although final results seem to be similar with all approaches
    - a risk of arthrofibrosis exists with early reconstruction or repair of all structures

- Fanelli and Edson reported
  - Multiligamentous knee injuries with 2- to 10-year follow-up
  - Outcomes of operative and nonoperative treatment of combined ligament injuries with MCL involvement
  - Normal valgus testing at 30 degrees of flexion
    - All patients treated operatively
    - seven of eight patients treated nonoperatively
- Less clear regarding the most effective treatment
  - combination of
    - relative rarity of the injury
    - heterogeneity of injury patterns
    - treatment approach and technique
    - associated medical and trauma issues

TREATMENT

Insall's treatment

- isolated MCL injuries
  - nonoperatively with full-time brace wear and a functional rehabilitation program
  - Immediate weight bearing
  - active and passive range of motion started
    - patient tolerates
  - A full-length brace : first 2 to 4 weeks
  - short-hinged knee brace : another 6 weeks
  - Time to return to play
    - depends on the degree of injury, the athlete's recovery, and the sport/position
    - typical return times between 4 and 6 weeks after injury

---

- isolated MCL injuries
  - Exceptions to the nonoperative treatment
    - large bony avulsions identified on radiographs
    - Stener-type lesions of the distal MCL
    - and patients with persistent functional valgus instability
- acute ACL/MCL combination injuries
  - Regardless of MCL injury grade
  - treated **with isolated ACL reconstruction after range of motion ha been re-established**
  - ACL and MCL reconstruction
    - persistent valgus laxity
    - particularly in extension
    - chronic ACL tears with residual valgus instability
  - standard post-ACL reconstruction rehabilitation

- **Multi-ligament injury**
  - prefer to address ACL/PCL/ MCL injuries with reconstruction of all injured ligaments
    - after range of motion has been regained
  - The cruciate ligaments are reconstructed initially
  - functional integrity of the MCL is then assessed

Medial collateral ligament reconstruction is necessary to restore anterior stability with anterior cruciate and medial collateral ligament injury

Junjun Zhu[3] · Jiangtao Dong[1,2] · Brandon Marshall[3] · Monica A. Linde[1] · Patrick Smolinski[1,3] · Freddie H. Fu[1,3]

Received: 15 March 2017 / Accepted: 12 May 2017

- The purpose of this study
  - compare knee kinematics and graft forces
  - in anterior cruciate ligament (ACL) reconstruction combined with one of two superficial medial collateral ligament (sMCL) reconstruction techniques

- **Conclusion**
  - single-bundle ACL reconstruction
    - not able to restore anterior tibial translation, valgus rotation, and external rotation
  - combined ACL and sMCL injuries and sMCL reconstruction was also required
  - ACL and parallel sMCL reconstruction
    - restored valgus and external rotation stability

Medial Collateral Ligament Reconstruction in Patients With Medial Knee Instability

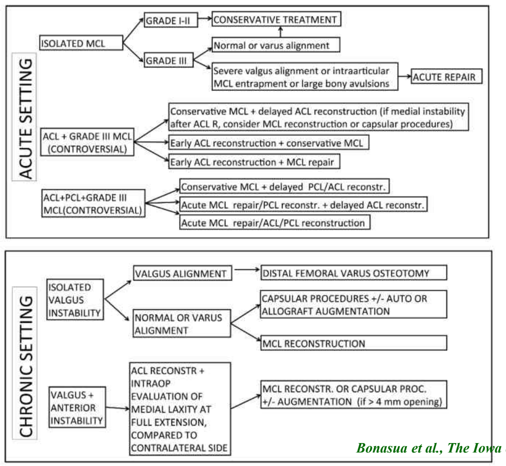
A Systematic Review

Antonios N. Varelas,*† BA, Brandon J. Erickson,‡ MD, Gregory L. Cvetanovich,‡ MD, and Bernard R. Bach Jr,‡ MD
Investigation performed at Rush University Medical Center, Chicago, Illinois, USA

- **Purpose**
  - compare the outcomes of isolated MCL reconstruction and multiligamentous MCL reconstruction
  - MCL reconstruction would significantly improve objective and subjective patient knee performance measures, baseline valgus laxity, range of motion

- Conclusion
  - The systematic review of 10 studies and 275 knees
  - patient outcomes after MCL reconstruction were significantly improved
  - no significant difference in outcomes between concomitant reconstructions

Treatment Algorithm for Medial and PM injuries



Bonasua et al., The Iowa orthopedic journal, 2012

Summary

Majority of MCL injuries alone: ***conservative***

Grade III MCL injuries with gross valgus instability at 0 degree: ***controversial***

More severe injuries with intra-articular MCL entrapment, large bony avulsion, multiple ligaments involvement, and severe valgus alignment: ***acute repair or augmentation***

Isolated symptomatic chronic MCL laxity: ***reconstruction***

Kim et al. JBJS, 2008
Bonasua et al., The Iowa orthopedic journal, 2012

2023 knee conference

Recurrent patella dislocation

Myongji hospital
Department of Orthopedic Surgery
R4 Lee In el
Presentation Date: 2023.06.12

Case review

박 O 형 F/18 #01032317

- Chief complaint
  - Rt. knee pain & instability
  - Onset : 5년 전
- Present illness
  - 18세 여자환자 지난 5년 동안 탈구력 5차례 과거력 있는 자로 지속적인 Rt. knee instability를 주소로 외래 경유 입원.

Past history

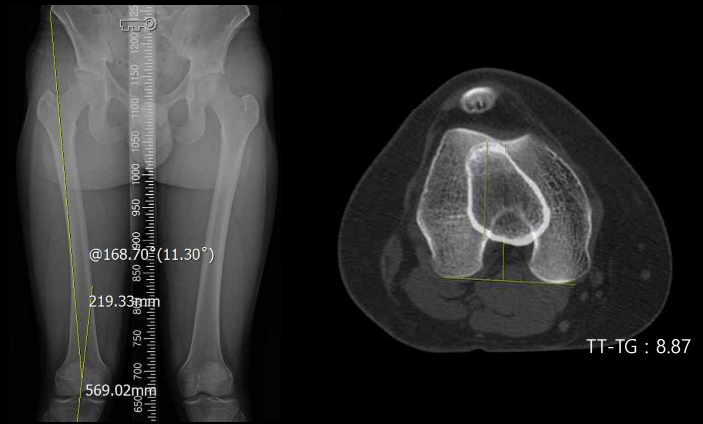
- Medical history
  - n-s
- Social history
  - Sports activity : moderate activity

Physical examination

- **General**
  - 신장 161cm, 체중 81.6kg
  - BMI : 31.48 (kg/m²)

- Exam plan
  - TT-TG
  - Insall-Salvati ratio
  - congruence angle
  - MRI

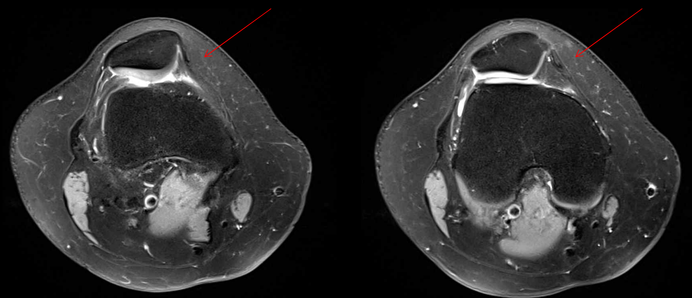
AP view, knee CT



Lateral view

Both Merchant view

MRI



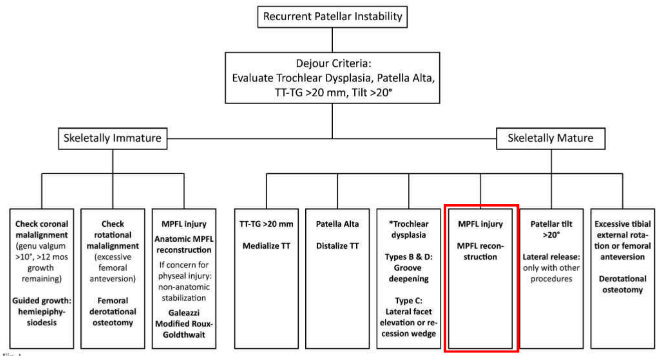


Fig. 1

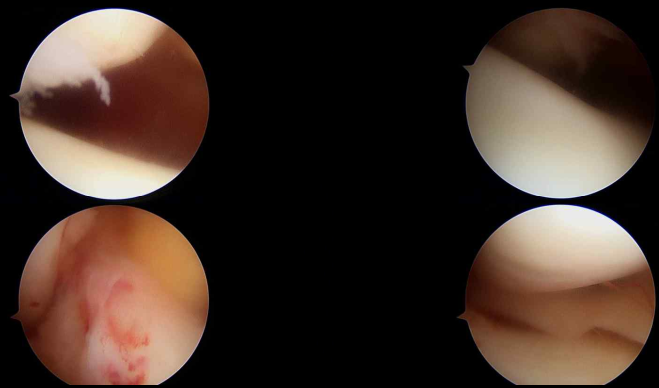
An algorithmic approach for the treatment of recurrent patellar instability. The asterisk indicates that caution should be exercised when trochleoplasty is being considered, given the technical challenges and controversial clinical outcomes.

Ref) An Algorithmic Approach to the Management of Recurrent Lateral Patellar Dislocation, Alexander E. Weber. 2016, J Bone Joint Surg Am

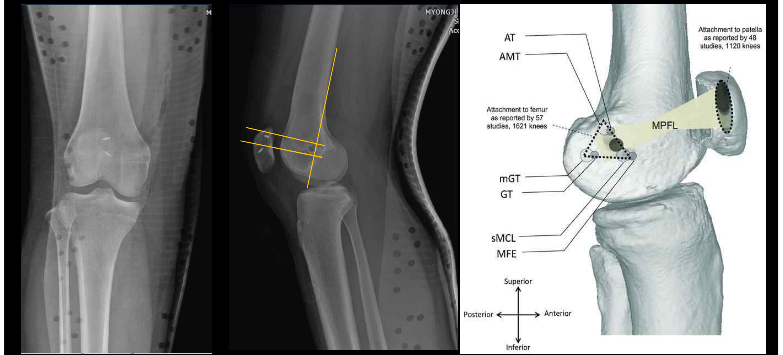
Diagnosis & Plan

- Diagnosis
  - Recurrent patella dislocation, knee, Rt.
  - Rupture, MPFL, knee, Rt.
- Plan
  - A/S exam + MPFL recon, knee, Rt.

A/S exam + MPFL recon, knee, Rt.



Post op knee x-ray



Knee surgery Sports Traumatology, Arthroscopy. 2017

Recurrent patella dislocation review

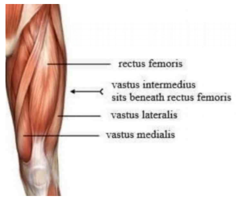
Introduction

- Etiology
  - Result from one or more traumatic dislocations
  - Abnormal contour or alignment of the joint itself
    - congenital or traumatic
  - Congenital relaxation of the soft supporting

cf) 대정.
(1) congenital dislocation
(2) habitual dislocation
(3) traumatic dislocation

Introduction

- Dynamic stabilizer
  ① V. lateralis : lateral 7-10°
  ② V. lateralis obliqus (VLO) : 31-39 °
  ③ V. medialis longus : medial 15-18 °
  ④ V. medialis obliqus (VMO) : medial 50-55 °



- Static stabilizer
  ① Shape of patella
  ② Femoral sulcus
  ③ Patellar tendon of appropriate length
  ④ Normally tensioned medial capsule reinforced by patellofemoral & patellotibial lig.
  ⑤ Medial patellofemoral ligament (MPFL)
  : main factor(50~60%) of recurrent patellar dislocation

Introduction

- **Q angle**
  - Definition :
    - Angle forced by the line of pull of the **quadriceps mechanism** and **patellar tendon**
  - Measure
    - In 30° flexion state
    - Line of between ASIS - patellar center ~ line of between Tibial tuberosity and patellar center
  - Normal range
    - Male 8-10 degree, Female 15 ± 5 degree (Campbell)
    - Average 15+- 3 degree, male 14 degrees, female 17 degree
  - Q-angle > 20 degrees abnormal !!

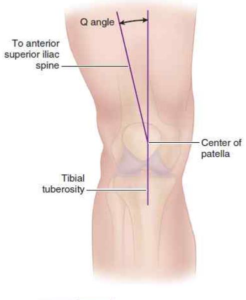


FIGURE 47-1 Q angle (see text).

① Genu valgum
② Increased femoral anteversion
③ External tibial torsion
④ laterally positioned tibial tuberosity
⑤ tight lateral retinaculum
⑥ IR of femur

Q angle ↑↑

Clinical features

1) History : most important diagnostic tools
   - Diffuse pain around the knee
     - Aggravated by going up and down stairs
   - Pain usually is located anterior in the knee
   - Giving way or going out of knee
   - Patella crepitus and swelling of the knee

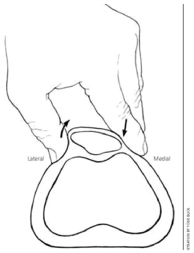
Physical exam

(1) apprehension test
- Relaxed knee in 20 to 30 degrees of flexion
- manually subluxes the patella laterally.
- Patient suddenly complains of pain and resists any further lateral motion of the patella → **Positive**

(2) The patellar grind test
- knee extension
- Applying pressure to the patella a
- Manually displacing it in the trochlear

Physical exam

(3) The patellar tilt test
- Relaxed knee in 20 ~ 30° degrees of flexion
- Fingers are placed along the medial side of the patella with the thumb on the lateral aspect
- Inability to raise the lateral facet → excessive lateral retinacular tightness



Physical exam

(5) J sign

- 앉아있는 환자가 무릎을 서서히 신전할 때 검사자가 앞에서 관찰
- Slight lateral subluxation of the patella as the knee approaches full extension
- Excessive lateral translation in extension which "pops" into groove as the patella engages the trochlea early in flexion
- Associated with patella alta

Radiographic features

1) AP view
→ bipartite patella / osteochondral fracture of med. patellar edge
→ loose body or osteochondral fracture

2) Lateral view : patella alta
→ Blumensaat's line
→ Blumensaat's line should extend to inferior pole of the patella at 30° degrees of knee flexion

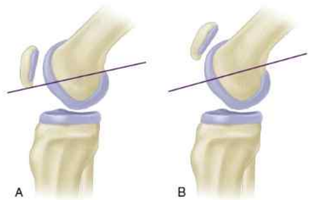


FIGURE 47.1 A, Normal knee. Lower pole of patella at Blumensaat line at 30 degrees of flexion of knee. B, Patella alta. Patella significantly proximal to Blumensaat line.

Insall ratio

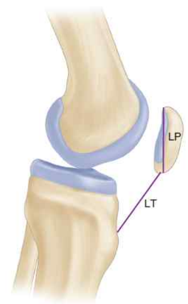


FIGURE 47-4 Insall method of diagnosing patella alta. Length of patellar tendon (LT) and length of patella (LP) have normal LT-to-LP ratio of 1.0. Variation of more than 20% indicates abnormal position.

- ▶ Length of patella tendon (LT)
- ▶ Length of patella (LP)

- ▶ Normal range = 1.0 ± 0.2
- ▶ Patella alta = LT / LP > 1.2

Dejour

▶ True lateral radiograph with the knee in 20 degrees of flexion

▶ Trochlear depth measured 1 cm from the top of the groove

→ should be 5 mm or more

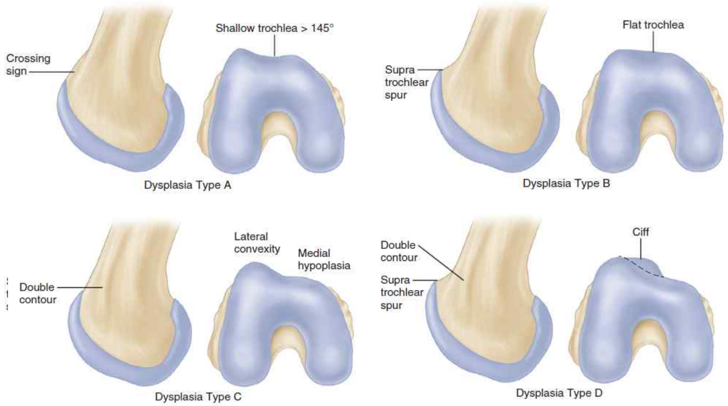
▶ Crossing sign

→ Anterior cortical outline of condyle intersects trochlear outline

▶ Supratrochlear spur

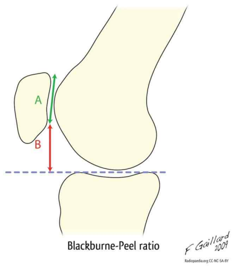
→ Trochlear line extends anterior to femoral cortex

FIGURE 47-6 "Crossing" sign and trochlear bump.



Blackburne and Peel

- patella 길이와 tibia 에서 patella 까지의 길이비 측정
- X-ray 상에서 더 쉽게 잴 수 있다.
- 정상은 0.54-1.06



Diagnosis

Axial view

▶ Most important routine view of the patellofemoral joint

▶ 45도 flexion 하는 Merchant view

▶ Sulcus angle (137 ± 6도) : 150도 이상 시 비정상

▶ Congruent angle (- 8 ± - 6도) : 16도 이상 시 비정상

▶ 동시에 양 무릎을 같은 조건에 두고 찍어야 비교

→ Quadriceps muscles은 relax 하고

knee는 20 ~ 45 도 flexion

→ Further flexion 시

대부분의 patellofemoral abnormalities가 정복

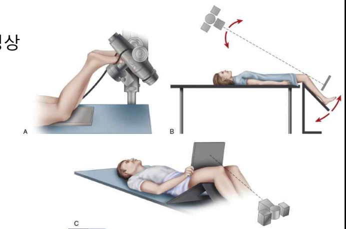
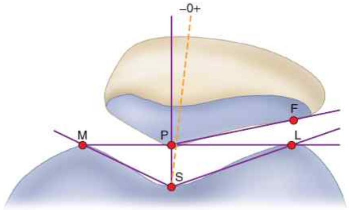


FIGURE 47.2 Radiographic techniques for evaluation of patellofemoral joint. A, Infrapatellar view. B, Axial view. C, Skyline view.

Diagnosis



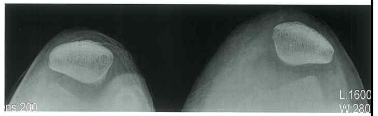


그림 V-41. 좌측 슬개골의 외측 탈구가 보인다(Merchant view).

FIGURE 47-10 Measurements of patellofemoral congruence described by Merchant et al. F, facet; L, lateral condyle; M, medial condyle; P, patellar ridge; S, sulcus. Angle *MSL* is sulcus angle (average, 137 degrees; standard deviation, 6 degrees). Line *SO* is zero reference line bisecting sulcus angle. Angle *PSO* is congruence angle (average, –8 degrees; standard deviation, 6 degrees). Line *PF* (lateral facet) and line *ML* form patellofemoral angle that should diverge laterally.

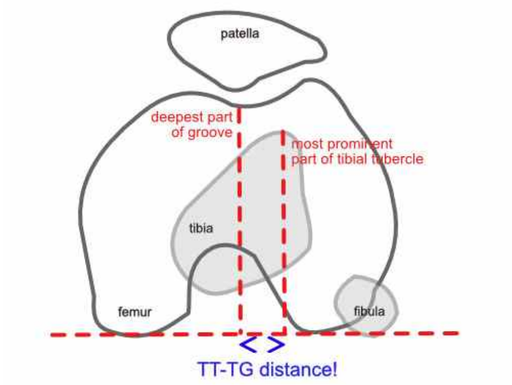
Abnormral range
Sulcus angle > 150°
Congruence angle > 16°

Diagnosis

30도 flexion axial CT

- Tibial tuberosity-trochlear groove (TT-TG) distance
  - 정상 : 13mm (7-17mm)
  - 20mm < : 확실한 비정상으로 수술해야 함 (대정)
-
- For recurrent instability
  - Distal realignment is indicated for a TT-TG distance of more than 20 mm

TT-TG distance



Diagnosis

MRI

- ▶ **Most useful for evaluating** the soft-tissue restraints of the patellofemoral joint and the chondral surfaces
- ▶ Standard MRI : 85% sensitive and 70% accurate in detecting injury to the **MPFL**
- ▶ Predominantly disrupted at the femoral origin
- ▶ MRI can detect characteristic findings of a patellar dislocation
  : cartilage damage, bone bruising on the medial patellar facet and the lateral femoral condyle
- ▶ Concomitant cartilage injuries
  : expected in 70% to 96%

TABLE 47.1

Radiographic Measurements of the Patella

TECHNIQUE	MEASUREMENT	CHARACTERISTICS
Blumensaat line (Fig. 47.1), lateral radiograph, to determine patella alta	With knee flexed 30 degrees, line is drawn through intercondylar notch	Should approximate the lower pole of the patella
Insall-Salvati index lateral radiograph	LT:LP = 1.0	Patella alta if ratio ≤1.2
Trochlear depth (Dejour) lateral radiograph	Trochlear depth measured 1 cm from top of groove	Should be ≥5 mm
Patellar height (Caton-Deschamps), lateral radiograph	Ratio between articular facet length of patella (AP) and distance between articular facet of patella and anterior corner of superior tibial epiphysis (AT). Knee flexed 30 degrees.	AP/AT ratio—normal 0.6-1.3 Patella infera—ratio <0.6 Patella alta—ratio >1.3
Blackburne-Peel ratio	Length of articular surface of patella to length measured from articular surface of tibia to inferior pole of patella	Normal ratio 0.54-1.06
Patellar tilt (CT scan)	Angle formed by intersection of the tangent of the posterior condyles and the major axis of the patella on 20-degree flexion scan	Normal angle: <20 degrees Angle >20 degrees: dysplasia
TT-TG (axial radiograph, CT scan)	Two lines drawn perpendicular to posterior bicondylar line, one line through middle of trochlear groove and second through tibial tuberosity. Distance between the lines is measured	>20 mm = malalignment
Crossing sign	Anterior cortical outline of condyle intersects trochlear outline	Dysplastic sulcus
Trochlear bump	Trochlear line extends anterior to femoral cortex	Dysplastic sulcus

CT, Computed tomography; *LP*, length of the patella; *LT*, length of the patellar tendon; *TT-TG*, tibial tubercle-trochlear groove.

Treatment
1. Conservative treatment

1) Acute patellar dislocation or subluxation

- Knee extension, hip flexion하여 quadriceps를 이완시키면 쉽게 정복됨
- Knee extension 위치에서 4-6주간 고정 (대정)
- Immobilization with compressive dressing and crutches ambulation
  - 3-5일간 시행 / acute reaction이 해결되면 푼다.
- hemarthrosis 있으면 aspiration 시행

Conservative treatment

Rehabilitation

① closed chain exercises
Wall sets (knee 40도 굴곡, 15-20초, 총 10-15회)
대퇴사두근의 등척성 근 운동

② Side and forward step-up exercise
Using a 6 to 8-inch platform

③ Short arc leg presses and endurance-type strengthening

④ Patellar stabilizing brace for 6-8wks

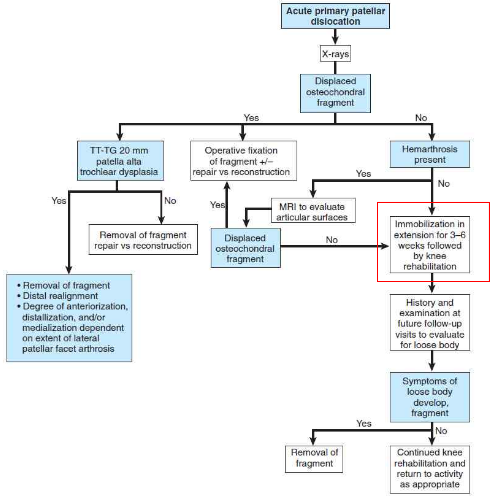


FIGURE 60-2 Algorithm for guiding the evaluation and management of acute primary patellar dislocation.

Acute patellar dislocation
--> operative indication

(acute, 1st time dislocation시)

① Osteochondral fracture
② Loose body formation
③ Joint incongruity
④ High-level athletic activities : after season off
Open repair of MPFL & VMO

Surgical treatment

▶ Patellofemoral malalignment and Recurrent patellar subluxation

▶ 5가지의 수술 방법 (대정)
① 외측지대 이완술 (Lateral release)
② 근위 신전 기전 재정렬 (Q < 17도) (Proximal soft tissue procedure)
③ 원위 신전 기전 재정렬 (Distal realignment)
④ 근위 및 원위 신전 기전 재정렬
⑤ 슬개골 절제술 및 신전 기전 재정렬

Surgical treatment

(2) lateral release
① Ix
- Isolated procedure for parapatellar pain
- Secondary to excessive lateral pressure syndrome
  - Ex) negative patellar tilt
  - EX) Less than one quadrant passive medial patellar glide (lateral tightness)

② open or arthroscopic procedure
③ Open Lateral Release
- M/C Cx : hemarthrosis
- Caution : Superolateral geniculate vessel !

Surgical treatment

(3) Proximal soft tissue procedure
① Ix
▶ Q angle < 17도
→ instability secondary to medial laxity with or without trochlear dysplasia
→ Instability in skeletally immature patients

② Realignment of the quadriceps muscle to the patella + lateral release

③ MPFL reconstruction
▶ Ix
→ Without sulcus dysplasia & osteophyte
→ Tuber-sulcus angle이 0~10도 외반, Insall index가 1.4미만일 경우 좋은 결과 (대정)

Realignment of the quadriceps muscle to the patella + lateral release

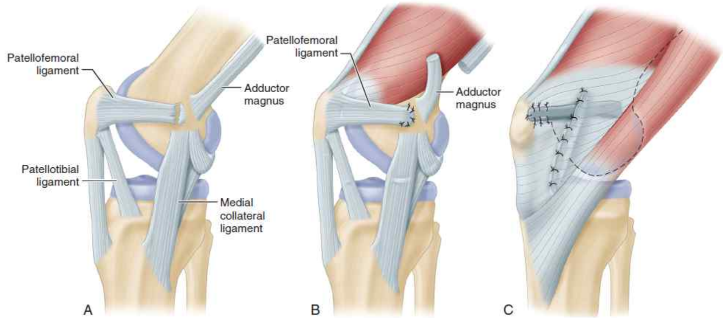


FIGURE 47-14 A, Medial patellofemoral ligament detached from medial femoral epicondyle after acute patellar dislocation. B, Medial patellofemoral ligament with firm edge of vastus medialis obliquus muscle reinserted to periosteum of medial femoral epicondyle, and adductor magnus tendon harvested. C, Adductor magnus tendon fixed near medial border of patella, and retinaculum duplicated.

Schottle's point

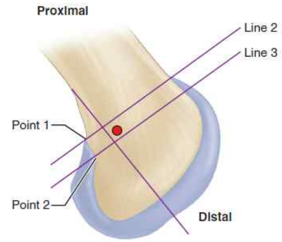


FIGURE 47-16 Schöttle and colleagues' radiographic landmark for femoral tunnel placement in medial patellofemoral ligament reconstruction. Two perpendicular lines to line 1 are drawn, intersecting the contact point of the medial condyle and posterior cortex (point 1, line 2) and intersecting the most posterior point of the Blumensaat line (point 2, line 3). For determination of vertical position, distance between line 2 and the lead ball center is measured as is the distance between line 2 and line 3. SEE TECHNIQUE 47-4.

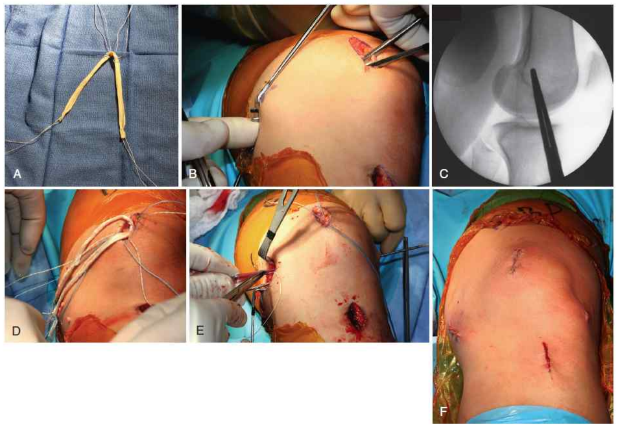
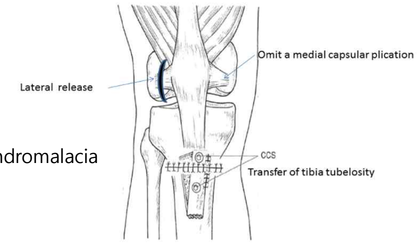


FIGURE 47-15 Phillips reconstruction of the medial patellofemoral ligament. A, Semitendinosus tendon graft. B, Creation of soft-tissue tunnel. C, Correct position confirmed radiographically. D, Whip stitch placed in each end of graft. E, Graft tails passed through soft-tissue tunnel. F, Closure. SEE TECHNIQUE 47-4.

Surgical treatment

Distal realignment



Journal of Knee Surgery. 2017

① Ix

▶ Q angle > 20도

▶ TT-TG > 15mm

▶ Patellar instability c inf. & lat. chondromalacia

② Elmslie - Trillat operation

▶ Ix : Q-angle > 20, skeletally mature Pt.

▶ Procedures that involve transplantation of the tibial tuberosity are contraindicated until the proximal tibial physis has closed → genu recurvatum

▶ Lateral retinacular release + medial retinacular duplication + medial transfer of tibial tuberosity

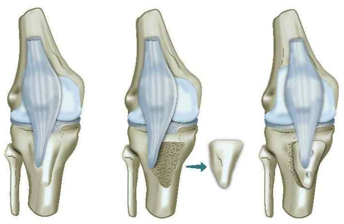
Distal realignment

③ Fulkerson osteotomy Technique

- Ix : Grade 3, 4 chondromalacia
- Oblique osteotomy of the tuberosity
- TT transfer to anteriorly and medially

- Q angle : Corrected to between 10 and 15 degrees.
- Moving anteriorly 8 to 10 mm.

Fig. 027 Tibial tuberosity osteotomy



Malaligned kneecap

Anteromedialization of tibial tuberosity

FIGURE 47.10 Fulkerson procedure. A, Preoperative lateral radiograph. B, Postoperative lateral radiograph. C, Anteroposterior radiograph. SEE TECHNIQUE 47.3.

Surgical treatment

Distal realignment

④ medial and distal transfer of the tuberosity (Simmons procedure)

- Ix : significant patella alta & Insall index > 1.2
- Caution : Patella baja
- 수술 중 tibia 에서 patella 사이 거리가 적어도 1.3cm 남도록 해야 한다

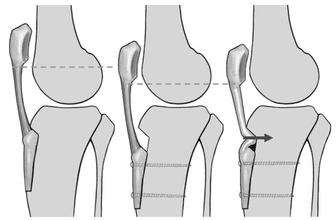


TABLE 47-3

Surgical Procedures for Treatment of Patellar Instability

LOW RISK—LOW REWARD	
Medial repair/imbrication	30% failure rate, approximately the same as conservative treatment Indication: first dislocation + repairable chondral defect Instability in skeletally mature In combination with distal realignment
Lateral release	Excessive lateral pressure syndrome In combination with realignment procedure when excessive tightness prevents patellar centering May increase risk for both medial and lateral patellar subluxation
LOW RISK—HIGH REWARD	
MPFL reconstruction	Indicated for recurrent MPFL deficiency ± trochlear dysplasia Proximal or anterior femoral placement or overtightening results in medial facet overload May combine with distal realignment
Elmslie-Trillat procedure	Indicated for instability, TT-TG >20 mm + strong repairable medial structures Healing time and risk for stress or contact fracture of proximal tibia much less than Fulkerson procedure
HIGH RISK—HIGH REWARD*	
Fulkerson distal realignment	Indicated for symptomatic lateral facet or distal pole arthritis + TT-TG >20 mm Contraindicated with proximal/medial facet arthritis Long healing time, increased risk of proximal tibial fracture with sports
Rotational high tibial osteotomy	Indicated for instability + severe rotational deformity More normalized gait compared with distal realignment
Trochleoplasty	Indicated for dysplastic trochlea Low recurrence rate Increased risk for osteonecrosis, DJD, arthrofibrosis Lateral condyle: increased pressure; increased DJD of lateral facet
Grooveplasty	Increased DJD Good results with less risk reported with MPFL reconstruction
3-in-1 procedure—extensor mechanism realignment + VMO advancement + transfer of the medial third of the patellar tendon to the MCL (Fig. 47-12)	Recurrent instability, TT-TG >20 mm Open physes

문제 1)

▣ 17세 여자가 넘어지면서 발생한 슬관절 내측부의 부종, 통증 및 압통을 주소로 내원하였다. 측정한 영상 검사 소견에서 TT-TG 12mm, Insall-Salvati 1.2, Congruence angle 13°, Sulcus angle 138° 측정되었고, MRI 상 슬개골 내측부와 대퇴 외과의 골타박(Bone contusion) 소견이 보였고, 내측 대퇴슬개인대의 파열 소견이 관찰되었다. 슬관절 내 loose body는 없었다. 이러한 부상이 처음일 경우 현 시점에서의 적절한 치료는? 20B/18B

① 석고 고정 후 재활 치료
② 내측 슬개대퇴인대 봉합술
③ 내측 슬개대퇴인대 재건술
④ 원위부 신전기전 재배열술
⑤ 대퇴활차 성형술

문제 1)

▣ 17세 여자가 넘어지면서 발생한 슬관절 내측부의 부종, 통증 및 압통을 주소로 내원하였다. 측정한 영상 검사 소견에서 TT-TG 12mm, Insall-Salvati 1.2, Congruence angle 13°, Sulcus angle 138° 측정되었고, MRI 상 슬개골 내측부와 대퇴 외과의 골타박(Bone contusion) 소견이 보였고, 내측 대퇴슬개인대의 파열 소견이 관찰되었다. 슬관절 내 loose body는 없었다. 이러한 부상이 처음일 경우 현 시점에서의 적절한 치료는? 20B/18B

① 석고 고정 후 재활 치료
② 내측 슬개대퇴인대 봉합술
③ 내측 슬개대퇴인대 재건술
④ 원위부 신전기전 재배열술
⑤ 대퇴활차 성형술

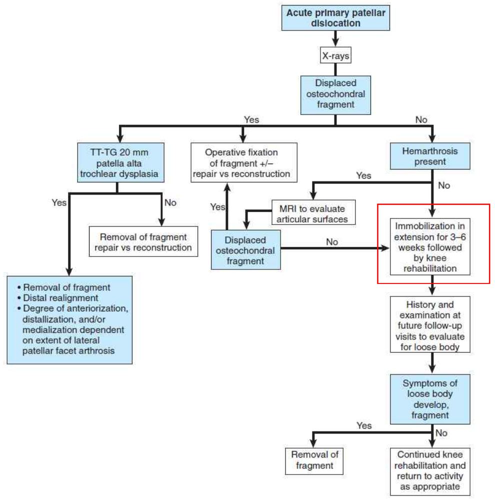


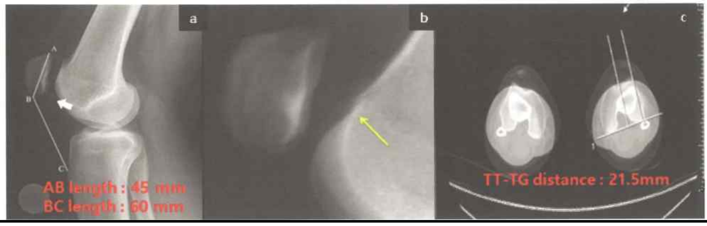
FIGURE 60-2 Algorithm for guiding the evaluation and management of acute primary patellar dislocation.

문제 2)

- 25세 여자로 슬개골이 빠지는 듯한 불안정성과 전방 슬관절 통증이 있어 내원하였다. 진찰 소견상 apprehension test에서 양성을 보였다. 촬영한 단순 방사선 사진과 30도 flexion axial CT 소견이다. 가장 적절한 치료는? 19B2

1) 내측 슬개대퇴인대 재건술
2) 경골결절 내측-원위 이전술
3) 내측 슬개대퇴인대 재건술 + 경골결절 내측 – 원위 이전술
4) 경골결절 전내측인전술
5) 외측 지대 이완술

Insall-Salvati ratio : 1.33 > 1.2
--> patella alta

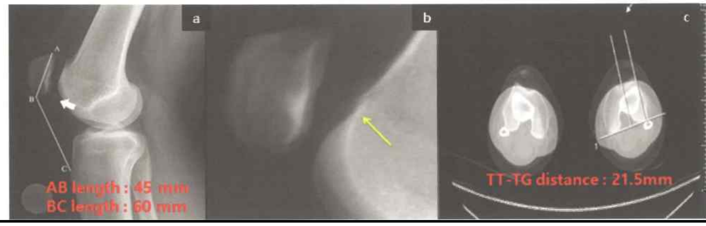


문제 2)

- 25세 여자로 슬개골이 빠지는 듯한 불안정성과 전방 슬관절 통증이 있어 내원하였다. 진찰 소견상 apprehension test에서 양성을 보였다. 촬영한 단순 방사선 사진과 30도 flexion axial CT 소견이다. 가장 적절한 치료는? 19B2

1) 내측 슬개대퇴인대 재건술
2) 경골결절 내측-원위 이전술
3) 내측 슬개대퇴인대 재건술 + 경골결절 내측 – 원위 이전술
4) 경골결절 전내측인전술
5) 외측 지대 이완술

Insall-Salvati ratio : 1.33 > 1.2
--> patella alta



Reference

1) 정형외과학 제7판
P. 1019 ~ 1024 // P. 1480 ~ 1483

2) Campbell's orthopedics 14th edition
Chapter 47 Recurrent dislocation P 2426 ~ 2437

3) Recognition and initial management of patellar dislocations
Author : Brian R Moore, MD, Joan Bothner, MD
Uptodate Sep 27, 2019

4) Surgical Treatment of Patellar Instability in Children and Adolescents,
J Korean Orthop Assoc 2018; 53: 201-209

5) Aframian A, Smith TO, Tennent TD, Cobb JP, Hing CB. Origin and insertion of the medial patellofemoral ligament: a systematic review of anatomy. Knee Surgery, Sports Traumatology, Arthroscopy. 2017

Hip arthroscopy

2023.06.14.
정형외과 R2. 김수영

Introduction

- First described in 1931 by Burman
- **Surgical procedure** that viewing the hip joint **without making a large incision** through the skin and other soft tissues.
- Used to **diagnose and treat** a wide range of hip problems

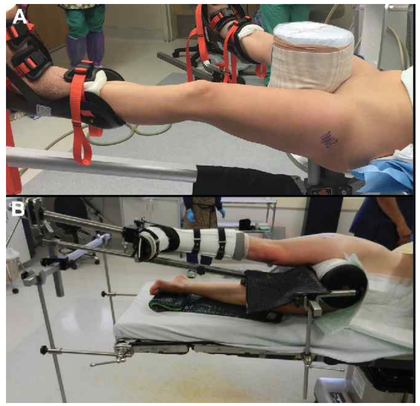
Indications

- **Labral tear (m/c)**
- **Removal of loose bodies**
- **Femoral acetabular impingement**
- **Chondral lesions**
- **Synovial abnormalities**
- **Rupture of Ligamentum teres**
- **Snapping hip syndromes**
- **Joint sepsis**
- **Extra-articular lesion**

  chronic trochanteric bursitis, gluteus medius & minimus tear, piriformis syndrome, calcific tendinitis..

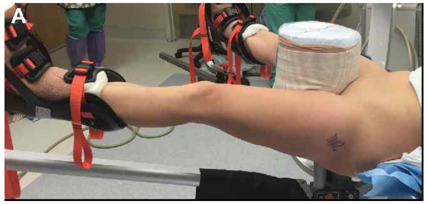
Position

- **Supine position**
- **Lateral position**



Supine position

- Hip joint **extension,** 25 dgr **abduction**, **neutral state**
- Traction within **2hr**, at least **8-10mm** space needed between acetabulum and femoral head
- Avoid to injury **pudendal n. by padding**

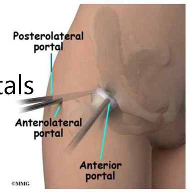


Lateral position

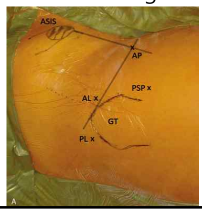
- 0-20 dgr **abduction**, 10-20 **flexion**, slightly **ext. rotation**

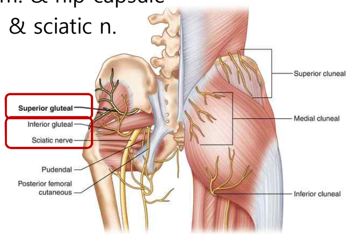
Portal

- Supine position uses three standard portals
  AL portal, PL portal, Anterior portal



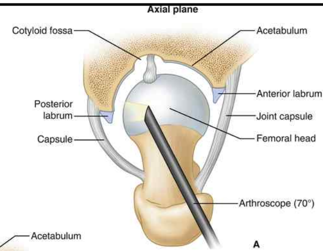
- **AL portal**
  - 1cm superior and anterior to the ant. edge of GT
  - passing through Gluteus medius m. & hip capsule
  - can be damage to sup. Gluteal n. & sciatic n.

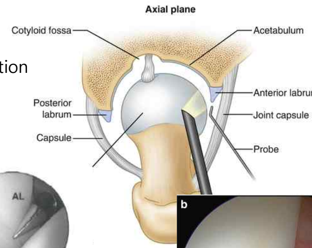




Portal

- **AL portal**
  well finding structure : ant. wall & ant. labrum
  cotyloid fossa
  acetabular ridge
  mid-posterior portion





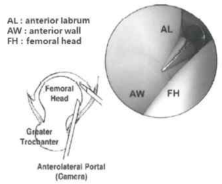
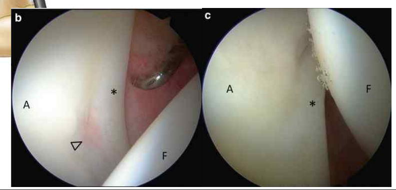
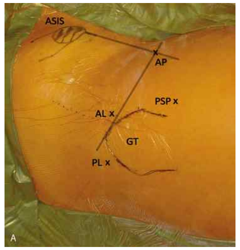


Fig. 14. view from anterolateral portal



Portal

- **PL portal**
  - 1cm posterior and superior to the GT
  - passing through Gluteus medius m. & minimus m.
  - can be damage to sciatic n.
  - well finding structure : post. wall & post. labrum



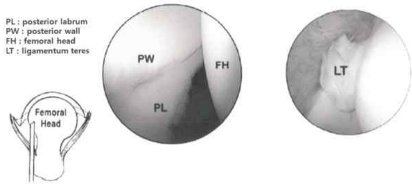
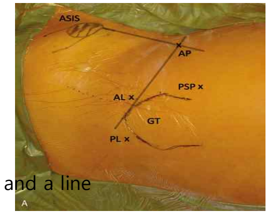


Fig. 17. view form posterolateral portal

Portal

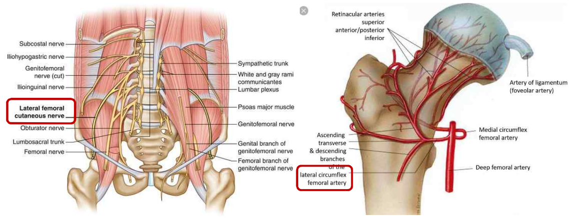


- **Anterior portal**

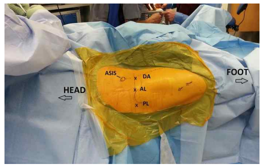
  Intersection of a line drawn from the tip of the GT and a line extending inferiorly from the ASIS
  (치골 결합 부위에서 측면으로 뻗은 수평선과 ASIS에서 아래로 이어진 수직선의 교차점)

  Passing through Sartorius & Rectus femoris m. & hip capsule

  Caution : lateral femoral cutaneous n. & lateral femoral circumflex a. & femoral a.



Portal



- **Anterior portal**

  well finding structure : ant. aspect of femoral neck, superolateral & lateral labrum, stellate crease, ligamentum teres, transverse acetabular ligament

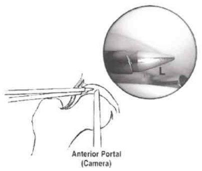
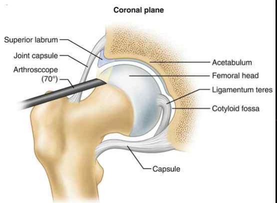
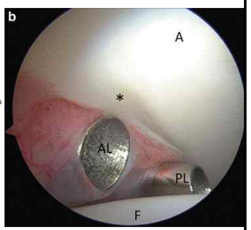
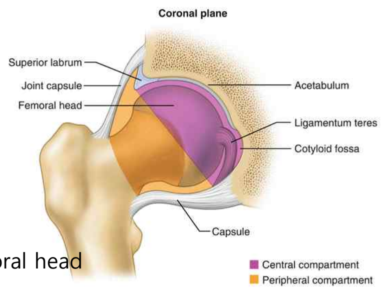


Fig. 12. view from the anterior portal





Compartment

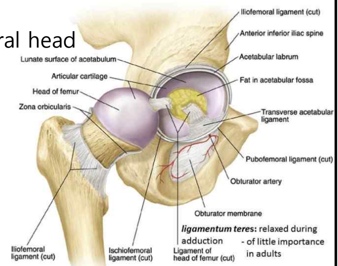


- **Central compartment**

  lunate cartilage
  acetabular fossa
  ligamentum teres
  weight bearing portion of femoral head

- **Peripheral compartment**

  non-weight bearing portion of femoral head
  femoral neck
  medial, anterior, lateral synovial fold
  zona orbicularis
  articular capsule



Compartment

- **Central compartment**
  traction O
  neutral, slight abduction, and neutral rotation at **supine**
  mild abduction, 10-20 dgr flexion, ext. rotation at **lateral**

- **Peripheral compartment**
  traction X, 45 dgr flexion

고관절 관절경 시 Anterior portal을 이용할 때 손상받기 쉬운 해부학적 구조의 명칭 두 개를 쓰시오

고관절 관절경 시 Anterior portal을 이용할 때 손상받기 쉬운 해부학적 구조의 명칭 두 개를 쓰시오

Anterior portal
lateral femoral cutaneous n.
ascending branch of lateral femoral circumflex a.

고관절 관절경술의 적응증이 아닌 것은?

1. Labral tear
2. Chronic trochanteric bursitis
3. Snapping hip syndromes
4. Ligamentum teres rupture
5. ONFH

고관절 관절경술의 적응증이 아닌 것은?

1. Labral tear
2. Chronic trochanteric bursitis
3. Snapping hip syndromes
4. Ligamentum teres rupture
5. ONFH

고관절 관절경술을 받은 환자에게 회음부의 감각 이상이 발생하였다. 수술은 골절 침대에서 환측 고관절을 약 10도 외전시켜 비구와 골두의 간격이 10mm 정도 되도록 견인하였다. 반대편 하지도 골반 경사가 없도록 견인하였으며 견인 시간은 총 60분이었다. 감각 이상의 원인으로 가장 가능성이 높은 것은?

1. 과도한 견인력
2. 과도한 견인시간
3. 하지의 지나친 외전
4. 반대편 하지의 견인
5. 불충분한 회음부 보호

고관절 관절경술을 받은 환자에게 회음부의 감각 이상이 발생하였다. 수술은 골절 침대에서 환측 고관절을 약 10도 외전시켜 비구와 골두의 간격이 10mm 정도 되도록 견인하였다. 반대편 하지도 골반 경사가 없도록 견인하였으며 견인 시간은 총 60분이었다. 감각 이상의 원인으로 가장 가능성이 높은 것은?

1. 과도한 견인력
2. 과도한 견인시간
3. 하지의 지나친 외전
4. 반대편 하지의 견인
5. 불충분한 회음부 보호

Reference

- Campbell, 13^{th}
- 대한정형외과학

Femoro-acetabular Impingement Syndrome

명지병원 정형외과

R4. 경태현

Index

▣ Introduction

▣ Types

▣ Symptoms

▣ Diagnosis

▣ Treatment

▣ Exercise

Introduction

▣ 젊은 환자들의 고관절 통증과 퇴행성 관절염의 원인

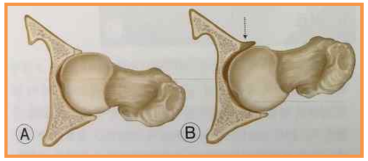
▣ 고관절 굴곡 & 내회전 시, 대퇴 경부와 비구 사이에 비정상적인 충돌 발생
- ▶ 비구 관절연골 분리, 비구순 파열
- ▶ 고관절의 조기 퇴행성 변화

▣ 정상가동범위
- ▶ 굴곡 : 0 ~ 120
- ▶ 신전 : 0 ~ 30
- ▶ 외전 : 0 ~ 45
- ▶ 내전 : 0 ~ 30
- ▶ 내회전 & 외회전 : 0 ~ 45

Types

▣ Cam type / Pincer Type

1. Cam type
   Non-spherical femoral head



① 대퇴골두와 경부 사이 offset의 전상방부가 움폭하게 파이지 않고 평평하거나 볼록하게 과형성되어 돌출된 변형인 두경부 골융기에 의해 발생

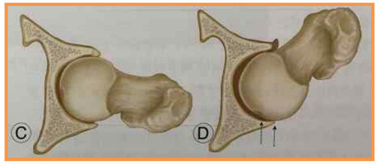
② 방사선 전후면 사진상 근위부 대퇴골의 모양이 마치 권총손잡이
→ Pistol grip deformity

③ 대퇴골두 골단 분리, Legg-Calve-Perthes 병, 대퇴경부 골절 부정유합

Types

▣ Cam type / Pincer Type

2. Pincer type
Excessive acetabular covering



① 비구의 외연이 대퇴 골두를 과도하게 감싸는 변형에 의해 발생

② 고관절 운동 시, 대퇴 경부와 비구의 전상방부가 충돌하게 되고
초기 충돌로 인해 골두가 하외측으로 아탈구 되면서
후하방부 비구 연골을 가격하여 연골분리 재차 발생

③ Coxa profunda, acetabular retroversion

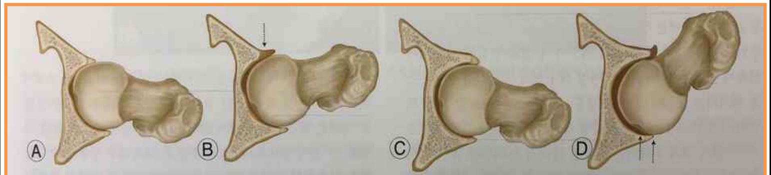


그림 IV-42. 대퇴비구 충돌 증후군의 유형. (A, B) Cam형 충돌 모식도. 고관절 굴곡 시 대퇴골두와 경부 사이에 과형성된 골 조직(bump)이 전방 비구연에 부딪힌다(화살표). (C, D) Pincer 형 충돌 모식도. 비구의 외연이 대퇴골두를 과도하게 감싼 상황에서 고관절을 굴곡할 때 전방 비구연에 충돌이 발생하고 이어 골두가 하외측으로 밀려나면서 후방 비구 연골을 가격한다(2개의 화살표).

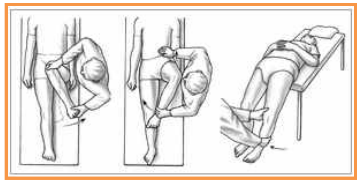
Symptoms

▣ 임상소견

1. 대부분의 환자들은 고관절의 굴곡와 내회전 제한을 보이며
쪼그려 앉는 동작을 힘들어 함

2. 서서히 발생하는 서혜부 통증

3. Anterior impingement test
① 굴곡, 내전, 내회전 시킬 때
(FADDIR) 통증 유발
② 고관절의 전상부에서 충돌이 있을 때



4. Posterior impingement test
① 신전, 외전, 외회전 시킬 때 통증 유발
② 고관절의 후방부 충돌이 있을 때

Diagnosis

▣ 진단

1. X-ray

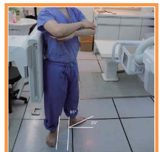
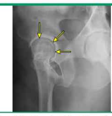


Fig. 5. Positioning for false-profile view. The pelvis is rotated 65° relative to the bucky wall stand, with the foot on the affected side parallel to the radiographic cassette.

False profile view of hip on plain radiography



A false profile view of the hip using plain radiographs as pictured above provides a good view of the posterior femoroacetabular joint (arrows).

① 골반 전후면 사진(비구 전염 여부 판단)
고관절 측면 사진(α각)
False profile 사진(관절후방부의 상태 확인)

② Cam type
▶ α각 측정 도움
▶ 대퇴골두 중심에서 시작하여 대퇴경부 축에 평행하는 선과
대퇴골두 중심으로부터 head-neck junction을 잇는 선이 이루는 각도
▶ α각이 55도 이상일 경우 Cam type 의심

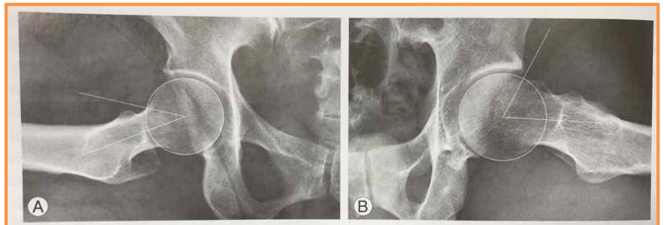
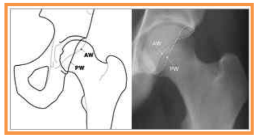


그림 IV-43. α각도. (A) α각이 33.7도로 정상 범위이다. (B) α각이 65.7도로 증가되어 있다.

Diagnosis



▣ 진단

③ Pincer type

▶ 정상적인 경우, 전방 비구연이 후방 비구연보다 내측에 존재

▶ 외측에 있던 후방 비구연이 전방 비구연과 엇갈리면서 내측으로 위치

→ Figure of eight sign , crossover sign

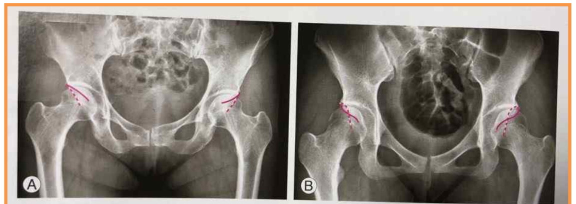


그림 IV-44. 비구 후염. (A) 정상의 경우 비구 전연이 내측에 비구 후연이 외측에 위치한다. (B) 비구 후염의 경우 비구 전연의 상방이 후연보다 외측에 위치해 8자 형으로 보인다(figure of eight 혹은 crossover 징후).

Diagnosis

▣ 진단

2. 관절조영 자기공명영상 (MRA)

① Labral tear, Articular cartilage injury 등과 같은 동반 병변을 확인

그림 IV-45. 대퇴 비구 충돌의 MRA (A) 및 3D CT (B). 전방 비구순 파열(화살표)과 대퇴골 두경부 골융기(화살촉)가 관찰된다.

Treatment

▣ 치료

1. 비수술적 치료

① 통증을 유발하는 활동을 제한

② NSAIDS, Physical therapy

2. 수술적 치료

① 적응증

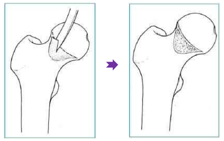
▶ 보존적 치료에 반응 없고
명백한 해부학적 이상이 발견된 경우

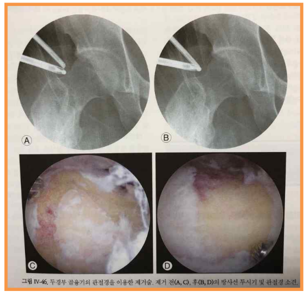
Treatment

▣ 치료

② Cam type
- ▶ 대퇴골두~경부 사이의 오프셋 중 주로 전상방부에 과형성된 골융기를 제거하여 정상적인 offset 복구

③ Pincer type
- ▶ 과도하게 돌출된 비구 외연을 절제
- ▶ 비구순 손상이 되지 않은 경우, 비구순을 분리하고 비구외연 절제한 후 재부착





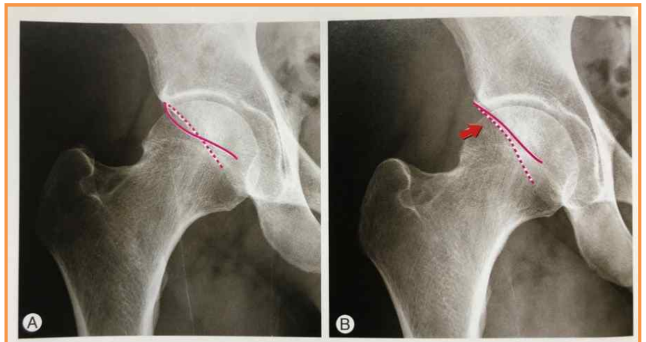


그림 IV-47. 비구 후염에 대한 비구 전연 절제술 전(A), 후(B) 방사선 사진. 돌출된 상부 비구 전연(화살표)이 제거되었다.

Exercise

▣ 문제1.

40세 여자 환자로 1개월 전부터 발생한 우측 둔부 통증으로 내과에서 의뢰되었다. 진찰 소견 상 우측 고관절을 90도 굴곡, 내전, 내회전 하였을 때 운동 범위 감소는 있으나, 통증은 없었다.
진행한 자기 공명 영상 검사 상, 우측 고관절 관절와순 파열과 단순 방사선 사진에서 대퇴 경부의 α 각은 60도와 대퇴 골두와 경부 접합부위에 골 융기 소견이 관찰되었다. 이 환자에서 가장 적절한 치료는?

① 근위 대퇴골 외반 절골술
② 관절경하 관절와순 봉합술
③ 경과관찰
④ 관절경하 골 융기 제거술
⑤ 관절경하 골 융기 제거술 및 관절와순 봉합술

1. 40세 여자 환자로 1개월전부터 발생한 우측 둔부 통증으로 내과에서 의뢰되었다. 진찰 소견상 우측 고관절을 90도 굴곡, 내전, 내회전 하였을 때 운동 범위 감소는 있으나 통증은 없었다. 진행한 자기 공명 영상 검사상 우측 고관절 관절와순 파열과 단순 방사선 사진에서 대퇴 경부의 α각은 60도와 대퇴 골두와 경부 접합 부위에 골 융기 소견이 관찰되었다. 이 환자에게 가장 적절한 치료는? 21B/20B/16B

㉮ 근위 대퇴골 외반 절골술
㉯ 관절경하 관절와순 봉합술
㉰ 경과관찰
㉱ 관절경하 골 융기 제거술
㉲ 관절경하 골 융기 제거술 및 관절와순 봉합술

답: ㉰

<Kim's solution>

환자의 problem list
1) inguinal pain (-), Rt. buttock pain (+)
2) anterior impingement test (-)
3) X-ray : α angle > 55도
4) MRA: Tear, labrum, Rt.
- 영상 검사와 임상 증상이 correlation되지 않는다
- The diagnosis of FAI is primarily made clinically from the patient's history and physical examination and then correlated with the radiographic findings
-> 수술의 indication은 conservative treatment에 반응이 없고 명백한 해부학적 이상이 발견될 경우
-> Accurate diagnosis of the source of pain in young adults or adolescents is crucial in obtaining optimal surgical outcomes with FAI surgery.

Journal of
Clinical Medicine

MDPI

Systematic Review

Conservative vs. Surgical Management for Femoro-Acetabular Impingement: A Systematic Review of Clinical Evidence

Giuseppe Anzillotti [1,2], Alberto Iacomella [1,2,*], Matteo Grancagnolo [1,2], Enrico Maria Bertolino [1,2], Maurilio Marcacci [1,2], Cristiano Sconza [1,2], Elizaveta Kon [1,2] and Berardo Di Matteo [1,2]

[1] Department of Biomedical Sciences, Humanitas University, 20072 Pieve Emanuele, MI, Italy
[2] IRCCS Humanitas Research Hospital, 20089 Rozzano, MI, Italy
[*] Correspondence: albertoiacomella96@gmail.com

Abstract: Femoro-acetabular impingement (FAI) syndrome is one of the most studied conditions in sports medicine. Surgical or conservative approaches can be proposed for treating FAI, although the best standard of care is not established yet. Our aim is to provide a comprehensive review of the best treatment for FAI syndrome evaluating differences in outcomes between surgical and non-operative management. A literature search was carried out on the PubMed, EMBASE, Scopus, and PEDro databases, using the following keywords: "femoroacetabular impingement", "FAI", in association with "surgery", "arthroscopy", "surgical" and "conservative", "physiotherapy", "physical therapy", "rehabilitation", "exercise". Only Level I RCTs were included. Four articles were selected for this systematic review. Our analysis showed different therapeutic protocols, follow-up periods, and outcomes; however, three out of the four studies included favored surgery. Our study demonstrates beneficial effects for both arthroscopic treatment and a proper regimen of physical therapy, nevertheless a surgical approach seemed to offer superior short-term results when compared to conservative care only. Further trials with larger sample sizes and longer follow-ups are needed to assess the definitive approach to the FAI condition.

Keywords: femoro-acetabular impingement; hip; arthroscopy; cam; pincer; physical therapy

check for updates

Citation: Anzillotti, G.; Iacomella, A.; Grancagnolo, M.; Bertolino, E.M.; Marcacci, M.; Sconza, C.; Kon, E.; Di Matteo, B. Conservative vs. Surgical Management for Femoro-Acetabular Impingement: A Systematic Review of Clinical Evidence. *J. Clin. Med.* **2022**, *11*, 5852. https://doi.org/

Table 1. Synopsis of the main features of the RCTs included in the systematic review.

Study	Study Design	Treatment Groups	Outcome Measures	Follow-Up	Rehabilitation Program	Main Results	Comments on Results
Griffin et al. [11]	RCT	171 surgical and 177 PT	iHOT-33 EuroQol EQ-5D-5L SF-12	12mo	6 to 10 sessions over 12 to 24 weeks with physiotherapist personalized hip therapy with an assessment of pain, function, and range of hip motion; patient education; an exercise program that has the key features of individualization, progression, and supervision; help with pain relief, which could include one X-ray or ultrasound-guided intra-articular steroid injection	At 12 mo follow-up, there was a mean adjusted difference of 6-8 points in the iHOT-33 score between groups, in favor of hip arthroscopy. This is a statistically significant difference that also exceeded the minimum clinically important difference for iHOT-33.	Hip arthroscopy is more clinically effective than best conservative care
Mansell et al. [12]	RCT	38 surgical and 40 PT	HOS iHOT-33 GRC	24mo	12 sessions over 6 weeks with joint mobilizations, mobilization with motion, therapeutic exercise, soft tissue mobility, stretching, motor control exercises and home exercise program.	There was no significant difference between the surgery and no surgery groups at any time point out to 2 years on the HOS ADL and sport subscales or the iHOT-33. There was a statistically significant improvement from baseline to 1 and 2 years on the HOS ADL subscale and the iHOT-33 in the surgery group only.	Despite improvements over time, no meaningful change was perceived by most patients. A high rate of crossover to the surgery group affected the power of the study and prevents us from making definitive conclusions.
Palmer et al. [15]	RCT	112 surgical and 110 PT	HOS ADL HOS sport NAHS HAGOS OHS iHOT-33 EQ-5D-3L PainDETECT HADS	8mo	Up to 8 physiotherapy sessions over 5 mo with physiotherapist personalized hip therapy, with emphasis on improving core stability and movement control.	The mean HOS ADL in the arthroscopic surgery group was 10.0 points (95% confidence interval 6.4 to 13.6, $p = 0.001$) higher than in the physiotherapy program group at 8mo follow-up.	Patients with FAI syndrome experience a greater improvement in symptoms with arthroscopic hip surgery than with physiotherapy and activity modification at 8mo follow-up.
Hunter et al. [14]	RCT	49 surgical and 50 PT	dGEMRIC score HOAMS iHOT-33 HOOS SF-12 GIS Modified UCLA	12mo	6 PT sessions over 12 weeks. If needed 4 more PT sessions were added between 12 weeks and 6 months. 1. An individualized and progressive exercise program supervised by a physiotherapist. 2. Education about the condition and its Management. 3. Advice regarding pain relief which could include referral to the participants' General Practitioner or ultrasound-guided intra-articular steroid injection.	The primary outcome of hip cartilage metabolism dGEMRIC showed no statistically significant difference Between PHT and arthroscopic hip surgery at 12 months follow-up. the range of secondary outcomes demonstrated statistically and clinically important improvements with significance between group differences favoring surgery.	This trial adds new information that shows the patient reported benefits of surgery are not explained by nor linked to better hip cartilage metabolism at 12 months.

6. Conclusions

Femoro-acetabular impingement syndrome is a common cause of pain and groin dysfunction in young active adults. Both arthroscopic treatment and a proper regimen of physical therapy are effective for pain relief and restoring functional status. However, the surgical approach seems to offer superior short-term results when compared to conservative care only. Further evaluations are needed to clarify whether surgery might prevail even at middle to long-term follow-up.

Reference

▣ 정형외과학 제 8판

▣ Imaging evaluation of the painful hip in adults
Authors : Cecilia Matilda Jude, MD, Shahla Modarresi, MD

▣ Plain Radiography of the Hip: A Review of Radiographic Techniques and Image Features / Hip & Pelvis
Seung-Jae Lim, MD, Yoon-Soo Park, MD

▣ Anzillotti G, Iacomella A, Grancagnolo M, Bertolino EM, Marcacci M, Sconza C, Kon E, Di Matteo B. Conservative vs. Surgical Management for Femoro-Acetabular Impingement: A Systematic Review of Clinical Evidence. J Clin Med. 2022 Oct 2;11(19):5852. doi: 10.3390/jcm11195852. PMID: 36233719; PMCID: PMC9572846.

Lower cervical injury classification & treatment

명지병원 정형외과
R2. 우창우

Lower cervical spine injury

- 척추의 손상 → 관찰되는 골절 그 자체로서보다는 해당 운동 분절의 인대 손상을 나타내주는 의미가 크다.
- 경추의 손상은 대부분 간접적 외력에 의하여 발생한다.
  - 외상이 가해지는 방향과 자세에 따라 점차 진행되어 일정한 양상의 손상에 이른다.

Lower cervical spine injury

- Instability
  - Horizontal translation
  : lateral flexion – extension view 상
  3.5mm 이상의 translation

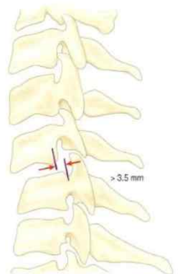


FIGURE 41.27 Sagittal plane translation of more than 3.5 mm suggests clinical instability. (Redrawn from White AA, Johnson RM, Panjabi MM: Biomechanical analysis of clinical stability in the cervical spine, *Clin Orthop Relat Res* 109:85, 1975.)

Lower cervical spine injury

- Instability
  - Horizontal translation
  : 11도 이상의 angulation of one vertebra to another

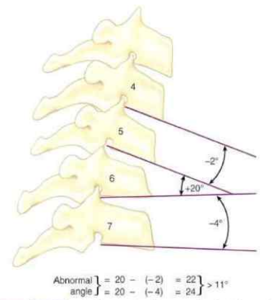


FIGURE 41.28 Significant sagittal plane rotation (>11 degrees) suggests instability. (Redrawn from White AA, Johnson RM, Panjabi MM: Biomechanical analysis of clinical stability in the cervical spine, *Clin Orthop Relat Res* 109:85, 1975.)

Lower cervical injury classification

- Stretch test
  - Used for determining clinical instability in lower cervical spine
  - Contraindicated in obviously unstable injury
  - Consistent feedback for neurological examination

  - Apply traction through gardner well tong
  - Lat. X-ray check
  - Initial 10 pound / add 3-5 pound
  - Check neurologic status

BOX 8-16 End Points for Stretch Test

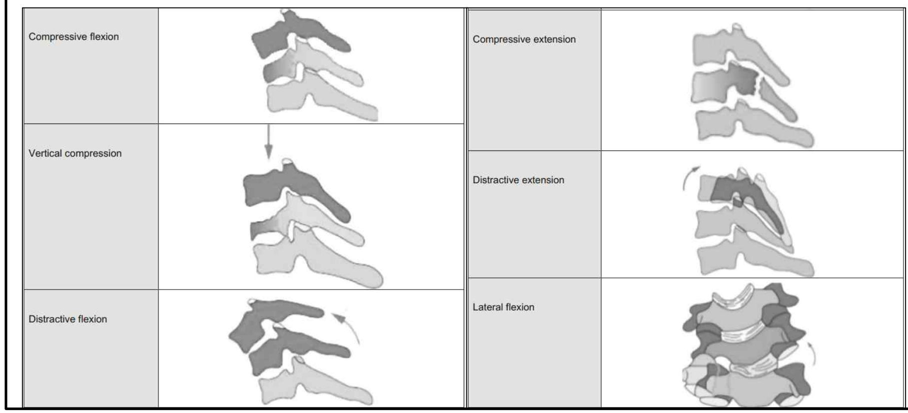
- Change in neurological status
- Increase of 1.7 mm between adjacent vertebral at any level
- Angulatory change of 7.5 degrees at any disc level
- Reaching one third of body weight or weight limit for tongs, whichever is less

Lower cervical injury classification

- Allen & Ferguson's classification
  - 6가지로 분류
  - 손상의 기전과 구조물 예측하는데 도움이 되나,
    많은 경우 정확한 정의에 맞지 않는 경우가 있다.

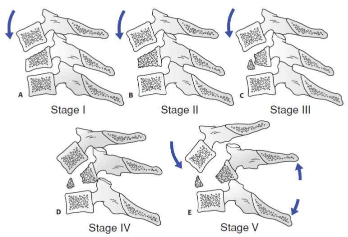
- Subaxial Injury Classification (SLIC) scoring system
  - 최근 사용되는 classification scoring system

Allen & Ferguson's lower cervical injury classification



Allen & Ferguson's lower cervical injury classification

<Compression flexion injuries>



- CF stage 1: Blunting of the anterosuperior vertebral body margin.

- CF stage 2: Beak appearance of the anterosuperior vertebral body margin; a sagittal vertebral body split may also be present.

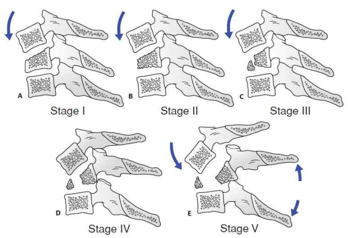
→ 전방 추체의 구조적 안정성이 유지되면서 후방 인대군의 손상이 없는 안정 손상

→ 8-12주간 경성 경추 보조기 or Halo vest

→ 고정을 제거한 후 불안정성 (+) : 후방 고정술

Allen & Ferguson's lower cervical injury classification

<Compression flexion injuries>

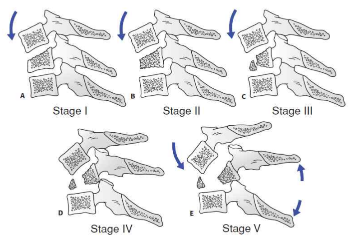


- CF stage 3: Oblique primary fracture line that extends from the anterior vertebral body to the inferior endplate. (This has been subsequently described by other authors as a so-called teardrop fracture.)

→ 잠재적 불안정 손상이 있어 MRI
  → 후방 인대군 손상 (-) : Halo vest
  → 후방 인대군 손상 (+) : 후방 유합술
→ 신경손상 있으면 전방 감압술 및 고정술

Allen & Ferguson's lower cervical injury classification

<Compression flexion injuries>



- CF stage 4: In addition to stage 3 features, posterior translation of the upper vertebra measuring less than 3 mm.

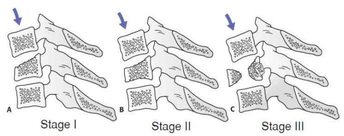
→ 신경손상 (-) : 후방 고정술
→ 신경손상 (+) : 전방 감압술 및 고정술
→ 후방인대군 손상 심할 경우 후방 고정술 및 유합술 추가

- CF stage 5: Posterior translation of the upper vertebra measuring 3 mm or more, facet gapping indicating anterior and posterior ligamentous injury.

→ 전방 감압술 및 고정술 + 후방 고정술 및 유합술

Allen & Ferguson's lower cervical injury classification

<Vertical compressive injuries>



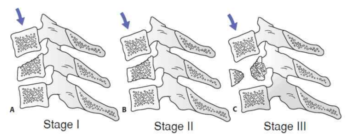
- VC stage 1: Central superior or inferior endplate fracture.

- VC stage 2: Superior and inferior endplate fractures, sometimes with vertebral body fracture lines that give the appearance of a quadrangular fracture fragment.

→ ant. column의 부분적 손상
→ 후방 인대군 손상 (-)
→ 6-8주간 경성 경추 보조기

Allen & Ferguson's lower cervical injury classification

<Vertical compressive injuries>

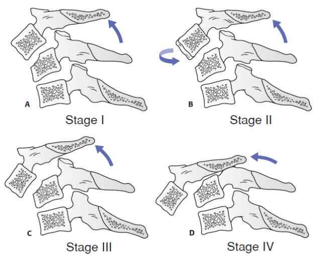


- VC stage 3: Vertebral body comminution, with or without retropulsion of fragments, with or without kyphotic (late flexion type), or translational (late extension type) deformity.

→ ant. column의 붕괴 및 후방 인대군 손상 (+)
→ 신경 손상 (-) :
  전방 감압술 및 고정술 or 후방 고정술 및 유합술
→ 신경 손상 (+) :
  전방 감압술 및 고정술 + 후방 고정술 및 유합술

Allen & Ferguson's lower cervical injury classification

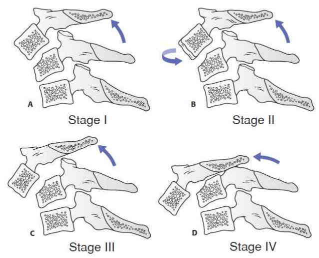
<Distractive flexion injuries>



- m/c type
- 의식 (+) & 전신 상태 안정적 : closed reduction
- 의식 (-) : closed reduction 금기
  - 54~80% 급성 추간판 탈출증이 동반되어 있음
  - MRI 먼저 시행하여 추간판 탈출 없는 경우 C/R
  - 추간판 탈출 있을경우 전방도달법을 이용하여 탈출된 추간판 제거 후 관혈적 정복술 시행

Allen & Ferguson's lower cervical injury classification

<Distractive flexion injuries>



- DF stage 1: Facet subluxation, gapping of the spinous processes, indicating failure of the PLC, with or without blunting of the anterosuperior vertebral body

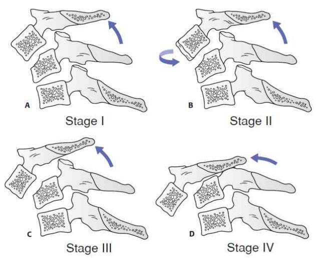
- DF stage 2: Unilateral facet dislocation, usually PLC is intact, rotational deformity.

→ Reduction 후 경성 경추 보조기 or Halo vest (8-12wks)

→ 고정을 제거한 후 불안정성 (+) :
전방 유합술 or 후방 극돌기간 고정술 및 유합술

Allen & Ferguson's lower cervical injury classification

<Distractive flexion injuries>



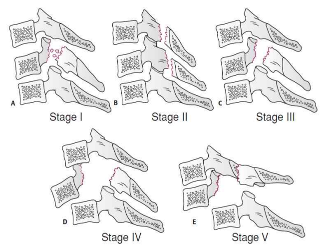
- DF stage 3: Bilateral facet dislocations, 50% translation of the upper vertebral body over the lower vertebral body.

- DF stage 4: 100% translation of the upper vertebral body over the lower vertebral body. (Appearance of a so-called floating vertebra.)

- 신경 손상 (-) : 후방 유합술
- 추간판 탈출 or 신경 손상 (+) : 전방 추간판 제거술 및 유합술
- C/R 실패한 경우 : 후관절 절제술 후 후방 유합술
- 전위 정도 및 인대 손상 정도 고려하여 전/후방 유합술 병행

Allen & Ferguson's lower cervical injury classification

<Compressive extension injuries>



- CE stage 1: Posterior arch fracture that may be a facet, pedicle, or lamina fracture, with or without rotation that can result in mild anterior translation. (These are more commonly referred to as lateral mass fractures.)

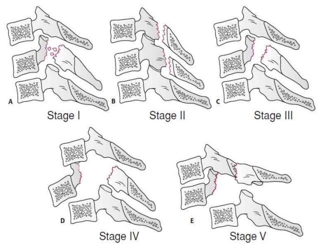
Transverse facet appearance : pedicle + articular process Fx.

- CE stage 2: Bilateral lamina fractures can occur at multiple levels.

→ 경성 경추 보조기 or Halo vest (8-12 잔)

Allen & Ferguson's lower cervical injury classification

<Compressive extension injuries>



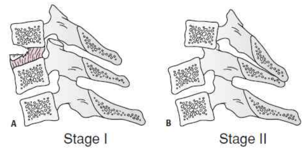
- CE stage 3: Bilateral lamina, facet, and pedicle fractures without vertebral body displacement. This injury is more often described as a floating lateral mass fracture.

- CE stage 4: As for CF stage 3, with partial anterior vertebral body displacement.
→ 후방 구조물 골절이 있어 강선을 이용한 후방 고정술 불가능
→ Lat. mass screw 또는 Pedicle screw 고정술 및 유합술
→ Lat. Mass 또는 Pedicle에 골절 있는 경우 원칙적으로 전방 연 부조직의 파열이 있어 전방 고정술을 시행

- CE stage 5: As for CE stage 3, with 100% anterior vertebral body displacement.
→ 전/후방 구조물 모두 손상 있어 전/후방 유합술 및 고정술
→ 전위된 추체 사이의 추간판 제거술 후 금속판을 이용한 전방 고정술 시행하고 추가적인 후방 lat. mass screw 고정

Allen & Ferguson's lower cervical injury classification

<Distractive extension injures>



- DE stage 1: Abnormal widening of the disc space may be associated with avulsion fractures of the anterior vertebral body margin. No evidence of posterior translation.

→ MRI 또는 Flexion-Extension 상에서 전방 인대군 손상 (-) : 경성 경추 보조기 or Halo vest (8-12wks)
→ 고정을 제거한 후 불안정성 (+) : 전방 유합술 및 고정술

- DE stage 2: DF stage 1 with posterior translation.

→ 전후방 구조물 모두 손상 (+) : 전후방 고정술

Allen & Ferguson's lower cervical injury classification

<Lateral flexion injures>

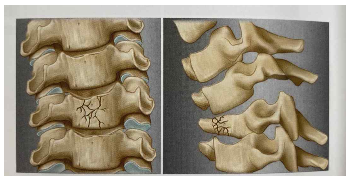


그림 54. 측굴곡 손상의 두 단계.

- LF stage 1: Unilateral uncovertebral fracture or asymmetric vertebral body compression.

- LF stage 2: Vertebral body, or posterior arch fractures, with lateral translation or unilateral facet gapping, coronal angular deformity is noted on an AP radiograph or coronal CT scan.

→ 골건인을 통해 정복을 한 후 halo vest
→ 정복의 유지가 어렵거나 각 변형 등 진행성 병변이 오는 경우 전방 추체 제거술 및 고정술

Subaxial Injury Classification (SLIC) scoring system

Subaxial Injury Classification (SLIC) Scale

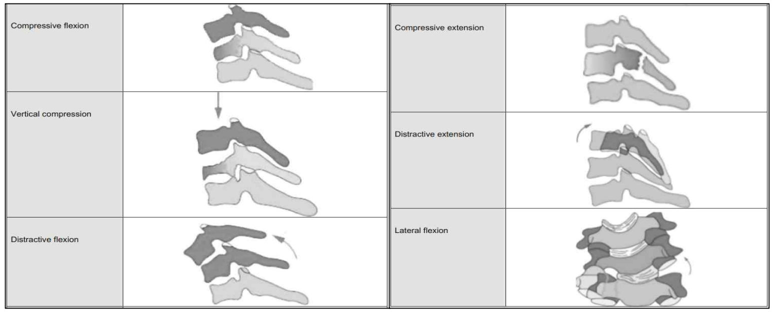
	POINTS
MORPHOLOGY	
No abnormality	0
Compression + burst	1+1 = 2
Distraction (e.g., facet perch, hyperextension)	3
Rotation or translation (e.g., facet dislocation, unstable teardrop, or advanced stage flexion compression injury)	4
DISCOLIGAMENTOUS COMPLEX	
Intact	0
Indeterminate (e.g., isolated interspinous widening, magnetic resonance imaging signal change only)	1
Disrupted (e.g., widening of anterior disc space, facet perch, or dislocation)	2
NEUROLOGIC STATUS	
Intact	0
Root injury	1
Compete cord injury	2
Incomplete cord injury	3
Continuous cord compression (neuro-modifier in the setting of a neurologic deficit)	+1

From Dorak M, Fisher CG, Fehlings MG, et al: The surgical approach to subaxial cervical spine injuries, Spine 32:2620, 2007.

- 점수가 높을수록 심한 손상
- 기존의 분류법에 비하여 신경학적 손상의 정도와 불안정성을 반영하여 점수화
- 4점 미만 = 비수술적 치료
- 4점 이상 = 외과적 감압술 및 고정술 고려

Take home message

<Allen & Ferguson's subaxial cervical spine injury classification>



Subaxial Injury Classification (SLIC) scoring system

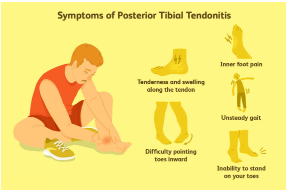
Subaxial Injury Classification (SLIC) Scale	POINTS
MORPHOLOGY	
No abnormality	0
Compression + burst	1+1 = 2
Distraction (e.g., facet perch, hyperextension)	3
Rotation or translation (e.g., facet dislocation, unstable teardrop, or advanced stage flexion compression injury)	4
DISCOLIGAMENTOUS COMPLEX	
Intact	0
Indeterminate (e.g., isolated interspinous widening, magnetic resonance imaging signal change only)	1
Disrupted (e.g., widening of anterior disc space, facet perch, or dislocation)	2
NEUROLOGIC STATUS	
Intact	0
Root injury	1
Compete cord injury	2
Incomplete cord injury	3
Continuous cord compression (neuro-modifier in the setting of a neurologic deficit)	+1

From Dorak M, Fisher CG, Fehlings MG, et al: The surgical approach to subaxial cervical spine injuries, Spine 32:2620, 2007.

4점 미만 = 비수술적 치료

4점 이상 = 외과적 감압술 및 고정술 고려

Posterior Tibial Tendon dysfunction



Myongji hospital
Department of Orthopedic Surgery
R4 Lee In el

Presentation Date: 2023.06.08

김 O 서 F/42 #00304226

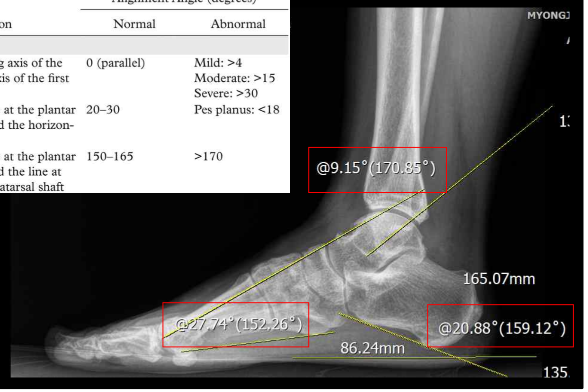
- Chief complaint
  - Both. ankle pain
  - Onset : 8개월 전

- Dx; Synovitis, ankle, Rt.
  Retrocalcaneal bursitis, ankle, Rt.
  OP; A/S synovectomy + endoscopic bursectomy (2022/04/12)

Ankle pre-Xray

Ankle pre-Xray

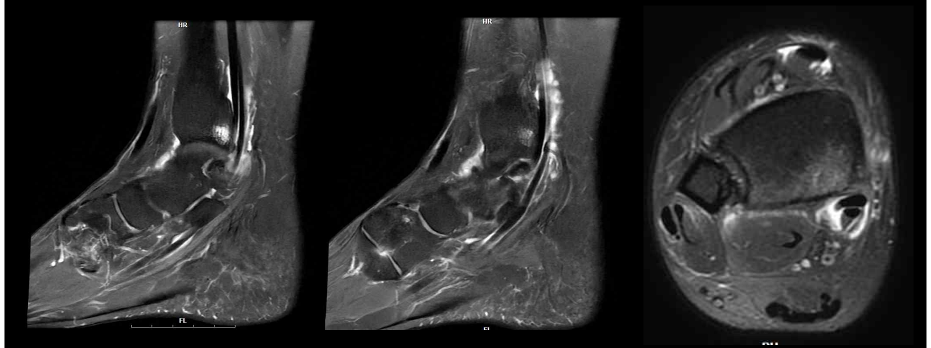
Metric	Construction	Alignment Angle (degrees): Normal	Alignment Angle (degrees): Abnormal
Lateral view: assessment of longitudinal arch			
Talus–first metatarsal angle (Meary angle)	Angle between the long axis of the talus and the long axis of the first metatarsal	0 (parallel)	Mild: >4 Moderate: >15 Severe: >30
Calcaneal inclination angle	Angle between the line at the plantar calcaneal surface and the horizontal plane	20–30	Pes planus: <18
Calcaneal–fifth metatarsal angle	Angle between the line at the plantar calcaneal surface and the line at the inferior fifth metatarsal shaft	150–165	>170



Ankle pre-Xray

Anteroposterior view: assessment of heel valgus and forefoot abduction			
Talocalcaneal angle (kite angle)	Angle between the line bisecting the head and neck of the talus and the line parallel to the lateral surface of the calcaneus	>25–40	>40 (heel va <25 (heel va
Talus–first metatarsal alignment	Line drawn along the long axis of the talus, extended into the forefoot, its orientation compared with that of the first metatarsal shaft	Talar axis angled slightly lateral to the shaft	Talar axis ar medial to shaft
Talonavicular coverage angle	Angle between the articular surface of the talar head and the articular sur-	0 (parallel)	>7

Ankle MRI (pre-OP)

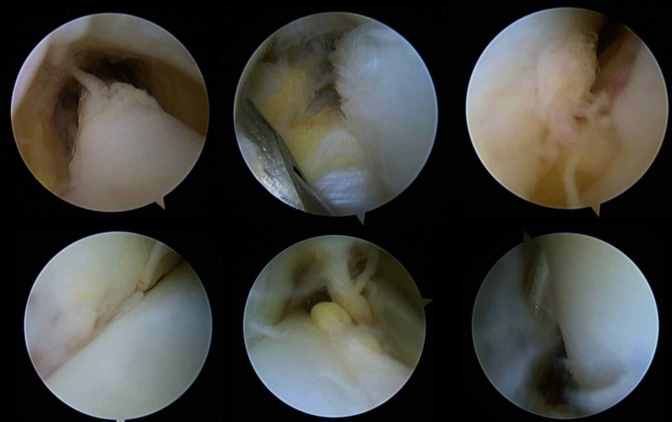


OP recording (2023.06.02)

- 수술 후 진단명
  - Tibialis posterior tendinitis

- 수술명
  - Posterior tibialis tendon → severe tenosynovitis
    → Endoscopic debridement & synovectomy 시행함

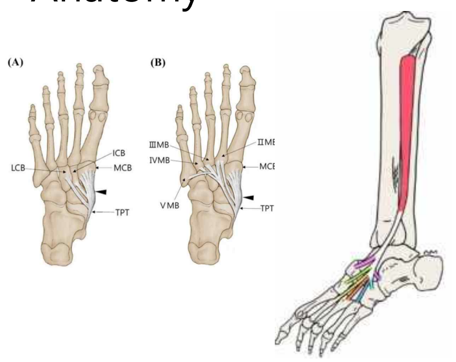
Ankle A/S (intra-OP)



Introduction

후경골건의 기능장애 (Posterior tibial tendon dysfunction, PTTD)
- 후천성 편평족 변형
- 빈도 : 서양 > 동양 // 비만인구 늘아나는 추세로 한국도 빈도가 늘어날 가능성 ↑↑
- 점진적으로 진행
- 족부 세로궁을 지탱하는 인대들의 기능도 떨어져 추후 심각한 변형을 초래

Anatomy



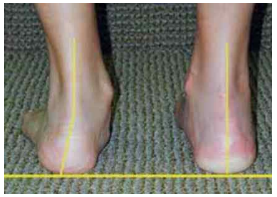
- TP origin site
  1. Tibial proximal 1/3 posterior area
  2. Interosseous membrane
- TP insertion site
  1. Medial tuberosity of navicular
  2. Plantar surface of foot
  3. All three cuneiforms
  4. Cuboid
  5. Base of 2nd, 3rd, 4th, 5th metatarsal
- No mesotenon

Biomechanics

- Function
  - Plantar flexion, hindfoot inversion
  - Midfoot에 insertion하기 때문에 forefoot adduction, supination
- 내측 세로궁의 높이를 높여주는 작용
- 횡족근관절들(transverse tarsal joint)에 강하게 잠긴 현상이 일어나고, 후족부가 강한 지렛대 역할을 하게하여 보행시 앞으로 강하게 밀어내며 뒤꿈치를 들어 전진(push-off)시키는 역활

Pathogenesis

- Locking, lever effect loss → foot laxity state
- Deformity components
  1. Medial longitudinal arch loss
  2. Subtalar joint eversion
  3. Hindfoot valgus
  4. Forefoot abduction
- Hindfoot valgus → Achilles tendon laterally move → talus eversion
- Deformity → impingement btw fibula & calcaneus



Pathogenesis

- Degenerative Tear
  - 중년의 비만여성
  - 고혈압, 당뇨, 비만, 스테로이드 치료의 기왕력 관련
- Acute Trauma
  - 열상, 골절, 탈구
- Anatomical characteristics
  - TP는 강력한 건이지만 2cm 이내의 짧은 건 이동거리에 인하여 쉽게 약해지는 단점
  - 족관절 내과 끝에서 1~2cm 정도 원위부까지는 혈액 순환이 적은 부분
  - 건이 족관절 내과 뒤를 급격한 예각으로 지나게 되는 부위
- Inflammatory diseases
  - 강직성 척추염, 건선 Reiter씨 증후군
  - 류마티스 관절염

Clinical manifestation

- 초기에는 내과의 바로 원위부에서 후족부의 후내방에 통증, 불편감 피로감
- 내과 하방에 건막염 생기면서 부종
- 변형증가하며 신발 착용에 불편함이 생길 정도로 발의 변형 심해짐

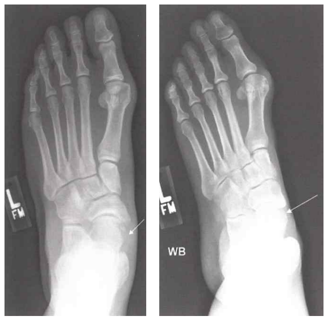
Classification

1. Stage I disease
   - Tenosynovitis
   - No foot deformity, double & single leg toe raise 가능

2. Stage II disease
   - Hindfoot remains flexible
   - Inability to perform a single – leg toe raise
   - Sinus tarsi impingement pain is present

   - Stage IIA (moderate tear of PTT)
   : <40% of the talar head uncovered

   - Stage IIB (severe tear of PTT)
   : > 40% of the talar head uncovered or subtalar impingement



Classification

3. Stage III disease
   - Rigid (inflexible) deformity
   - Significant lateral sinus tarsi pain is present
   - Subtalar osteoarthrosis
   - Lateral hindfoot impingement

4. Stage IV disease
   - Valgus positioning and incongruency of the ankle joint → difficult problem

   - Stage IV A (flexible tibiotalar valgus)
   : deltoid lig. abnormality

   - Stage IV B (rigid tibiotalar valgus)
   : tibiotalar osteoarthrosis

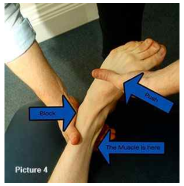
Myerson Classification

Stage	Deformity	Disease Progression	Treatment
I	None	PTT tendinosis or tenosynovitis Functional tendon	Conservative treatment initially Tenosynovectomy
II			
IIA	Flexible moderate deformity (<40% of the talar head uncovered)	Tendinosis or a low- to moderate-grade tear of the PTT Laxity of the spring ligament	Orthoses Tendon transfer Medializing calcaneal osteotomy Subtalar arthroereisis Medial column stabilizing procedure
IIB	Flexible severe deformity (>40% of the talar head uncovered or subtalar impingement)	High-grade tear of PTT Incompetent spring ligament Sinus tarsi syndrome	Consider adding lateral column lengthening with or without spring ligament reconstruction
III	Rigid (inflexible) deformity	Subtalar osteoarthrosis Lateral hindfoot impingement	Subtalar arthrodesis or triple arthrodesis Consider adding medial ray procedure for plantar flexion of the first metatarsal
IV			
IVA	Flexible tibiotalar valgus	Deltoid ligament abnormality	Flatfoot reconstruction and deltoid ligament reconstruction
IVB	Rigid tibiotalar valgus	Tibiotalar osteoarthrosis	Consider adding tibiotalar fusion or ankle arthroplasty

Physical Examination

- 과잉 족지 관찰 징후 (Too many toes sign)
- 뒤꿈치 내번 검사 (Heel inversion test)
- 단측 뒤꿈치 올림 검사 (single heel raise test) : most sensitive
- 후경골근 근력 검사 (Tibialis posterior muscle power test)



Physical Examination

운동범위 (Range of motion)
- 거골하관절 및 족관절의 운동범위 및 아킬레스건의 구축평가가 중요
- 족배굴곡 정도를 측정하여 구축이 확인되면 건 연장술을 시행

- 거골하관절의 가동은 수술 방법 결정에 매우 중요한 요소
- 후족부 내번이 안되는 경우에는 고정된 외반변형이 생겼다는 의미로 건 이전술 불가능
- 거골하 관절 중립 위치에서 횡족근관절의 내전이 없거나, 전족부의 고정된 회의 변형이 있으면 관절 유합술 고려

Treatment

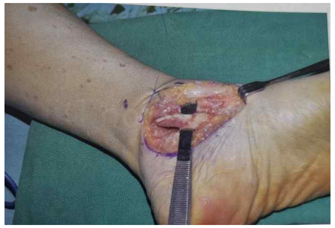
- 증상 있는 환자는 비수술적 치료부터 시작, 2기 이상일 경우 수술적 치료 염두

1. Non-operative treatment
   - Ix) 급성 건 활막염, 한쪽 발뒤꿈치 들기는 가능하나 통증
   - 안정가료
   - NSAID
   - 스테로이드 주사는 금기
   - 증상 개선 시 내측 뒤꿈치 바닥 쐐기를 장착한 바닥 딱딱한 신발 착용
   - 내측 뒤꿈치 거상, 세로궁 지지대, 내측 전족부 받침 → 보조기 사용

Treatment

2. Operative treatment
   - 수술적 치료는 편평족 분야에 준하여 진행

   - Tenosynovectomy
   - 내과 아래 후경골건에서 시작하여 주상골까지 피부 절개
   - 건막을 절개하고 건의 병변을 관찰 → 후경골건 주위의 비후된 활막
   - 건으로부터 활막 조직을 가능한 한 근위까지 제거
   - 건 파열이 관찰되면 봉합술 혹은 이식술 시행
   - 수술 약 3주후 단하지 석고고정 제거 하고 재활운동 시작



chapter 09 건과 근막질환, 6 후경골건 기능장애, 족부족관절, 대한족부족관절학회

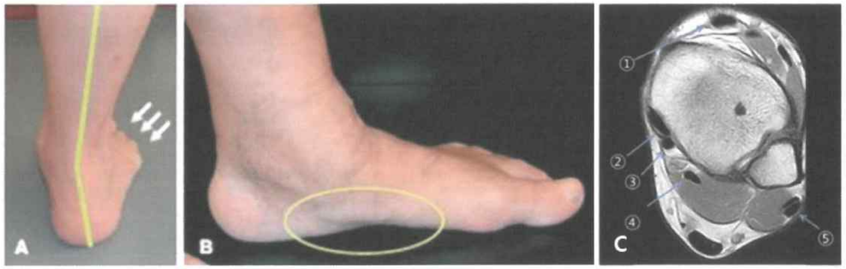
Treatment

2. Operative treatment
   - Stage II
     - Tendon transfer (FHL, FDL)
     - Calcaneal osteotomy combined
     - Arthrodesis of one or more midfoot joints

   - Stage III
     - Conservative care fail → arthrodesis

   - Stage IV
     - Ankle or tibiotalocalcaneal arthrodesis
     - Hind foot deformity를 correction 할 수 있다면 total ankle arthroplasty
     - Triple arthrodesis

1. 후족부 내측 부위의 통증이 있는 성인 환자에서 내측 종아치의 소실과 후족부의 외반 변형이 관찰되었다. 이 변형과 가장 관련이 있는 건을 사진 (C)에서 고르시오. 19B2



㉮ 1
㉯ 2
㉰ 3
㉱ 4
㉲ 5

환자의 problem list
1) adult, hindfoot valgus, Too many toe sign (+)
2) medial longitudinal arch 소실
-> PTTD의 deformity component와 관련된다
MRI) ① TA, ② TP ③ FDL ④ FHL ⑤ PL

Articular Cartilage defect

Department of Orthopedic Surgery, Myongji Hospital
Presenter : R1. 우창우

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

Cartilage

Persists at almost all joint

Deformable / pliant, strong / load bearing

Rubber like padding

Cover and protects the ends of long bones

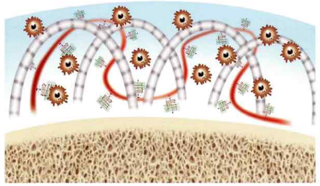


그림 7.1.1 관절연골 기질의 구조

Biology and Structure

Main function of articular cartilage

- To provide a low-friction surface for motion

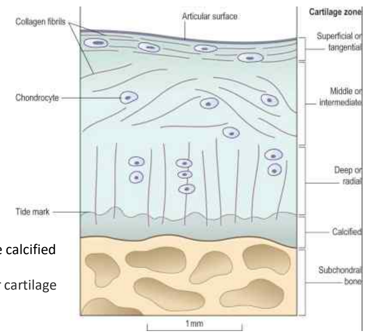
- To resist tensile, shear, and compressive forces

Grossly, appears as a smooth, homogenous tissue approximately 2-5mm thick

Chondrocyte + Extra cellular matrix (collagen and proteoglycans)

Adults articular cartilage

- Superficial zone
  - Small elongated cells (parallel to the surface)
  - Covered by a thin film of synovial fluid (lubricin)
- middle zone
  - Chondrocytes are large and rounded
  - Surrounded by largest diameter of collagen fibrils
  - Highest concentration of proteoglycans
- deep zone
  - Vertical collagen fibrils
  - Collagen types IX and XI & collagen type II
- Tide mark
  - the transition zone between the non-calcified and the calcified articular cartilage
  - the region of critical mechanical weakness in articular cartilage
- Calcified zone
  - small volume of cells embedded in a calcified matrix
  - Type X collagen providing structural integrity & shock absorber



Healing response

Limited capacity for natural healing

: Owing to lack of blood supply, absence of chondrogenic progenitor cell,

↓ mitotic activity

Cartilage injury, divided into **3 categories** based on depth

(1) Cell and matrix damage without visible surface change

: Damage only to matrix, spares chondrocyte

→ Restoration of the matrix by chondrocyte matrix synthesis

: If the damage involves chondrocyte death

→ Spontaneous repair is limited and results in matrix structure alteration

Healing response

(2) Cartilage disruption with visible defects

: Visible damage to cartilage surface and does not extend into the subchondral bone does not initiate a reparative response

→ Results in chondrocyte apoptosis and cessation of matrix synthesis

→ ↑permeability, ↓ability to resist tensile and compressive loads

→ Progression to osteoarthritis

Healing response

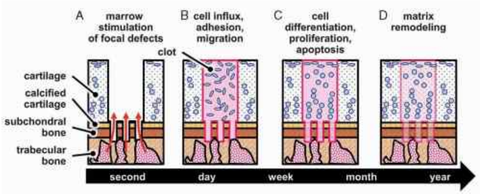
(3) Visible cartilage and subchondral bone disruption

: Gain access to the vascular system and elicit reparative response

→ formation of hematoma, fibrin clot, inflammatory response, migration of mesenchymal stem cell to bone marrow

→ Result in formation of fibrocartilage within 6-8wks

→ Matrix consists mainly Type I collagen and different composition and structure compare with normal cartilage



Classification

Classification of Articular Cartilage Lesions by Severity

GRADE	OUTERBRIDGE	MODIFIED OUTERBRIDGE	ICRS
0	Normal cartilage	Intact cartilage	Intact cartilage
I	Softening and swelling	Chondral softening or blistering with intact surface	Superficial (soft indentation or superficial fissures and cracks)
II	Fragmentation and fissures in area less than 0.5 inch in diameter	Superficial ulceration, fibrillation, or fissuring less than 50% of depth of cartilage	Lesion less than half the thickness of articular cartilage
III	Fragmentation and fissures in area larger than 0.5 inch in diameter	Deep ulceration, fibrillation, fissuring, or chondral flap more than 50% of cartilage without exposed bone	Lesion more than half the thickness of articular cartilage
IV	Exposed subchondral bone	Full-thickness wear with exposed subchondral bone	Lesion extending to subchondral bone

ICRS, International Cartilage Repair Society.

Published in final edited form as:
Am J Sports Med. 2014 September ; 42(9): 2253–2261. doi:10.1177/0363546513508744.

Stem Cell Therapies for Knee Cartilage Repair: The Current Status of Preclinical and Clinical Studies

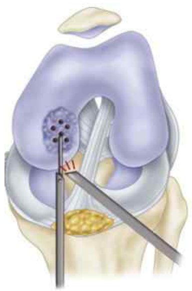
John A. Anderson, MD MSc[*,1,2], **Dianne Little, BVSc PhD**[1], **Alison P. Toth, MD**[1], **Claude T. Moorman III, MD**[1], **Bradford S. Tucker, MD**[2], **Michael G. Ciccotti, MD**[2], and **Farshid Guilak, PhD**[1]

[1]Department of Orthopaedic Surgery, Duke University Medical Center, Durham, North Carolina.

[2]Rothman Institute Cartilage Center, Rothman Institute, Philadelphia, Pennsylvania.

- Background
  - Articular damage of knee cause significant morbidity
  - Operative Tx.
    - Failure of non-operative Tx.
    - Acute osteochondral fractures resulting in full-thickness loss of cartilage
- Limted approach for focal cartilage lesions
- Current techniques
  - Microfracture
  - Autologous cell or tissue grafting
  - Autologous chondrocyte implantation
  - Micronized articular cartilage allografts
- Long term results may be variable and unknown

Marrow Stimulation (Microfracture)



Microfracture

Enhance chondral resurfacing by providing suitable environment for new tissue formation

Taking advantage of the body's own healing potential

Goal of this procedure

: To alleviate the pain and attendant disabilities

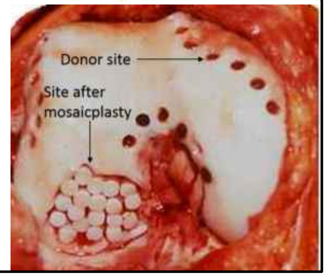
: To late degenerative changes in the joint by restoring joint surface

OATs
(Osteochondral Autologous transplantation)

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

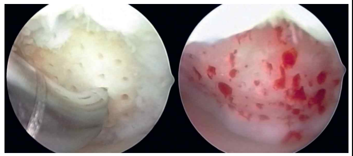
Direct transplantation of osteochondral segments from less loaded region to symptomatic focal defect

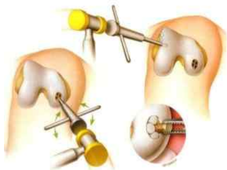
Multiple, small diameter osteochondral grafts or plugs producing a mosaic-like structure makes potentially easier matching of the surface contour of the defect site and more stable than larger grafts

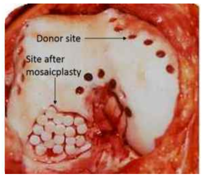


MYONGJI HOSPITAL SPORTS MEDICAL CENTER

- Microfracture
  - Steadman et al – improvement in clinical knee score
  - Minas et al – Subseqeunt surgery more difficult
- Mosaicplasty
  - Donor site morbidity
  - Limited availability
  - Mismatch geometry
- Advantages
  - Low complexity
  - Patient undergoing only 1 surgery
  - Use of patient's own tissue

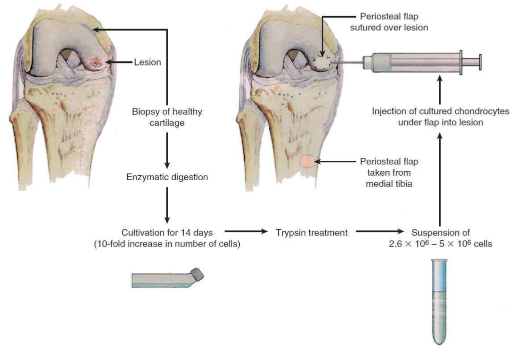






MYONGJI HOSPITAL SPORTS MEDICAL CENTER

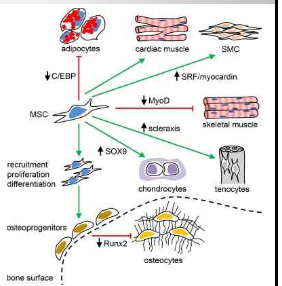
- ACI (Autologous chondrocyte implantation)

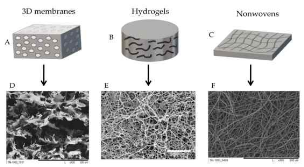


- ACI (Autologous chondrocyte implantation)
  - Requires 2 operation
  - May result periosteal overgrowth
- ACI vs Microfracture & Mosaicplasty
  - Controversial
- Newer ACI technique
  - Use biomaterials seeded with chondrocytes as a scaffold instead of periosteal patch
  - Still have
    - Iatrogenic damage
    - Require 2 operations
    - Donor site morbidity

- Adult stem cells
  - Provide more readily accessible source of cells for treatment of chondral or osteochondral defects
  - Bone marrow derived mesenchymal stem cells (MSCs)
  - Adipose-derived stem cells (ASCs)
    - Multipotent differentiation capabilities in the mesenchymal lineage, similar to MSCs

- Pre-clinical
  - Animals
    - Pre-differentiated MSC
    (supplemented with TGF-B, basic fibroblast GF)
    - Undifferentiaed MSC
    - Scaffold for tissue engineering
    - Gene transfer (SOX-9)
- Clinical
    - IKDC
    - Tegner
    - Lysholm





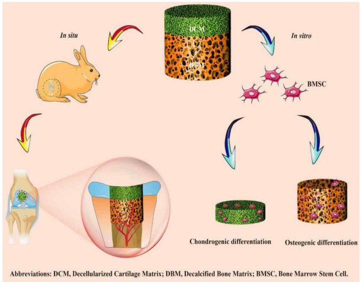
- Animal studies of stem cell based cartilage repair
- Small animal models
  - Rabbit model - Defects with a 5mm diameter and 1mm depth were created in the medial femoral condyle
    - Predifferentiated MSCs (supplemented with TGF-B, basic fibroblast GF)
    - Undifferentiated MSCs
    - Untreated

    → Transplantation of MSCs produced superior healing compared with untreated cartilage defect irrespective of differentiation
  - Comparing MSCs and ACI
    - Both group similar cartilage regenerative profiles
    - Both treatment superior tissue regeneration compared with untreated defects

    → MSCs advantage - prolonged expansion time without phenotype transformation and the homing and engraftment of other stem cell

- Scaffold
- Compared with the hydrogel composite without MSCs, the 2 groups of hydrogels with MSCs (one with the addition of TGF-β1) facilitated subchondral bone formation
- Biphasic osteochondral composite
  - Chondral phase consisting of hyaluronate and atelocollagen
  - Osseous phase consisting of hyaluronic acid and β–tricalcium phosphate

→ Scaffold composite held promise for defect repair



- Sox9 gene transfer – higher repair rate

- Large animal models – clinically relevant to human condition
- Hepp P et al.
  - Chondrogenically predifferentiated ovine MSC / hydrogel constructs (preMSC gels)
  - Undifferentiated ovine MSC/hydrogel constructs (unMSC gels)
  - Cell-free collagen hydrogels (CF gels)
  - Untreated controls

  → preMSC gels showed significantly better histological scores with morphological characteristics of hyaline cartilage

- MSC-seeded triphasic constructs VS the OATS (osteoarticular transfer system) procedure
  - Macroscopic and biomechanical analyses showed no significant differences between groups at 12 months
- The disadvantages of OATS
  - Morbidity at the donor site
  - Limited size of the transplant
  - Hemarthrosis
  - Difficulty in shaping host tissue to fit the defect area
  - Inadequate bonding of the graft cartilage to surrounding tissue

- The role of growth factors in treating osteochondral defects
  - A defect-only group
  - collagen gel–only group
  - collagen gel containing MSCs alone
  - MSCs and a gel induced with TGF-β
- Pineda et al - Both treatments using MSCs resulted in a superior gross and histological appearance and better histological scores than the non-MSC group
- Using undifferentiated MSCs resulted in a superior outcome than using TGF-β induced differentiated MSCs, especially with regard to the restoration of subchondral bone
- TGF-B and growth factors : stimulates chondrogenesis
  - influence may be variable
  - Synovial proliferation and fibrosis / Induction of osteophyte formation

- MSCs combined with microfracture to address osteochondral defects
  - Hypothesis : there may be a problem with the migration and proliferation of MSCs embedded within fibrin
    - MSCs suspended in hyaluronan + microfracture
    - microfracture alone
  - → No difference clinically or histologically in the 2 groups at 12 months,
  - MSC + micro Fx. group had increased aggrecan content and tissue firmness.
- Compared with microfracture MSC treatment was superior in terms of a short- term arthroscopic inspection and also in longer term macroscopic, histological, and quantitative magnetic resonance imaging (MRI) analyses
  - Repair tissue in the MSC group had better type II collagen content and orientation
  - Improved sulfated glycosaminoglycan content
  - Greater integration into the surrounding normal cartilage, with greater thickness and a smoother surface

- Clinical studies of stem cell based cartilage repair
  - Systemic review

Results for Searching "Stem Cells and Knee" on PubMed

Authors (Year)	Outcomes	Institution	No. of Patients	Brief Description	Stem Cell Delivery Method
Nejadnik et al (2010)[69]	IKDC, ICRS, SF-36, Lysholm, Tegner	National University, Singapore	72	Observational cohort study; 36 patients underwent ACI, and 36 patients underwent BM-derived MSC implantation; concluded that BM-derived MSCs were as effective as chondrocytes in clinical outcomes	2-stage implantation; BM-derived MSCs harvested and then later arthrotomy performed to implant
Haleem et al (2010)[43]	Lysholm, revised HSS,MRI, arthroscopic ICRS	Cairo University, Egypt	5	Case series; all patients' symptoms improved at 12 mo; ICRS arthroscopic scores were 8 of 12 and 11 of 12 for 2 patients; at 12 mo, MRI showed complete congruity in 3 patients and incomplete congruity in 2 patients	2-stage implantation; autologous BM-derived MSC culture expanded, placed on PR-FG intraoperatively, and then transplanted into defects
Davatchi et al (2011)[21]	VAS, walking time to pain, stair climbing	Tehran University, Iran	4	Case series; walking time to pain improved in 3 patients; improved stair climbing and VAS scores for all	Direct delayed injection; 30mL of BM taken and cultured for growth for 4 to 5 wk
Koh et al (2013)[54]	WOMAC, Lysholm, VAS, MRI	Yonsie Sarang Hospital, South Korea	18	Case series; infrapatellar fat pad harvested after arthroscopic debridement; clinical scores improved, and MRI scores improved; results positively related to number of stem cells injected	Direct delayed injection; after arthroscopic surgery, fat pad stem cells and PRP injected into knees

Results for Searching "Stem Cells and Knee" on clinicaltrials.gov

Title	Outcomes	Institution	No. of Patients	Brief Description	Identifier
Transplantation of Bone Marrow Stem Cells Stimulated by Proteins Scaffold to Heal Defects Articular Cartilage of the Knee	KOOS, ICRS	University of Marseille, France	50	Fresh non–culture-expanded autologous BM-derived MSCs, stimulated with a protein matrix, are mixed in a collagen HA scaffold; this paste is transplanted into the prepared defect, under arthroscopic surgery, with an injection of PRP	NCT 01159899
Treatment of Knee Osteoarthritis With Autologous Mesenchymal Stem Cells	VAS, Oswestry, SF-36, MRI (CartiGram)	Fundacion Teknon and IBGM, University of Valladolid, Spain	12	Used 40 million BM-derived MSCs for grade 2 to 4 OA	NCT 01183728
The Effects of Intra-articular Injection of Mesenchymal Stem Cells in Knee Joint Osteoarthritis	WOMAC, VAS	Royan Institute, Iran	40	Case-control study; BM-derived MSCs will be administered at 1 mo and 4 mo after harvest; clinical and MRI follow-up to 6mo	NCT 01504464
Autologous Stem Cells in Osteoarthritis	ROM, WOMAC, SF-36, VAS	Hospital Universitario Dr Jose E. Gonzalez, Mexico	30	One group receives acetaminophen, and the other receives BM-derived MSCs	NCT 01485198
Adult Stem Cell Therapy for Repairing Articular Cartilage in Gonarthrosis	VAS, SF-36, MRI	Centro Medico Teknon, Institut de Terapia Regenerativa Tissular, CETIR Sant Jordi, Spain	15	For grade 2 to 3 OA; at 21 d, 40 million BM-derived MSCs injected and clinical and MRI follow-up to 12 mo	NCT 01227694
Allogeneic Mesenchymal Stem Cells in Osteoarthritis	WOMAC, VAS, analgesia intake, MRI	Sanjay Gandhi Post Graduate Institute of Medical Sciences, India	60	Allogenic MSCs used in different times	NCT 01453738
Autologous Mesenchymal Stem Cells vs Chondrocytes for the Repair of Chondral Knee Defects	SF-12, WOMAC	La Paz University Hospital, Spain	30	RCT of ASCs vs chondrocytes	NCT 01399749
Allogeneic Mesenchymal Stem Cells for Osteoarthritis	WOMAC, VAS, analgesia intake, MRI	KPJ Ampang Puteri Specialist Hospital,Malaysia	72	RCT of BM-derived MSCs vs PlasmaLyte and hyaluronan	NCT 01448434
Evaluation of Safety and Exploratory Efficacy of CARTISTEM, a Cell Therapy Product for Articular Cartilage Defects	IKDC, Lysholm, KOOS, VAS, MRI	Rush University, USA	12	Cartistem is human umbilical cord blood-derived MSCs for grade 3 to 4 OA	NCT 01733186
ADIPOA - Clinical Study	WOMAC, ROM, SF-8, MRI	University Hospital of Montpellier, France	18	Differing concentrations of ASCs (2 million vs 10 million vs 50 million) will be injected into knees with grade 3 to 4 OA and compared	NCT 01585857
Study to Compare the Efficacy and Safety of Cartistem and Microfracture in Patients With Knee Articular Cartilage Injury or Defect	ICRS, VAS, biopsy, WOMAC, IKDC	Korea University Guro Hospital, South Korea	104	Comparison of Cartistem vs microfracture for grade 4 OA	NCT 01041001

- Pubmed
  - MSCs were compared with ACI in 72 matched symptomatic patients with full-thickness cartilage defects, as diagnosed by clinical examination and MRI.
  - The International Knee Documentation Committee (IKDC), Tegner, and Lysholm scores were similar between groups
  - → No difference between groups in terms of clinical outcomes
  - But Greater improvement over time in the MSC group
  - Advantages of MSCs over ACI
    - Single surgery
    - Reduced costs
    - Minimal donor site morbidity

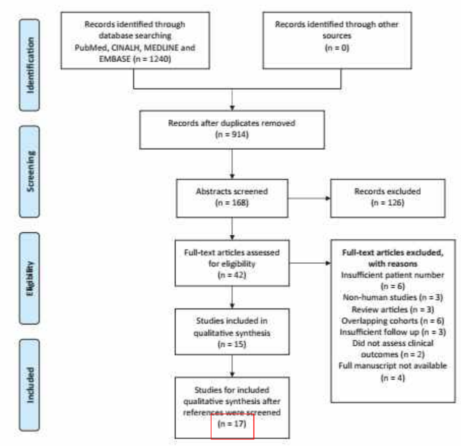
- clinicaltrials.gov
  - Stem cell delivery methods varied and included direct injections and both 1 and 2 stage implantations into the defect
  - General outcome measures include
    - Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)
    - VAS
    - IKDC
    - Short Form–12 Health Survey (SF-12)
    - Lysholm
    - Knee injury and Osteoarthritis Outcome Score (KOOS)
    - Histology
    - MRI
    - arthroscopy

Mesenchymal Stem Cells in the Treatment of Cartilage Defects of the Knee

A Systematic Review of the Clinical Outcomes

Monketh Jaibaji,[*†] MBBS, MRCS, Rawan Jaibaji,[†] BSc, and Andrea Volpin,[‡] MD
Investigation performed at the Division of Interventional Science, University College London, London, UK

- Systemic review assessing clinical and functional outcomes of mesenchymal stem cell implantation
- 17 studies encompassing 367 patients
  - Clinical outcomes : VAS, WOMAC IKDC etc..
  - Radiologic outcomes : MOCART scores
  - Histologic findings : Arthroscopic 2nd look and biopsy – Hyaline or fibrocartilage



- Clinical scores

Improvement in

- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)
- VAS
- IKDC
- Tegner
- Lysholm
- Knee injury and Osteoarthritis Outcome Score (KOOS)

- Histologic finding
  - Majority of deep portion : hyaline cartilage
  - Superficial portion – hyaline & fibrous cartilage

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

TABLE 4
MOCART Scoring System Assessment Criteria[39a]

Degree of defect filling: hypertrophy, incomplete, exposed subchondral bone	
Integration of border zone: complete vs incomplete	
Repair tissue	
	Surface: intact or damaged
	Structure: homogeneous vs inhomogeneous
Signal intensity of repair tissue: isointense, moderately hyperintense, markedly hyperintense	
Subchondral	
	Lamina: intact or nonintact
	Bone: intact, edema, granulation tissue/cyst/sclerosis
Adhesions: present vs not present	
Synovitis: present vs not present	

[a]MOCART, magnetic resonance observation of cartilage repair tissue.

- Significant improvement in mokart score

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

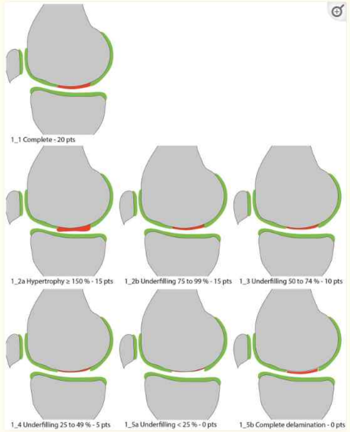


Figure 1.

Volume of cartilage defect filling compared to native cartilage.

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

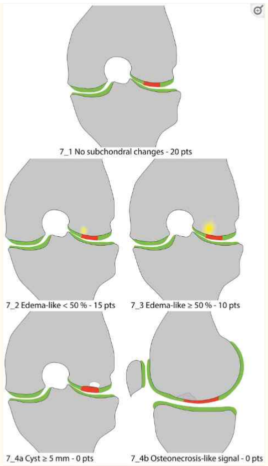


Figure 7.

Subchondral changes.

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

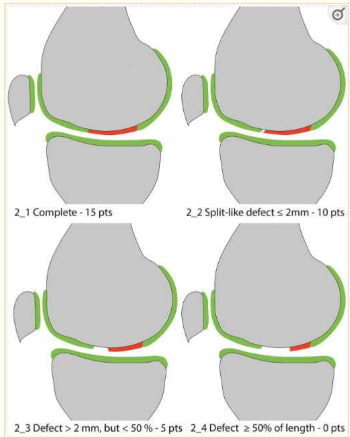


Figure 2.

Integration into adjacent cartilage.

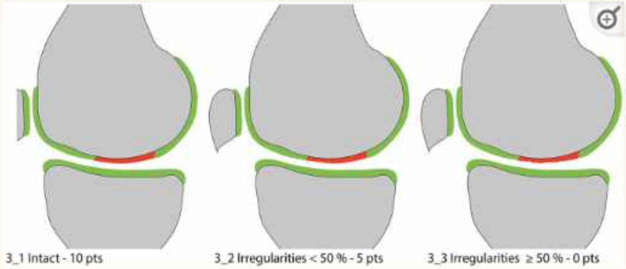


Figure 3.

Surface of the repair tissue.

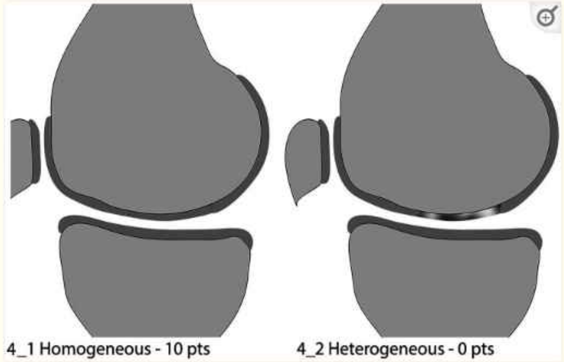


Figure 4.

Structure of the repair tissue.

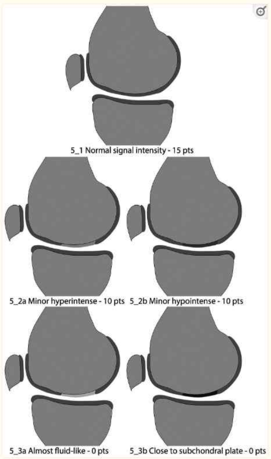


Figure 5.

Signal intensity of the repair tissue.

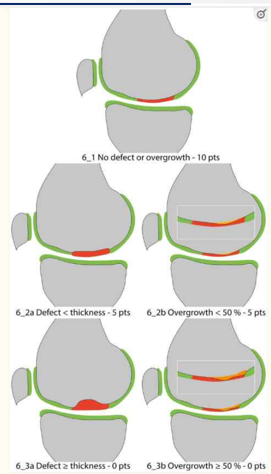


Figure 6.

Bony defect or bony overgrowth.

- More research is needed to establish the optimal cell source, preparation method, dose of cells
- More research needed to establish any superiority over ACI
- The combination of MSCs with scaffolds, growth factors, and gene therapy need further investigation

Reference

슬관절학 3판

Campbell's 14th

Mesenchymal Stem Cells in the Treatment of Cartilage Defects of the Knee, 2021. AJSM, Monketh jaibagi et al.

Stem Cell Therapies for Knee Cartilage Repair: The Current Status of Preclinical and Clinical Studies, 2014. AJSM, John A. Anderson et al.

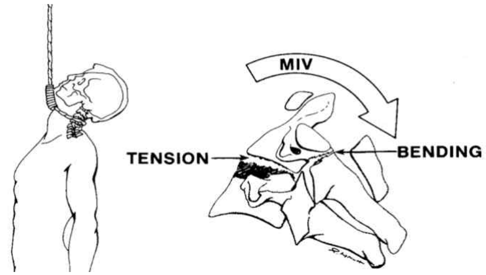
The MOCART (Magnetic Resonance Observation of Cartilage Repair Tissue) 2.0 Knee Score and Atlas

Hangman fracture
Odontoid fracture

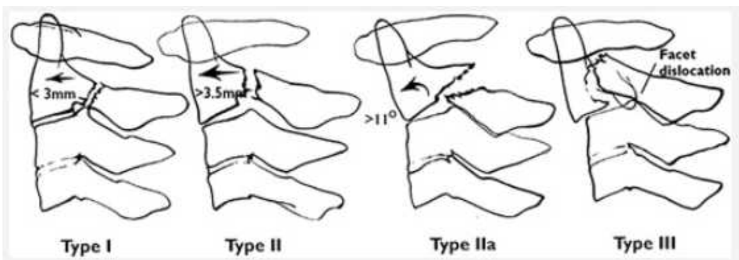
명지병원 정형외과
R1. 김현진

Definition of hangman fracture

- Traumatic spondylolisthesis of the axis

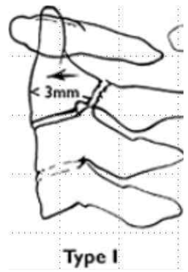


Type & Classification (Levine and Edwards Classification)



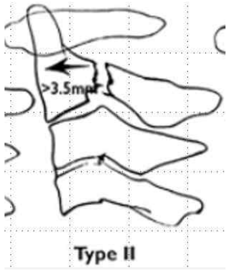
Type I

- *Mechanism*
  - Axial compression and hyperextension
- *Characteristics*
  - < 3mm horizontal displacement C2/3
  - No angulation
  - C2/3 disc remains intact
  - Stable fx pattern
- *Treatment*
  - Rigid collar x 4-6 weeks



Type II

- *Mechanism*
  - Hyperextension and axial load followed by rebound flexion
- *Characteristics*
  - > 3mm of horizontal displacement
  - Significant angulation
  - Vertical fracture line
  - C2/3 disc and PLL are disrupted
  - Unstable fracture pattern



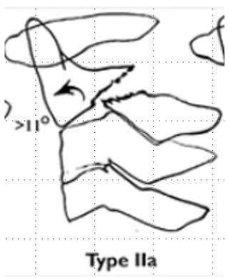
Type II

- *Treatment*
  ① 3-5mm의 전위나 10도 이하의 각 변형
  - - 견인으로 정복이 잘되며 정복 후 곧바로 halo vest apply

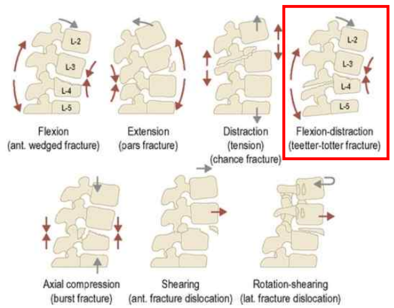
  ② 5mm 이상의 전위나 10도 이상의 각 변형
  - - 견인 후 골절의 일차적 골유합을 얻기 위해 4주간 견인을 유지한 후 halo vest (12wks)
  - - 외고정으로 70%에서 골유합을 얻지만 불유합시 수술적 치료 해야 한다
  - - 따라서 견인하여 정복이 되면 조기에 수술적 치료 시행하기도 한다.
  - (제 2-3경추 전방 유합술 또는 C2 pedicle screw 고정술)

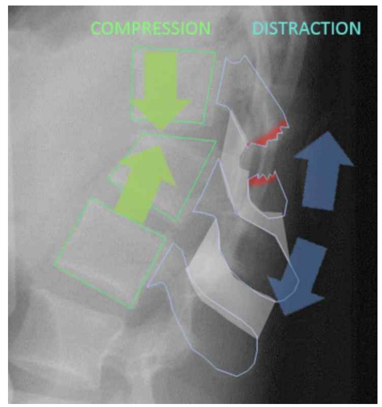
Type IIA

- *Mechanism*
  - Flexion-distraction
- *Characteristics*
  - No horizontal displacement
  - Horizontal fracture line
  - Significant angulation



Flexion-distraction



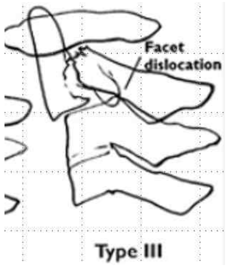


Type IIA

- *Treatment*
  - Avoid traction in Type IIA.
  - Reduction with gentle axial load + hyperextension, then compression halo immobilization for 6-12 weeks.

Type III

- *Mechanism*
  - Flexion-Compression injury
- *Characteristics*
  - Type I fracture with associated bilateral C2-3
  - facet dislocation
  - Rare injury pattern
- *Treatment*
  - Surgical reduction of facet dislocation followed required.

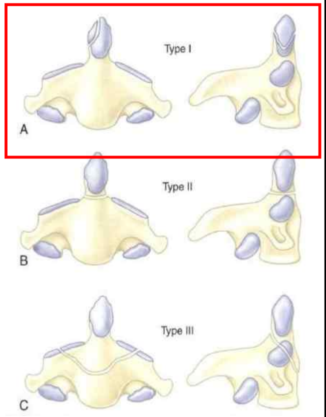


수술 전 주의사항

- 술전 MRI 촬영으로 제 2-3 경추 추간판의 손상 및 척추관 내의 추간판 존재 여부를 확인 해야 한다. (대정)
- 추간판 손상이 있다면 일차적으로 전방 도달법으로 추간판을 제거한 후 전방 유합술 및 고정술을 시행 후 후방 도달법으로 후관절 정복술을 시행해야 한다. (대정)

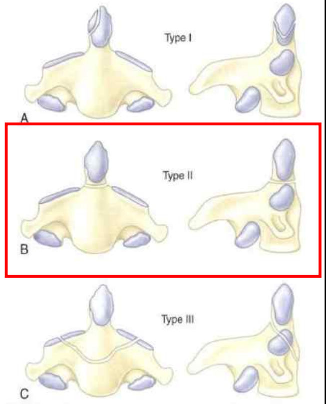
Odontoid fracture – Type I

- Avulsion of the tip of the odontoid
- Union rate : 100%
- Tx : rigid external immobilization such as a halo vest
- rigid collars are an option
- Tx : 연성 경추 보조기 (6-8wks) (대정)



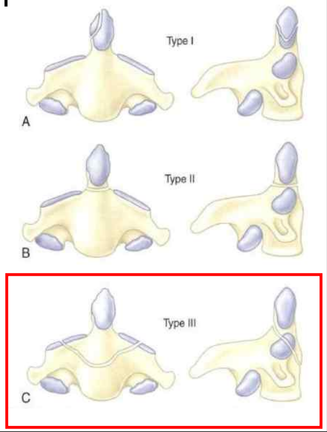
Odontoid fracture – Type II

- Fracture through the base or waist of the odontoid process
- Tx : minimally displaced, halo vest immobilization is recommended
- OP Ix.
  - ① anatomical reduction cannot be achieved in traction
  - ② not maintained with immobilization
  - ③ elderly patients(50세)
- 전위가 없는 골절의 경우 halo vest로 12주간 고정하는데 견고한 외고정에도 불구하고 약 30% 정도 에서 불유합 (대정)



Odontoid fracture – Type III

- Fractures of the body below the base of the odontoid
- Tx : rigid external immobilization such as a halo vest
- Tx : 견인 등으로 정렬을 맞춘 뒤 윤조끼 보조기로 8-12주간 고정 (대정)
- Union rate : 84%



1. 경추 손상 환자의 방사선 사진이다. 손상 기전은? 20B2

㉮ 굴곡 신연
㉯ 신전 신연
㉰ 굴곡 압박
㉱ 수직 압박
㉲ 신전 압박

정답 : 가

Halo vest
Gardner-Wells tong

명지병원 정형외과
R1. 김현진

Halo vest

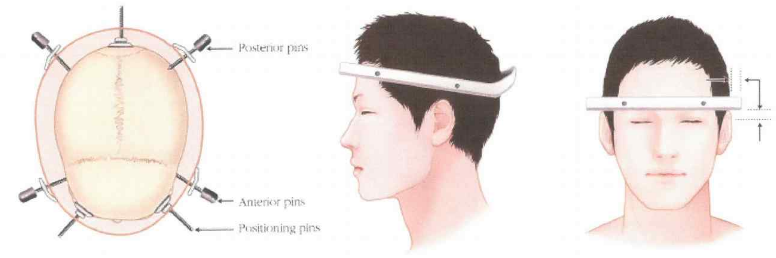
- 특성
  - (1) most effective brace for limiting motion within the cervical spine
  - (2) craniocervical junction, sub-axial region, and cervicothoracic junction effect
  - (3) management of many types of cervical injuries, especially bony injuries involving the Craniocervical junction

Halo vest

- Complication
  - (1) pin site infection, loosening [가장 많다.] (40%)
  - (2) dural penetration, loosening without infection, or even skull fracture at or near the pin site
  - (3) failure to maintain adequate fracture

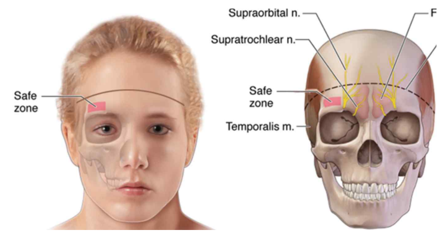
Halo vest application

- Select the smallest ring that allows at least 1 cm skin clearance when placed below the largest diameter of the skull. (눈썹과 귓바퀴 상부 1cm에 halo ring을 위치시킨다)



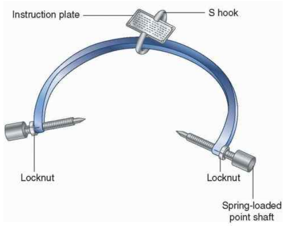
Halo vest application

- Anterior pin을 위치시킬 때 supraorbital & supratrochlear n & temporalis m.의 손상을 피하기 위해 lat. 1/3 of eyebrow에 위치 시킨다. (med. 1/3에 위치시킬 경구 nerve injury 발생)
- Posterior pin의 위치는 anterior pin 보다 약간 낮게 귀 뒤쪽에 위치시킨다.



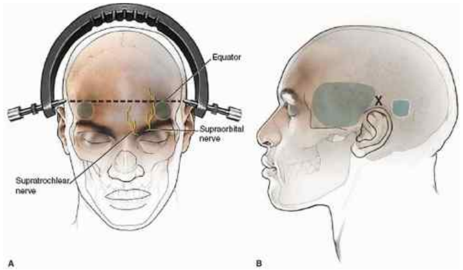
Gardner-Wells tong

- Skeletal traction
- 도수 정복을 하기 위해선 환자가 의식이 있어야 하고 , 신경 증상이 정확히 기록되어야 하며 두개골 골절이 없는 것이 확인되어야 한다.

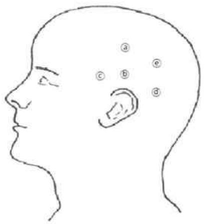


Gardner-Wells tong application

- Identify a point 1 to 2 cm above the top of the ear and 0 to 2 cm posterior to the auditory meatus bilaterally



1. 경추부 외상으로 내원한 환자에게 Gardner-Wells tong traction을 apply 하고자 한다. 이 때 pin의 위치로 가장 적절한 곳을 고르시오. 20B2



정답 : 나

㉮ ⓐ
㉯ ⓑ
㉰ ⓒ
㉱ ⓓ
㉲ ⓔ

Articular Cartilage defect

Department of Orthopedic Surgery, Myongji Hospital
Presenter : R4. 경태현

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

CASE

F/65

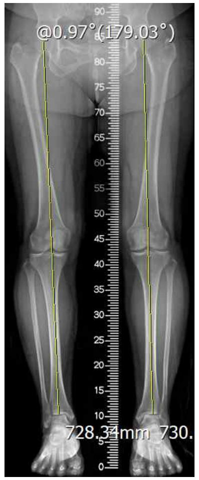
Lt. Knee pain

(o: several yrs ago)

KL G2

ICRS 3

Normal alignment



Arthroscopic findings

CASE

M/53

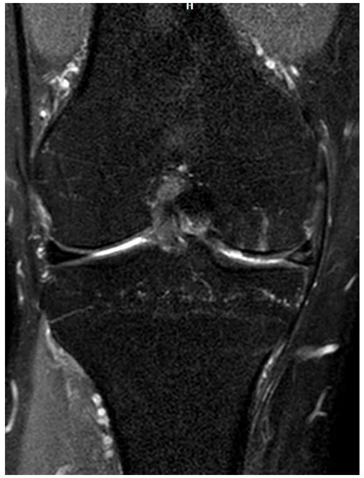
Rt. Knee pain

(o: several yrs ago)

KL G2

ICRS 4

Normal alignment



Case review

Arthroscopic findings

Articular Cartilage Defect

Cartilage

Persists at almost all joint

Deformable, pliant / strong, load bearing

Rubber like padding

Cover and protects the ends of long bones

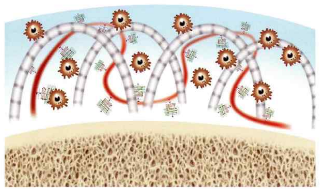


그림 7.1.1 관절연골 기질의 구조

Biology and Structure

Main function of articular cartilage

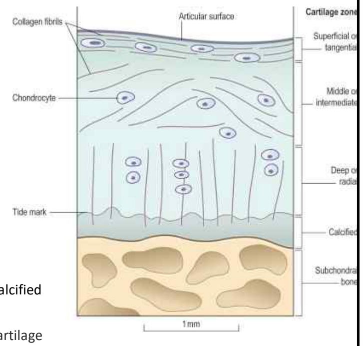
- To provide a low-friction surface for motion
- To resist tensile, shear, and compressive forces

Grossly, appears as a smooth, homogenous tissue approximately 2-5mm thick

Chondrocyte + **Extra cellular matrix** (collagen and proteoglycans)

Adults articular cartilage

- Superficial zone
  - Small elongated cells (parallel to the surface)
  - Covered by a thin film of synovial fluid (lubricin)
  - Resist to tensile and shear force
- Middle zone
  - Chondrocytes are large and rounded
  - Surrounded by largest diameter of collagen fibrils
  - Highest concentration of proteoglycans
- Deep zone
  - Vertical collagen fibrils
  - Collagen types IX and XI & collagen type II
- Tide mark
  - the transition zone between the non-calcified and the calcified articular cartilage
  - the region of critical mechanical weakness in articular cartilage
- Calcified zone
  - small volume of cells embedded in a calcified matrix
  - Type X collagen providing structural integrity & shock absorber



MYONGJI HOSPITAL | SPORTS MEDICAL CENTER

Healing response

Limited capacity for natural healing

: Owing to lack of blood supply, absence of chondrogenic progenitor cell,

↓ mitotic activity

Cartilage injury, divided into **3 categories** based on depth

(1) Cell and matrix damage without visible surface change

: Damage only to matrix, spares chondrocyte

→ Restoration of the matrix by chondrocyte matrix synthesis

: If the damage involves chondrocyte death

→ Spontaneous repair is limited and results in matrix structure alteration

MYONGJI HOSPITAL | SPORTS MEDICAL CENTER

Healing response

(2) Cartilage disruption with visible defects

: Visible damage to cartilage surface and does not extend into the subchondral bone does not initiate a reparative response

→ Results in chondrocyte apoptosis and cessation of matrix synthesis

→ ↑permeability, ↓ability to resist tensile and compressive loads

→ Progression to osteoarthritis

MYONGJI HOSPITAL | SPORTS MEDICAL CENTER

Healing response

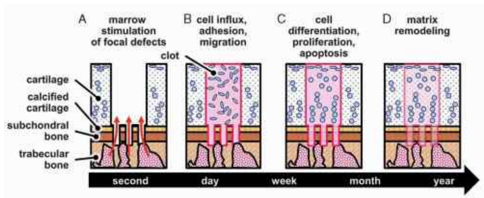
(3) Visible cartilage and subchondral bone disruption

: Gain access to the vascular system and elicit reparative response

→ formation of hematoma, fibrin clot, inflammatory response, migration of mesenchymal stem cell to bone marrow

→ Result in formation of fibrocartilage within 6-8wks

→ Matrix consists mainly Type I collagen and different composition and structure compare with normal cartilage



MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Classification

Classification of Articular Cartilage Lesions by Severity

GRADE	OUTERBRIDGE	MODIFIED OUTERBRIDGE	ICRS
0	Normal cartilage	Intact cartilage	Intact cartilage
I	Softening and swelling	Chondral softening or blistering with intact surface	Superficial (soft indentation or superficial fissures and cracks)
II	Fragmentation and fissures in area less than 0.5 inch in diameter	Superficial ulceration, fibrillation, or fissuring less than 50% of depth of cartilage	Lesion less than half the thickness of articular cartilage
III	Fragmentation and fissures in area larger than 0.5 inch in diameter	Deep ulceration, fibrillation, fissuring, or chondral flap more than 50% of cartilage without exposed bone	Lesion more than half the thickness of articular cartilage
IV	Exposed subchondral bone	Full-thickness wear with exposed subchondral bone	Lesion extending to subchondral bone

ICRS, International Cartilage Repair Society.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Published in final edited form as:
Am J Sports Med. 2014 September ; 42(9): 2253–2261. doi:10.1177/0363546513508744.

Stem Cell Therapies for Knee Cartilage Repair: The Current Status of Preclinical and Clinical Studies

John A. Anderson, MD MSc[*,1,2], **Dianne Little, BVSc PhD**[1], **Alison P. Toth, MD**[1], **Claude T. Moorman III, MD**[1], **Bradford S. Tucker, MD**[2], **Michael G. Ciccotti, MD**[2], and **Farshid Guilak, PhD**[1]

[1]Department of Orthopaedic Surgery, Duke University Medical Center, Durham, North Carolina.

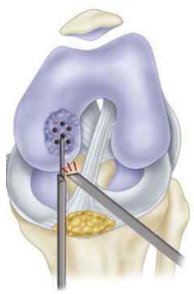
[2]Rothman Institute Cartilage Center, Rothman Institute, Philadelphia, Pennsylvania.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

- Background
  - Articular damage of knee cause significant morbidity
  - Operative Tx.
    - Failure of non-operative Tx.
    - Acute osteochondral fractures resulting in full-thickness loss of cartilage
- Limited approach for focal cartilage lesions
- Current techniques
  - Microfracture
  - Autologous cell or tissue grafting
  - Autologous chondrocyte implantation
  - Micronized articular cartilage allografts
- Long term results may be variable and unknown

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Marrow Stimulation (Microfracture)



Microfracture

Enhance chondral resurfacing by providing suitable environment for new tissue formation

Taking advantage of the body's own healing potential

Goal of this procedure

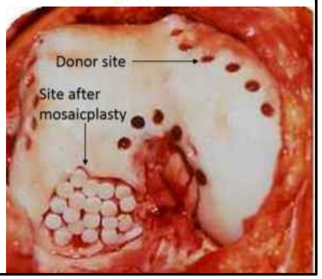
: To alleviate the pain and attendant disabilities

: To late degenerative changes in the joint by restoring joint surface

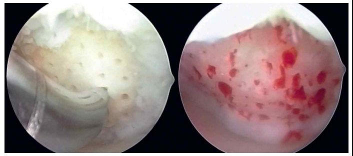
OATs (Osteochondral Autologous transplantation)

Direct transplantation of osteochondral segments from less loaded region to symptomatic focal defect

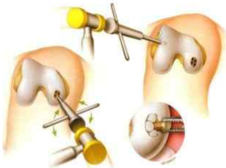
Multiple, small diameter osteochondral grafts or plugs producing a mosaic-like structure makes potentially easier matching of the surface contour of the defect site and more stable than larger grafts

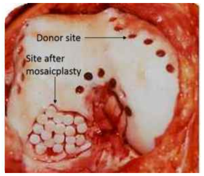


- Microfracture
  - Steadman et al – improvement in clinical knee score
  - Minas et al – Subseqeunt surgery more difficult

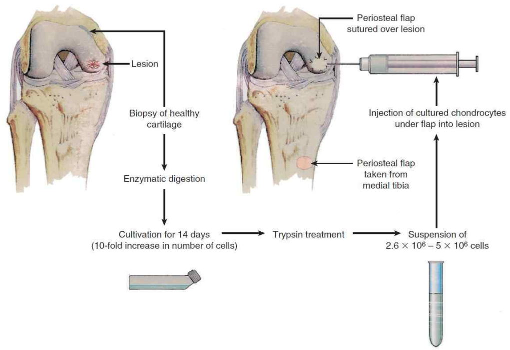


- Mosaicplasty
  - Donor site morbidity
  - Limited availability
  - Mismatch geometry
- Advantages
  - Low complexity
  - Patient undergoing only 1 surgery
  - Use of patient's own tissue





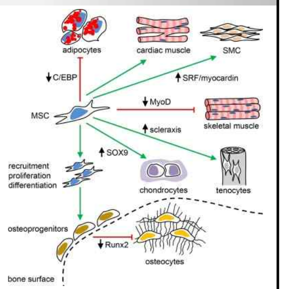
- ACI (Autologous chondrocyte implantation)



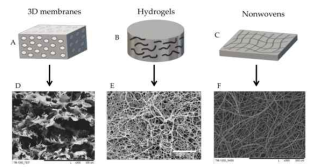
- ACI (Autologous chondrocyte implantation)
  - Requires 2nd stage operation
  - May result periosteal overgrowth
- ACI vs Microfracture & Mosaicplasty
  - Controversial
- Newer ACI technique
  - Use biomaterials seeded with chondrocytes as a scaffold instead of periosteal patch
  - Still have
    - Iatrogenic damage
    - Require 2 operations
    - Donor site morbidity

- Adult stem cells
  - Provide more readily accessible source of cells for treatment of chondral or osteochondral defects
  - Bone marrow derived mesenchymal stem cells (MSCs)
  - Adipose-derived stem cells (ASCs)
    - Multipotent differentiation capabilities in the mesenchymal lineage, similar to MSCs

- Pre-clinical
  - Animals
    - Pre-differentiated MSC
    (supplemented with TGF-B, basic fibroblast GF)
    - Undifferentiaed MSC
    - Scaffold for tissue engineering
    - Gene transfer (SOX-9)



- Clinical
    - IKDC
    - Tegner
    - Lysholm



- Animal studies of stem cell based cartilage repair
- Small animal models
  - Rabbit model - Defects with a 5mm diameter and 1mm depth were created in the medial femoral condyle
    - Predifferentiated MSCs (supplemented with TGF-B, basic fibroblast GF)
    - Undifferentiated MSCs
    - Untreated

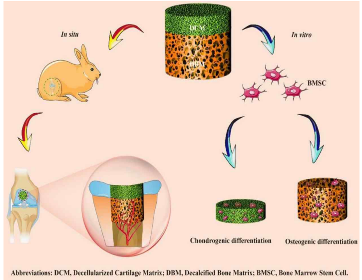
    → Transplantation of MSCs produced superior healing compared with untreated cartilage defect irrespective of differentiation

  - Comparing MSCs and ACI
    - Both group similar cartilage regenerative profiles
    - Both treatment superior tissue regeneration compared with untreated defects

    → MSCs advantage - prolonged expansion time without phenotype transformation and the homing and engraftment of other stem cell

- Scaffold
- Compared with the hydrogel composite without MSCs, the 2 groups of hydrogels with MSCs (one with the addition of TGF-β1) facilitated subchondral bone formation
- Biphasic osteochondral composite
  - Chondral phase consisting of hyaluronate and atelocollagen
  - Osseous phase consisting of hyaluronic acid and β–tricalcium phosphate

  → Scaffold composite held promise for defect repair



- Sox9 gene transfer – higher repair rate

- Large animal models – clinically relevant to human condition
- Hepp P et al.
  - Chondrogenically predifferentiated ovine MSC / hydrogel constructs (preMSC gels)
  - Undifferentiated ovine MSC/hydrogel constructs (unMSC gels)
  - Cell-free collagen hydrogels (CF gels)
  - Untreated controls

  → preMSC gels showed significantly better histological scores with morphological characteristics of hyaline cartilage

- MSC-seeded triphasic constructs VS the OATS (osteoarticular transfer system) procedure
  - Macroscopic and biomechanical analyses showed no significant differences between groups at 12 months
- The disadvantages of OATS
  - Morbidity at the donor site
  - Limited size of the transplant
  - Hemarthrosis
  - Difficulty in shaping host tissue to fit the defect area
  - Inadequate bonding of the graft cartilage to surrounding tissue

- The role of growth factors in treating osteochondral defects
  - A defect-only group
  - collagen gel–only group
  - collagen gel containing MSCs alone
  - MSCs and a gel induced with TGF-β

- Pineda et al - Both treatments using MSCs resulted in a superior gross and histological appearance and better histological scores than the non-MSC group
- Using undifferentiated MSCs resulted in a superior outcome than using TGF-β induced differentiated MSCs, especially with regard to the restoration of subchondral bone

- TGF-B and growth factors : stimulates chondrogenesis
  - influence may be variable
  - Synovial proliferation and fibrosis / inflammatory leukocytes attraction/ Induction of osteophyte formation

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

- MSCs combined with microfracture to address osteochondral defects
  - Hypothesis : there may be a problem with the migration and proliferation of MSCs embedded within fibrin
    - MSCs suspended in hyaluronan + microfracture
    - microfracture alone

  → No difference clinically or histologically in the 2 groups at 12 months,
  - MSC + micro Fx. group had increased aggrecan content and tissue firmness

- Compared with microfracture, MSC treatment was superior in terms of a short- term arthroscopic inspection and also in longer term macroscopic, histological, and quantitative magnetic resonance imaging (MRI) analyses
  - Repair tissue in the MSC group had better type II collagen content and orientation
  - Improved sulfated glycosaminoglycan content
  - Greater integration into the surrounding normal cartilage, with greater thickness and a smoother surface

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

- Clinical studies of stem cell based cartilage repair
  - Systemic review

Results for Searching "Stem Cells and Knee" on PubMed

Authors (Year)	Outcomes	Institution	No. of Patients	Brief Description	Stem Cell Delivery Method
Nejadnik et al (2010)[69]	IKDC, ICRS, SF-36, Lysholm, Tegner	National University, Singapore	72	Observational cohort study; 36 patients underwent ACI, and 36 patients underwent BM-derived MSC implantation; concluded that BM-derived MSCs were as effective as chondrocytes in clinical outcomes	2-stage implantation; BM-derived MSCs harvested and then later arthrotomy performed to implant
Haleem et al (2010)[43]	Lysholm, revised HSS,MRI, arthroscopic ICRS	Cairo University, Egypt	5	Case series; all patients' symptoms improved at 12 mo; ICRS arthroscopic scores were 8 of 12 and 11 of 12 for 2 patients; at 12 mo, MRI showed complete congruity in 3 patients and incomplete congruity in 2 patients	2-stage implantation; autologous BM-derived MSC culture expanded, placed on PR-FG intraoperatively, and then transplanted into defects
Davatchi et al (2011)[21]	VAS, walking time to pain, stair climbing	Tehran University, Iran	4	Case series; walking time to pain improved in 3 patients; improved stair climbing and VAS scores for all	Direct delayed injection; 30mL of BM taken and cultured for growth for 4 to 5 wk
Koh et al (2013)[54]	WOMAC, Lysholm, VAS, MRI	Yonsie Sarang Hospital, South Korea	18	Case series; infrapatellar fat pad harvested after arthroscopic debridement; clinical scores improved, and MRI scores improved; results positively related to number of stem cells injected	Direct delayed injection; after arthroscopic surgery, fat pad stem cells and PRP injected into knees

Results for Searching "Stem Cells and Knee" on clinicaltrials.gov

Title	Outcomes	Institution	No. of Patients	Brief Description	Identifier
Transplantation of Bone Marrow Stem Cells Stimulated by Proteins Scaffold to Heal Defects Articular Cartilage of the Knee	KOOS, ICRS	University of Marseille, France	50	Fresh non–culture-expanded autologous BM-derived MSCs, stimulated with a protein matrix, are mixed in a collagen HA scaffold; this paste is transplanted into the prepared defect, under arthroscopic surgery, with an injection of PRP	NCT 01159899
Treatment of Knee Osteoarthritis With Autologous Mesenchymal Stem Cells	VAS, Oswestry, SF-36, MRI (CartiGram)	Fundacion Teknon and IBGM, University of Valladolid, Spain	12	Used 40 million BM-derived MSCs for grade 2 to 4 OA	NCT 01183728
The Effects of Intra-articular Injection of Mesenchymal Stem Cells in Knee Joint Osteoarthritis	WOMAC, VAS	Royan Institute, Iran	40	Case-control study; BM-derived MSCs will be administered at 1 mo and 4 mo after harvest; clinical and MRI follow-up to 6mo	NCT 01504464
Autologous Stem Cells in Osteoarthritis	ROM, WOMAC, SF-36, VAS	Hospital Universitario Dr Jose E. Gonzalez, Mexico	30	One group receives acetaminophen, and the other receives BM-derived MSCs	NCT 01485198
Adult Stem Cell Therapy for Repairing Articular Cartilage in Gonarthrosis	VAS, SF-36, MRI	Centro Medico Teknon, Institut de Terapia Regenerativa Tissular, CETIR Sant Jordi, Spain	15	For grade 2 to 3 OA; at 21 d, 40 million BM-derived MSCs injected and clinical and MRI follow-up to 12 mo	NCT 01227694
Allogeneic Mesenchymal Stem Cells in Osteoarthritis	WOMAC, VAS, analgesia intake, MRI	Sanjay Gandhi Post Graduate Institute of Medical Sciences, India	60	Allogenic MSCs used in different times	NCT 01453738
Autologous Mesenchymal Stem Cells vs Chondrocytes for the Repair of Chondral Knee Defects	SF-12, WOMAC	La Paz University Hospital, Spain	30	RCT of ASCs vs chondrocytes	NCT 01399749
Allogeneic Mesenchymal Stem Cells for Osteoarthritis	WOMAC, VAS, analgesia intake, MRI	KPJ Ampang Puteri Specialist Hospital,Malaysia	72	RCT of BM-derived MSCs vs PlasmaLyte and hyaluronan	NCT 01448434
Evaluation of Safety and Exploratory Efficacy of CARTISTEM, a Cell Therapy Product for Articular Cartilage Defects	IKDC, Lysholm, KOOS, VAS, MRI	Rush University, USA	12	Cartistem is human umbilical cord blood-derived MSCs for grade 3 to 4 OA	NCT 01733186
ADIPOA - Clinical Study	WOMAC, ROM, SF-8, MRI	University Hospital of Montpellier, France	18	Differing concentrations of ASCs (2 million vs 10 million vs 50 million) will be injected into knees with grade 3 to 4 OA and compared	NCT 01585857
Study to Compare the Efficacy and Safety of Cartistem and Microfracture in Patients With Knee Articular Cartilage Injury or Defect	ICRS, VAS, biopsy, WOMAC, IKDC	Korea University Guro Hospital, South Korea	104	Comparison of Cartistem vs microfracture for grade 4 OA	NCT 01041001

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

- Pubmed
  - MSCs were compared with ACI in 72 matched symptomatic patients with full-thickness cartilage defects, as diagnosed by clinical examination and MRI.
  - The International Knee Documentation Committee (IKDC), Tegner, and Lysholm scores were similar between groups

  → No difference between groups in terms of clinical outcomes
  - But greater improvement over time in the MSC group

  - Advantages of MSCs over ACI
    - Single surgery
    - Reduced costs
    - Minimal donor site morbidity

- clinicaltrials.gov
  - Stem cell delivery methods varied and included direct injections and both 1 and 2 stage implantations into the defect
  - General outcome measures include
    - Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)
    - VAS
    - IKDC
    - Short Form–12 Health Survey (SF-12)
    - Lysholm
    - Knee injury and Osteoarthritis Outcome Score (KOOS)
    - Histology
    - MRI
    - arthroscopy

MYONGJI HOSPITAL | SPORTS MEDICAL CENTER

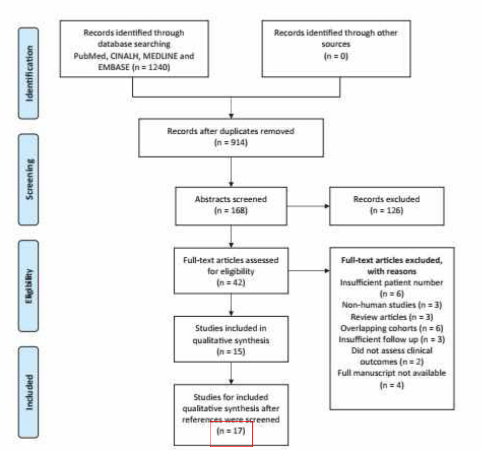
Mesenchymal Stem Cells in the Treatment of Cartilage Defects of the Knee

A Systematic Review of the Clinical Outcomes

Monketh Jaibaji,*† MBBS, MRCS, Rawan Jaibaji,† BSc, and Andrea Volpin,‡ MD
Investigation performed at the Division of Interventional Science, University College London, London, UK

- Systemic review assessing clinical and functional outcomes of mesenchymal stem cell implantation
- 17 studies encompassing 367 patients
  - Clinical outcomes : VAS, WOMAC IKDC etc..
  - Radiologic outcomes : MOCART scores
  - Histologic findings : Arthroscopic 2nd look and biopsy – Hyaline or fibrocartilage

MYONGJI HOSPITAL | SPORTS MEDICAL CENTER



MYONGJI HOSPITAL | SPORTS MEDICAL CENTER

- Clinical scores

Improvement in

- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)
- VAS
- IKDC
- Tegner
- Lysholm
- Knee injury and Osteoarthritis Outcome Score (KOOS)

- Histologic finding
  - Majority of deep portion : hyaline cartilage
  - Superficial portion – hyaline & fibrous cartilage

TABLE 4
MOCART Scoring System Assessment Criteria[39a]

Degree of defect filling: hypertrophy, incomplete, exposed subchondral bone
Integration of border zone: complete vs incomplete
Repair tissue
Surface: intact or damaged
Structure: homogeneous vs inhomogeneous
Signal intensity of repair tissue: isointense, moderately hyperintense, markedly hyperintense
Subchondral
Lamina: intact or nonintact
Bone: intact, edema, granulation tissue/cyst/sclerosis
Adhesions: present vs not present
Synovitis: present vs not present

[a]MOCART, magnetic resonance observation of cartilage repair tissue.

- Significant improvement in mokart score

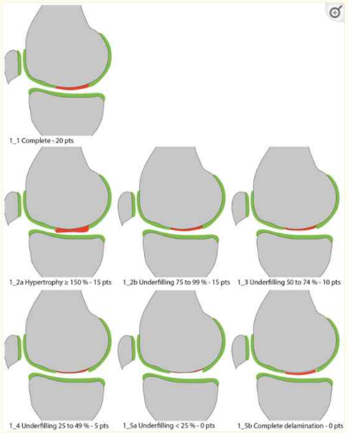


Figure 1.

Volume of cartilage defect filling compared to native cartilage.

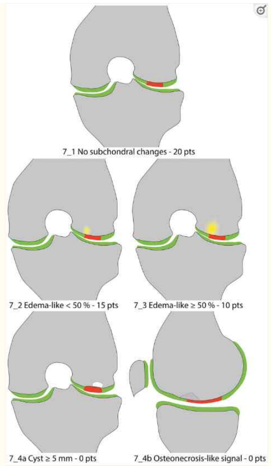


Figure 7.

Subchondral changes.

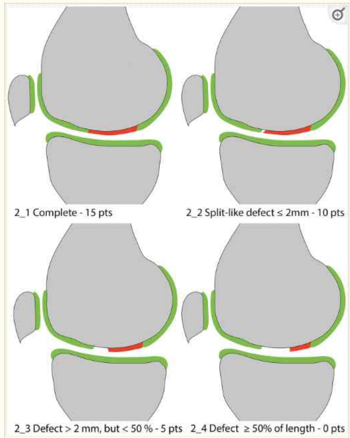


Figure 2.

Integration into adjacent cartilage.

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

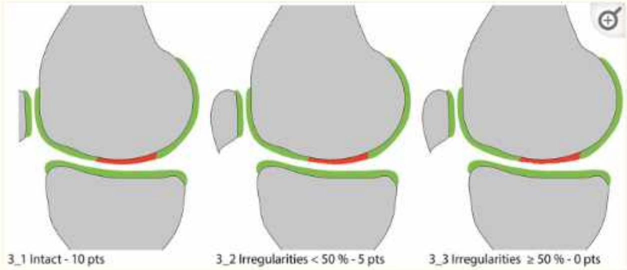


Figure 3.

Surface of the repair tissue.

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

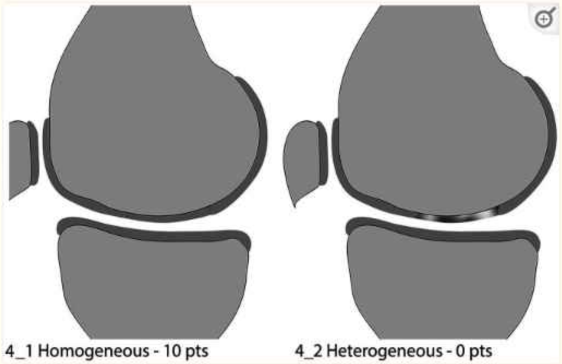


Figure 4.

Structure of the repair tissue.

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

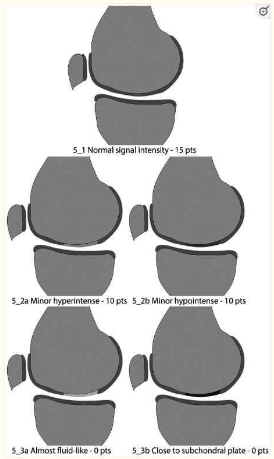


Figure 5.

Signal intensity of the repair tissue.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

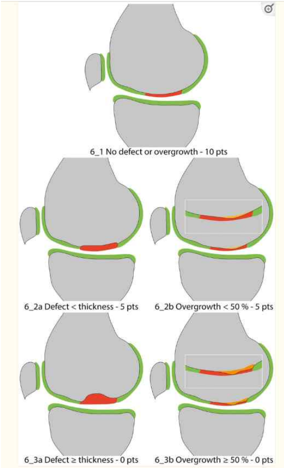


Figure 6.

Bony defect or bony overgrowth.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

- More research is needed to establish the optimal cell source, preparation method, dose of cells
- More research needed to establish any superiority over ACI
- The combination of MSCs with scaffolds, growth factors, and gene therapy need further investigation

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

문제

35세 남자가 1년 전부터 지속적으로 반복되는 우측 슬관절 동통과 부종으로 인해 일상생활에 지장이 있다. 방사선 검사에서 하지 정렬은 정상이다. MRI 검사에서 3.5cm 크기의 ICRS grade 4a 관절연골 손상이 대퇴 활차에 관찰된다. 가장 적절한 치료는?

① 경과관찰
② 미세골절술
③ 자가 골연골이식술
④ 자가 연골세포이식술
⑤ 자가 골수유래세포이식술

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

문제

35세 남자가 1년 전부터 지속적으로 반복되는 우측 슬관절 동통과 부종으로 인해 일상생활에 지장이 있다. 방사선 검사에서 하지 정렬은 정상이다. MRI 검사에서 3.5cm 크기의 ICRS grade 4a 관절연골 손상이 대퇴 활차에 관찰된다. 가장 적절한 치료는?

① 경과관찰
② 미세골절술
③ 자가 골연골이식술
④ 자가 연골세포이식술
⑤ 자가 골수유래세포이식술

정답 4

문제 해석

젊은 환자에서 cartilage injury의 치료법을 묻는 문제이다.

Cartilage injury의 수술적 치료의 적응증은 1. symptomatic하여 일상생활에 지장이 있으면서, 2. 3arthritic change는 없으며, 3. 45세 이하이며, 4. Alignment 문제가 없고, 5. Stable하며 6. Meniscus의 2/3이상이 intact하여야 한다. 위 환자는 모두 만족한다.

OATS의 적응증은 focal한 2 이하의 unipolar lesion에서 사용한다. 반면 ACI의 적응증은 큰 넓이의 lesion 에서 사용한다. 2cm-10cm 의 크기에서 사용된다. 참고로 심평원 기준으로는 4cm를 초과하는 단독 병변 또는 2-4cm의 다발성 병변에서 다른 치료가 실패한 경우 시행한다.

Reference. 정형외과학 8th. 2권. P1330

Keyword 중복 point

- Cartilage injury의 treatment algorithm을 기억하자 (정형외과학 8th. 2권. Fig. V-51)

Articular cartilage defect size에 따른 치료

Size	diameter	Treatment
<1cm²	<1.12cm	Observation Abrasion chondroplasty Microfracture Osteochondral auotograft transfer
1~2cm²	1.12~1.59cm	Abrasion chondroplasty Microfracture Osteochondral auotograft transfer
2~3.5cm²	1.59~2.11cm	Fresh osteochondral allograft Autologous chondrocyte implantation
3.5~10cm²	2.11~3.56cm	Autologous chondrocyte implantation

Reference : campbell's 14^{th}.

Reference

- 슬관절학 3판
- 대한정형외과학 8판
- Campbell's 14^{th}
- Mesenchymal Stem Cells in the Treatment of Cartilage Defects of the Knee, 2021. AJSM, Monketh jaibagi et al.
- Stem Cell Therapies for Knee Cartilage Repair: The Current Status of Preclinical and Clinical Studies, 2014. AJSM, John A. Anderson et al.
- The MOCART (Magnetic Resonance Observation of Cartilage Repair Tissue) 2.0 Knee Score and Atlas

CMC joint arthritis

2023.06.29
정형외과 R1. 정승호

Hand Arthritis

- Degenerative arthritis
- Rheumatoid arthritis
- Ulnar impaction syndrome
- Gouty arthritis
- Psoriatic arthritis
- Post-traumatic arthritis

Hand Arthritis

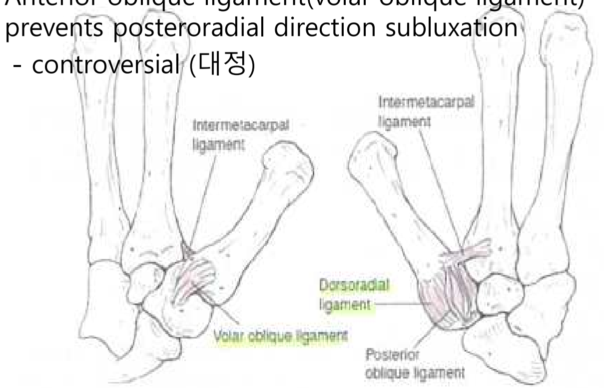
- Degenerative arthritis
  - IP joint
  - CMC joint
  - wrist joint
- Rheumatoid arthritis
- Ulnar impaction syndrome
- Gouty arthritis
- Psoriatic arthritis
- Post-traumatic arthritis

CMC joint arthritis

- Relatively wide ROM range joint
- Concave articular surface supported by capsule & juxta-ligamentous structure
- Involving CMC joint of thumb : m/c
  - during pinch motion

CMC joint arthritis

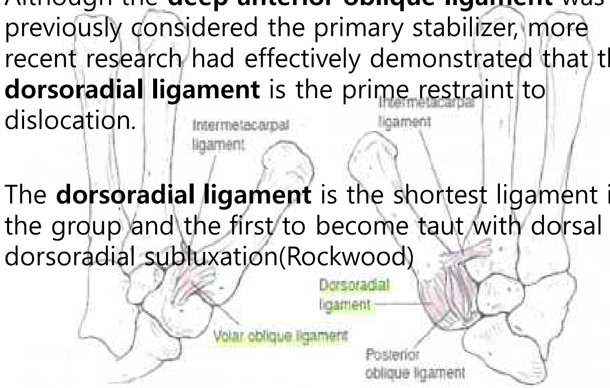
- Anterior oblique ligament(volar oblique ligament) prevents posteroradial direction subluxation
  - controversial (대정)



CMC joint arthritis

- Although the **deep anterior oblique ligament** was previously considered the primary stabilizer, more recent research had effectively demonstrated that the **dorsoradial ligament** is the prime restraint to dislocation.

- The **dorsoradial ligament** is the shortest ligament in the group and the first to become taut with dorsal or dorsoradial subluxation(Rockwood)

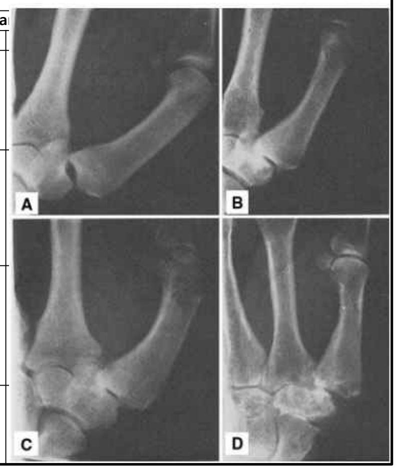


Classification

Classification systems of **thumb carpometacarpal arthrosis**			
	Eaton-Littler	Burton	dell
Stage 1	No joint destruction Joint space widened if effusion present Less than one-third subluxation	Ligamentous laxity, pain, positive grind test Dorsoradial metacarpal subluxation	Symptoms with heavy use, positive grind test Narrowed joint space, subchondral sclerosis
Stage 2	Slight decrease in joint space Marginal osteophytes < 2mm May be on-third subluxation	Crepitus, instability, chronic subluxation Degenerative charges on radiograph	Pain with normal use, crepitus Ulnar osteophyte, less than one-third subluxation
Stage 3	Significant joint destruction with cysts and sclerosis Osteophytes > 2mm Greater than one-third subluxation	Pantrapezil degenerative changes	CMC adduction deformity, MCP joint hyperextension May have pantrapezial arthritis and one-third subluxation
Stage 4	Involvement of multiple joint surface	Stage 2 or 3 with arthritis at the MCP joint	Cystic changes and total loss of joint space CMC joint may be totally immobile

Classification

Classification systems of **thumb carpometacarpal a**	
	Eaton-Littler
Stage 1	No joint destruction Joint space widened if effusion present Less than one-third subluxation
Stage 2	Slight decrease in joint space Marginal osteophytes < 2mm May be one-third subluxation
Stage 3	Significant joint destruction with cysts and sclerosis Osteophytes > 2mm Greater than one-third subluxation
Stage 4	Involvement of multiple joint surface



Treatment

- Conservative treatment
  - NSAIDs, steroid injection
  - splint apply for 3wks
  (3주간의 weaning시기로 치료하면 일부에서 장기적인 효과를 나타낼 수 있다.)

Treatment

- Operative treatment
  1. anterior oblique ligament reconstruction
  2. MC osteotomy
  3. Complete or partial trapeziectomy
     + ligament reconstruction
     + interpositional arthroplasty using tendon
  4. Trapeziectomy + hematoma arthroplasty
  5. Implant arthroplasty
  6. CMC joint arthrodesis
  7. Arthroscopic thumb CMC arthroplasty

Treatment

- Operative treatment
  1. anterior oblique ligament reconstruction
  - stage 1 에서 효과적
  - stage 3,4 에서는 효과적이지 못하다
  - Ligament reconstruction alone seems to be suitable for posttraumatic or early osteoarthritic changes at the trapeziometacarpal joint
  - FCR, APL, ECRL, PL

Treatment

- Operative treatment
  2. MC osteotomy
  - stage 1,2 에서 효과적
  (신전 절골술은 관절 접촉면을 수장측의 손상된 연골로부터 배측의 정상 연골로 이동시켜주는 효과가 있다고 알려져 있다.)

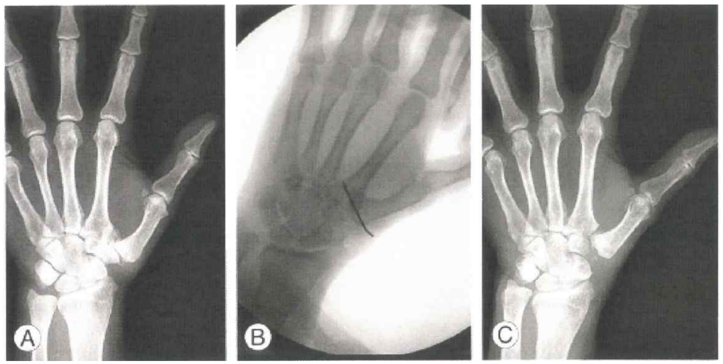
Treatment

- Operative treatment
  3. Complete or partial trapeziectomy
     + ligament reconstruction
     + interpositional arthroplasty using tendon

  - Complete trapezial excision : when involving S-T joint
  - Interposition tendon : FCR, PL, APL

Treatment

- Operative treatment
  4. Trapeziectomy + hematoma arthroplasty
  - trapeziectomy 절제할 때 주위의 연부조직을 최대한 보존한 상태로 절제
  - 약간의 견인 상태로 중수골을 K강선으로 고정하여 약 5주간 유지
  - hematoma arthroplasty : hematoma consolidation effect



Treatment

- Operative treatment
  5. Implant arthroplasty
  - indication to elderly patients with a subluxated trapeziometacarpal joint with synovitis, joint narrowing, osteophytes, and positive grind test
  - the position of the prosthesis must be immobilized in a cast for 6wks
  - complications :
    implant subluxation (~20%)
    dislocation (~19%)
    silicone synovitis (~50%)

Treatment

- Operative treatment
  6. CMC joint arthrodesis
  - Indications
    I) under 40 yrs
    II) demands highly activity life style
    III) stage 2,3

  - should permit pulp to pulp pinch to the index finger

Treatment

- Operative treatment
  7. Arthroscopic thumb CMC arthroplasty
  - Indications
    I) early stage with thumb CMC debridement
    II) late stage with resection of both CMC and S-T joints

- Arthroscopic stage
  - Stage 1 : diffuse synovitis w/o cartilage loss and ligamentous laxity of the volar capsule
  - Stage 2 : focal wear of the central to dorsal articular surface on the trapezium
  - Stage 3 : diffuse articular cartilage loss on the trapezium

1. 중노동을 하는 29세 남자가 3년간의 무지 수근중수 관절(carpometacarpal joint)의 동통으로 내원하였다. 진찰 소견 상 중등도의 후방 불안정성이 있으며, 중수지 관절의 운동 범위는 정상이었다. 방사선 검사상 관절 간격의 감소 및 골 경화, 연골하 골 낭종, 3mm의 골극이 관찰되었다. 가장 적절한 치료는? 13B/08B

㉮ 인대 재건술
㉯ 절제 관절 성형술
㉰ 절제 관절 성형술 및 인대 재건술
㉱ 관절 유합술
㉲ 관절 치환술

표 3-13 Classification systems of thumb carpometacarpal arthrosis

	Eaton	Burton	dell
Stage 1	No joint destruction Joint space widened if effusion present Less than one-third subluxation	Ligamentous laxity, pain, positive grind test Dorsoradial metacarpal subluxation	Symptoms with heavy use, positive grind test Narrowed joint space, subchondral sclerosis
Stage 2	Slight decrease in joint space Marginal osteophytes < 2mm May be on-third subluxation	Crepitus, instability, chronic subluxation Degenerative charges on radiograph	Pain with normal use, crepitus Ulnar osteophyte, less than one-third subluxation
Stage 3	Significant joint destruction with cysts and sclerosis Osteophytes > 2mm Greater than one-third subluxation	Pantrapezil degenerative changes	CMC adduction deformity, MCP joint hyperextension May have pantrapezial arthritis and one-third subluxation
Stage 4	Involvement of multiple joint surface	Stage 2 or 3 with arthritis at the MCP joint	Cystic changes and total loss of joint space CMC joint may be totally immobile

환자의 problem list

1) 29세 남자, 중노동
2) Eaton stage III CMC joint arthritis
-> 보기 ㉣의 indication에 해당한다

CMC joint arthrodesis 의 Ix (대정)

1) 40세 이하이거나
2)무거운 물체를 다루거나 힘을 많이 사용하는 직업인 경우
3) stage II, III

오답 노트 정리하기

㉮ anterior oblique ligament reconstruction은 stage I에서 효과적이고, stage III, IV에서는 효과적이지 못하다
㉯ Resction arthroplasty도 advanced stage에서 사용가능하나 instability가 발생할 수 있으므로 중노동을 해야 하는 환자에게 적절하지 못하다
㉰ 사용가능한 option이나 술 후 단점으로 중수지골이 축성 방향으로 내려 앉아 무지열의 길이와 집기력 (pinch strength)이 정상보다 감소하므로 중노동을 해야 하는 환자에게 적절하지 않다
㉱ 노인에서 제한적으로 사용한다

1. 32세 남자. 우측 무지의 CMC joint 주변의 통증으로 보존적 치료를 시행하였으나 통증은 지속되었다. 단순 방사선 사진상에서 CMC joint destruction은 없었고, 약간의 joint space의 감소, marginal osteophyte는 1mm 소견이 관찰 되었다. 가장 적절한 치료는? 14B2

㉮ Implant arthroplasty
㉯ complete trapeziectomy
㉰ MC extension osteotomy
㉱ complete trapeziectomy + ligament reconstruction + tendon interposition
㉲ trapeziectomy + hematoma arthroplasty

표 3-13 Classification systems of thumb carpometacarpal arthrosis			
	Eaton	Burton	dell
Stage 1	No joint destruction Joint space widened if effusion present Less than one-third subluxation	Ligamentous laxity, pain, positive grind test Dorsoradial metacarpal subluxation	Symptoms with heavy use, positive grind test Narrowed joint space, subchondral sclerosis
Stage 2	Slight decrease in joint space Marginal osteophytes < 2mm May be on-third subluxation	Crepitus, instability, chronic subluxation Degenerative charges on radiograph	Pain with normal use, crepitus Ulnar osteophyte, less than one-third subluxation
Stage 3	Significant joint destruction with cysts and sclerosis Osteophytes > 2mm Greater than one-third subluxation	Pantrapezil degenerative changes	CMC adduction deformity, MCP joint hyperextension May have pantrapezial arthritis and one-third subluxation
Stage 4	Involvement of multiple joint surface	Stage 2 or 3 with arthritis at the MCP joint	Cystic changes and total loss of joint space CMC joint may be totally immobile

환자의 problem

- 32세 남자
- Eaton stage II의 CMC joint arthritis
-> 젊은 환자의 Eaton stage II에 대한 치료로 보기 ㉰가 가장 적절한 답이다
-> 신전 절골술은 관절 접촉면을 수장측의 손상된 연골로부터 배측의 정상 연골로 이동시켜주는 효과가 있다

㉮ 노인에서만 제한적으로 사용
㉯ S-T joint에 퇴행성 변화가 있으면 complete trapezial excision을 한다. 즉 advanced stage에 사용한다
㉱ advanced stage에 사용한다
㉲ advanced stage에 사용한다

1. 50세 여자가 3년간의 무지 수근중수 관절(carpometacarpal joint)의 동통으로 내원하였다. 진찰 소견 상 중등도의 후방 불안정성이 있으며 방사선 검사상 관절 간격의 감소 및 골 경화, 연골하 골 낭종, 4mm의 골극이 관찰되었고 주상대능형 관절염(scaphotrapezial joint)이 동반되었다. 가장 적절한 치료는? 21B

㉮ 관절 유합술
㉯ 인공 관절 치환술
㉰ 절제 관절 성형술
㉱ 중수지 신전 절골술
㉲ 인대 재건술

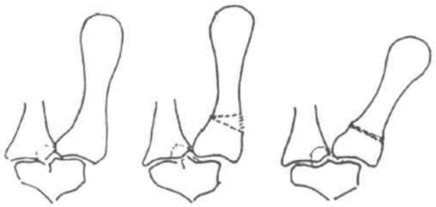
환자의 problem list

1) 50세 여자.
2) Eaton stage IV CMC arthritis

- S-T joint에 퇴행성 변화가 있으면 complete trapezial excision

오답 노트 정리하기

㉮ scaphotrapeiotrapezoidal (STT) arthritis가 있을 경우 contraindication
㉯ 결과가 좋지 않아 노인환자에서 제한적으로 사용한다
㉱ indications : early Stage I-II disease
contraindications : hypermobility or fixed subluxation of the CMC joint, MCP hyperextension > 10°



㉲ anterior oblique ligament reconstruction은 stage I에서 효과적이고, stage III, IV에서는 효과적이지 못하다

Lesser toe deformity

명지병원 정형외과
R3. 이 규 환

Lesser toe deformity

CONTENTS

Hammer toe & Claw toe

- Definition
  - abnormal flexion posture of the proximal interphalangeal joint of one of the lesser four toes

- Fixed type
- Flexible type

Hammer toe & Claw toe

- Flexion contracture is severe and long duration, the metatarsophalangeal joint usually is deformed in the opposite direction
  → extension deformity in MTPJ

- Distal joint usually stays supple, but it also may develop a flexion or an extension deformity

Hammer toe & Claw toe

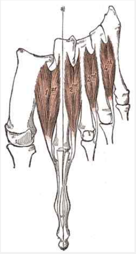
- Claw toe vs Hammer toe
  - Claw toe
    - by neuromuscular diseases
    - a similar deformity is present in all toes
    - always have extension deformity at the metatarsophalangeal joint
    - often have a flexion deformity at the distal interphalangeal joint
  - Hammer toe
    - only one or two toes are involved
    - extension of the metatarsophalangeal joint may or may not be present
    - usually does not occur a flexion deformity at the distal interphalangeal joint

Etiology

- Claw toe
  - Caused by neuromuscular diseases
  - Loss of intrinsic function of the foot

  → allowing the EDL extend the MTPJ and the FDL to flex the IPJ
    - Although the long extensors of the toes may extend IPJ with the MTPJ in neutral, when an extension posture of the MTPJ develops, the long extensor loses its excursion and no longer can extend the IPJ
  - The powerful flexors of the toe (attaches to the base of the distal phalanx)

  → accentuate the deformity, causing flexion of the IPJ



Etiology

- Hammer toe
  - have no underlying intrinsic imbalance
  - long-term use of poorly fitting shoes
    - Crowding of the toes within an excessively tight toe box causes some deformation of the MTPJ and IPJ that over time can lead to flexible and eventually fixed deformities at these joints
  - long second ray
  - hallux valgus (causing pressure against the second toe)
  - connective tissue disorders
  - trauma

Clinical findings

- Painful area in hammer toe
  - dorsum of the PIPJ
    - hard corn caused by pressure from the toe box or vamp of the shoe develops
  - end corn
    - When a flexion posture or end-bearing posture of the DIPJ is present, a painful callus develops just plantar to the nail end
  - painful callus may develop beneath the metatarsal head
    - if the proximal phalanx subluxates dorsally
- DM, myelomeningocele → in decreased sensibility patients
  - ulceration and deep infection can develop at one or more of these areas of pressure

Treatment

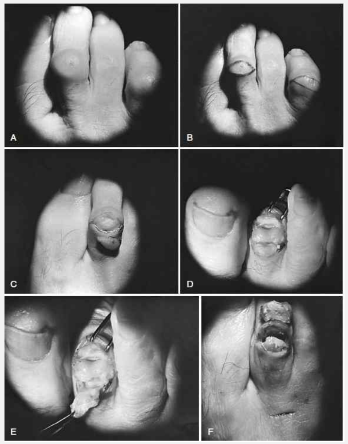
- Conservative Tx.
  - Usually is disappointing
  - Various pads and strappings
    - to reduce the deformity and relieve pressure over painful points
  - Daily manipulations and taping the toe so that the metatarsophalangeal joint is not extended
    - not of long duration and an extension deformity at the metatarsophalangeal joint is not present
    - when the passive stretching and taping cease, recurrence is likely

Treatment

- Operative Tx.
  - Soft-tissue procedures
    - Ix.
      - age<30
      - no deformity at the MTPJ
      - no fixed flexion deformity at the PIPJ
    - flexor-to extensor transfer(esp; FDL)
  - Bone and joint procedures
    - resection of the PIPJ
    - resection of base of proximal phalanx
    - resection of the distal 3rd and 4th proximal phalanx
    - complete proximal phalangectomy
    - PIPJ arthrodesis
  - Hammer toe encompasses a spectrum of deformities, and the indicated procedure varies, depending on the stage of the deformity when first seen and the diagnosis

Treatment

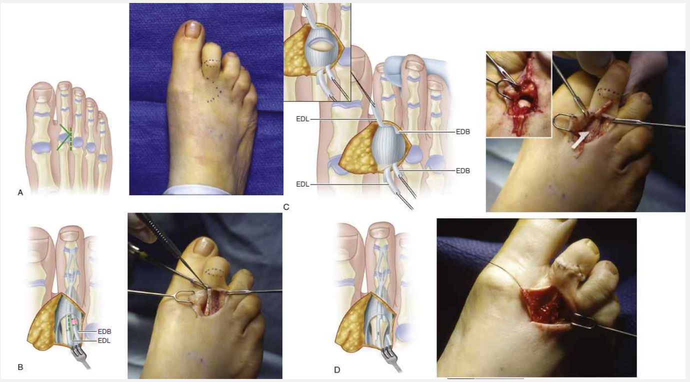
- Mild deformity
  - No fixed contracture at the MTPJ and PIPJ is evident
  - Deformity increases on weight bearing
  - Flexor-to-extensor transfer using the flexor digitorum longus (in young patients)
- Moderate deformity
  - Fixed flexion contracture at the PIPJ
  - No extension contracture at the MTPJ
  - Resection of the head and neck of the proximal phalanx and dermodesis



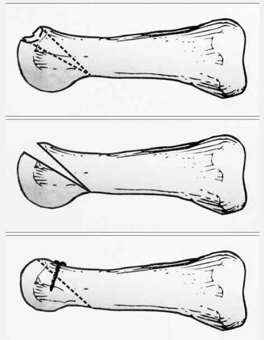
Treatment

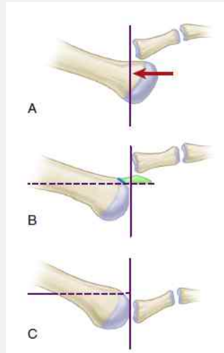
- Severe deformity
  - Fixed flexion contracture at the PIPJ with a fixed extension contracture at the MTPJ
  - Subluxation/Dislocation of the proximal phalanx on the metatarsal head may be present
  - Without subluxation or dislocation of the MTPJ
    - Resection the head and neck of the proximal phalanx + lengthen EDL + tenotomize EDB + (dorsal capsulotomy at the MTPJ)
  - With subluxation or dislocation of the MTPJ
    - MTPJ arthroplasty or distal metatarsal osteotomy (Weil) may be needed to decompress the MTPJ

- Without subluxation or dislocation of the MTPJ
  - Resection the head and neck of the proximal phalanx + lengthen EDL + tenotomize EDB + (dorsal capsulotomy at the MTPJ)



- With subluxation or dislocation of the MTPJ
  - MTPJ arthroplasty or distal metatarsal osteotomy (Weil) may be needed to decompress the MTPJ





Mallet toe

- Definition
  - abnormal flexion posture of the distal interphalangeal joint

- can occur as an isolated deformity or in conjunction with hammer toe deformity at the PIPJ
- most often in the second toe(longest toe)

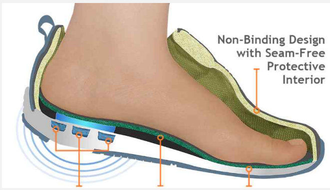
Etiology & Clinical finding

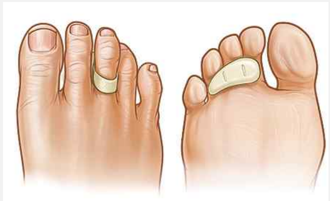
- Projection of the second toe distal to the other toes can cause pressure at the tip of the toe with a narrow or short toe box
- This flexion posture can attenuate the terminal extensor tendon until it no longer can extend the distal joint

- The most frequent complication of a mallet toe is a painful end corn just beneath the nail
- The end corn results from chronic pressure at the tip of the toe
- In DM, the corn can ulcerate and progress to a deep infection before the patient is aware of the problem
- Congenital mallet toe usually requires no treatment

Treatment

- Conservative Tx.
  - Use of pads and splints of mallet toe is difficult and generally unrewarding
  - Extra-depth shoes can be helpful, along with the use of a toe crest to relieve pressure at the tip of the toes by elevating them





Treatment

- Operative Tx.
  - Flexor tenotomy at the distal interphalangeal flexion crease
  - Subtotal or total resection of the middle phalanx with dorsal dermodesis (a tenotomy of the flexor digitorum longus can be added if the bony resection and dermodesis do not hold the toe in the corrected position)
  - Amputation of the distal half of the distal phalanx to include the nail and the matrix.

Treatment

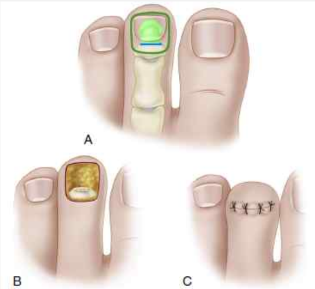
- Flexor tenotomy at the distal interphalangeal flexion crease
  - flexor-to extensor transfer is technically difficult
  - In elderly patients, a flexor tenotomy at the distal interphalangeal flexion crease may relieve the symptoms

Treatment

- If the mallet deformity is of long duration and fixed in severe flexion
  - resection of a portion or all of the middle phalanx
  - dorsal dermodesis

Treatment

- Amputation of the distal half of the distal phalanx to include the nail and the matrix
  - Syme procedure
  - prefer the resection dermodesis procedure for a severe mallet toe with an end corn because it preserves the nail



Question

- 신경학적 이상이 없는 여자가 제 2 족지의 다음과 같은 변형으로 내원하였다. 연부조직 또는 골성 술식의 수술방법을 결정하는데 있어서 가장 중요한 인자는?

- 1. 굳은살의 크기
- 2. 족지의 굴곡력
- 3. 족지 변형기간
- 4. 족지관절 굴곡정도
- 5. 족지의 고정변형 유무

Question

- 신경학적 이상이 없는 여자가 제 2 족지의 다음과 같은 변형으로 내원하였다. 연부조직 또는 골성 술식의 수술방법을 결정하는데 있어서 가장 중요한 인자는?

- 1. 굳은살의 크기
- 2. 족지의 굴곡력
- 3. 족지 변형기간
- 4. 족지관절 굴곡정도

- 5. 족지의 고정변형 유무

환자의 problem
1) underlying intrinsic imbalance (-)
-> cf) claw toe - underlying intrinsic imbalance (+)
2) PIP joint의 abnormal 한 flexion deformity
3) MTP joint extension & DIP joint flexion
-> Severe hammer toe deformity

수술 방법에 있어서 족지의 고정변형 유무가 가장 중요하다
1) 경도의 변형 : 굴곡건 이전술
2) 중등도의 변형 : 근위 지절의 절제 관절 성형술, 근위 지절 유합술
3) 중증의 변형 : 족근 중족 관절의 연부조직 유리술, 장족지신건의 연장술, 단족지신건의 절제술 등을 추가

J Shoulder Elbow Surg (2023) 32, S69–S74

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Effect of reverse shoulder arthroplasty humeral component retroversion on acromial strain

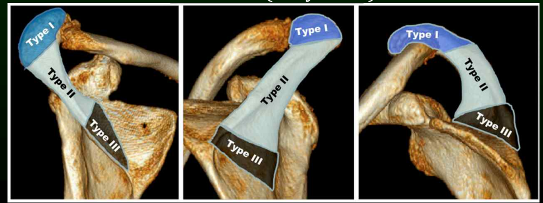
Michael O'Leary, MD[a,*], Brett Haislup, MD[a], Thomas Gillin, BSc[a], Pooyan Abbasi, MSc[a], Luke Austin, MD[b], Melissa Wright, MD[a], Anand M. Murthi, MD[a]

[a]Shoulder and Elbow Service, Department of Orthopaedics, MedStar Union Memorial Hospital, Baltimore, MD, USA
[b]Rothman Orthopaedic Institute, Philadelphia, PA, USA

Introduction

- Reverse shoulder arthroplasty (RSA)
  - In some biomechanical studies, these design choices have been shown to impact strain at the acromion and scapular spine.
  - This may have an effect on the incidence of acromial and scapular spine stress fractures, a potentially devastating complication after RSA
- The incidence of acromial stress fractures has been reported in the literature between 3.9% and 10.2%.

  Mahendraraj KA, JSES, 2021
- Classified acromial stress fracture (Levy 2013)



Introduction

- Outcomes following RSA with acromial stress fracture are worse than those without fracture regardless of treatment, and many go on to nonunion. It is therefore critical to identify implant factors that may impact the risk of these fractures.

  Kriechling P, JSES, 2021
- No previous studies have examined the implications of humeral component version on acromion and scapular spine strain
- Changes to humeral component version impact the position of the humerus relative to the scapula throughout the shoulder range of motion.
- This could alter impingement of the greater tuberosity on the acromion in glenohumeral abduction and could change the force vectors across the glenoid baseplate and resultant strain at the acromion and scapular spine.

  Bauer S, J Clin Med, 2021
  Kerrigan AM, JSES, 2021

Purpose

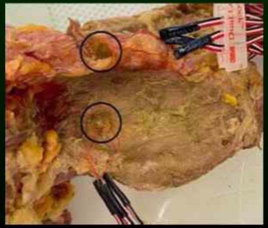
- As the tendency in practice has been to place the humeral component in more anatomic retroversion to improve range of motion, there has been an anecdotal increase in acromial and scapular spine stress fractures. This may be confounded by the tendency to also use more lateralized systems for the same potential benefit, which has been clearly shown in the literature to increase stress at the scapular spine and acromion.
- Purpose
  - to examine the relationship between humeral stem retroversion and strain at the scapular spine and acromion.

Specimen preparation

- 8 fresh frozen cadaveric upper extremity specimens
  - Mean age : 88.1 years
  - Prepared by removing all soft tissue except for the deltoid muscle, CA ligament, AC joint capsule
- Implantation : RSA implant sysmtem (Zimmer Biomet Comprehensive Reverse system; Zimmer biomet, Warsaw, IN, USA)
- Humeral stem : cementless, 0° retroversion
- Humeral tray : +0 humeral polyethylene bearing surface
- Glenoid : 25mm base plate (central screw, 4 peripheral locking screws)
- +0.36 mm glenosphere with eccentric set

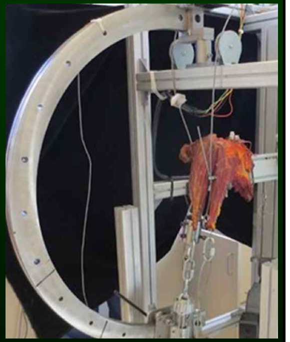
Strain gauge attachment

- 2 C2A-06-031WW-120 stacked rosettes (Vishay Measurements Group, Inc., Malvern, PA, USA)
- 3 strain gauges (0° , +45 ° , -45 °) : placed in locations corresponding to Levy type II and type III acromial and scapular spine fractures
- the acromial rosette was secured with glue on a line drawn and measured from the posterolateral corner of the acromion to the superior glenoid. The scapular spine rosette was placed 1 cm medial to the lateral flare of the base of the acromion.



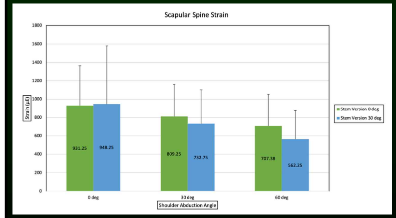
Specimen mounting & setting

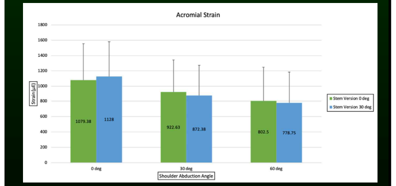
- Shoulder biomechanical testing frame
  - Cylinder metal rigid screws



Result

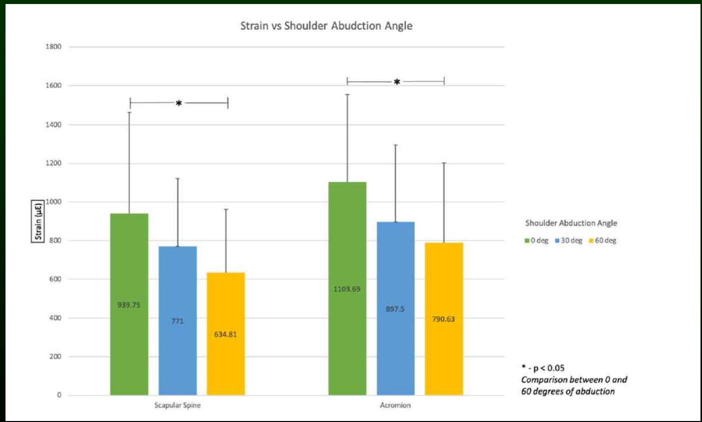
- Flowchart of patient inclusion





Result

- Study Population Characteristics



Result

- Clinical outcomes

Table 2. Comparison of Preoperative and Postoperative Measurements

Category	Preoperative	Postoperative	*P* Value
VAS	7.75 ± 1.72	1.59 ± 1.81	.0001
SANE	53.59 ± 18.24	91.63 ± 8.78	.0001
ASES	48.09 ± 12.04	88.28 ± 14.21	.0001
Rowe instability score	50.31 ± 11.14	88.91 ± 18.35	.0001
Forward flexion	155.78 ± 8.24	157.19 ± 7.72	.4727
External rotation	68.44 ± 4.48	67.03 ± 6.33	.2995
Internal rotation	T 9.59 ± 2.66	T 9.75 ± 2.99	.7675

ASES, American Shoulder and Elbow Surgeons Shoulder Score; SANE, Single Assessment Numeric Evaluation; VAS, visual analog scale.

- Significant improvements in patient reported outcome measures at final follow-up

Discussion

- In our population of 32 active-duty service members with a type VIII SLAP tear undergoing combined mini-open subpectoral biceps tenodesis and arthroscopic posterior labral repair
  --> 30 patient return to active military duty.

- Outcomes following these procedures were very promising, with a majority of patients demonstrating **statistically and clinically significant increases** in outcomes with a low surgical failure rate.

- In older patient populations, Biceps tenodesis may lead to better functional outcomes and return to preinjury levels of activity, particularly

Paoli AR, Arthroscopy, 2019

Discussion

- Exact incidence of type VIII SLAP tears --> not defined
  - Active-duty military patients experience a greater incidence of SLAP tears, as well as posterior labral tears, when compared with civilians
  - It is therefore reasonable to suspect that type VIII tears may occur at a greater rate within this population.

Limitation

- Retrospective study
- Sample size
- almost entirely male (93.75%)
- active duty service members

Conclusion

- Active-duty military patients with type VIII SLAP tears following mini-open subpectoral biceps tenodesis combined with posterior labral repair.

- Statistically and clinically significant increases in outcome scores
- Marked improvement in pain
- High rates of return to unrestricted active-duty

- An appropriate treatment strategy for the management of this injury

Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 39, No 8 (August), 2023: pp 1781-1789

Superior Capsular Reconstruction Partially Restores Native Glenohumeral Joint Loads in a Dynamic Biomechanical Shoulder Model

Lukas N. Muench, M.D., Felix Dyrna, M.D., Alexander Otto, M.D., Ian Wellington, M.D., Elifho Obopilwe, M.S., Bastian Scheiderer, M.D., Andreas B. Imhoff, M.D., Knut Beitzel, M.D., Augustus D. Mazzocca, M.S., M.D., and Daniel P. Berthold, M.D.

From the Department of Sports Orthopaedics, Technical University of Munich, Munich, Germany (L.N.M., A.O., B.S., A.B.I., D.P.B.); Department of Orthopaedic Surgery, University of Connecticut, Farmington, Connecticut, U.S.A. (L.N.M., A.O., I.W., E.O., D.P.B.); Gelenkzentrum Rose, Leipzig, Germany (F.D.); Arthroscopy and Orthopedic Sportsmedicine, ATOS Orthoparc Clinic, Cologne, Germany (K.B.); and Massachusetts General Hospital, Massachusetts General Brigham, Harvard Medical School, Boston, Massachusetts, U.S.A. (A.D.M.).

Journal Review
명지병원 정형외과
R3. 이준우

Introduction

- Superior capsular reconstruction (SCR)
  - emerged as a surgical treatment option for young patients with irreparable posterosuperior rotator cuff tears (PSRCT) and absence of significant cuff tear arthropathy.
- Initially, promising clinical outcomes were observed after SCR
  - However, reported failure rates remain inconsistent, which have been shown to vary between 4% and 70% of cases, depending on technique and graft choice.

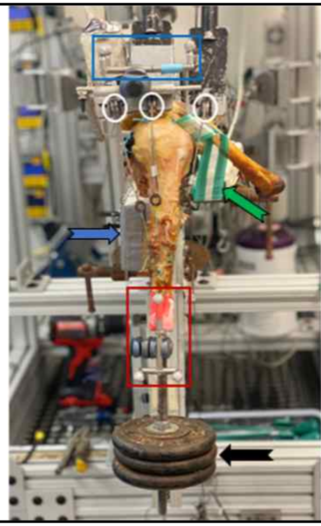
- The biomechanical rationale for SCR
  - to improve shoulder kinematics by preventing superior decentralization of the humeral head
  - consequently allowing for a greater efficiency of the deltoid muscle during glenohumeral abduction in a cuff-deficient shoulder.
- SCR holds considerable joint-preserving potential, its true effect on glenohumeral contact mechanics during dynamic glenohumeral abduction motion remains largely unknown.

- Purpose of the this study
  - to evaluate the effect of an irreparable PSRCT on glenohumeral joint loads

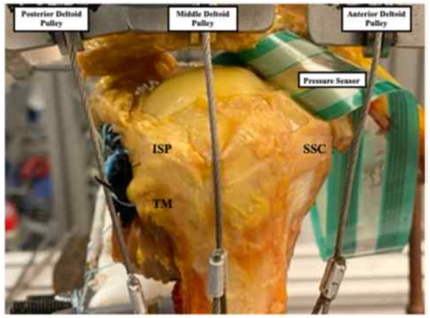
  and to quantify improvement after SCR using an acellular dermal allograft
- Hypothesis
  - performing an SCR would reverse increased glenohumeral joint loads caused by an irreparable PSRCT.

Methods

- 10 fresh-frozen, cadaveric shoulders (mean age: 63.1 years)
  - all specimens showed intact soft tissues without severe osteoarthritic changes
  - the rotator cuff muscles and the coracoacromial ligament carefully preserved.
  - the anterior, middle, and posterior deltoid tendons were detached from the muscle belly at the deltoid tuberosity and preserved with anchor loops being sutured to the tendinous insertions
    ** (locking running stitch, No. 2 FiberWire; Arthrex, Naples, FL)
  - the SSP, SSC, and the ISP/TM were sutured to pulley-straps using No. 5 FiberWire (Arthrex)

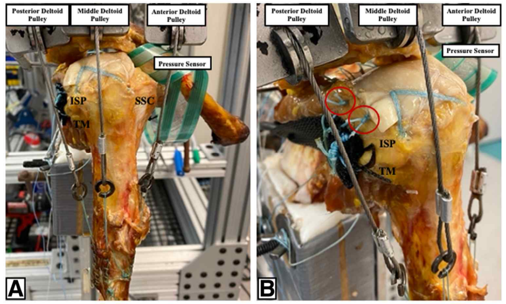


- **Blue rectangle** : For 3-dimensional motion tracking, a stationary triad, consisting of 3 optical markers, was placed on the acromion, with its center in line with the pulley of the middle deltoid.
- **White circles** : The respective pulleys for the anterior, middle, and posterior deltoid are placed according to anatomic landmarks, to recreate the native force vectors.
- **Green arrow** : The pressure sensor was passed through the opening in the anterior rotator interval and carefully placed between the humeral head and glenoid surface.
- **Blue arrow** : The potted scapular body is mounted to the shoulder simulator on a 6 degrees-of-freedom jig.
- **Red rectangle** : The second moving triad was mounted to the humeral shaft with its longitudinal axis in line with the center of the stationary triad placed on the acromion.
- **Black arrow** : A steel rod was cemented into the distal humerus and loaded with 1.7 kg, 30 cm distally from the center of the humeral head representing a constant moment arm for each tested shoulder.



- Testing conditions
  (1) native state
  (2) irreparable PSRCT
    - created by sharply dissecting the footprint of the supraspinatus and cranial part of the infraspinatus on the greater humeral tuberosity to the articular margin.
    - SSP muscle belly was detached from the fossa supraspinata to create an irreparably retracted tear.

  (3) SCR was performed using a 3-mm-thick acellular dermal allograft (ArthroFLEX, LifeNet Health, Virginia Beach, VA)



** Posterior margin convergence was performed by attaching the graft to the infraspinatus tendon and underlying shoulder capsule using 2 side-to-side sutures (red circles).

** Graft fixation was performed at 30 of glenohumeral abduction in the scapular plane and neutral rotation.

- Medial fixation : 3 double-loaded 3-mm suture anchors (SutureTak; Arthrex) were inserted into the superior glenoid at the 10-o'clock, 12-o'clock, and 2-o'clock position.
- Lateral fixation (at the greater tuberosity) : a knotless double-row technique (SpeedBridge Kit; Arthrex) with 4 suture anchors (4.75-mm BioComposite SwiveLock; Arthrex).

- Size of the graft determined based on the following 4 measurements
  - anteroposterior distance between glenoid anchors
  - anteroposterior distance between tuberosity anchors
  - mediolateral distance between posterior anchors
  - mediolateral distance between anterior anchors

- Outcome parameters
  - glenohumeral Abduction Angle (gAA)
  - Superior humeral head Migration relative to the native state (SM)
    - calculated as the change in distance between the 2 tripods relative to the native state.
  - cumulative Deltoid Forces (cDF; N)
    - calculated as the summation of anterior, middle, and posterior deltoid forces
  - Evaluation of glenohumeral contact mechanics
    - glenohumeral Contact Area (gCA)
    - glenohumeral Contact Pressure (gCP)

Results

- glenohumeral Abduction Angle (gAA)
  - PSRCT resulted in a significant decrease of gAA (41.2 ± 3.2°) compared with the native (56.4 ± 1.7°; P < .001) and SCR condition (50.3 ± 2.2° ; P < .001).
  - Further, performing an SCR did not restore native gAA
- Superior humeral head Migration relative to the native state (SM)
  - The PSRCT resulted in an increase in SM of 13.0 ± 5.2 mm relative to the native state.
  - The SCR reduced SM to 5.4 ± 2.2 mm relative to the native state, which was significantly less SM when compared with the PSRCT (P < .001).

Table 1. Glenohumeral Abduction Angle

	Rest	15°	30°	45°	Maximum
Native	31.4 ± 0.5	70.2 ± 8.3	130.7 ± 17.5	143.8 ± 17.1	158.2 ± 17.8
PSRCT	31.2 ± 1.1	78.8 ± 24.5	182.7 ± 34.6*	245.0 ± 46.0*	–
SCR	31.7 ± 0.8	71.6 ± 11.4	155.9 ± 29.1*,†	201.2 ± 46.8*,†	225.8 ± 50.7*

NOTE. Cumulative deltoid force (N; mean ± SD) across abduction angles for each tested condition.
Maximum, maximum abduction angle (native = 56.4 ± 1.7°; SCR = 50.3 ± 2.2°); PRSCT, posterosuperior rotator cuff tear; SCR, superior capsular reconstruction; SD, standard deviation.
*Statistically significant compared with native.
†Statistically significant compared with PSRCT.

- cumulative Deltoid Force (cDF)
  - When compared with the native state, the PSRCT led to a significant increase in cDF at 30° (P < .001) and 45° (P < .001) of abduction.
  - SCR significantly reduced cDF at 30° (P < .007,) and 45° (P < .007) when compared with the PSRCT state.
  - However, SCR did not restore native cDF at 30° (P < .015), 45° (P < .001), and maximum angle (P < .001)

Table 2. Glenohumeral Abduction Angle

		Rest	15°	30°	45°	Maximum
Contact area, mm^2	Native	275.1 ± 82.6	286.1 ± 77.7	317.6 ± 80.0	350.3 ± 93.6	348.8 ± 94.8
	PSRCT	205.7 ± 61.0*	227.6 ± 61.1	257.7 ± 79.6*	286.1 ± 83.8*	–
	SCR	239.4 ± 67.3†	260.4 ± 61.9†	287.8 ± 78.0†	312.9 ± 83.2†	340.7 ± 97.9
Contact pressure, kPa	Native	170.4 ± 104.6	191.2 ± 104.1	220.0 ± 112.3	249.8 ± 107.6	344.7 ± 97.4
	PSRCT	224.4 ± 129.1	260.2 ± 135.6*	307.0 ± 129.9*	360.4 ± 126.9*	–
	SCR	194.6 ± 99.7	216.3 ± 113.8†	242.7 ± 111.4†	294.6 ± 103.8*'†	380.7 ± 113.5*

NOTE. Glenohumeral contact mechanics (mean ± SD) across abduction angles for each tested condition.
Maximum, maximum abduction angle (native = 56.4 ± 1.7°; SCR = 50.3 ± 2.2°); PRSCT, posterosuperior rotator cuff tear; SCR, superior capsular reconstruction; SD, standard deviation.
*Statistically significant compared with native.
†Statistically significant compared with PSRCT.

- glenohumeral Contact Area (gCA)
  - SCR significantly increased gCA compared with the PSRCT, which was similar to the native state at all angles
- glenohumeral Contact Pressure (gCP)
  - SCR was not able to restore native gCP at 45 degrees and maximum gAA

Discussion

- The most important finding of the this study
  - SCR using an acellular dermal allograft only partially restored native glenohumeral joint loads and shoulder kinematics in a cadaveric dynamic shoulder model.
  - However, significant improvements after SCR were found compared with the irreparable PSRCT.

  → Indicates that the ability of an SCR to fully restore shoulder function in the setting of an irreparable PSRCT may be limited, despite its previously proposed biomechanical advantages.

- Restoration of native shoulder kinematics and glenohumeral contact mechanics was not achieved in the present study.
  - Previous studies reported that performing an SCR for irreparable RCTs has been widely reported to result in significantly improved biomechanical properties similar to the native rotator cuff
    → Most of these studies have been conducted using static shoulder models, which are inherently limited to their study design.
  - Consequently, the authors of this study feel that a dynamic model is best suited to reveal the true biomechanical properties following SCR.

ELSEVIER
Arthroscopy: The Journal of Arthroscopic & Related Surgery
Volume 38, Issue 1, January 2022, Pages 20-21

Infographic

Superior Capsular Reconstruction: Proposed Biomechanical Advantages

Matthew R. Cohn M.D., Amar S. Vadhera B.S., Grant E. Garrigues M.D., Nikhil N. Verma M.D.

Show more

+ Add to Mendeley Share Cite

https://doi.org/10.1016/j.arthro.2021.11.011

ELSEVIER
Arthroscopy: The Journal of Arthroscopic & Related Surgery
Volume 37, Issue 1, January 2021, Pages 402-410

Systematic Review

Superior Capsular Reconstruction Provides Sufficient Biomechanical Outcomes for Massive, Irreparable Rotator Cuff Tears: A Systematic Review

Tyler J. Smith D.O. [a], Anirudh K. Gowd M.D. [b], John Kunkel D.O. [a], Lisa Kaplin D.O. [b], Brian R. Waterman M.D. [b]

Show more

+ Add to Mendeley Share Cite

https://doi.org/10.1016/j.arthro.2020.09.007 Get rights and content

- However, the increased graft tension still does not seem to sufficiently depress the humeral head during the initial abduction motion.
  - At lower abduction angles, the vector of the deltoid is more vertical, thus the graft may not be able to completely withstand the vertically directed, increased deltoid force, consequently allowing for superior migration of the humeral head.
  - As a result, the graft is not able to actively depress the humeral head and is simply acting as a subacromial spacer, preventing painful contact of the humeral head with the undersurface of the acromion.
- This study found that performing an SCR using an acellular dermal allograft resulted in a significant reduction of compensatory deltoid forces when compared with the PSRCT.

Limitations

- First, biologic healing was not evaluated
- Second, the latissimus dorsi or pectoralis major were not considered in this study.
- Third, SCR was performed using a 3-mm-thick allograft, consequently leaving unknown what potential influence a thicker graft would have on glenohumeral contact mechanics.
- Further, the shoulder model was not able to account for differing laxity of the glenohumeral joint capsule
- In addition, passing the pressure mapping sensor through the opened rotator interval did not allow for an anterior margin repair, which may have influenced glenohumeral kinematics and contact mechanics.

Conclusion

- In this dynamic shoulder model, SCR only partially restored native glenohumeral joint loads.
- However, SCR significantly decreased glenohumeral contact pressure, cumulative deltoid forces, and superior migration, while increasing abduction motion, when compared with the posterosuperior rotator cuff tear.

Cavus Foot

R2. 우창우
2023.07.21

Anatomy

- ***Two longitudinal arches***

: Medial longitudinal arch
: Lateral longitudinal arch

- ***Transverse arch***

: Anterior transverse arch
: Posterior transverse arch

Anatomy

- ***Use of arched foot***

- Supports body weight

- Acts as a lever to propel body forward

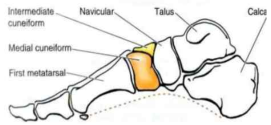
- Shock absorber

- Cancavity protects soft tissues of sole against pressure

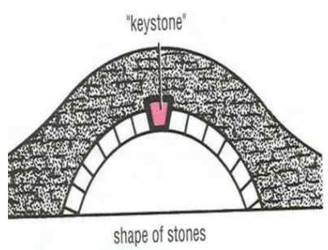
Medial longitudinal arch

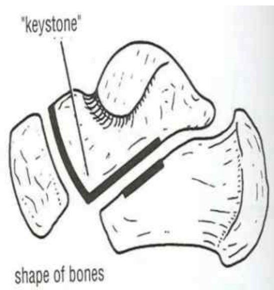
- ***Higher than lateral***

- ***Talar head acting as a key stone***



(A) Medial longitudinal arch (medial view)

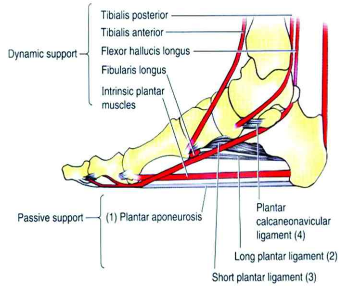




Medial longitudinal arch

- *Tibialis anterior attached to*
  - *1st MT, medial cuneiform*

- *Peroneus longus*
  - *Pass laterally to providing support to arch*

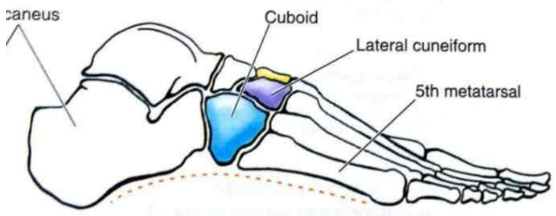


(E) Medial longitudinal arch (medial view)

Lateral longitudinal arch

- *Flatter than medial longitudinal arch*

- *Rests on ground during standing*

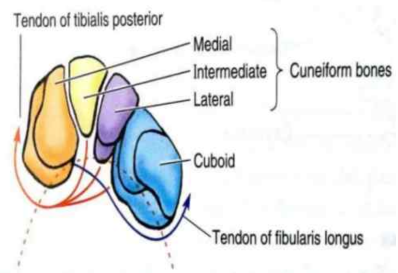


(B) Lateral longitudinal arch (lateral view)

Transverse arch

- *Medial and lateral act as pillars*

- *Peroneus longus and tibialis posterior*



(C) Transverse arch (anterior view)

Pes Cavus

- ***Definition***

  : Abnormally high medial longitudinal arch

- ***Components***
  - Increased calcaneal pitch
  - Varus of the hindfoot
  - Plantar flexion of the medial forefoot
  - Adduction of the entire forefoot

Etiology

Muscular disease	Muscular dystrophy
Nerve disease	Charcot–Marie–Tooth disease Polymeuritis Spinal dysraphism Interspinal tumor
Anterior horn cell	Poliomyelitis. Spinal dysraphism Diastematomyelia, Syringomyelia Spinal cord tumor, Spinal muscular atrophy
Long tract and central disease	Friedreich's ataxia Roussy–Levy syndrome Primary cerebellar disease Cerebral palsy
Idiopathic	Idiopathic cavus foot Residual club foot Arthrogryposis
traumatic	Compartment syndrome Crush injury Severe burn Foot malunion

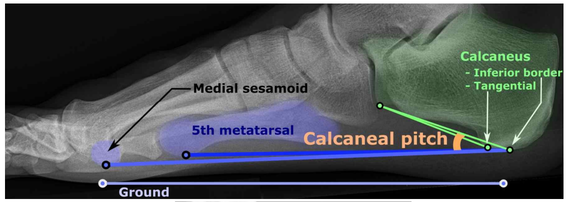
Clincal features

- *High arch*
- *Hyper-extension in MTP joint*
- *Hyper-flexion in IP joint*
- *Pronation and adduction of forefoot*
- *Disease progression leads to fixed deformity*

Deformities

- *Increased calcaneal pitch*

→ more than 30 degrees



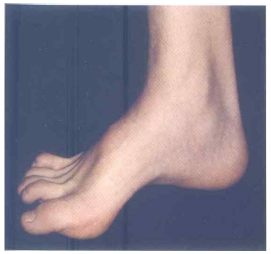
Deformities

- *Claw foot : degeneration of intrinsic muscle*
- *Lumbricalis : MTP flexion + PIP and DIP extension*

→ Stabilizer of MTP joint

- *Lumbricalis not acting to stabilize the MTP joint*

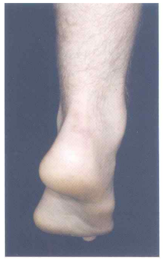
→ Unopposed FDL & FDB : PIP and DIP flexion



Deformities

- *Pronation and adduction of the forefoot*
- *Fixed or flexible varus deformity of the heel*
- *Tightness of the Achilles tendon with or without an equinus contracture*

Ex) Charcot-marie-tooth
Muscle imbalance
→ Weak TA + relatively good TP

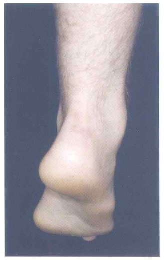


Muscle imbalance

- **In neuromuscular disease**

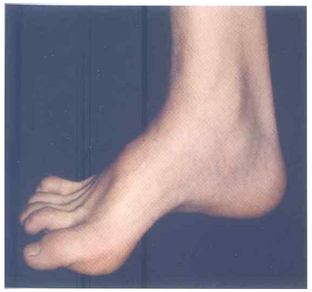
1. Imbalance of extrinsic-intrinsic muscle
   : MTP joint - extension, IP joint – flexion → Claw foot
2. Peroneus longus sparing
   : Pronation of the forefoot
3. Peroneus brevis weakness
   : Forefoot equinus
4. Strong posterior tibialis
   : Varus deformity of the heel to restore tripod
5. Achilles tendon acting as invertor

→ Disease progression leads to
Subtalar joint contraction



Deformities

- *Plantar fascia contracture*
- *Commonly develops in all forms of cavus foot*



Deformities

- ***Calluses beneath the metatarsal arch***

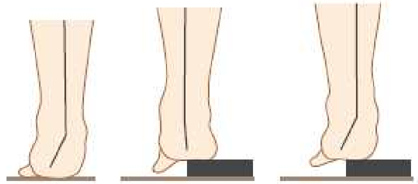
Physical examination

- Coleman block test

Rigid or flexible?

Interpretation:

- Test is based on premise that there is fixed flexion of 1st metatarsal
- This test negates effect that forefoot (first metatarsal in plantar flexion) may have on the hindfoot in stance;
- Correction while the patient is standing on the block
  Hindfoot is considered flexible. – surgical procedure directed to correcting fore foot pronation
- Rigid, then surgical correction of both forefoot & hindfoot are required

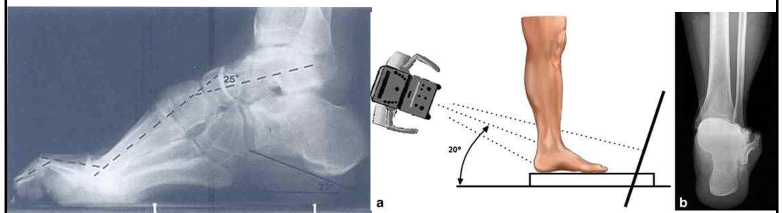


Radiographic findings

- ***Standing lateral view***

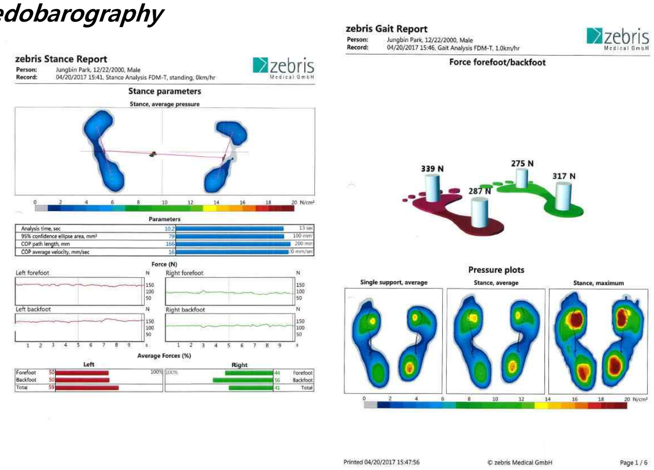
  : ankle joint position,
  calcaneal pitch,
  midfoot and forefoot position,
  degree of plantar flexion of the first ray

- ***Hind foot alignment view***



Radiographic findings

- ***Pedobarography***



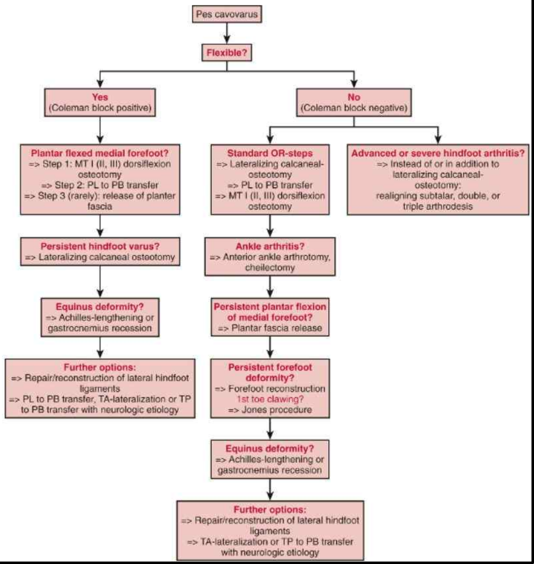
Treatment

- ***Conservative treatment***
  - Stable or slowly progressive deformities in many cases
  - Stretching program
  - Orthoses

Treatment

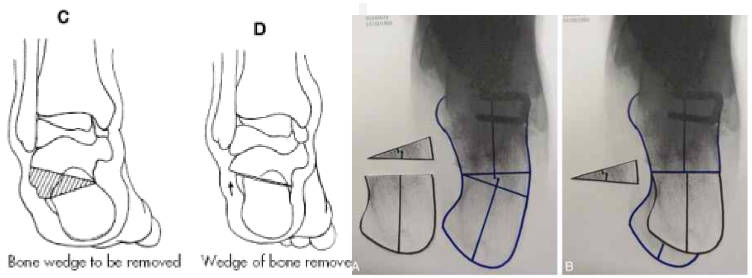
- ***Surgical treatment***
- Soft tissue procedure
  - Tendo-Achilles lengthening
  - Plantar fasciotomy
  - Tibialis posterior split transfer (TPST)
  - Tibialis anterior split transfer (TAST)
- Bony procedure
  - Dwyer
  - Double level osteotomy
  - 1st MT DW osteotomy

Treatment



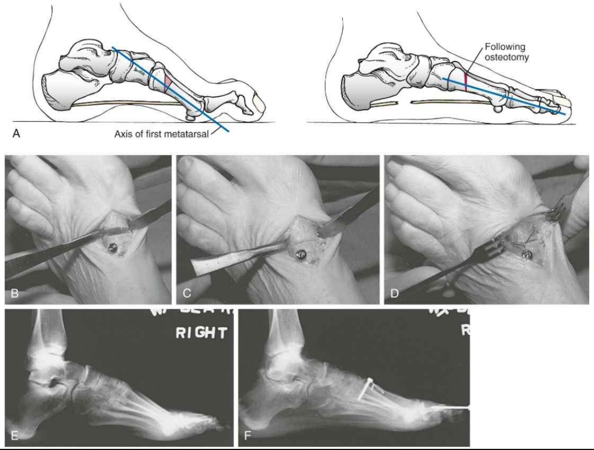
Surgical procedures

- ***Dwyer osteotomy***



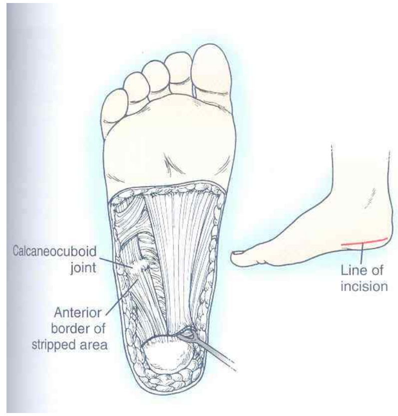
Surgical procedures

- *1st MT DW osteotomy*



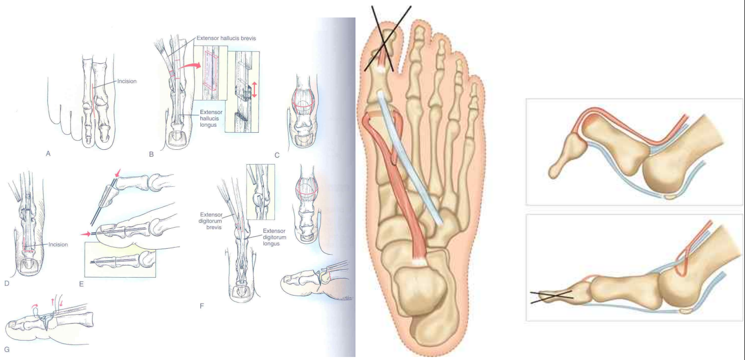
Surgical procedures

- *Plantar fascia release*



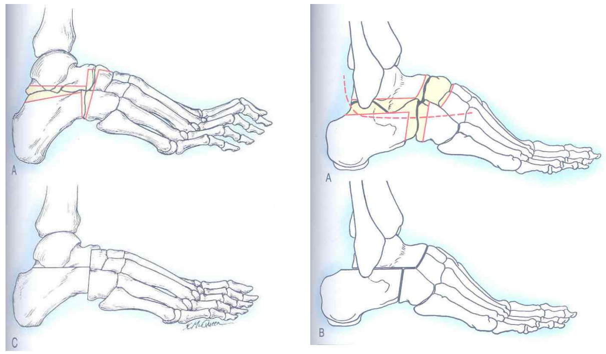
Surgical procedures

- *Correction of clawing toe*
- *Modified jones technique*



Surgical procedures

- *Tripple arthrodesis for severe rigid cavus deformity*



1. Cavovarus foot을 주소로 내원한 환자에서 다음과 같은 검사에서 후족부 내반이 교정 되었다. 이 환자에서 시행할 수 있는 수술 방법으로 옳지 않은 것은? 14B2

㉮ plantar release
㉯ 1st MT osteotomy
㉰ medial cuneiform osteotomy
㉱ calcaneal osteotomy
㉲ Gould closing wedge greenstick dorsal proximal metatarsal osteotomy

답: 라

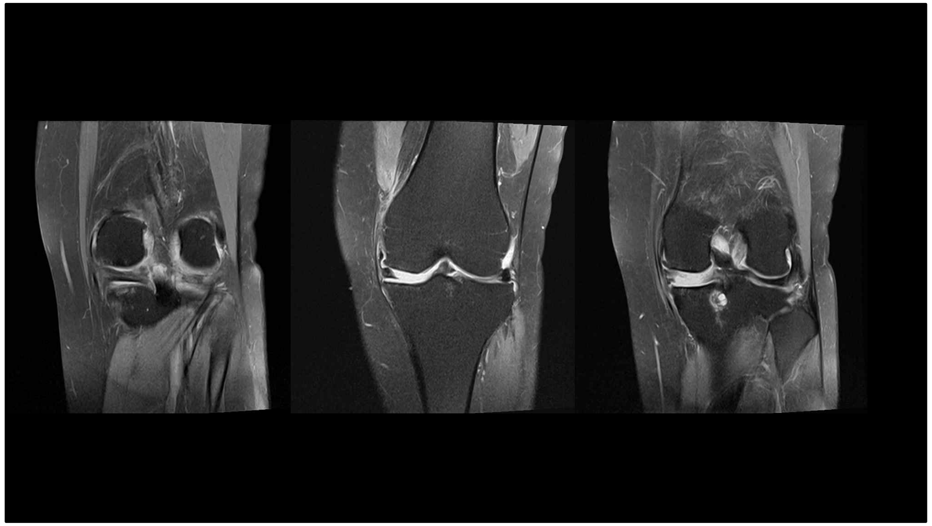
HTO & DFO

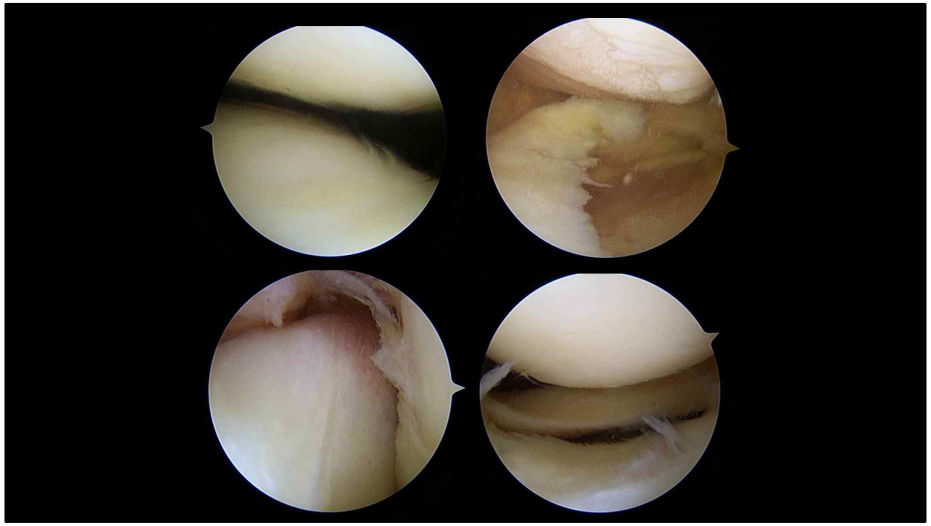
2023.07.24
명지병원 정형외과
R2. 김 수 영

Case #1

#01091261 정O옥 F/61

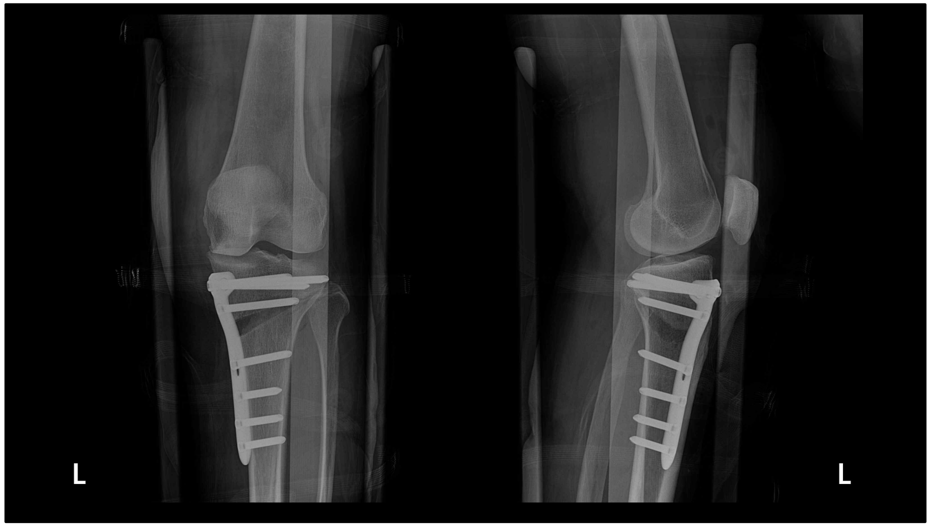
- CC: Lt. knee pain (onset : 5yrs ago)
- PI
  - 61세 여자환자 내원 5년 전부터 특이 외상력 없이 발생한 Lt. knee pain을 주소로 외래 경유 입원함
    - 붓고 물이 차고 힘주기도 아파요
    - 약 먹어도 호전되지 않아요
- OP history : none
- Medical history : none
- Height : 160cm Weight : 64kg BMI : 25kg/m^2

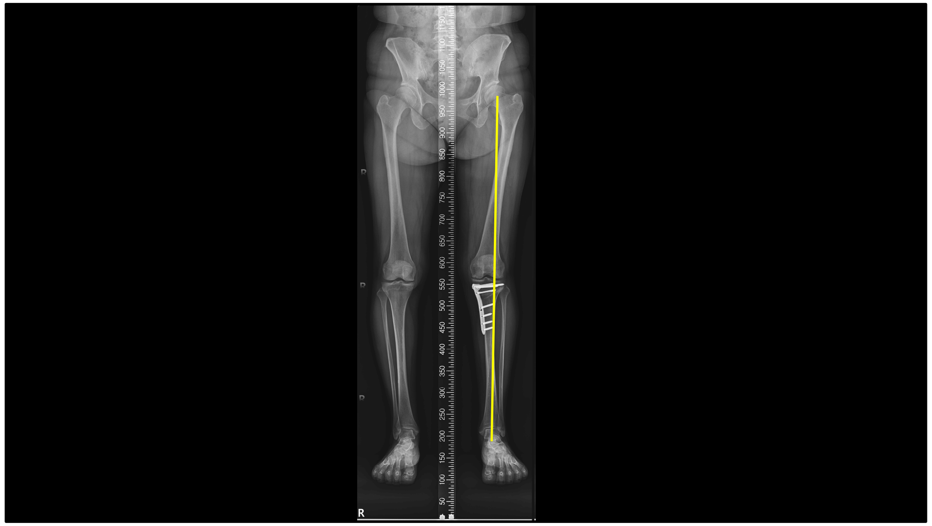




Management

- OP : HTO + MM partial meniscectomy + A/S debridement, knee, Lt.

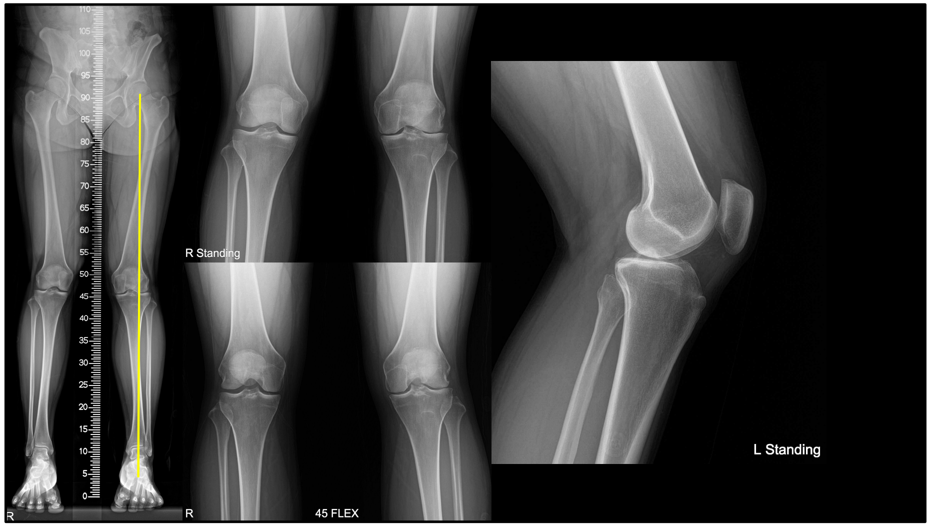


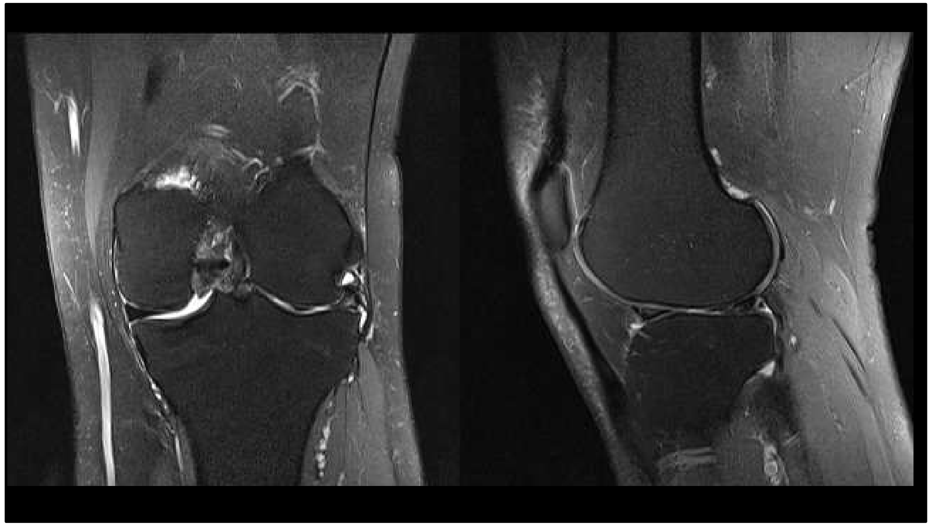


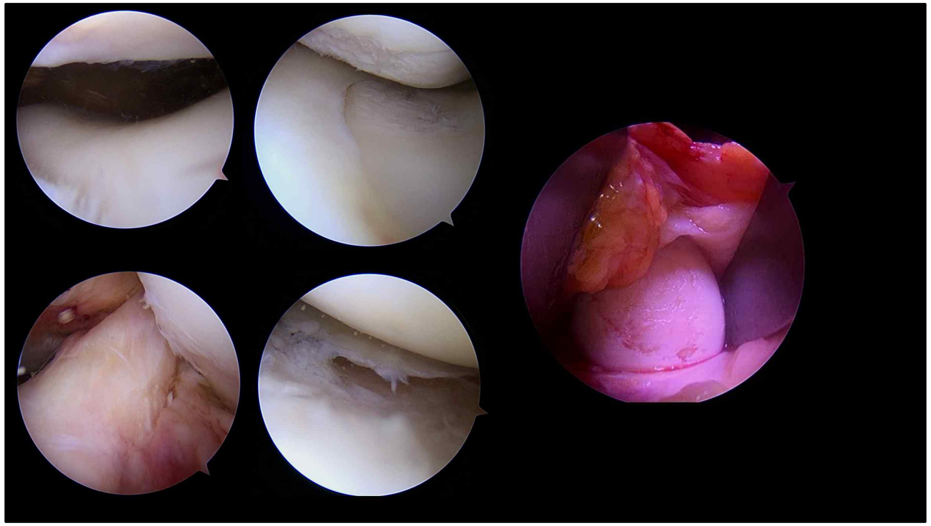
Case #2

#01137997 임O나 F/32

- CC: Lt. knee pain (onset : 4yrs ago)
- PI
  - 32세 여자환자 내원 4년 전 산에서 내려오면서 무릎 돌아가며 수상 후 발생한 Lt. knee pain을 주소로 외래 경유 입원함.
- OP history : none
- Medical history : none
- Height : 170cm Weight : 83kg BMI : 28.7kg/m^2

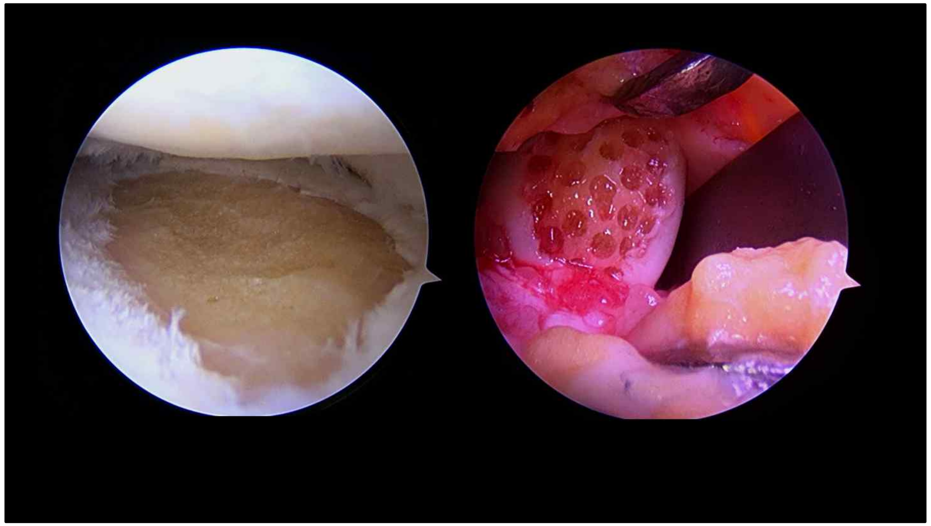


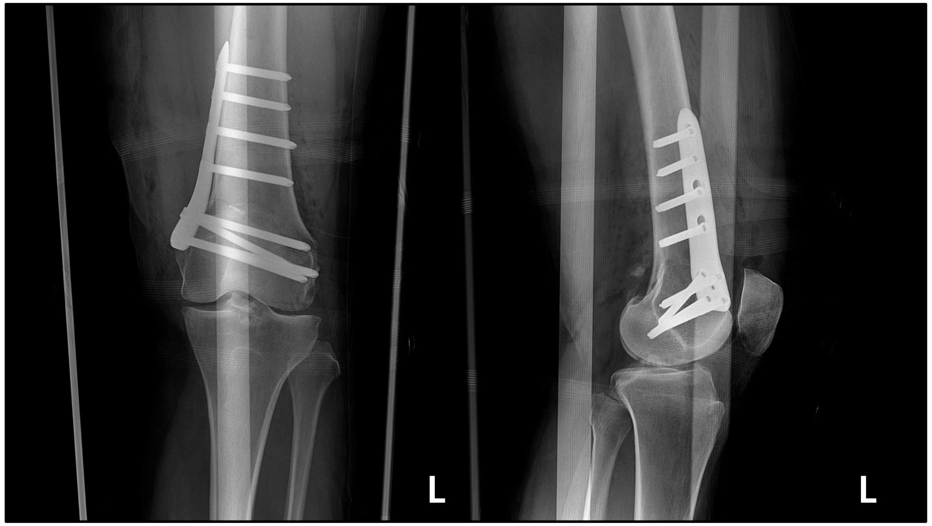


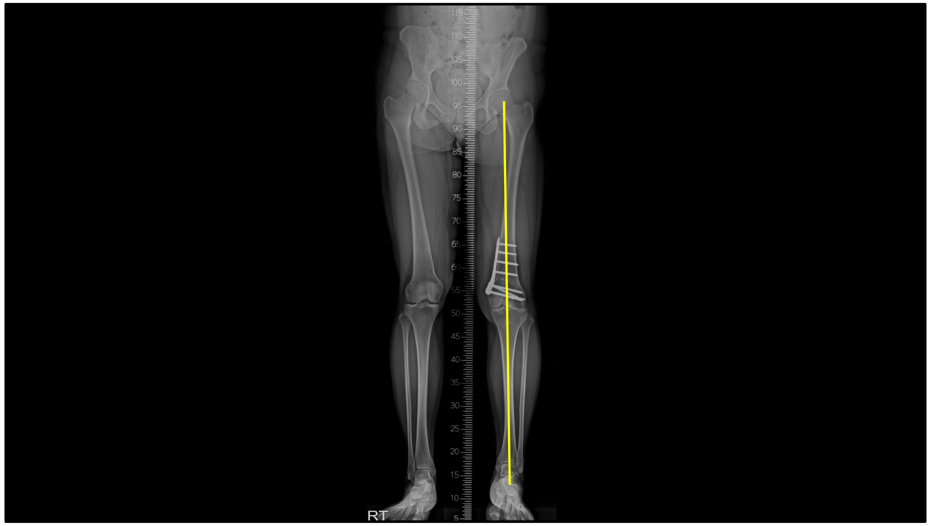


Management

- OP
  - DFO + DLM partial meniscectomy + LFC cartilage repair(cartistem) + MFC debridement, knee, Lt.







High Tibial Osteotomy

Knee osteoarthritis

- Initial management of most patients should be nonoperative
  - Physical therapy, ambulatory aids, pain medications, etc.
  - Changes in daily activity

TABLE 9.5

American Academy of Orthopaedic Surgeons' Recommendations for Less Invasive Treatment of Osteoarthritis of the Knee

RECOMMENDATION	YES/NO	STRENGTH OF RECOMMENDATION
1. Participation in self-management programs, strengthening low-impact aerobic exercises, and neuromuscular education; engagement in physical activity consistent with national guidelines is recommended.	Yes	Strong
2. Weight loss in patients with a body mass index of greater than 25.	Yes	Moderate
3A. Acupuncture	No	Strong
3B. Physical agents (including electrotherapeutic modalities)	?	Inconclusive
3C. Manual therapy	?	Inconclusive
4. Valgus directing force brace (medial compartment unloader)	?	Inconclusive
5. Lateral wedge insoles for symptomatic medial compartment osteoarthritis	No	Moderate
6. Glucosamine and chondroitin	No	Strong
7A. Nonsteroidal antiinflammatory drugs or Tramadol	Yes	Strong
7B. Acetaminophen, opioids, pain patches	?	Inconclusive
8. Intraarticular corticosteroids	?	Inconclusive
9. Hyaluronic acid	No	Strong
10. Growth factor injections and/or platelet- rich plasma	?	Inconclusive
11. Needle lavage	No	Moderate

Derived from Jevsevar DS, Brown GA, Jones DL, et al: The American Academy of Orthopaedic Surgeons evidence-based guideline on treatment of osteoarthritis of the knee, 2nd Edition, *J Bone Joint Surg* 95(20):1885–1886, 2013.

Campbell's Orthopedics 14th edition

Knee osteoarthritis

- Surgical procedures
  - Arthroscopic debridement
  - Osteochondral or chondrocyte transplantation
  - **High tibial osteotomy(HTO) or proximal tibial osteotomy**
  - **Distal femoral osteotomy(DFO)**
  - Arthroplasty
  - Arthrodesis

  → Depends on age, activity expectations, the severity of the disease, the number of knee compartments involved

Campbell's Orthopedics 14th edition

High Tibial Osteotomy (HTO)

- Well-established procedure for the treatment of **unicompartmental osteoarthritis** of the knee
- Varus/valgus deformities are fairly common
  - Cause abnormal distribution of the weight-bearing stresses within the joint
  - Varus deformity (m/c) : accelerating medial OA
- **Biomechanical rationale of HTO**
  - **"Unloading"** of the involved joint compartment **by correcting the malalignment** and **redistributing the stresses** on the knee joint

Campbell's Orthopedics 14th edition

High Tibial Osteotomy (HTO)

- Indications
  - Pain and disability
    → Interfere with high-demand employment or recreation
  - Evidence of degenerative arthritis on radiographs
    → confined to **one compartment** with a corresponding varus or valgus deformity
  - Able to carry out a rehabilitation program
    → full extension & flexion over 90 degrees
    → use crutches or a walker and have sufficient muscle strength

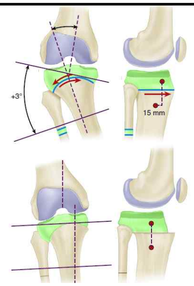
Campbell's Orthopedics 14th edition

High Tibial Osteotomy (HTO)

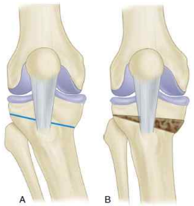
- Contraindications (Campbell)
  - **Narrowing of lateral compartment** cartilage space
  - Lateral tibial subluxation of more than 1cm
  - Medial compartment tibial bone loss of more than 2 or 3mm
  - Flexion contracture of more than 15 degrees
  - Knee flexion of less than 90 degrees
  - More than 20 degrees of correction needed
  - Inflammatory arthritis
  - Significant peripheral vascular disease
- Contraindications (대정)
  - Absolute
    - Diffuse, non-specific knee pain
    - Meniscectomy history of weight bearing joint space (controversial)
    - Infectious arthritis
    - Rheumatic arthritis
    - Correction over 20 degrees
    - Flexion contracture over 15 degrees
    - Patients' unrealistic expectants
  - Relative
    - Old age (>60)
    - PFJ pain
    - ROM less than 90 degrees
    - Obesity
    - Severe arthrosis
    - Ligament instability

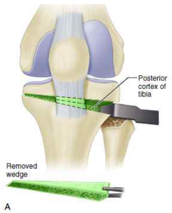
Campbell's Orthopedics 14th edition
정형외과학 제8판

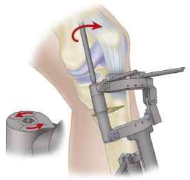
High Tibial Osteotomy (HTO)



- Four basic types (commonly used)
  - Lateral closing wedge
  - Medial opening wedge
  - Dome (Barrel vault)
  - Medial opening hemicallotasis







Campbell's Orthopedics 14th edition

Lateral closing wedge high tibial osteotomy (LCWHTO)

- Coventry recommended lateral approach to correct a varus deformity and a medial approach to correct a valgus deformity
- Bauer et al. for calculating the size of the wedge
  - 1 degree of correction for each 1 mm of length at the base of the wedge. This is true only if the tibia is 57 mm wide
  - W = diameter × 0.02 × angle or tangent tables
- Posterior slope ↓ (cf. MOWHTO : ↑)
  - Slope change under 5'

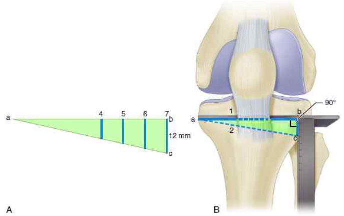


FIGURE 9.13 **A,** Calculation of size of bone wedge to be removed to accomplish desired degrees of correction with high tibial osteotomy. Apex angle *(a)* is number of degrees of correction desired for wedge osteotomy. Line *ab* corresponds to width of tibia and is marked off in 4-, 5-, 6-, and 7-cm distances from point a. Height of base of wedge can be measured (line *bc* for tibia, 7 cm wide). When tibia is 4 cm wide, height of base measured from diagram is 8 mm. **B,** Transferring calculations of size to wedge of osteotomy of tibia. Line *ab* represents transverse saw cut 2 cm below joint line with metal ruler inserted into cut. Angle at a represents correction desired and distance down second ruler. Line *bc* represents height of base of wedge to achieve this angular correction when *ab* represents width of tibia being osteotomized.

Campbell's Orthopedics 14th edition

정형외과학 제8판

Lateral closing wedge high tibial osteotomy (LCWHTO)

- Completion of the osteotomy requires **disruption of the proximal tibiofibular** joint
  - Removing the inferomedial portion of the fibular head
  - Disruption of the proximal tibiofibular syndesmosis

FIGURE 9.15 Partial removal of fibular head in lateral or valgus osteotomy of proximal tibia.

Campbell's Orthopedics 14th edition

Medial open wedge high tibial osteotomy (MOWHTO)

- Tricortical iliac crest autograft, hydroxyapatite wedges
- Opening wedge osteotomy should be done if the involved extremity is 2 cm or more shorter than the contralateral extremity
- Leg-length discrepancy is a common finding after open wedge osteotomy
  - If the leg involved is of equal length or longer than the contralateral leg, consideration should be given to a lateral closing wedge osteotomy

Campbell's Orthopedics 14th edition

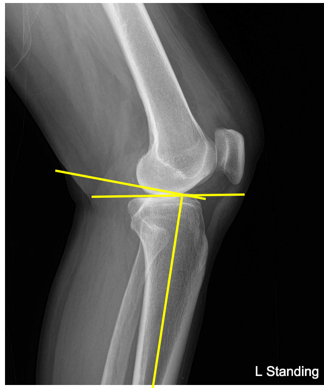
Lateral closing wedge high tibial osteotomy		Medial opening wedge high tibial osteotomy	
Advantages	Disadvantanges	Advantages	Disadvantanges
Near the deformity (knee joint)	Decreasing posterior slope	**Avoid exposing lateral aspect of leg (peroneal n., fibula procedure)**	Increasing tibia posterior slope
At cancellous bone (heals rapidly)	Possible concomitant fibular osteotomy	**No limb shortening**	Higher nonunion rate
Held firmly in position with fixation devices	Narrow window for modifications once bone wedge removed	**Direct exposure**	Patella baja - Increased PFJ pressure
Permits exploration of knee through the same incision	More involved exposure violating anterior compartment	**Can handle concurrent ACL deficiency**	Hardware irritation
Delayed or nonunion rate is low	Conversion TKR : tibia stem can collide with lateral cortex (대정)	**Easier control of correction angle**	Need bone graft
Prolonged immobilization is unnecessary		**Less extensive soft tissue dissection**	
		Ability to correct the alignment in two planes(coronal sagittal)	
		Indication	
		Patient with laxity of the MCL or combined ACL deficiency **Laprade et al)** **decreased varus and ER laxity for PLC-deficient knees**	

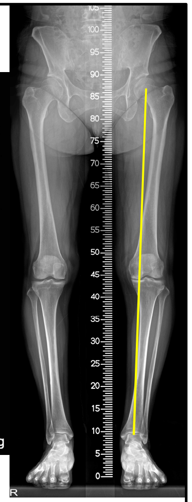
Comparative studies have no consistently demonstrated either technique to be superior to the other

Knee arthroscopy
Campbell's Orthopedics 14th edition
대한정형외과학 제8판

Preoperative plan

- Simple radiograph
  - Standing scanogram
    - Evaluate axis
    - **Centered patella!!**
  - Lateral view
    - Posterior slope
    - Patella position
  - Skyline view
    - PFJ evaluation
  - Stress view
    - AP or ML Instability

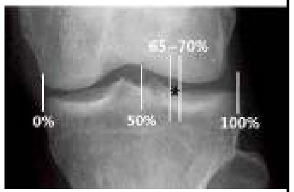




정형외과학 제8판

Preoperative plan

- Correction target
  - 8~10′ valgus in relationship of anatomical axis
  - 3~5′ valgus in relationship of mechanical axis
    - Mechanical axis should pass lateral to the lateral tibial spine
  - Mechanical axis should pass the **Fujisawa point**
    - MTP : 65~70%
    - LTP : 30~40%
  - No consensus about definite correction angle
    - Consider lateral ligament laxity, weight bearing, etc.



정형외과학 제8판

REVIEW ARTICLE Open Access

How to achieve an optimal alignment in medial opening wedge high tibial osteotomy?

Byoung Youl Kang[1], Do Kyung Lee[2], Hyeon Soo Kim[2] and Joon Ho Wang[1*]

Abstract
Medial opening wedge high tibial osteotomy (MOWHTO) is a widely used surgical treatment option for medial compartmental osteoarthritis with varus deformity. It is important that proper lower limb alignment is achieved. However, there has been no consensus about an optimal alignment in MOWHTO. Most studies suggest that achieving valgus alignment is necessary, and recent studies support slight valgus mechanical alignment of less than 3° of mechanical femorotibial angle. Overcorrection and undercorrection is not recommended for achieving good surgical outcomes. To prevent undercorrection and overcorrection in MOWHTO, the method of placing the weight-bearing line in the target range must be precise. There are several ways to place a weight-bearing line within the target range. While the most important factor for a successful MOWHTO is achieving an ideal mechanical axis correction, there are a few other factors to consider, including joint line obliquity, posterior tibial slope, ligament balancing, and patellar height. Several factors exist that lead to undercorrection and overcorrection. Preoperative amount of varus deformity, lateral hinge fracture, and fixation failure can result in undercorrection, while medial soft tissue laxity and the amount of correction angle and target point beyond hypomochlion can result in overcorrection. This study aimed to review the literature on optimal alignment in MOWHTO and report on the factors to be considered to prevent correction errors and how to achieve an optimal alignment.

Keywords: Medial opening wedge high tibial osteotomy, High tibial osteotomy, Undercorrection, Overcorrection, Optimal alignment, Operative planning, Correction error, Mechanical axis, Soft tissue laxity

Kang, et al. BMC 2022

What is an optimal alignment in MOWHTO?

There has been no consensus about an optimal alignment in MOWHTO, and most studies suggest that achieving valgus alignment is necessary to acquire long-term clinical success and prevent recurrence of varus deformity [15]. Fujisawa et al. [16] reported good results when the postoperative weight-bearing line passed 30–40% laterally from the center of the knee joint. In postoperative arthroscopy, cartilage remodeling by fibrous cartilage was found in patients with properly performed high tibial osteotomy (HTO). Coventry et al. [17, 18] suggested an alignment of 10° valgus of the anatomical femorotibial angle [3–5° of mechanical femorotibial angle (mFTA)] is optimal. With respect to longevity, 3–5° of mFTA showed excellent outcomes at 10 years of follow-up. Similarly, Hernigou et al. [19] reported that among 93 knees treated with MOWHTO, 22 knees with 3–5° of mFTA obtained the best results after an average follow-up of 11.5 years, in terms of pain relief and prevention of joint arthrosis progression.

Kang, et al. BMC 2022

Recent studies have different opinions from studies that emphasized valgus alignment, which is more than 3° of valgus mFTA. In a recent biomechanical study [20], beyond 3° of valgus mFTA there is no benefit in terms of reducing the pressure on the medial compartment without damage to the lateral compartment cartilage. In a computer-simulated knee model study [21], the peak contact pressure of the medial compartment when walking significantly decreased in only neutral mechanical alignment, and it was lower than peak contact pressure of the lateral compartment. The same results were obtained when squatting. Similarly, Atkinson et al. [22] reported that valgus alignment is not necessary, based on the finding that correction to near neutral alignment rather than excessive valgus alignment is sufficient to provide regenerative stimulation to the articular cartilage of the medial compartment without damaging the lateral compartment. Although there are inherent limitations in biomechanical studies, the findings of which may differ from the clinical outcomes of actual patients, these results need to be considered.

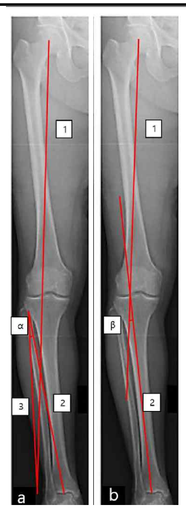
Kang, et al. BMC 2022

Jakob et al. [23] suggested that the target mechanical axis should not be absolute, but should be considered according to each patient's articular cartilage state as MOWHTO induces regeneration of damaged cartilage. They recommended that the correction angle should be

Kang, et al. BMC 2022

Preoperative plan

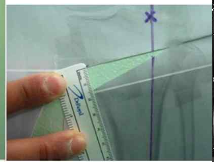
- Miniaci method
- Dugdale method



Kang, et al. BMC 2022

Preoperative plan

- Real-size weight bearing scanogram method
  - Actual size(100%)



Preoperative plan

- 3D printing patient specific instrument (PSI)

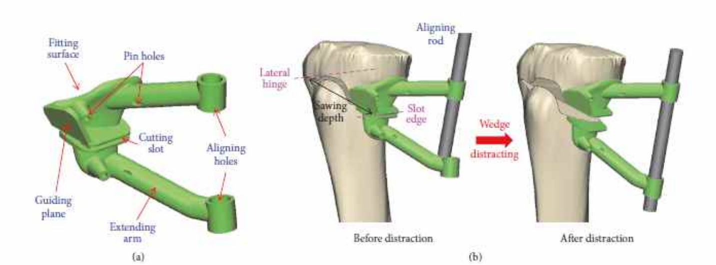
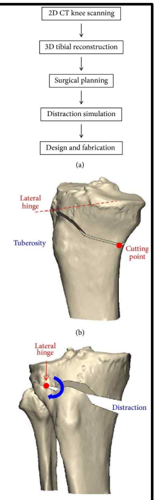


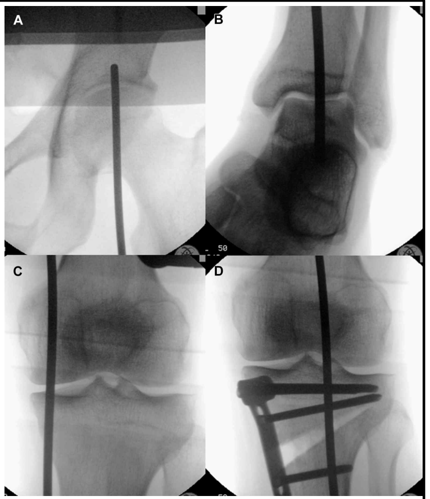
FIGURE 4: Schematic diagrams of (a) the PSI guide for medial opening wedge HTO and (b) intraoperative usage before and after distraction.



Yang et al. Biomedical Research International. 2018

Intraoperative

- Cable or rod method
  - Discrepancy (non weight bearing)
    - → Valgus force on knee joint
    - → Axial force

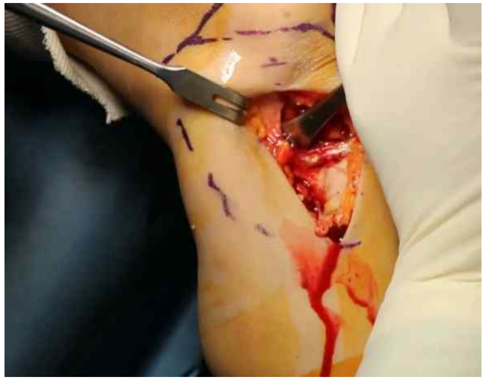


Skin incision

- Knee flexion 90′
- Proximal anteromedial incision
  - Midway between **medial border of patellar tendon** & **tibial posterior border** (5cm)
- Easy to release MCL distally compared to horizontal incision

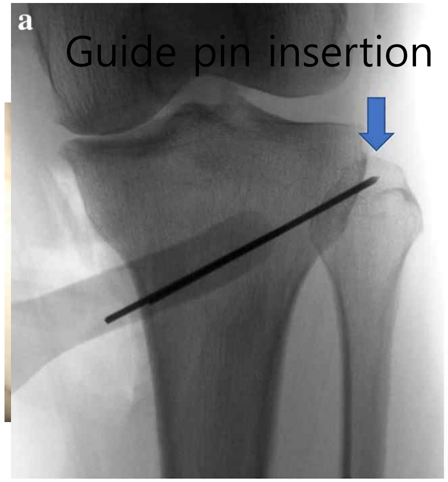
Knee arthroscopy

MCL release

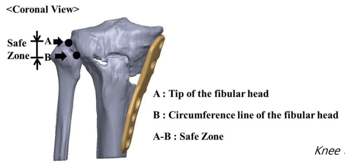


- Partial dissection of pes anserinus
  - Reverse L-shape
- MCL subperiosteal detachment
  - Effective decompression of the medial joint space

Guide pin insertion



- True AP view with knee **full extension**
- Begin above the pes anserinus tendon attachment
  - At least 3cm away from the medial tibial articular surface
- Insert K-wire
  - 1.5cm below lateral tibial articular surface
  - At the level of fibula head (safe zone)

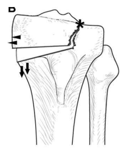


Biplane osteotomy

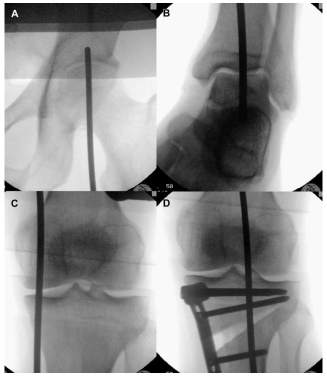
- Tibial tuberosity osteotomy
- 2nd osteotomy
  - Below inserted K-wires
  - 110′ with 1st osteotomy plane
  - 1cm of the lateral tibial cortical bone acts as a hinge
  - Need **protection of posterior structures**
  - Insufficient **osteotomy should be completely done** with osteotome (especially posterior cortex)
- Biplanar osteotomy advantage
  - Improving rotational stability
  - Anterior stability of osteotomy surface when knee is extended

Gap opening

- 3~4 chisels are used
  - Slowly with great care **to prevent lateral cortical hinge fracture**
- Then using bone spreader
  - Length or angle planned before surgery
- Check if there is enough gap
  - **Trapezoidal gap** to prevent the increase of the posterior tibial slope
  - Anterior gap to be 50-60% of the posterior gap

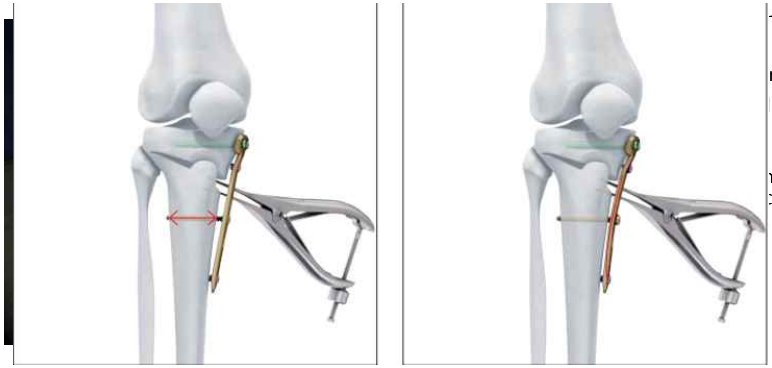


Check the mechanical axis



- Intraoperative alignment rod
- Axial compression should be applied for weight bearing effect

Plate insertion



- Center of anteromedial tibia surface

n

nation
to

the plate
hinge
ity
in hinge

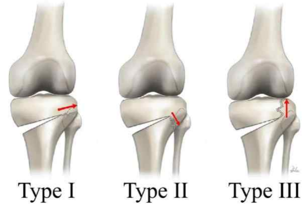
Closure

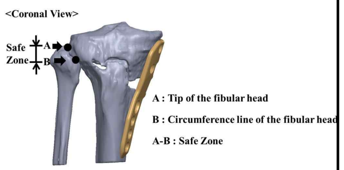
Complications of MOWHTO

- Lateral hinge fracture
- Increased posterior tibial slope angle (PTSA)
- Correction error (over or under)
- Joint line obliquity
- Patella problem
- Popliteal artery injury
- Infection
- Compartment syndrome

Lateral hinge fracture

- Cause loss of correction, implant failure, malunion, nonunion
- To reduce lateral hinge fracture
  - Osteotomy site : safe zone
  - Chisel gently
  - Sufficient osteotomy (anterior & posterior cortex)
    - Lateral cortex should be remained at least about 1cm
  - Using locking plate
- Postoperative CT scan can be helpful to detect fracture

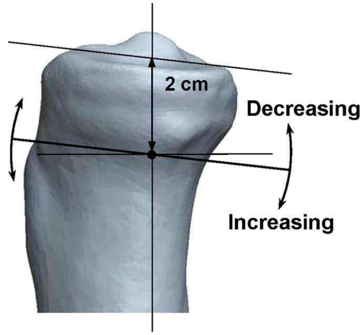




Knee arthroscopy

Increased posterior tibial slope angle (PTSA)

- PTSA ↑
  - Tibia anterior translation ↑
  - Helpful for PCL injury (with posterior instability, hyperextension)
- PTSA ↓
  - Hyperextension
    - Helpful for patient who were not able to fully extend the knee before surgery
  - Tibia anterior translation ↓
    - Helpful for ACL injury



Knee arthroscopy
Kevin et al. JOR, 2010

Increased posterior tibial slope angle (PTSA)

- Increased PTSA
  - Overloading of ACL
- To prevent
  - Wedge gap should be trapezoidal
    - *Song et al.*) Anterior gap = 67% of posterior
  - Complete **posterior cortex cut**
  - Enough posterior soft tissue release
  - Bone spreader & plate be applied to **posterior** of the gap

Knee arthroscopy
Kang, et al. BMC 2022

Inc ... le (PT

- *Wa* ... **nge the sagi** ... an be chai

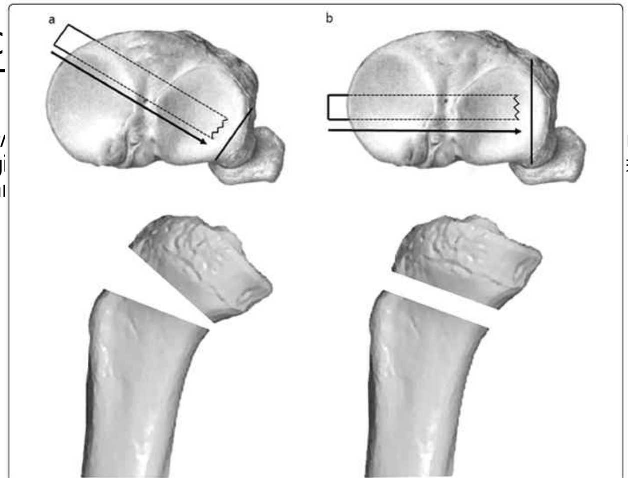


Fig. 4 The effect of the cortical hinge on the posterior tibial slope. **a** Posterolateral cortical hinge osteotomy with uneven anterior and posterior gap. **b** True lateral cortical hinge osteotomy with even anterior and posterior gap

Knee arthroscopy
Kang, et al. BMC 2022

Correction error (over or under)

- Undercorrection
  - Stable fixation is an important factor in maintaining the osteotomy gap
    - *Hernigou et al.*) lower correction loss rate in locking plate group than conventional plate group
  - Lateral hinge fracture

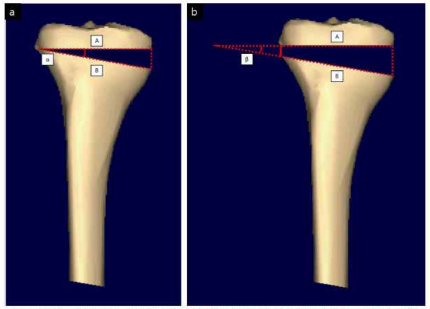


Fig. 5 Correction error due to hinge fracture. **a** Properly conducted osteotomy and **b** Lateral hinge fracture. Correction error might be affected by the lateral hinge fracture

Knee arthroscopy
Kang, et al. BMC 2022

Correction error (over or under)

- Overcorrection : excessive load on lateral compartment
- Discrepancy of pre- intra- postoperative alignment
  - Intraoperative : **non weight bearing** condition
    - **Valgus or axial force** can be applied
  - **Soft tissue laxity**
    - Joint line convergence angle (JLCA) of standing patients
    - JLCA normal range : 0-2′
    - *Lee, et al.*) Overcorrection is due to reduction of JLCA after soft tissue reduction after HTO
      - Medial soft tissue laxity and severity of varus deformity, can result in overcorrection

Knee arthroscopy
Kang, et al. BMC 2022

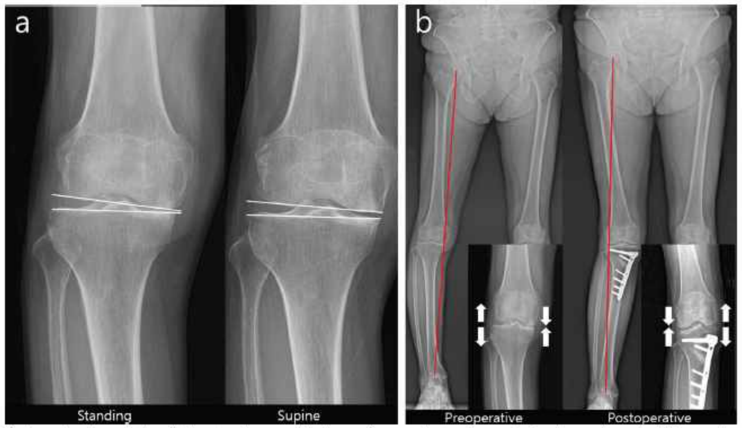


Fig. 6 Perioperative change in the soft tissue tension around the knee. **a** Preoperative standing and supine knee radiographs. **b** Preoperative and postoperative scanogram. The difference of joint line convergence angle between weight-bearing and supine X-ray implies the possibility of soft tissue tension change after medial opening wedge high tibial osteotomy. The medial joint space is opened, and the lateral joint space is closed by shifting the weight-bearing axis after medial opening wedge high tibial osteotomy. This results in unexpected overcorrection

Kang, et al. BMC 2022

Correction error (over or under)

- *Heijens et al.)*
  - Hypothesized that there is a certain mFTA beyond which JLCA changes significantly : "Hypomochlion"
    - Valgus 2° of mFTA
    - 57.5% of the tibial plateau from the medial border
  - Medial soft tissue laxity & varus deformity requiring a large correction angle
    - Using hypomochlion as the target point, can help prevent overcorrection.

Joint line obliquity

- Severe varus deformity
  - Tibia or combined tibia & femur
  - Proximal tibia should be overcorrected to solve these problems by OWHTO → can **increase knee joint obliquity** in coronal plane
    - Joint shearing stress ↑ and femoral subluxation
  - **Double osteotomy** can be considered
    - Prevent joint line obliquity
- No consensus on what degree of joint line obliquity is appropriate
  - Coventry et al.) less than 10′ is acceptable
  - Babies et al.) 4′ or less could achieve high survival rate

Knee arthroscopy

Joint line obliquity

- Radiologic parameter to evaluate joint line obliquity : medial proximal tibial angle (MPTA)
  - Normal : average 87′
  - Nakayama et al.)
    - **Shearing stress increase** when the joint line obliquity is **5-10′** (**95′ of MPTA**)
    - Therefore, if preoperative MPTA is expected to be greater than 95′, **double level osteotomy** should be performed

Knee arthroscopy

DLO considerations

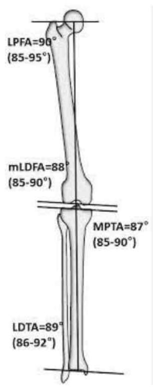
Table 4 Indications, targets, techniques for DLO

	Criteria for DLO if simple HTO would result in:			Targets of DLO		
Author and year	MPTA	LDFA	Wedge size	MPTA	LDFA	HKA
Akamatsu et al. 2021	> 95°	> 88°	> 15 mm	90°–95°	84°–87°	4°
Akaoka et al. 2020	> 95°	> 90°	> 15 mm		85°	0°–2°
Babis et al. 2002						
Grasso et al. 2021	< 85°	> 90°				
Hai et al. 2020	> 95°	> 90°		90°–94°	85°–89°	2°
Iseki et al. 2021	> 95°		> 15 mm	90°	85°	
Nakayama et al. 2021	> 95°		> 15 mm			
Nakayama et al. 2020				90°	85°	0.5°–1°
Rupp et al. 2022						
Saragaglia et al. 2012				88°–92°		0°–4°
Saragaglia et al. 2005						0°–4°
Schröter et al. 2019	> 87°	> 90°				0°–2°

DLO double-level osteotomy, *MPTA* medial proximal tibial angle, *LDFA* lateral distal femoral angl tricalcium phosphate

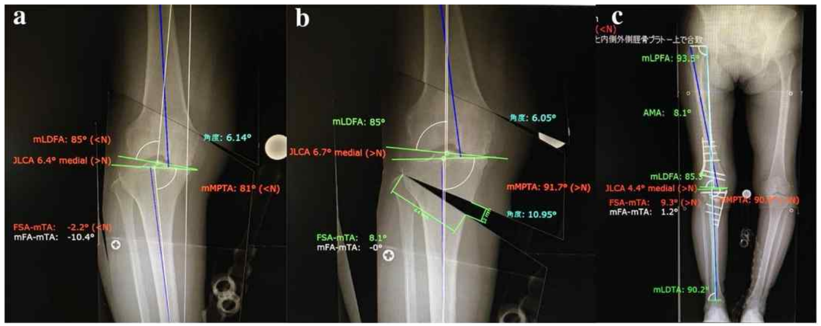
*The authors reported that they performed closing-wedge femoral osteotomies, but did not specify otomies

**The authors reported that they performed opening-wedge tibial osteotomies, but did not specify otomies



Knee arthroscopy

DLO considerations



Knee arthroscopy

DLO considerations

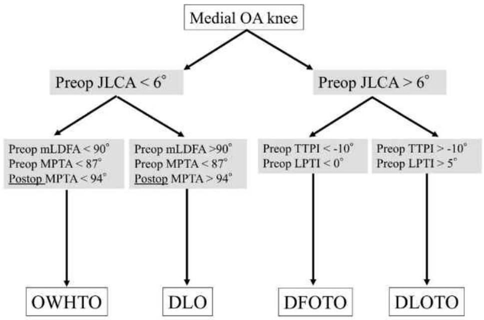
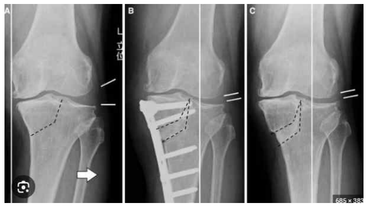


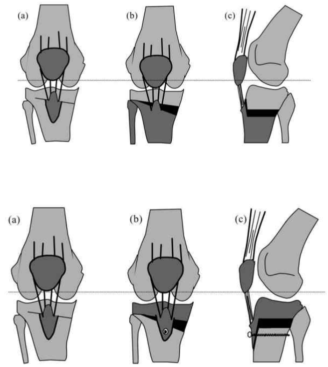
Fig. 2. A flow chart for the indication of DFOTO or DLOTO based on deformity analysis.



H.saito, Asia-pacific journal of sports medicine

Patella problem

- Patella baja
  - Distally transferred patella **increases the contact pressure** of the patellofemoral joint
  - Degenerative change & anterior knee pain
  - *Gaasbeek et al.*) Biplanar distal tuberosity osteotomy
    - Opens the gap distally rather than proximally to the tibial tuberosity.
- Patella maltracking
  - Overcorrected valgus knee : Q angle alteration



Distal Femoral Osteotomy

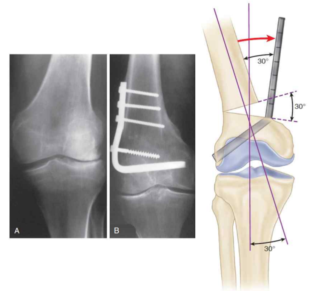
Distal femoral varus osteotomy (DFO)

Table 1. Indications and Contraindications

Indications
- Moderate corrections up to 10 degrees for opening wedge
- Larger corrections from 12 to 27 degrees for closing wedge
- Lateral compartment mild to moderate osteoarthritis
- Lateral condyle cartilage lesions (with or without cartilage restoration)
- Lateral meniscal transplants

Absolute contraindications
- Severe medial or tricompartmental osteoarthritis
- Symptomatic medial compartment disease
- Inflammatory arthritis
- Severe osteoporosis

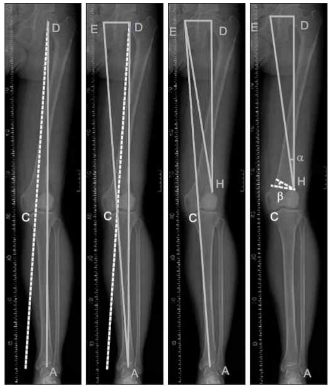
Relative contraindications
- Severe patellofemoral osteoarthritis
- Nicotine use
- High body mass index
- Individuals older than 55 years



Michael et al. Arthroscopy technique. 2016.

Distal femoral varus osteotomy (DFO)

- Lateral opening wedge osteotomy
- Medial closing wedge osteotomy



Michael et al. Arthroscopy technique. 2016.

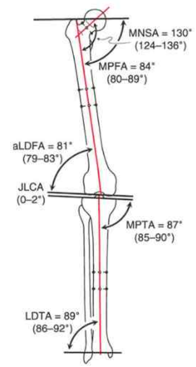
Distal femoral varus osteotomy (DFO)

- Complications
  - Femoral a., sciatic n. injury
  - Delayed or nonunion
  - Recurrence of deformity
  - Joint stiffness
  - Infection

1. 57세 여자가 지속되는 좌측 슬관절의 내측 통증과 내반 변형으로 촬영한 단순 방사선 사진과 자기 공명 영상 검사이다. 방사선 촬영에서 해부학적 외측 원위 대퇴각(LDFA)은 81도, 해부학적 내측 근위 경골각(MPTA)은 79도 및 내측에 국한된 K-L grade III의 퇴행성 관절염 소견이 보였다. 가장 적절한 치료는?
21B/20B2/19B2

㉮ Lateral closing wedge HTO
㉯ Medial open wedge HTO
㉰ Medial open wedge DFO
㉱ Medial closing wedge DFO
㉲ Anterior open wedge osteotomy

1. 57세 여자가 지속되는 좌측 슬관절의 내측 통증과 내반 변형으로 촬영한 단순 방사선 사진과 자기 공명 영상 검사이다. 방사선 촬영에서 해부학적 외측 원위 대퇴각(LDFA)은 81도, 해부학적 내측 근위 경골각(MPTA)은 79도 및 내측에 국한된 K-L grade III의 퇴행성 관절염 소견이 보였다. 가장 적절한 치료는?
21B/20B2/19B2



㉮ Lateral closing wedge HTO
㉯ Medial open wedge HTO
㉰ Medial open wedge DFO
㉱ Medial closing wedge DFO
㉲ Anterior open wedge osteotomy

Increased posterior tibial slope angle (PTSA)

- Increased PTSA
  - Overloading of ACL
- To prevent
  - Wedge gap should be trapezoidal
    - *Song et al.*) Anterior gap = 67% of posterior
  - Complete **posterior cortex cut**
  - Enough posterior soft tissue release
  - Bone spreader & plate be applied to **posterior** of the gap

Knee arthroscopy
Kang, et al. BMC 2022

Reference

- Campbell's Orthopedics 14th Edition, PART III RECONSTRUCTIVE PROCEDURES OF THE KNEE IN ADULTS
- 정형외과학 8th edition
- Knee arthroscopy
- Kang et al. How to achieve an optimal alignment in medial opening wedge high tibial osteotomy?. KSRR. 2022.
- Yang et al. Clinical Experience Using a 3D-Printed Patient-Specific Instrument for Medial Opening Wedge High Tibial Osteotomy. BioMed Research International. 2018.
- Heijens et al. The coronal hypomochlion: a tipping point of clinical relevance when planning valgus producing high tibial osteotomies. Bone Joint J. 2016.
- Ryu et al. Reliability of preoperative planning method that considers latent medial joint laxity in medial open-wedge proximal tibial osteotomy. Orthop J Sports Med. 2021.

J Shoulder Elbow Surg (2023) 32, 1662–1672

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Biomechanical consequences of glenoid and humeral lateralization in reverse total shoulder arthroplasty

Bei Liu, MD, MS[a], Young Kyu Kim, MD[a], Andrew Nakla, BS[b], Min-Shik Chung, BS[b], Daniel Kwak, BA[b], Michelle H. McGarry, MS[b], Thay Q. Lee, PhD[b], Joo Han Oh, MD, PhD[a,*]

[a]Department of Orthopaedic Surgery, Seoul National University College of Medicine, Seoul National University Bundang Hospital, Seongnam, Republic of Korea
[b]Orthopaedic Biomechanics Laboratory, Congress Medical Foundation, Pasadena, CA, USA

2023.07.25
명지병원 정형외과
R2. 김수영

Introduction

- Reverse total shoulder arthroplasty (RTSA)
  - Treatment option for irreparable massive rotator cuff tears or cuff tear arthropathy.
- Grammont presented the biomechanical concept of medicalization and distalization of the center of rotation (COR)
  - Minimized the torque on the glenoid component
  - Increased the deltoid efficiency
  - Enhanced the recruitment of deltoid fibers to serve as additional abductors

Introduction

- Several drawbacks of the design
  - Medialization of the glenoid leads to - higher risk of scapular notching and instability
  - Lack of active external rotation (ER) improvement
  - Shoulder contour could be altered when the humerus is medialized and distalized because of the reduced offset and increased arm length
  - Humeral medialization also produces a cam effect and a reduction in deltoid wrapping - causing the deltoid to generate a distraction moment on the prosthesis and decrease joint stability

Introduction

- The optimal adjustment of medial or lateral offset of the COR between glenosphere and humeral offset has yet to be determined.
- Prior studies have limited their focus to either the humeral or glenoid implant design or only evaluated outcomes using lateralized implant options.
  - Chan et al :
    - Evaluated the impact of lateralized humeral components on rotator cuff torque using a cadaver model
  - Henninger et al :
    - Conducted a biomechanical study to determine the biomechanical effects of changing COR with a lateral offset glenosphere
- Neither examined lateralized implant options at both the glenoid and humeral sides nor directly compare the biomechanical consequences resulting from implant configuration

Introduction

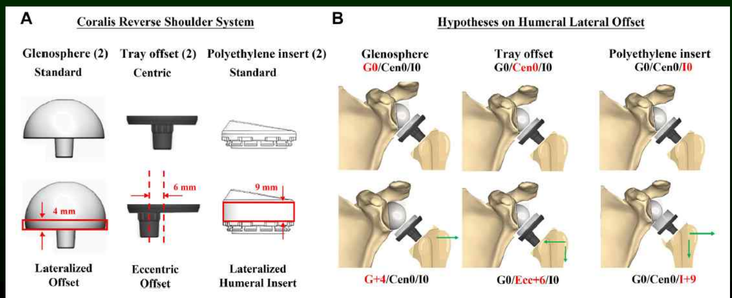
- Aim
  - Quantify the effectiveness of lateralization of RTSA with varying configurations of glenoid and humeral components
  - Measure : Impingement-free ROMs, simulated ER and abduction capability, and anterior dislocation force
- Hypothesis
  - Lateralization would increase impingement-free ROM, improve simulated active ROM, and joint stability.

Method

- Specimen preparation
  - 8 fresh-frozen cadaveric shoulder specimens with rotator cuffs (mean age, 58.6 ± 9.7 years; range, 42-68 years)
  - All soft tissues and muscles were removed from the specimens, except for the insertions of the subscapularis, teres minor (TM), and the deltoid
  - To simulate a massive cuff tear : insertions of the supraspinatus and infraspinatus were removed
  - The humerus was transected 2cm distal to the deltoid tuberosity
  - Suture loops were placed at the muscle-tendon to facilitate muscle loading during testing

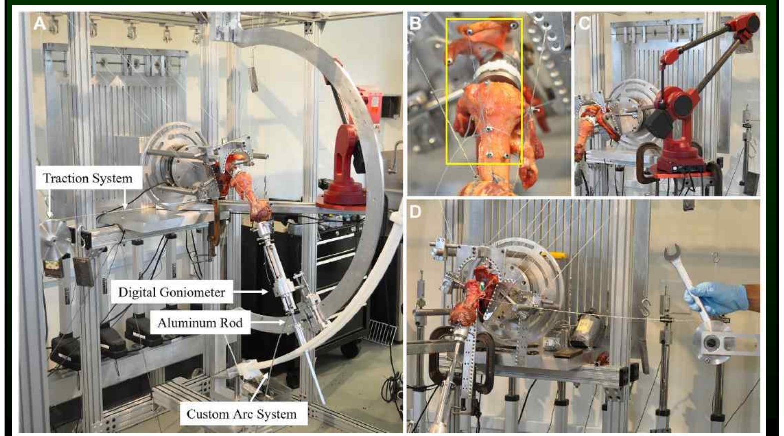
Method

- Surgical procedures of the RTSA
  - Each specimen was implanted with the Coralis reverse shoulder system (Corentec, Seoul, Republic of Korea)
  - Lateral glenosphere and lateral humerus design - changing 3 parameters
  - 8 Component configurations



Method

- Biomechanical testing protocol and outcome measurements



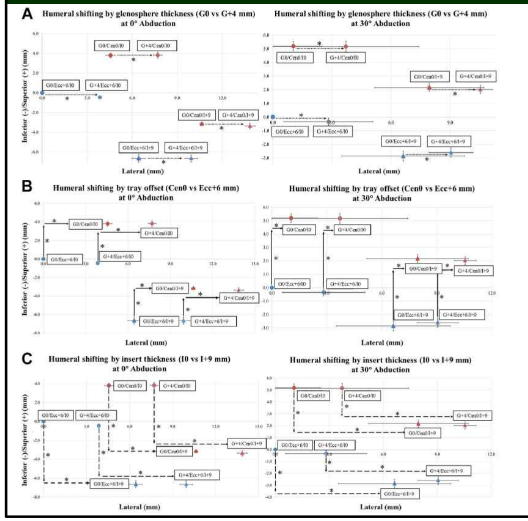
Results

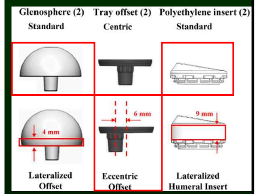
Table I Indications for surgery in the lateralized and nonlateralized glenosphere groups

Indication	Lateralized glenosphere (n = 27)	Nonlateralized glenosphere (n = 26)
RCT arthropathy	21 (77.8)	20 (76.9)
Massive RCT	–	2 (7.7)
Avascular necrosis	1 (3.7)	–
Glenohumeral arthritis	1 (3.7)	–
Post-traumatic osteoarthritis	1 (3.7)	–
Failed hemiarthroplasty	1 (3.7)	–
Failed anatomic TSA	1 (3.7)	1 (3.8)
Failed reverse TSA	–	1 (3.8)
Humeral head fracture malunion	1 (3.7)	1 (3.8)
Proximal humerus nonunion	–	1 (3.8)

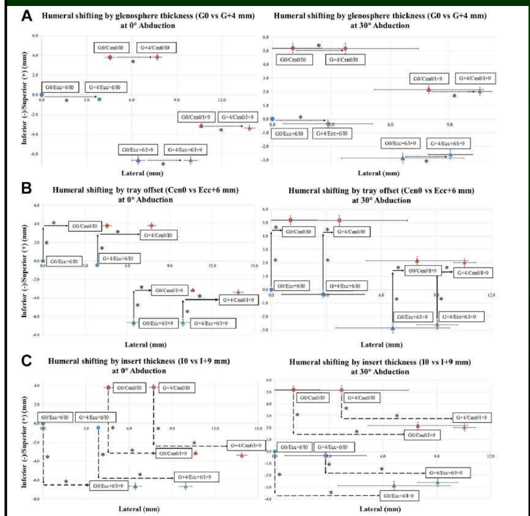
RCT, rotator cuff tear; *TSA*, total shoulder arthroplasty.
Data are presented as n (%).

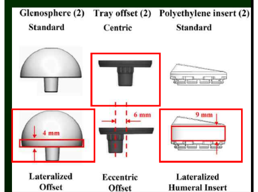
Results – position of the humerus



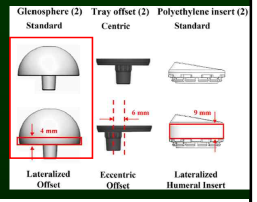


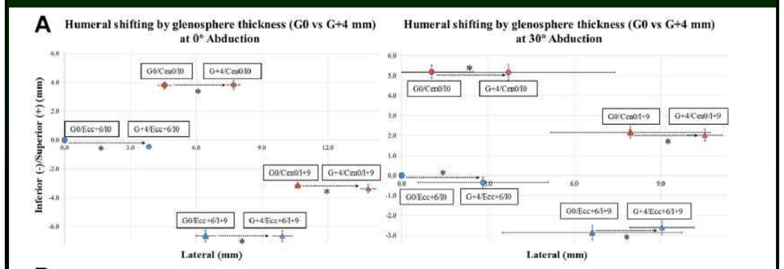
Results – position of the humerus



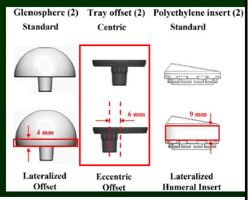


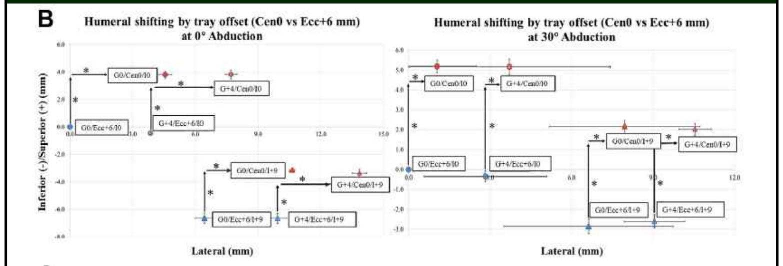
Results – position of the humerus



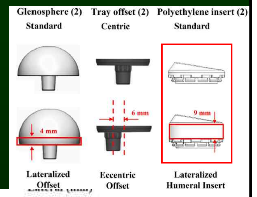


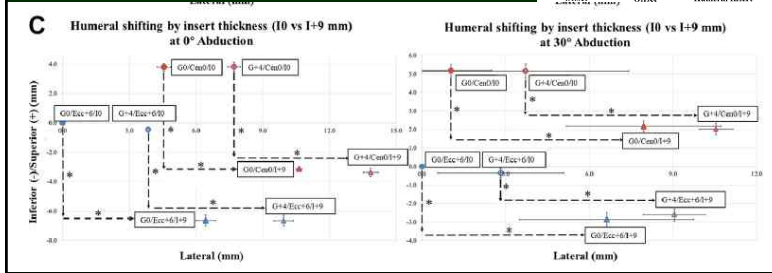
Results – position of the humerus





Results – position of the humerus





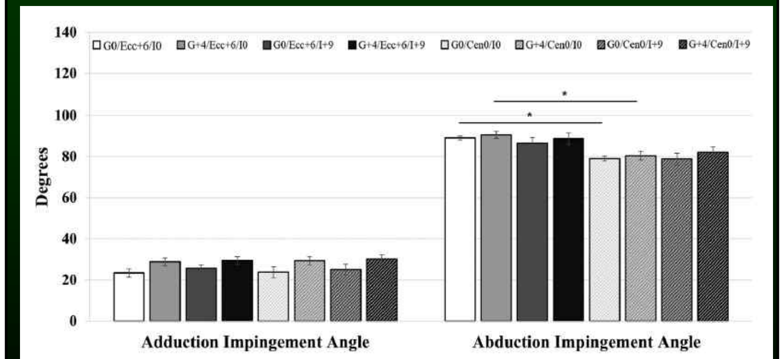
Results

Table I Partial correlation between shifting of humeral position and passive ROM, active ROM, and stability

	Lateral shifting		Superior or inferior shifting	
	r	*P* value	*r*	*P* value
Passive ROM				
Add angle	0.288	.022*	0.006	.960
Abd angle	−0.414	.001*	−0.383	.002*
IR angle at 0° Abd	−0.039	.761	−0.099	.440
ER angle at 0° Abd	0.249	.049*	0.049	.701
IR angle at 30° Abd	0.103	.423	−0.053	.680
ER angle at 30° Abd	0.292	.020*	0.017	.892
Active ROM				
ER capability				
Baseline muscle load load				
10 N to TM	0.263	.037*	−0.059	.643
15 N to TM	0.333	.008*	−0.042	.743
+50% muscle load				
10 N to TM	0.210	.098	−0.086	.505
15 N to TM	0.269	.033*	−0.066	.608
+100% muscle load				
10 N to TM	0.180	.158	−0.144	.262
15 N to TM	0.241	.057	−0.099	.442
Abd capability				
15 N to middle deltoid	−0.174	.172	0.156	.223
20 N to middle deltoid	−0.089	.489	0.073	.570
25 N to middle deltoid	−0.027	.831	0.141	.272
30 N to middle deltoid	−0.094	.465	−0.008	.953
Anterior dislocation force				
Baseline muscle load	0.133	.299	−0.237	.062
+50% muscle load	0.069	.593	−0.151	.237
+100% muscle load	0.087	.499	−0.183	.151

ROM, range of motion; *Add*, adduction; *Abd*, abduction; *IR*, internal rotation; *ER*, external rotation; *TM*, teres minor.
* Statistically significant.

Results



Results

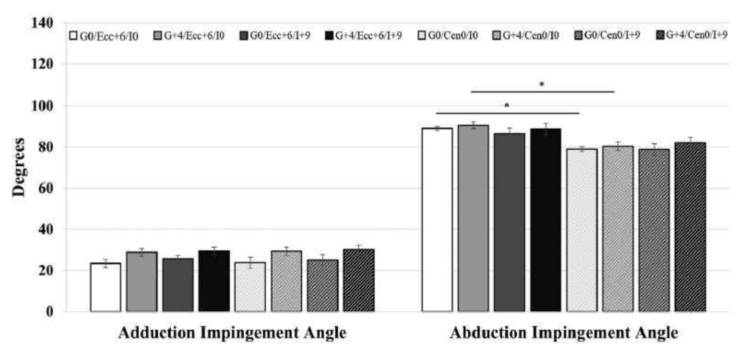


Figure 4 Maximal adduction and abduction angles achieved before impingement in different implant configurations. Error bars represent standard error of the mean. *A significant difference ($P < .05$) between implant configurations by glenosphere thickness, humeral tray eccentricity, and insert thickness. (*G*, glenosphere; *Cen*, centric tray; *Ecc*, eccentric tray offset; *I*, insert thickness).

Results

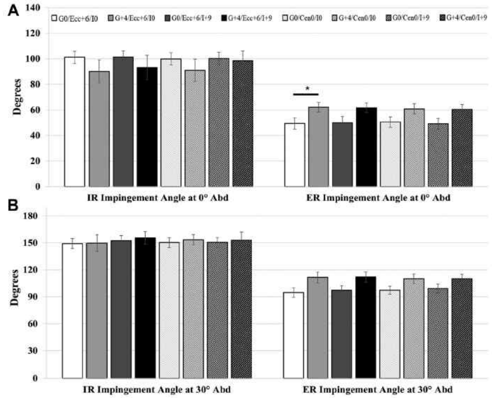


Figure 5 Maximal IR and ER angles achieved before impingement in different implant configurations (**A**, 0° Abd; **B**, 30° Abd). Error bars represent standard error of the mean. *A significant difference ($P < .05$) between implant configurations by eccentricity, insert, and glenosphere thickness. (*G*, glenosphere; *Cen*, centric tray; *Ecc*, eccentric tray offset; *I*, insert thickness; *IR*, internal rotation; *ER*, external rotation; *Abd*, abduction).

Results

Table I Partial correlation between shifting of humeral position and passive ROM, active ROM, and stability

	Lateral shifting		Superior or inferior shifting	
	r	*P* value	*r*	*P* value
Passive ROM				
Add angle	0.288	.022*	0.006	.960
Abd angle	−0.414	.001*	−0.383	.002*
IR angle at 0° Abd	−0.039	.761	−0.099	.440
ER angle at 0° Abd	0.249	.049*	0.049	.701
IR angle at 30° Abd	0.103	.423	−0.053	.680
ER angle at 30° Abd	0.292	.020*	0.017	.892
Active ROM				
ER capability				
Baseline muscle load load				
10 N to TM	0.263	.037*	−0.059	.643
15 N to TM	0.333	.008*	−0.042	.743
+50% muscle load				
10 N to TM	0.210	.098	−0.086	.505
15 N to TM	0.269	.033*	−0.066	.608
+100% muscle load				
10 N to TM	0.180	.158	−0.144	.262
15 N to TM	0.241	.057	−0.099	.442
Abd capability				
15 N to middle deltoid	−0.174	.172	0.156	.223
20 N to middle deltoid	−0.089	.489	0.073	.570
25 N to middle deltoid	−0.027	.831	0.141	.272
30 N to middle deltoid	−0.094	.465	−0.008	.953
Anterior dislocation force				
Baseline muscle load	0.133	.299	−0.237	.062
+50% muscle load	0.069	.593	−0.151	.237
+100% muscle load	0.087	.499	−0.183	.151

ROM, range of motion; *Add*, adduction; *Abd*, abduction; *IR*, internal rotation; *ER*, external rotation; *TM*, teres minor.
* Statistically significant.

Results

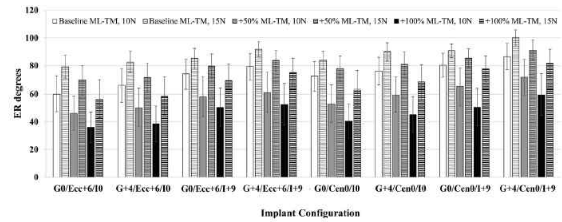


Figure 6 ER degrees achieved by increasing the load applied to the TM under the baseline and additional muscle load. (*ML*, muscle load; *TM*, teres minor; *ER*, external rotation; *G*, glenosphere; *Cen*, centric tray; *Ecc*, eccentric tray offset; *I*, insert thickness).

Results

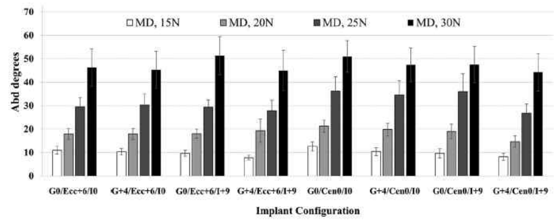


Figure 7 Abduction degrees achieved by increasing the load applied to the middle deltoid. (*MD*, middle deltoid; *Abd*, abduction; *Std*, a standard thickness of glenosphere; *G*, glenosphere; *Cen*, centric tray; *Ecc*, eccentric tray offset; *I*, insert thickness).

Results

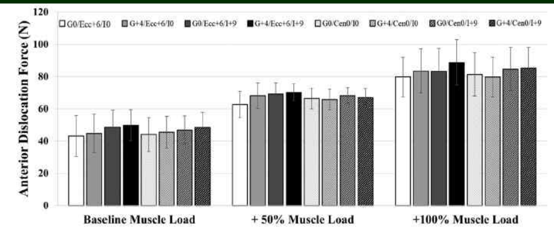


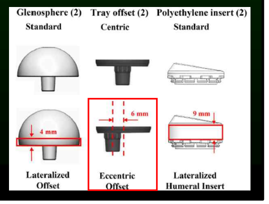
Figure 8 Anterior dislocation forces achieved under the baseline and additional muscle load. (*G*, glenosphere; *Cen*, centric tray; *Ecc*, eccentric tray offset; *I*, insert thickness).

Discussion

- Data : Isolated humeral lateralization was achieved with a thicker glenosphere, whereas humeral distalization and lateralization could be achieved through the adjustment of humeral components, including humeral tray offset and insert thickness.
- The impingement-free abduction angle negatively correlated with humeral lateralization and proximalization : indicating that greater abduction angles tend to be achieved with more medialized and distalized implants using the eccentric humeral tray.
- Thus, the eccentric humeral tray had the most significant effect on the maximal abduction angle before impingement.

Discussion

- Tashjian et al
  - Reported a reduction of passive abduction angle with lateralization due to increased humeral insert thickness
  - Our findings support that the abduction impingement angle negatively correlated with humeral lateralization and proximalization
- Greater impingement-free abduction angle could be achieved by "less lateralizing with distalizing" the humerus, and thereby an eccentric tray has the largest effect on maximizing the impingement-free abduction angle.



Discussion

- Gutierrez et al and Kim et al
  - Reported the effect of lateralization in increasing impingement-free ROMs based on computer models.
- Data presented that impingement-free adduction angle and lateralization had a positive linear relationship, suggesting that they tended to increase together.
- Li et al
  - Reported an increased impingement-free ER with a lateralized glenosphere.
- Data also showed a trend toward improved passive ER when increasing the glenosphere thickness to +4 mm

Discussion

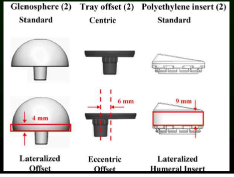
- For the stability of RTSA, the anterior dislocation forces were not significantly different between configurations and were not correlated with the humeral position
- Theoretically, lateralization improves the tension of the rotator cuff tendon and increases the compressive forces on the glenohumeral contact, which may lead to greater stability
- Although our results revealed a trend toward increased anterior dislocation forces following increased lateralization, no significant differences were observed
- This lack of significance could be attributed to the nature of the current cadaver model and the original lateralized implant design that was used in the current test

Discussion

- The results of this study also suggested that lateralization on either the glenoid or humeral side can improve the impingement-free motion in adduction and ER, thus providing the clinical advantages of decreasing scapular notching, and improving functional outcomes.
- Less lateralization with distalization of the humerus by an eccentric humeral tray could be used to increase the impingement-free abduction angle and thus prevent acromial notching in abduction.
- Because simulated active abduction angle was not significantly influenced by lateralization within the maximum range of passive abduction impingement angle, an eccentric humeral tray could be considered for its clinical relevance of increasing the abduction angle without significantly impacting the active abduction capability.

Conclusion

- Lateralization is achievable at both the glenoid and humeral sides but has different effects; therefore lateralized implant options should be selected according to patients' needs.
- Lateralization is an effective strategy for reducing adduction notching while increasing ER capability.
- Thicker glenospheres only affected humeral lateralization.
- The centric humeral tray would be selected for less distalization to avoid overlengthening, whereas an eccentric humeral tray is the most effective for distalization and medialization in reducing abduction notching to the acromion and for patients with pseudoparalysis.



UKA

2023.07.31
명지병원 정형외과
R3 이규환

Case

History taking

01093781 조O심 F/62

- CC : Lt knee pain
- Onset : 약 5년 전,
- Agg. : 1년 전부터 통증 악화
  앉았다 일어나려할 때 통증 악화

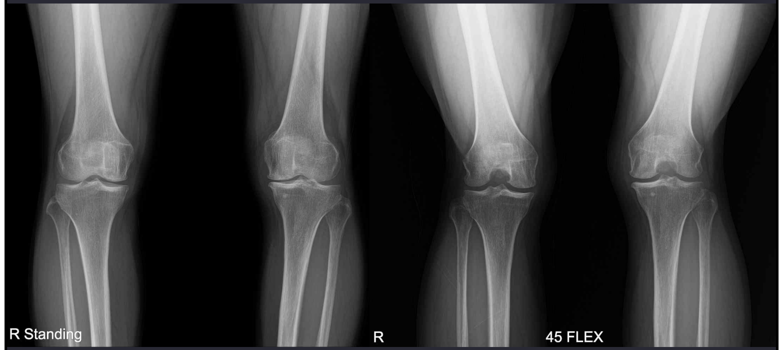
Present illness & Mechanism

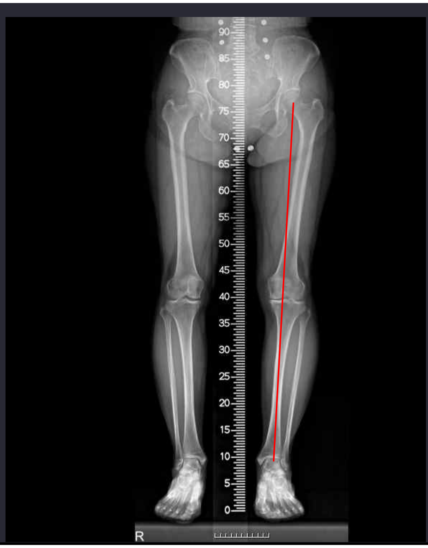
- 62세 여자환자 내원 5년 전부터 간헐적으로 좌측 슬부 통증 있었으며, 1년 전부터 통증 악화되어 앉았다 일어날 때와 걸을 때 시큰거려 일상생활에 제약있는 상태로 타병원에서 진료보았으며 전체인공관절치환술 권유받고 본원 외래 내원함.

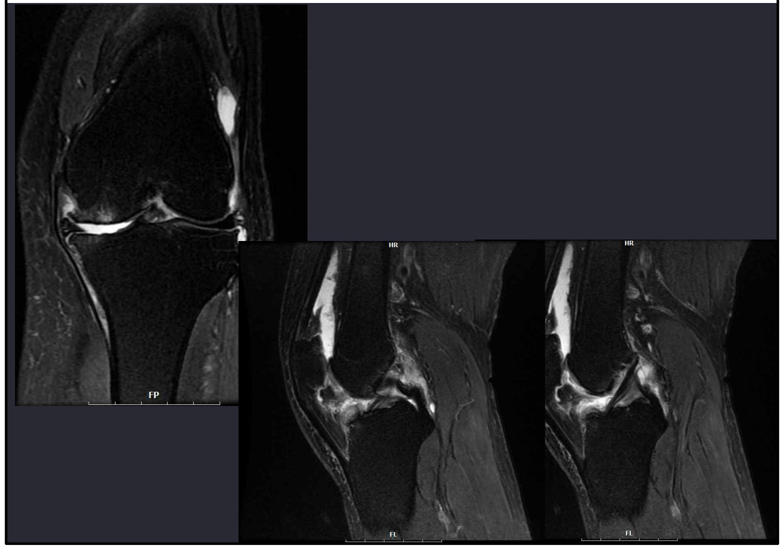
- Past history
  - HL, Depression
- Social history
  - Job : 주부
  - Sport activity : Low activity

P/Ex

- General
  -BMI : 신장 151cm, 체중 45kg -> BMI : 19.7
  -Medical comorbidities (-)
- ROM : WNL
- McMurray test (+)
- MJLT (+)
- LJLT (-)
- ADT (-) / Lachmann (-)
- Piviot shift test (-)
- PDT (-) / Posterior sagging (-)





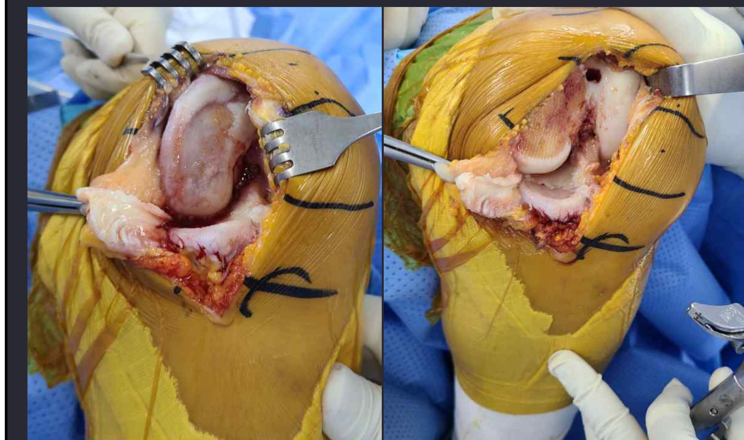


- Dx: Advanced medial OA, knee, Lt.

- 62yrs
- BMI 19.7
- No flexion contracture
- Low activity demand
- One compartment involved
- <5° **varus deformity**

- Tx. : UKA

Intra OP finding



Post op. X-ray

Topic review

Unicompartmental knee arthroplasty

Introduction

- **Unicompartmental knee replacement**
  - Surgical procedure that selectively replaces only one of the three compartments of the knee with an artificial joint when the knee has arthritis
- **Advantage**
  - Less skin incisions and osteotomy
    - preserves much of the normal tissue and function of the knee
  - Less blood loss
  - Greater Post OP ROM, quicker recovery
  - Revision arthroplasty is relatively easier than TKR, HTO
- **Disadvantage**
  - Narrow indication
  - Relatively difficult surgical technique
  - High early failure rate, and lack of validation of long-term survival of the device

Prosthetic designs

MacIntosh, Mckeever, Swanson...	(1950)
St. Georg Sledge	(1969)
Marmor	(early 1970s)
Brigham	(1974)
Porous-coated anatomic knee	(1980s)
O'connor	
Oxford	**(1978)**
Miller-Galante knee	
Interpositional Implants (UniSpacer)	

Survival rate of modern UKA prosthesis

TABLE

REPORTED SURVIVAL RATES* FOR VARIOUS UNICOMPARTMENTAL KNEE ARTHROPLASTY

Study	Prosthesis	Follow-Up	Survivorship
Squire and Callaghan et al (1999)	Marmor	22 years	84%
Scott et al (1991)	Unicondylar knee	9 years	90%
		10 years	85%
		11 years	82%
Murray et al (1998)	Oxford (mobile bearing)	10 years	98%
MacKinnon et al (1988)	St. Georg sledge	57 months	95%
Naudie et al (2004)	Miller-Galante	5 years	94%
		10 years	90%
Berger et al (2005)	Miller-Galante	10 years	98%
		13 years	96%

* Survival rates reported with revision to total knee arthroplasty as the endpoint.

Classic indication of UKA

- One compartment arthritic change
- The other compartment without change
- PFJ without moderate to severe change
- <15˚ angular deformity
- No physically active/heavy labor
- >90˚ ROM, <15˚ flexion contracture
- Non inflammatory arthritis
- Intact ACL
- Age > 60 years
- No obesity

➡ **6% of candidates for arthroplasty meets criteria of UKA**

Modern indication of UKA

Mobile–bearing UKA: Oxford® (Biomet)

- Varus deformity < 15˚
- Flexion contracture < 15˚
- Further flexion > 110˚
- Regardless of age, weight & activity
- Regardless of P–F O.A.

_ Pandit et al.[8]

Fixed–bearing UKA: ZUK® (Zimmer)

- Varus/valgus deformity < 10˚
- Extension deficit < 10˚
- ROM > 90˚
- Age, activity level, weight–not considered determinants
- No clinical or radiological evidence of P–F O.A.

_ Panni et al.[9]

Ideal indication between HTO & UKA

	HTO	HTO or UKA	UKA
Age	<65 Y	55–65 Y	>55 Y
Activity level	Active	Moderately active	Low demands
BMI	Any	<30	<30
Varus deformity	5–15˚	5–10˚	0–5˚
AP instability	Any	No to grade I	No to grade I
ML instability	No to grade II	No to grade I	No to grade I
ROM	120˚	100˚	90˚
Flexion contracture	<5˚	<5˚	<5˚
OA severity	Ahlback I–II	Ahlback II	Any

Dettoni F, Iowa Orthop J, 2010

Ahlback and Kellgren–Laurence classification

Ahlbäck grade	Ahlbäck definition	K-L grade	Kellgren & Laurence definition
		Grade 1 'Doubtful'	Minute osteophyte, doubtful significance
		Grade 2 'Minimal'	Definite osteophyte, unimpaired joint space
Grade I	Joint space narrowing (JS < 3 mm)	Grade 3 'Moderate'	Moderate dimunition of joint space
Grade II	Joint space obliteration	Grade 4 'Severe'	J. space greatly impaired + sclerosis of subchondral bone
Grade III	Minor bone attrition (0–5 mm)	Grade 4 'Severe'	J. space greatly impaired + sclerosis of subchondral bone
Grade IV	Moderate bone attrition (5–10 mm)	Grade 4 'Severe'	J. space greatly impaired + sclerosis of subchondral bone
Grade V	Severe bone attrition (>10 mm)	Grade 4 'Severe'	J. space greatly impaired + sclerosis of subchondral bone

Ahlback and Kellgren–Laurence classification

Various surgical technique & prosthesis of UKA

Mobile bearing vs Fixed bearing
Metal backed modular vs all polyethylene tibial component
Instrument guide system
Conventional surgery vs. minimal invasive surgery

Mobile bearing vs Fixed bearing

- **Mobile bearing**
  - offering more congruent bearing surfaces with a large contact area
    → generates less contact stresses
  - decreasing the risk of aseptic loosening, polyethylene wear, and implant revision in the long term
  - technically more difficult
  - Without precise alignment and ligament balancing, it can lead to bearing dislocation or impingement causing increased wear.

- **Fixed bearing**
  - technically easier to implant, no risk of bearing dislocation
    - has a flat tibial articular surface
  - less conforming as flexion occurs
  - can lead to point loading due to the flat tibial articular surface

Mobile bearing vs Fixed bearing

- Mobile bearing and Fixed bearing prostheses did not differ in terms of:
  (1) clinical outcomes
  (2) radiographic outcomes
  (3) revision rates
  (4) survivorship

Zhang et al, Sci Rep, 2020
Lee et al, J cli Med, 2022

- The differences in timing of failure
  - bearing dislocation led to earlier failures in the mobile bearing prosthesis
  - later failures were related to polyethylene wear in the fixed bearing prosthesis

Metal backed modular vs all polyethylene tibial component

- **Metal backed component**
  - better modularity
    → more easier to exchange poly insert
    → better load distribution
  - back side wear

- **All polyethylene component**
  - less bone resection
  - less migration
  - easier revision

Metal backed modular vs all polyethylene tibial component

- Superior functional outcomes were reported metal-backed medial UKA compared to all-polyethylene medial UKA

- KSS socre
- KOOS score
- WOMAC score (total, pain, stiffness, function)

Jelle P. et al, HSS J, 2017
Vincenzo et al, Int Orthop, 2021

Complication of UKA

Early	Late
PE dislocation	Loosening
Instability or F-T subluxation	Progressive OA to other compartment
MTP fracture	Wear
Patellofemoral impingement	

Problem in conversion TKA from HTO & UKA

Conversion from HTO	Revision from UKA
Exposure(skin incision, patellar adhesion)	Bony deficiency
Osseous deformity	Necessitating grafts or wedges
Difficulty of ligament balancing	Slight worse clinical result
Prolonged surgical time	Prolonged surgical time
Increased blood loss	Increased blood loss

Which procedure is the best for unicompartmental OA?

- Their own advantages and disadvantages, **no definite answer**
- A customized approach to HTO & UKA
- Considering factors

Overlap of indication
Importance of precise procedure
Patient demographic factor
Less invasiveness, low complication rate
Early return to daily life, comfortableness after surgery
Easy conversion to TKA

Quiz 1

- 슬관절 내측부 동통을 호소하는 60세 환자가 병력상 5년 전 내측 반월상 연골 아전절제술을 시행받았다. 방사선 검사 상 내측 관절간격 감소와 골극이 관찰 되었다. MRI 검사 상 전방십자인대 및 외측관절구획은 정상이었다. 대퇴경골의 역학적 축은 3도 내반을 보였으며, 내측 근위 경골간각은 89도 였다. 운동범위는 굴곡구축 5도, 후속굴곡 100도였다. 가장 적절한 치료는?

- ① 근위 경골 절골술
- ② 자가 연골세포 이식술
- ③ 관절경적 변연절제술
- ④ 인공관절 부분치환술
- ⑤ 동종 반월상연골 이식술

Quiz 1

- 슬관절 내측부 동통을 호소하는 60세 환자가 병력상 5년 전 내측 반월상 연골 아전절제술을 시행받았다. 방사선 검사 상 내측 관절간격 감소와 골극이 관찰 되었다. MRI 검사 상 전방십자인대 및 외측관절구획은 정상이었다. 대퇴경골의 역학적 축은 3도 내반을 보였으며, 내측 근위 경골간각은 89도 였다. 운동범위는 굴곡구축 5도, 후속굴곡 100도였다. 가장 적절한 치료는?

- ① 근위 경골 절골술
- ② 자가 연골세포 이식술
- ③ 관절경적 변연절제술
- ④ 인공관절 부분치환술
- ⑤ 동종 반월상연골 이식술

Quiz 2

- 1년 전 좌측 슬관절에 대하여 가동형 단일구획치환술(mobile bearing unicomparmental knee arthroplasty)를 시행 받은 환자가 일주일 전 방바닥에 앉았다 일어나면서 파열음과 함께 운동 장애가 발생하여 내원하였다. 시행한 방사선 검사 이다. 가장 적절한 진단은?

- ① 감염
- ② 골용해
- ③ 치환물 해리
- ④ 삽입물 주위 골절
- ⑤ 폴리에틸렌 삽입물 탈구

Quiz 2

- 1년 전 좌측 슬관절에 대하여 가동형 단일구획치환술(mobile bearing unicomparmental knee arthroplasty)를 시행 받은 환자가 일주일 전 방바닥에 앉았다 일어나면서 파열음과 함께 운동 장애가 발생하여 내원하였다. 시행한 방사선 검사 이다. 가장 적절한 진단은?

- ① 감염
- ② 골용해
- ③ 치환물 해리
- ④ 삽입물 주위 골절
- ⑤ 폴리에틸렌 삽입물 탈구

Reference

- Campbell's operative orthopedics 14th edition p.401-416
- 대한정형외과학회 제8판 p.1015-1019
- 슬관절학 제 3판 chapter XIV-8

Arthrogenic Muscle Inhibition (AMI)

명지병원 정형외과
R3. 이준우

MYONGJI HOSPITAL
SPORTS MEDICAL CENTER

Introduction

- **Dr. Pierre Chambat's** interest in "flexion contracture" back in 1999
- Unexplained, inconsistent an extension deficit in patients
- Hypotonic vastus medialis oblique (VMO)
  → reflex contracture of hamstring muscles
- Extension deficit → walking abnormalities, proprioception, atrophy and chronic weakness of the quadriceps, stiffness, arthrofibrosis, early arthrosis
- Regain full extension contractions of the VMO through simple exercises

Introduction

- What is AMI?
- 손상 (외상 혹은 수술) 받은 관절 주변의 손상되지 않은 근골격계의 신경학적 억제
- 즉, 우리 몸의 방어 기제이다.
- 무릎 : 대퇴사두근, 발목 : 비골근

- AMI is observed in patients with OA, RA, anterior knee pain, patella contusion, following anterior cruciate ligament (ACL) rupture and reconstruction, after meniscal damage and menisectomy, and in patients who have undergone knee joint arthroplasty

Introduction

- AMI is most severe in the first few days after joint damage before reducing somewhat, plateauing in the medium term (up to 6 months), and then slowly declining in the longer term (18-33 months)

Mechanisms of Arthrogenic Muscle Inhibition

in Journal of Sport Rehabilitation

Click name to view affiliation

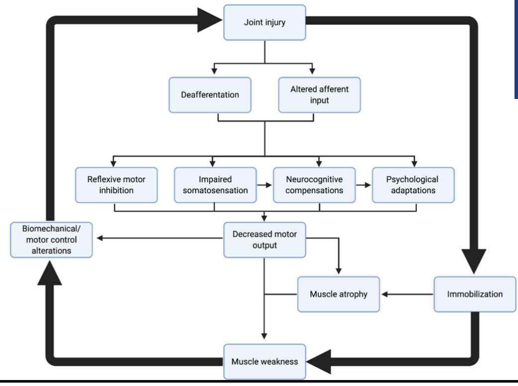
Adam S. Lepley and Lindsey K. Lepley

DOI: https://doi.org/10.1123/jsr.2020-0479

Keywords: muscle weakness; reflex inhibition; corticospinal excitability; somatosensation; motor control

First Published Online: 01 Sep 2021

In Print: Volume 31: Issue 6 **Page Range:** 707–716



Mechanism of AMI

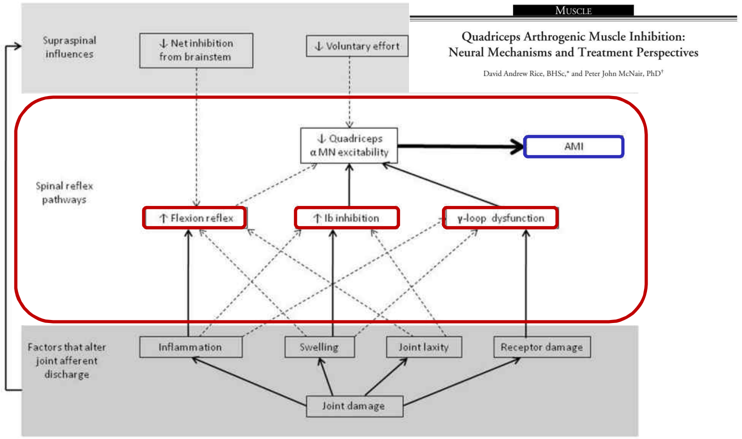
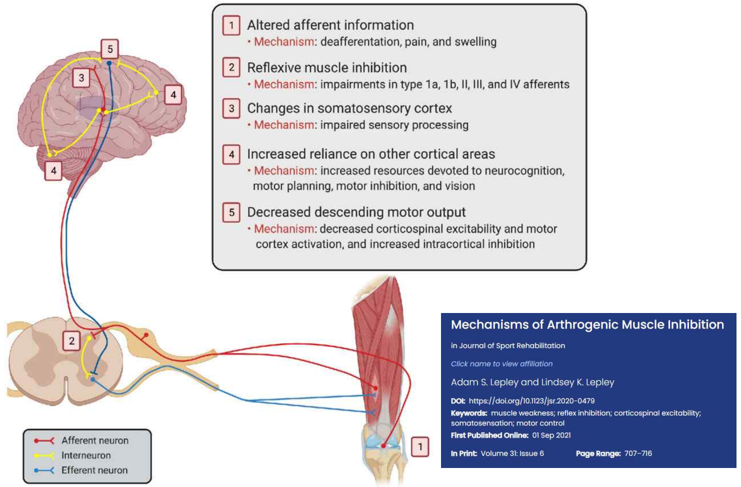


Figure 1 Schematic diagram summarizing the proposed mechanisms contributing to quadriceps arthrogenic muscle inhibition (AMI). Solid lines are mechanisms with stronger evidence to support their existence.

Mechanism of AMI

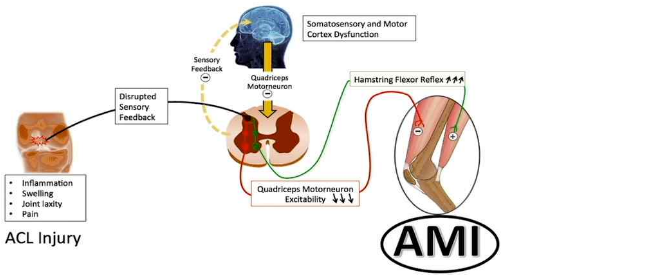


Mechanism of AMI

▣ ACL rupture → pain, laxity, hemarthrosis or something else → trigger the AMI

▣ 3 levels of interaction

- First at the local level: the affected joint
  → Activation of afferent pathways
  → Stimulating the frontal cortex at the origin of the quadriceps inhibition
  → Finally activation of the spinal reflex cause reflex contraction of the hamstrings

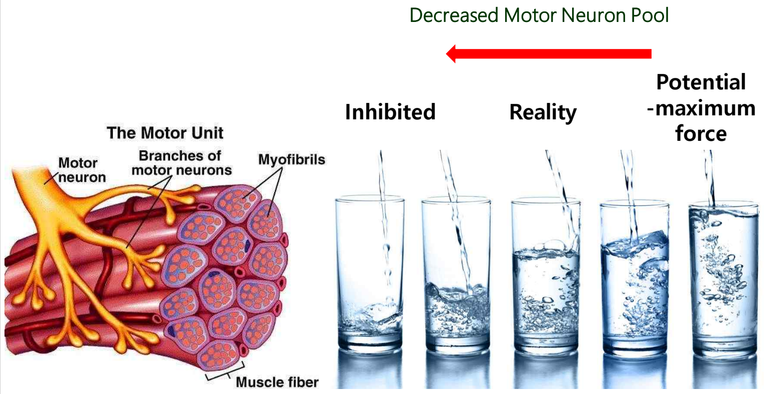


Mechanism of AMI

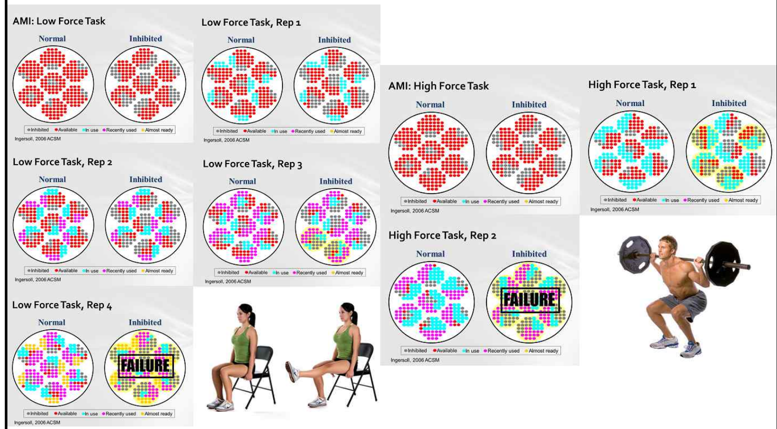
▣ Aspiration

- 1250460 이O훈 M/50
- OP : A/S MM partial meniscectomy + PFJ chondroplasty, knee, both.
- Chief complaint : Sudden Rt. knee pain with stiffness (extension deficit) on POD#1

Mechanism of AMI



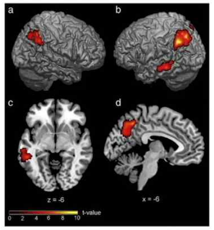
Mechanism of AMI



Functional brain MRI with AMI

▣ 2019.10 – 2022.5 / 28 patients with an ACL rupture in the 4 weeks

▣ A mean age of 24 years with right-handed patients with a recent rupture of ACL of the left knee



▣ Patients with and without motor inhibition

▣ Functional MRI of the three weeks after accident

▣ Significant difference in activation of motor regions in the motor inhibition population
→ The putamen, the superior motor area, and the Insula

Proportion of AMI in ACL rupture

▣ 2021.10 – 2022.2 / 300 patients with ACL rupture in the first six weeks

▣ 56% of patients with a recent ACL rupture had motor inhibition
(Grade 1 – 50% / Grade 2 – 50%)

▣ **80%** of patients were Grade 1 or 2 “**A**”, reducible with a few simple exercises in the consultation room

▣ Patients who had already undergone ipsi or contralateral ACL surgery were 40 times less likely to have AMI

Classification

■ **Classification of AMI**

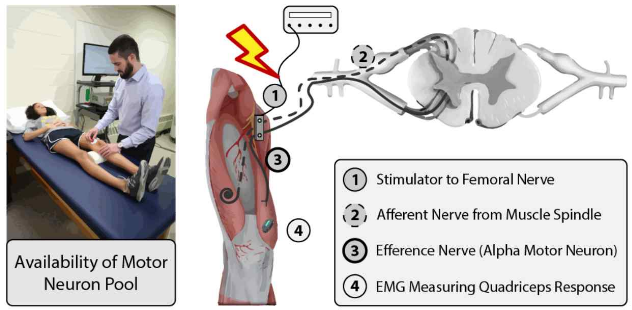
- **Grade 1(1A, 1B) :** motor inhibition of the VMO
- **Grade 2(2A, 2B) :** inhibition of the VMO associated with a reflex contracture of the hamstrings
- **Grade 3 :** Grade 2 for several months, retraction of the posterior capsule, the extension deficit becomes chronic and irreducible
  → extensive posterior arthrolysis is the only treatment

A : when we can remove this reflex mechanism during consultation by the exercises

B : when the removal of this reflex mechanism is not possible during consultation and specific and often long term management by trained physiotherapists is necessary

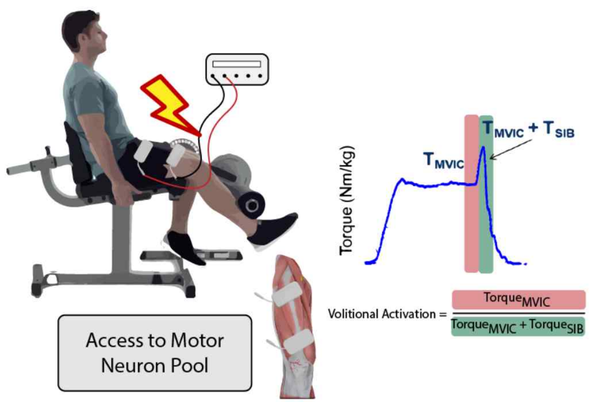
Diagnosis

■ Hoffmann Reflex to assess motor neuron pool availability



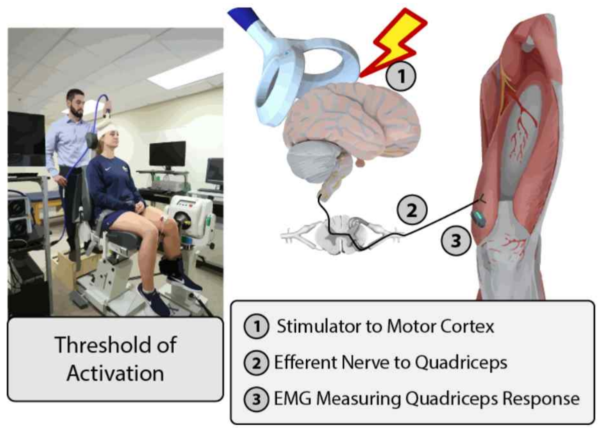
Diagnosis

■ Superimposed Burst Technique to assess volitional activation

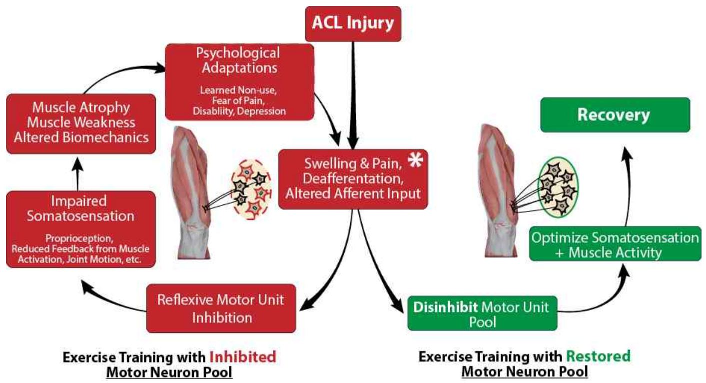


Diagnosis

■ Transcranial Magnetic Stimulation to assess cortical inhibition



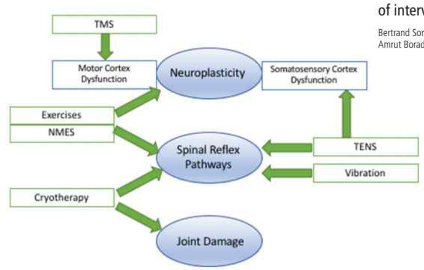
Management



First, Disinhibition

Management

Therapeutic Interventions- Level of Action



Arthrogenic muscle inhibition after ACL reconstruction: a scoping review of the efficacy of interventions

BJSM, 2019

Bertrand Sonnery-Cottet,[1] Adnan Saithna,[2,3] Benedicte Quelard,[4] Matt Daggett,[5] Amrut Borade,[1] Hervé Ouanezar,[1] Mathieu Thaunat,[1] William G Blakeney[1,6]

Figure 2 Therapeutic interventions for arthrogenic muscle inhibition and their level of action. NMES, neuromuscular electrical stimulation; TENS, transcutaneous electrical nerve stimulation; TMS, transcranial magnetic stimulation.

Table 3 GRADE table

	Risk of bias	Inconsistency	Indirectness	Imprecision	GRADE score
Cryotherapy	Negligible	Negligible	Serious*	Negligible	Moderate
Exercise	Serious†	Negligible	Negligible	Negligible	Moderate
NMES	Serious‡	Serious§	Negligible	Negligible	Low
TENS	Negligible	Serious§	Serious¶	Negligible	Low
Vibration	Negligible	Negligible	Serious**	Very serious††	Very low
Ultrasound	Negligible	Negligible‡‡	Serious§§	Very serious¶¶	Very low

Management

■ **Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure**

How to Rapidly Abolish Knee Extension Deficit After Injury or Surgery: A Practice-Changing Video Pearl From the Scientific Anterior Cruciate Ligament Network International (SANTI) Study Group

Jean-Romain Delaloye, M.D., Jozef Murar, M.D., Mauricio González Sánchez, M.D., Adnan Saithna, B.Med.Sci.(Hons), M.B.Ch.B., Dip.S.E.M., M.Sc., F.R.C.S.(Tr&Orth), Hervé Ouanezar, M.D., Mathieu Thaunat, M.D., Thais Dutra Vieira, M.D., and Bertrand Sonnery-Cottet, M.D.

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 1: Identification of Quadriceps Activation Failure and Hamstring Contracture**

Fig 1. Knee extension deficit evaluation of right knee (asterisk) with patient in supine position.

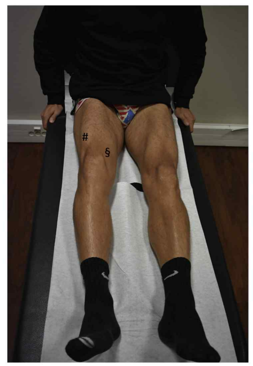


Fig 2. Right quadriceps inactivation with lack of vastus medialis contraction (section sign) and active knee extension deficit. The rectus femoris contraction (pound sign) is maintained with active hip flexion.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 2 : Hamstring fatiguing**

Fig 3. Hamstring fatigue. The patient is asked to repetitively contract against resistance (A) and relax the hamstrings (B). To help fully relax the hamstrings, the practitioner should gently support the foot on its way down to the examination table. A right knee is shown with the patient in the prone position.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 2 : Hamstring fatiguing**

Fig 4. Full knee extension (asterisk) recovery after hamstring fatigue. A right knee is shown with the patient in the prone position.

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 2 : Hamstring fatiguing**

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 3 : Reactivation of Quadriceps Muscle Contraction**

Fig 5. Passive muscle contraction of quadriceps. The patient is requested to do a heel lift (arrow) and straighten the knee. The practitioner can facilitate the movement by holding the great toe. A right knee is shown with the patient in the supine position.

Management

■ Technique to Abolish Knee Extension Deficit and Quadriceps Activation Failure

- **Step 3 : Reactivation of Quadriceps Muscle Contraction**

Fig 6. Active isometric muscle contraction of quadriceps. The patient is asked to contract the muscle without lifting the heel. To check the correct contraction of the muscle, the practitioner should palpate the patella to feel its proximal migration (arrow). A right knee is shown with the patient in the supine position.

Management

Arthrogenic muscle inhibition after ACL reconstruction: a scoping review of the efficacy of interventions BJSM, 2019

Bertrand Sonnery-Cottet,[1] Adnan Saithna,[2,3] Benedicte Quelard,[4] Matt Daggett,[5] Amrut Borade,[1] Hervé Ouanezar,[1] Mathieu Thaunat,[1] William G Blakeney[1,6]

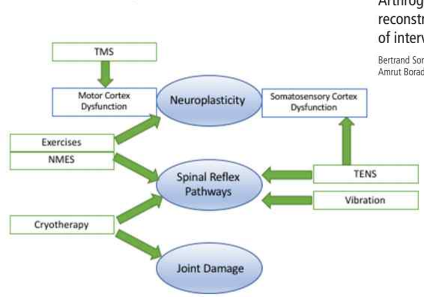


Figure 2 Therapeutic interventions for arthrogenic muscle inhibition and their level of action. NMES, neuromuscular electrical stimulation; TENS, transcutaneous electrical nerve stimulation; TMS, transcranial magnetic stimulation.

Table 3 GRADE table

	Risk of bias	Inconsistency	Indirectness	Imprecision	GRADE score
Cryotherapy	Negligible	Negligible	Serious*	Negligible	Moderate
Exercise	Serious†	Negligible	Negligible	Negligible	Moderate
NMES	Serious‡	Serious§	Negligible	Negligible	Low
TENS	Negligible	Serious§	Serious¶	Negligible	Low
Vibration	Negligible	Negligible	Serious**	Very serious††	Very low
Ultrasound	Negligible	Negligible‡‡	Serious§§	Very serious¶¶	Very low

Management

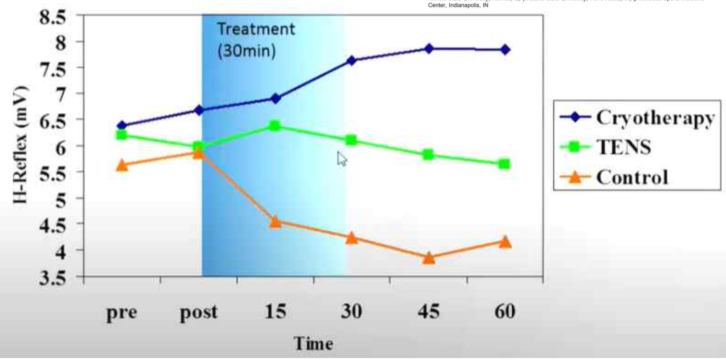
■ **Cryotherapy & TENS**

Journal of Athletic Training 2001;37(1):25–31
© by the National Athletic Trainers' Association, Inc
www.journalofathletictraining.org

Cryotherapy and Transcutaneous Electric Neuromuscular Stimulation Decrease Arthrogenic Muscle Inhibition of the Vastus Medialis After Knee Joint Effusion

J. Ty Hopkins*; Christopher D. Ingersoll†; Jeffrey Edwards†; Thomas E. Klootwyk‡

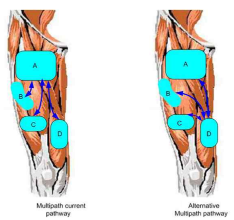
*Illinois State University, Normal, IL; †Indiana State University, Terre Haute, IN; ‡Methodist Sports Medicine Center, Indianapolis, IN



Management

■ **Isometric quadriceps setting exercise**

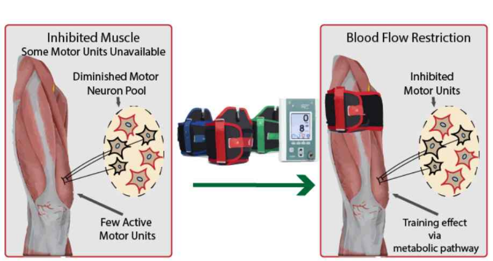
- Quadriceps strength deficits are frequent after knee surgery
- When gross quadriceps weakness, neuromuscular electric stimulation (NMES) is recommended



Management

■ **Blood Flow Restriction Training**

- Benefits with low load = High task



Blood Flow Restrict with Low Resistance Exercise

근육조직에서의 산소결핍

무산소성 대사과정으로 전환
= Type Ⅱ Muscle 동원

IGF-1 Ea
(인슐린유사성장인자 + 국소 성장 인자)

근세포-M-TOR효소 →신호경로 활성화

P70 ribosomal s6 kinase 1,
Ribosomal S6 인산화 증가

단백질 합성의 향상

Management

■ **Blood Flow Restriction Training**

Low-intensity resistance training with blood flow restriction exercise (LRT-BFR)
= **중-저강도**
(2~30% of 1RM)

=

High-intensity resistance training (HRT)
= **고강도**
(70% of 1RM)

Similar effect!!

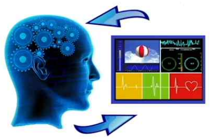
- **Neuromuscular adaptation**
- **Muscle strength**
- **Muscle mass**
- **Functional performance**

Hughes et al. BJSM. 2017
Pereira et al. Int J Phys Med Rehabil. 2019

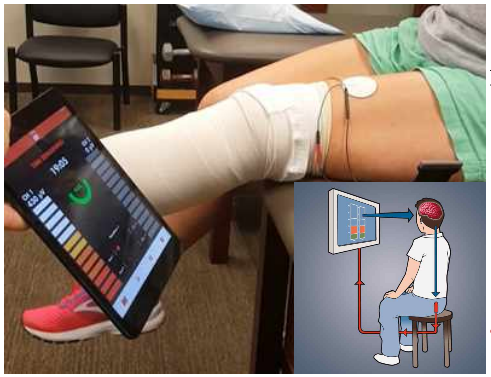
Management

■ The use of an **electrostimulation device with visual control** will allow central stimulation via the eyes

→ **"Biofeedback"** which is used in urology and is very effective for AMI



Management



Electromyography
→ Visuomotor feedback
→ Increase cortical motor excitability

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Conclusion

▣ Preoperative evaluation of AMI at Myongji hospital

- Classification of AMI

- **Grade 0 —** Normal VMO contraction
- **Grade 1 -** VMO contraction inhibited with no knee extension deficit
  - **1a -** Activation failure reversible within a few minutes of commencing simple active-assisted extension exercises
  - **1b -** Refractory to simple active-assisted extension exercises, requiring longer and specific rehabilitation programs
- **Grade 2 -** VMO contraction inhibited with associated knee extension deficit due to hamstring contracture
  - **2a -** Activation failure and loss of motion reversible within a few minutes of fatiguing the hamstrings and commencing simple active-assisted extension exercises
  - **2b -** Refractory to fatiguing of the hamstrings and/or simple active-assisted extension exercises therefore longer and specific rehabilitation programs required
- **Grade 3 -** Passive chronic extension deficit due to posterior capsular retraction
  - Extensive posterior arthrolysis mandatory with specific preoperative and postoperative rehabilitation programs

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

Conclusion

▣ Preoperative management of AMI at Myongji hospital

1. Exercise (Hamstring fatiguing & Quadriceps muscle contraction)
2. Cryotherapy
3. Transcutaneous electric neuromuscular stimulation (TENS)
4. Neuromuscular electric stimulation (NMES)
5. Blood flow restriction training
6. Biofeedback – 추후 개발하여 적용

	Phase 1 (0-3 wks)	Phase 2 (4-6 wks)	Phase 3 (extended)
ROM :			
0-120	O		
0-130		O	
Weight Bearing :			
Tolerable	O		
Modalities :			
Neuromuscular Electrical Stimulation	O	O	O
Blood Flow Restriction	O	O	O
Pain / Swelling Control (Cryotherapy)	O	O	O
Strengthening :			
Q-Set, SLR 4 way	O		
Short Arc Q-set	O		
Active Knee Extension (90-0)		O	
Knee extension machine (90-30)		O	O
Hamstring Curl	O	O	
Wall Sit, Mini Squat, toe raise	O		
Squat, Leg Press		O	O
Split Squat, Lunge		O	O
Single leg squat		O	O
Sidestepping with resistance band		O	O
Proprioception :			
Weight shifting, Single leg balance	O		
Cup walking, Tandem stance	O		
Balance board, Rocker, Roller board, Bosu		O	O
ball		O	O
Perturbation			O
Jump, Plyometric, Agility			

MYONGJI HOSPITAL SPORTS MEDICAL CENTER

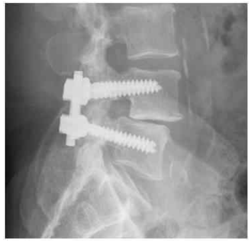
ROM	0-3 wk	4-6 wk	7-12 wk	
	0 - 90º	0 - 120º	0 -130º	Free
WB	0-3 wk	4-7 wk	8wk ~	
	Crutch / Brace (0º Lock) TWB	Brace FWB	Brace off	
M-Strength	0-3 wk	4-6 wk	7-9 wk	10-12 wk
	-Q-muscle Activation -SLR -Bilateral Squat (0-50º, Static)	-Bilateral Squat (Ecc&Con) -Leg extension (90º-45º) -Active Leg curl (No resistance) -Sagittal plane	[redacted]	
Proprioception	0-3 wk	4-6 wk	7-9 wk	10-12 wk
	weight shifting, Marching	Cup walking, Single Leg Standing Balance board	Single and Double Leg exercise on Balance board	Perturbation
Functional exercise	0-3 wk	4-6 wk	7-9 wk	10-12 wk
	Prepare of Normal Walking	Normal Walking	-Stair Sagittal, Frontal plane	-Bilateral Landing -Triplanar motion

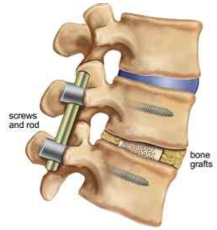
Pedicle screw

2022.06.29
R1 우창우

Introduction

- Used to add extra support and strength in spinal fusion
- Placed above and below the vertebrae that were fused





Cervical spine

- **Pedicle diameter**

-C2. C7 : 다른 부위보다 넓다

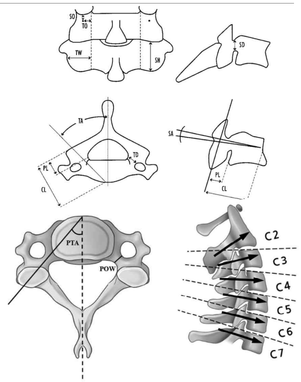
-C3, C4, C5: smaller screws (<4.5 mm) and more care in placement

- **Pedicle angle**

- medially at all levels, most medial angulation at C5, least at C2 and C7

- **Pedicle slop**

- upward at C2 & C3, parallel at C4 & C5, downward at C6 & C7

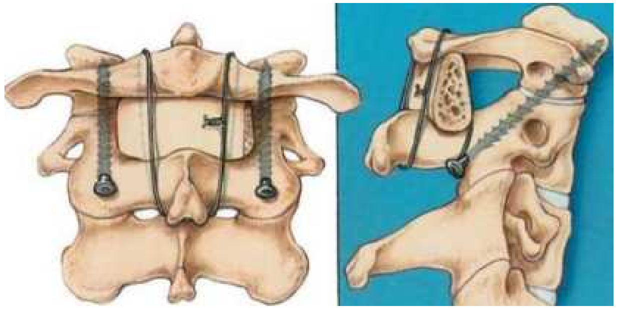


Cervical spine

- **C1 Lat. mass screw placement / C2 isthmic screw placement**

Cervical spine

◦ Posterior C1-C2 transarticuLar screws

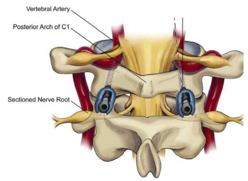


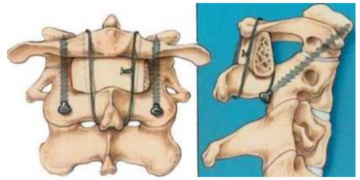
Cervical spine

- Caution
-Vertebral artery rupture

-하외측을 통과하게 되면 vertebral artery의 손상을 가져온다

-너무 높게 삽입되면 C2 nerve root injury



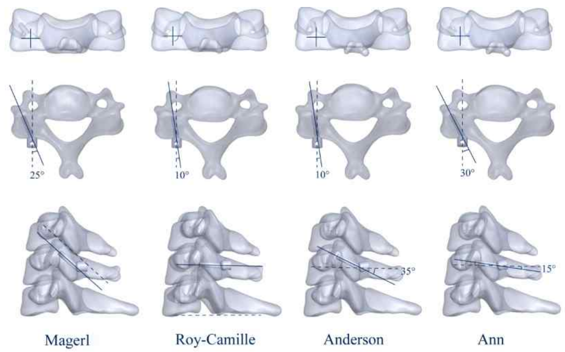


Cervical spine

- C3-C6 pedicle screw placement

Cervical spine

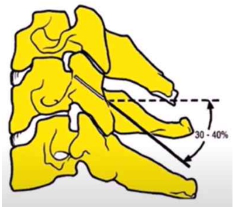
- C3-C6 Lateral mass screw placement

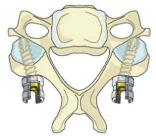


Cervical spine

- C3-C6 Lateral mass screw placement

- 외측 경사 부족할 경우 :vertebral artery injury
- 전방 경사 지나칠 경우 : nerve root injury
- 전방 경사 부족할 경우 : facet joint violation





T-L spine

- 1)Pedicle diameter

-Horizontal plane : L5에서 가장 넓고, T5에서 가장 좁다

-SagittaL plane : T11에서 가장 길고, T1에서 가장 짧다

- 2)Pedicle angle

(1)horizontal plane (convergence)

- L5 에서 약 25도로 가장 크고, T12만 divergence, T11 에서 parallel

(2)sagittaL plane : L5만 caudal , L3-T1 사이는 모두 cephalad

(3)lateral wall이 medial wall 보다 훨씬 thinner

- screw insertion시 생기는 pedicle fracture의 대부분은 lateral

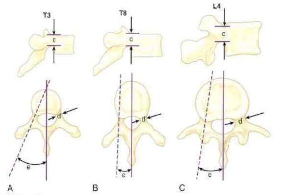


FIGURE 37.4 Pedicle dimensions of T3 **(A)**, T8 **(B)**, and L4 **(C)** vertebrae. Vertical diameter *(c)* increases from 0.7 to 1.5 cm, horizontal diameter *(d)* increases from 0.7 to 1.6 cm with minimum of 0.5 cm in T5. Direction is almost sagittal from T4 to L4. Angle *(e)* seldom extends beyond 10 degrees. More proximally, direction is more oblique: T1 = 36 degrees, T2 = 34 degrees, T3 = 23 degrees. L5 is oblique (30 degrees) but is large and easy to drill. (Redrawn from Roy-Camille R, Saillant G, Mazel CH: Plating of thoracic, thoracolumbar, and lumbar injuries with pedicle screw plates, *Orthop Clin North Am* 17:147, 1986.)

T-L spine

- T-L spine localization techique

Pedicle screw

- 3 techniques for open localization of the pedicle

(1) the intersection technique

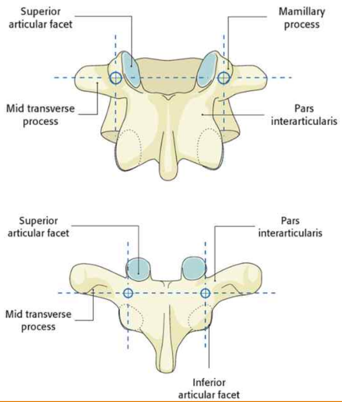
- Bisects the transverse process at a spot overlying the pedicle

(2) the pars interarticularis technique

- Laminae and the pars interarticularis provide landmarks

(3) the mammillary process technique.

- Mammillary process: small prominence of bone at the base of the transverse



INTERSECTION TECHNIQUE

- m/c used method of localizing the pedicle

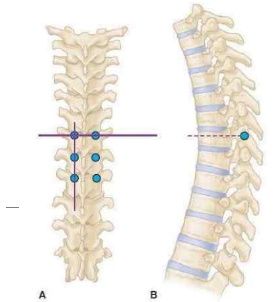
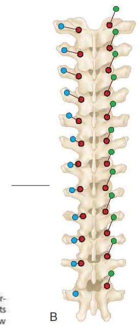
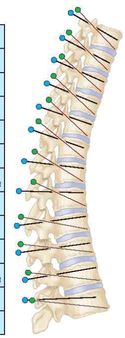


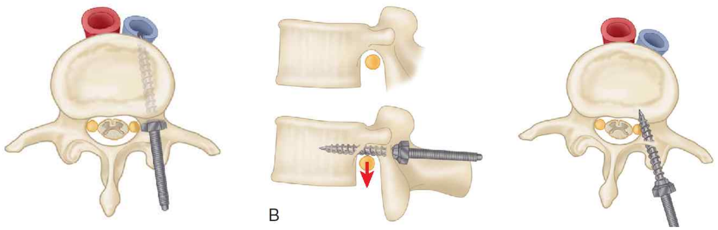
FIGURE 37-5 Pedicle entrance point in thoracic spine at intersection of lines drawn through middle of inferior articular facets and middle of insertion of transverse processes (1 mm below facet joint). **A**, Anteroposterior view. **B**, Lateral view. (Redrawn from Roy-Camille R, Saillant G, Mazel CH: Plating of thoracic, thoracolumbar, and lumbar injuries with pedicle screw plates, *Orthop Clin North Am* 17:147, 1986.)



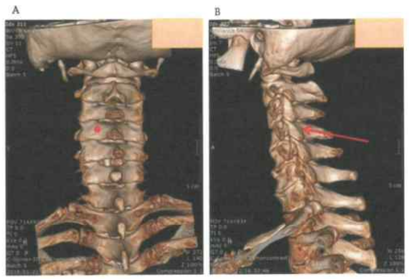
Level	Cephalad-Caudad Starting Point	Medial-Lateral Starting Point
T1	Midpoint TP	Junction: TP-Lamina
T2	Midpoint TP	Junction: TP-Lamina
T3	Midpoint TP	Junction: TP-Lamina
T4	Junction: Proximal Third-Midpoint TP	Junction: TP-Lamina
T5	Proximal Third TP	Junction: TP-Lamina
T6	Junction: Proximal Edge-Proximal Third TP	Junction: TP-Lamina-Facet
T7	Proximal TP	Midpoint Facet
T8	Proximal TP	Midpoint Facet
T9	Proximal TP	Midpoint Facet
T10	Junction: Proximal Edge-Proximal Third TP	Junction: TP-Lamina-Facet
T11	Proximal Third TP	Just medial to lateral pars
T12	Midpoint TP	At the level of lateral pars



T-L spine



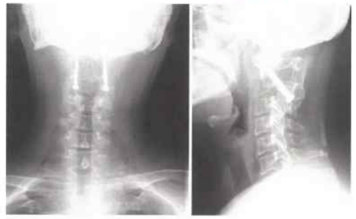
1. 외측괴 나사를 그림 A와 같이 붉은 색 지점에 삽입구를 잡고, divergence 없이 시상면에 평행한 방향으로 그림 B의 붉은 색 화살표와 같은 방향으로 삽입하였다. 손상 받았을 가능성이 가장 높은 구조물은? 18B/17B2/17I



㉮ 경추척수
㉯ 교감신경절
㉰ 제4경추신경근
㉱ 제5경추신경근
㉲ 척추동맥

답: 마

1. 사진과 같은 고정술 시 나사못이 제 2 경추 협부의 하외측을 통과하게 되면 (A)에 손상을 주고 지나치게 상방을 향할 경우 (B)에 손상을 줄 수 있다. 올바른 조합은? 16B/10B2



㉮ Cord - vertebral a.
㉯ C2 nerve - C1 nerve
㉰ C1 nerve - C2 nerve
㉱ Vertebral a. - C1 nerve
㉲ Vertebral a. - C2 nerve

답: 마

References

- Campell's Operative Orthopedics 13 th
- AO Surgical Reference
  (https://www2.aofoundation.org/wps/portal
  /surgery)

- Spine Surgery-Tricks of the Trade; 3 rd edition
  (Alexander R Vaccaro)

J Shoulder Elbow Surg (2022) 31, 1294–1299

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

A biomechanical study on the effect of long head of biceps tenotomy on supraspinatus load and humeral head position during shoulder abduction

Govender Shavana, MSc[a], Jessica Y. Cronjé, MSc[a], Chris Mcduling, PrEng[b], Reinder B. Verbeek, N3 Eng[c], Tshifhiwa Nkwenika, MSc Statistics[d], Erik Hohmann, PhD[e,f,*], Keough Natalie, PhD[a,g]

[a]*Department of Anatomy, University of Pretoria, Pretoria, South Africa*
[b]*Materials Science and Manufacturing, Council for Scientific and Industrial Research, Pretoria, South Africa*
[c]*CEO Elite Surgical Supplies, Pretoria, South Africa*
[d]*Biostatistics Unit, South Africa Medical Research Council, Pretoria, South Africa*
[e]*Medical School, University of Pretoria, Pretoria, South Africa*
[f]*Department of Orthopaedics Surgery and Sports Medicine, Burjeel Hospital for Advanced Surgery, Dubai, UAE*
[g]*Department of Anatomy and Cellular Biology, College of Medicine & Health Sciences, Khalifa University, Abu Dhabi, UAE*

Introduction

- Long head of biceps tendon (LHBT)
  - Stabilizer for the GH joint during abduction and assists other muscles in shoulder movements
    - Preserving the LHBT to maintain shoulder function and stability
      - Itoi et al.
    - No significant deficits in shoulder function after biceps tenotomy
      - Yamaguchi et al.
  - Initiaing abduction
    - Electromyographic(EMG) activity similar to the deltoid muscle during arm abduction
      - Chalmers et al.
    - LHBT contributes o internal rotation of the humerus at the neutral arm position (0 degrees of abduction) but restricts rotation at angle above 45 degrees of abduction
      - Eshuis et al.

Introduction

- Supraspinatus
  - Initiate arm abduction and controls abduction for the first 15 degrees
  - Beyond 15 degrees, it assists the deltoid muscle in further arm abduction up to 90 degrees
  - Shoulder joint stability
    - counteracting gravitational forces and maintaining contact between the head of the humerus and the glenoid fossa

Purpose

- To determine the effect of bicpes tendon tenotomy on the load of the supraspinatus tendon/muscle complex during abduction of the arm from 0 to 15 degrees.
- Hypothesis
  - Biceps tenotomy has no effect on supraspinatus load during initial abduction

Materials and Methods

- 11 fresh frozen human specimens of the upper extremity
  - 5 left / 6 right
  - Age range 44-88 years
  - Mean weight 2.96 ± 0.56 kg
  - Did not show any visible signs of the shoulder surgery or pathology of the long head biceps, the rotator cuff, or deltoid muscle

  - Excluded
    - Any visible signs of previous surgery
    - Macroscopic full thickness or partial thickness tear of the supraspinatus tendon

- Manual force-loading experiment on a single-wheeled pulley system to simulate the anatomical function of the supraspinatus muscle
- The force applied in a horizontal plane, following the direction of the supraspinatus muscle fibers, while the arm was abducted to 15 degrees.
- This procedure was repeated three times on each specimen
- Long head of biceps tendon (LHBT) was cut within the bicipital groove, and the test protocol was repeated.
- Biceps tenotomy is typically performed at the insertion of the tendon, but in this study, tenotomy at the bicipital groove was chosen to preserve the integrity of the shoulder capsule, which plays a role in shoulder stability.

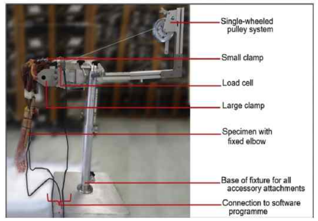


Figure 2 Image showing the equipment setup for each test with the load cell attached to the small clamp. Attached to the large clamp is a right specimen fixed at the elbow.

Result

Table I Descriptive statistics for condition 1 (LHBT intact) and condition 2 (LHBT cut)

Arm	Condition 1		Condition 2	
	Angle	Load	Angle	Load
001	14.85	58.60	14.85	58.67
002	13.94	62.70	13.95	53.44
003	15.35	84.90	15.35	94.51
004	17.85	61.27	17.85	54.00
005	16.75	30.84	16.63	21.78
006	16.00	38.14	16.04	27.18
007	11.44	7.02	11.50	7.38
008	15.18	25.43	15.13	36.60
009	18.10	44.94	18.10	40.60
010	15.08	45.32	15.04	24.98
011	15.09	43.62	15.03	36.14
Mean	15.42	45.71	15.40	41.37
SD	1.84	21.04	1.82	23.43
SE	0.55	6.34	0.55	7.06
95% CI	14.44-16.52	33.85-57.75	14.40-16.49	27.29-53.80

LHBT, long head of biceps tendon; *SD*, standard deviation; *SE*, standard error; *CI*, confidence interval.
Angle in degrees and Load in Newtons (N).

Result

- Neutral position
  - LHBT intact : 4.89 ° ± 1.84 °
  - Tenotomy : 4.90 ° ± 1.82 °

- Mean load
  - LHBT intact : 45.71 N ± 21.04 N
  - Tenotomy : 41.37 N ± 23.43 N

- Mean abduction angle
  - LHBT intact : 15.42 °
  - Tenotomy : 15.4 °

Result

- Humeral head displacement observed in the tenotomy group
  - Humeral head initially displaced inferiorly, and when abduction was initiated superior translation of the humeral head was observed

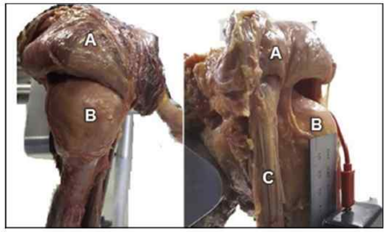


Figure 1 Image showing the humeral head displacement observed before and after the LHBT was cut. Left: Lateral view of a right humeral head in condition 1. Right: Anterior view of a left humeral head in condition 2. Inferior humeral head displacement: A—deltoid; B—humeral head; C—short head of the biceps brachii.

Discussion

- No significant differences between the mean load of abduction on the supraspinatus muscle during abduction when comparing the presence of the long head of biceps tendon (LHBT) to when the LHBT was tenotomized (cut)
- Both biceps tenotomy and tenodesis do not affect the function of the supraspinatus muscle during initial arm abduction
- Although there were no significant differences in abduction force between the two testing conditions, 73% of the sample showed a decrease in load on the supraspinatus muscle when the biceps tendon was tenotomized.
- This suggests that the LHBT has a stabilizing effect during early abduction, and tenotomy reduces the amount of load required by the supraspinatus muscle to initiate the same function.

Discussion

- No EMG activity in the biceps muscle during abduction movements
  - Yamaguchi et al.
  - Levy et al.
- EMG activity in the biceps during flexion and abduction, similar to the activity in the deltoid muscle
  - Chalmers et al.
  - Sakurai et al.

➢ Stabilizing force during abduction is likely related to passive resistance rather than biceps muscle activity

Limitation

- Small sample size in cadaveric laboratory studies
- The age range of the specimens and tissue quality may have resulted in selection and measurement bias.
- Biceps tenotomy was performed at the bicipital groove to maintain shoulder capsule integrity, but the intra-articular tendon stump could potentially have influenced the outcome measures.
- The degree of chondral and degenerative changes in the joint surfaces was not specifically assessed, which could have affected the measured loads.

Conclusion

- LHBT has no critical role with initial abduction of the arm
- LHBT does not appear to increase loads required for the supraspinatus muscle/tendon complex to perform the same action of abduction
- LHBT does however play a role in maintaining stability and orientation of the joint during abduction

2023 knee conference

Anterior Knee pain : chondromalacia & plica syndrome & patella tendinitis

명지병원 정형외과
23.07.10
R1. 김현진

Case review

송O섭 M/19 1230033

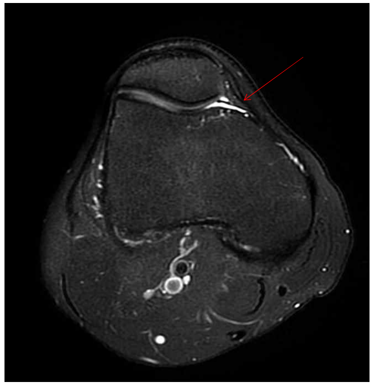
- Diagnosis : Plica syndrome, knee, Rt.
- Operation : A/S med. plica excision, patella decortication, knee, Rt.

송O섭 M/19 1230033

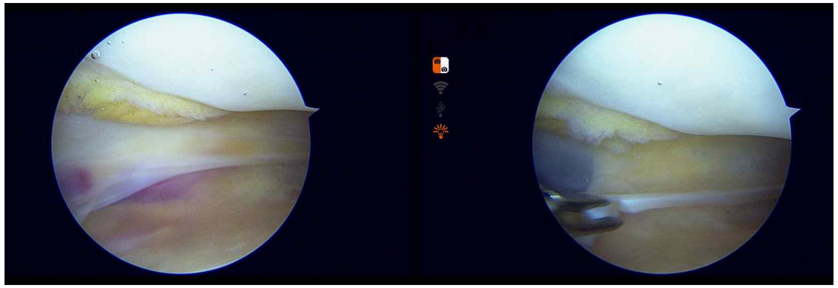
- Chief complaint
  - Rt. knee pain (Onset : 2년 6개월 전)
  - 축구하다 무릎 빠지는 소리 나며 수상 후 간헐적으로 지속되는 Rt. knee pain 을 주소로 외래 내원함.

MRI Finding

- Medial hypertrophied plica tear
- Diagnosis : Plica syndrome, knee, Rt.



Intra-op finding



Anterior knee pain

(1) : Chondromalacia patellae
(2) : Plica syndrome
(3) : Patella tendinitis

Anterior knee pain

- Anterior knee pain is one of the most common conditions to bring active young patients to a sports injury clinic.
- The causes of AKP can be traced not only to structures within and around the knee, but also to factors outside the knee, such as limb malalignment, weakness of specifc hip muscle groups, and core and ligamentous laxity.
- Female military tactical athletes showed an incidence rate of 16.7 per 1000 person-years compared with enlisted males' incidence rate of 12.7 per 1000 person-years across all AKP diagnoses

History-Taking

- The onset of pain is insidious, and the progression is gradual
- The most prominent symptom, the pain experienced by the patient, must be evaluated on the basis of its location site. This is very important for localizing the pathology
- Pain localized by the patient to the tibial tuberosity
  - Osgood-Schlatter disease
- Pain localized by the patient to the inferior pole of patella
  - Sinding-Larsen-Johansson disease

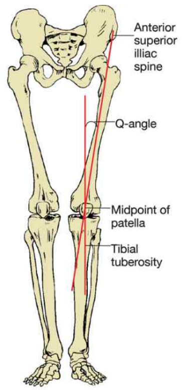
- Most patients, however, experience pain in one of two patterns
  - retro-patellar or peripatellar
- Pain usually occurs in response to activities that burden the patellofemoral joint, such as climbing up or down stairs, squatting, kneeling, and prolonged flexion of the knee joint.
- The so-called movie theater sign is observed when the patient experiences knee pain upon sitting with their knees flexed for a continuous period.
- The pain may improve on knee extension.

Clinical Examination

- The femoral anteversion can be estimated by the Craig's test performed with the patient prone with knees flexed to 90°
  - Normal : 8-15° in adults
  - Angle< 8°: Retroversion
  - Angle>15°: Increased anteversion leads to squinting patellae and pigeon-toed walking

Clinical Examination

- Q-angle (quadriceps angle) is the angle between the quadriceps tendon and the patellar tendon.
- It provides useful information about the knee joint's alignment.
- The Q-angle is formed in the frontal plane by two line segments
  - one drawn from the anterior superior iliac spine (ASIS) to the center of the patella
  - the other drawn from the center of the patella to the tibial tubercle
- Q-angle > 20° is a risk factor for patellar subluxation



Q-angle

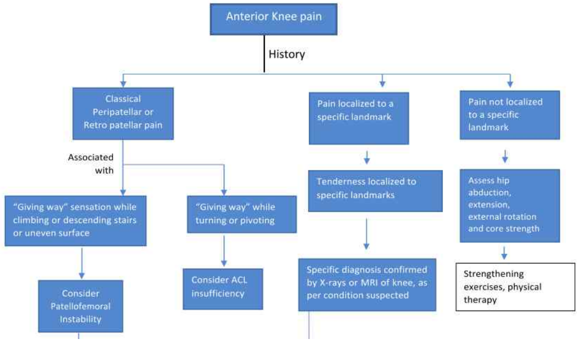
Clinical Examination

- Hofa's test is conducted to localize pain to the Hofa fat pad, by exerting pressure on the fat pad with the fngers while the patient is asked to actively contract their quadriceps

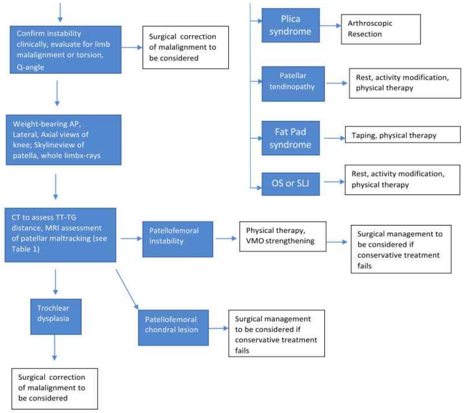
Clinical Examination

- Patellofemoral grind test is used to determine patellofemoral syndrome. To perform this test, have the patient lie supine with the knee extended. Place the web space of your thumb on the superior border of the patient's patella. Have the patient contract their quadriceps muscle while applying downward and inferior pressure on the patella.

Proposed algorithm for AKP



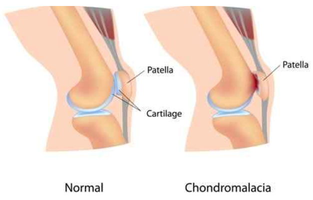
Proposed algorithm for AKP



Chondromalacia patellae

Definition

- Softening and fibrillation of articular cartilage of patella



- Superficial layer vs Deep layer
  Superficial layer : usually associated with OA
  Deep layer : Recover after period of time

- Iatrogenic Vs Secondary

  Iatrogenic : 일과성,
  관절 연골에 포진(blister)이 심층으로부터 발생하여 터지며 균열 생성
  → 심할 경우 Crabmeat appearance
  Secondary : 외상 등으로 인함
  연골 표면에 Fibrillation → OA로 진행

Symptom

- Younger Age
- Female > Male
- 슬관절의 무력감, 운동 후 동통
- 계단 오르내리기 어려움
- Flexion 상태에서 오래 앉아 있으면 통증(Cinema sign)
- Extension 시 통증이 사라짐
- Flexion 상태에서 compression 시 통증 호소

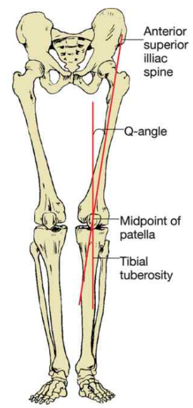
Physical Examination

- Patellar Grind Test (Clarke's test)

1. Patient is positioned in supine or long sitting with the involved knee extended.
2. The examiner places the his hand just superior to the patella while applying pressure.
3. The patient is instructed to gently and gradually contract the quadriceps muscle.
4. A positive sign on this test is pain in the patellofemoral joint.

Diagnosis

- Clinical Symptom & PEx.
- Simple x-ray
  OA, level of patella, Q-angle > 20 : more likely hood
- MRI
- Arthroscopy

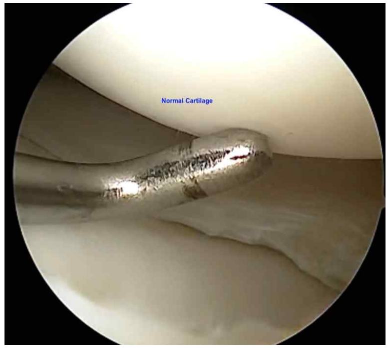


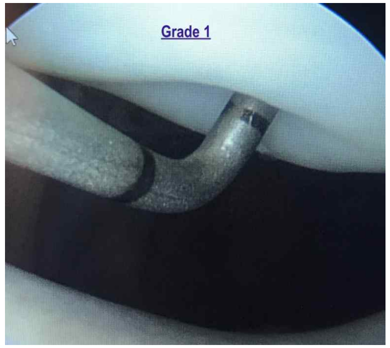
Q-angle

Arthroscopic grading

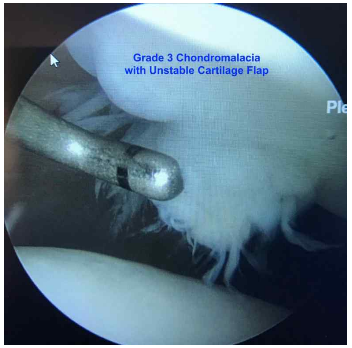
Arthroscopic grade	Finding
Grade 1	local softening with no break in surface
Grade 2	fibrillation or fissured
Grade 3	fissuring to bone, crab meat appearance
Grade 4	bone exposed / full thickness chondral defect

Arthroscopic grading

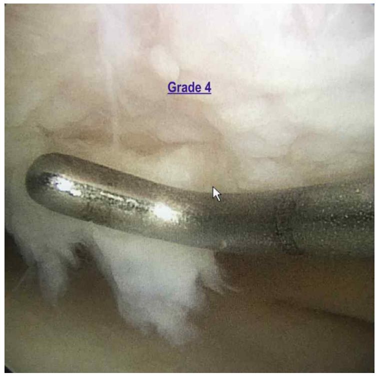




Arthroscopic grading



Arthroscopic grading



Treatment

- Conservative Tx.
  - Early stage : Rest, Hot pack, Immobilizer
  - Avoid pain triggering positions : sitting with knee flexed, using stairs
  - Exercise on strengthening hamstring, quadriceps and gastrocnemius
  - Pain control medication

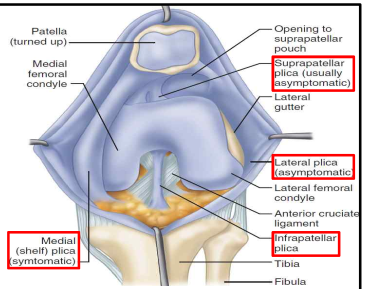
- Surgical Tx.
  - Chondrectomy, Drilling, Maquet procedure
  - Correction of patella lateral subluxation

Plica syndrome

Introduction

- During fetal development, the knee is separated into 3 compartments by synovial membranes
- **At 4-5 months, the partitions resolve to form a single cavity** → **Incomplete or partial resorption** results in incomplete synovial shelves or plicae

Anatomy & Incidence



- Commonly described as suprapatellar, mediopatellar, infrapatellar, and lateral

- Medial patellar plicae have been reported in 5-70% of individuals
- Suprapatellar plicae in approximately 17%
- Infrapatellar plicae usually are reported to be the most common

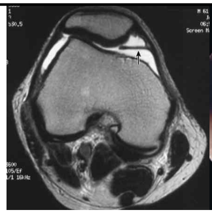
Causes

- Any condition that produces chronic irritation, trauma, or scarring may result in thickening of the plicae
- Poorly placed medial arthrotomy incisions : Damage the medial plica sufficiently to cause scarring and subsequent symptoms
- Bumping the flexed knee on a hard object : Traumatize a plica and inflame and thicken it sufficiently to cause symptoms

Physical Examinations

- With the patient seated on the edge of the examining table and the leg dangling
- Palpation along the medial side of the patella as the patient flexes and extends the knee
- Often localizes the abnormal plica as it flips over the MFC and may produce a momentary "stuttering" of the patella

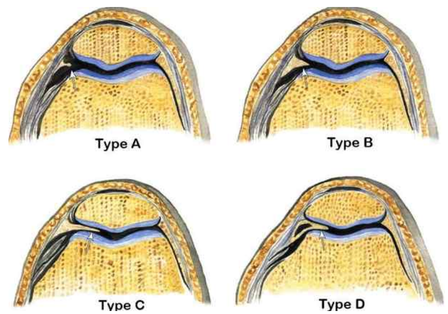
Diagnosis



- MRI
  - Low signal intensity on both T1- and T2-weighted images
- Dynamic ultrasonography
  - Accuracy of 88%, sensitivity of 90%, and specificity of 83%
  - However, this technique is highly operator dependent
- Diagnosed best by A/S examination
  - Careful assessment of the width and texture of the plica by viewing and probing is important

Sakakibara & Watanabe Classification

- Type A : Cord-like elevation in the medial wall
- Type B : Shelf-like appearance, but it does not arthroscopically cover the anterior surface of the medial condyle
- Type C : Large shelf-like appearance that covers the anterior surface of the MFC
- Type D : Special variation in which double insertions in the medial wall are seen



Treatment - conservative

- Restriction of activities
- Use of anti-inflammatory agents
- Intra-articular corticosteroid injection
- Institution of an isometric exercise program for the quadriceps muscles

- Often result in sufficient reduction of edema and synovitis → The plica assumes a more normal resiliency and therefore does not produce symptoms

Treatment - Surgical excision

- If a plica has become fibrotic and hyalinized and conservative measures fail to relieve a patient's symptoms

- Usually is done by A/S techniques, although a limited excision can be performed through a medial parapatellar incision

- Simply incising or sectioning the plica is not recommended because of the possibility that the continuity of the plica will be restored by scar tissue

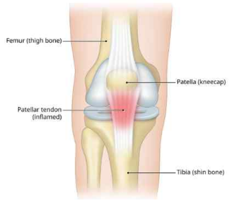
Patella tendinitis

Introduction

- Jumper's knee

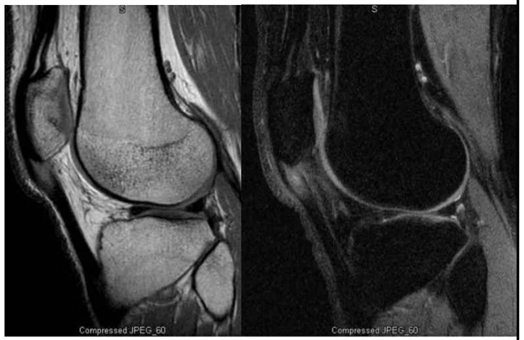
- Most common in elite athletes in jumping sports

- Physical examination usually reveals tenderness at the inferior pole of the patella



IMAGING

- Radiographs
  - Usually normal finding
- MRI
  - Increased signal intensity on both T1 and T2 images



Blazina classification

- Phase I
  - pain only after activity
- Phase II
  - pain during and after activity but no significant functional impairment
- Phase III
  - pain during and after activities with progressive difficulty in satisfactory performance
- Phase IV
  - End-stage disease with stress fracture through the patella or disruption of the extensor mechanism

Treatment

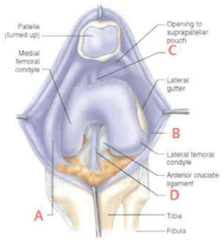
- Conservative treatment
  - Patients with symptoms of phase 1 or 2
  - Activity modification, rest, and anti-inflammatory medication.
  - Cortisone injections should not be used because they may increase the risk of tendon rupture.

Treatment

- Surgical treatment
  - Blazina Stage III disease
  - Chronic pain and dysfunction not amendable to conservative treatment
  - Partial tears
  - Resect angiofibroblastic and mucoid degenerative area
  - Follow with bone abrasion at tendon insertion and suture repair/anchors as needed

문제

1. 슬관절에서 가장 흔한 plica와 가장 증상을 유발하는 plica의 기호의 조합으로 옳은 것은? 11B

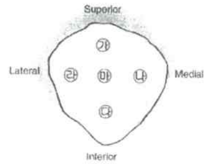


㉮ C - B
㉯ B - C
㉰ D - A
㉱ A - D
㉲ B - D

정답: 다

문제

1. 슬개골 연골 연화증이 가장 호발하는 슬개골 관절면의 부위는? 08I



정답 : 나

Middle medial facet에 호발

Pediatric cervical spine

명지병원 정형외과
R1. 김현진

Pediatric cervical spine

1. Anomalies of the odontoid
2. Atlantoaxial rotatory subluxation
3. Basilar impression

1. Anomalies of the odontoid

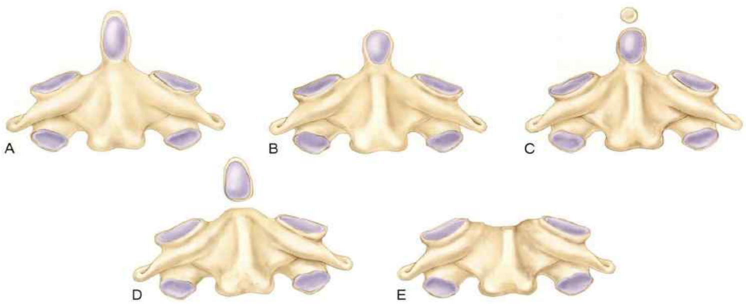
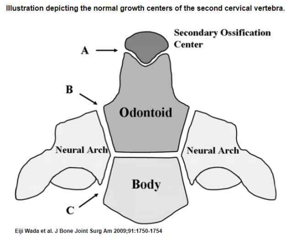


FIGURE 43-1 Types of odontoid anomalies. A, Normal odontoid. B, Hypoplastic odontoid. C, Ossiculum terminale. D, Os odontoideum. E, Aplasia of odontoid.

Three types of anomalies of odontoid

- Aplasia or agenesis : Complete absence of the odontoid
- Hypoplasia : Partial development of the odontoid
- Os odontoideum
  - Odontoid is an oval or round ossicle with a smooth, sclerotic border
  - Separated from the axis by a transverse gap, leaving the apical segment without support
  - Frequently asymptomatic and remains undiscovered until it is brought to the physician's attention by trauma or the onset of symptoms
    - The exact incidence of os odontoideum is unknown, but it is probably more common than appreciated
- Associated syndromes : Down syndrome, Klippel-Feil syndrome, Morquio syndrome, and spondyloepiphyseal dysplasia

- Ossiculum terminale : secondary ossification center
  - Appears at age 3 and fuses by age 12



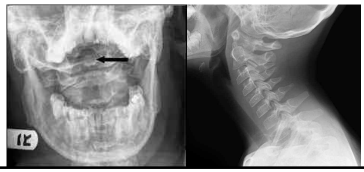
Causes of anomalies of odontoid

- Trauma - up to 50% of patients.
- A congenital etiology : Down syndrome, Klippel-Feil malformation, multiple epiphyseal dysplasia, and other skeletal dysplasias

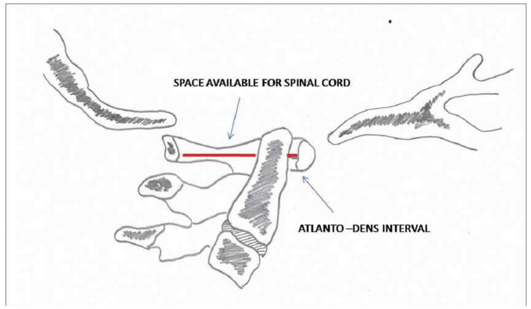
- Os odontoideum : Infection or trauma or osteonecrosis

- Diagnosis
  - Signs & symptoms : variable
    - Neck pain, torticollis, or headache
    - Neurologic symptoms vary from transient episodes of paresis after trauma to complete myelopathy caused by cord compression
    - Vertebral a. compression : seizure, syncope, vertigo, visual disturbance 유발

  - Radiographic findings
    - C-spine x-rays : lat & open-mouth odontoid view
    - CT scans, MRI
    - Lateral flexion & extension radiographs



- Diagnosis
  - Radiographic findings
    1) Space available for spinal cord (SAC) ≤ 13mm → instability
    2) Atlantodental instability (ADI) ≥ 3mm (성인), 4-5mm (소아) → instability



- Treatment
  - Conservative treatment (cervical traction or immobilization)
  - Operative stabilization (for os odontoideum)
    1) Neurological involvement (even transient)
    2) Instability of > 5mm posteriorly or anteriorly
    3) Progressive instability
    4) Persistent neck complaints
  - Pre-op skull traction (for 1-2 weeks) → if neurological deficit (+)
    1) For reduction
    2) For recovery of neurological Fx.
    3) For decreased spinal cord irritation

- Operative treatment : Atlantoaxial fusion
  - Gallie
  - Brooks and Jenkins
  - Harms and Melcher
  - Megerl and Seeman

- Gallie techinique
  - Advantage: One wire passed beneath lamina of C1
  - Disadvantage: Wire may cause unstable C1 vertebra to displace posteriorly and fuse in dislocated position
  - need for postoperative halo immobilization

FIGURE 43.6 Posterior translation of atlas after C1-2 posterior Gallie fusion.

- Brooks and Jenkins
  - Advantage: Greater resistance to rotational movement, lateral bending, and extension.
  - Disadvantage: Requires sublaminar wires at C1 and C2.

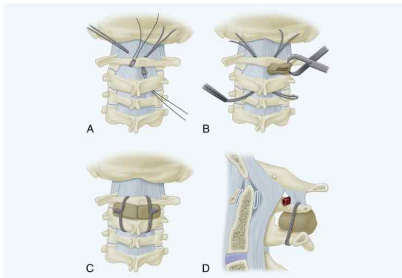


FIGURE 43.8 Brooks-Jenkins technique of atlantoaxial fusion. A, Insertion of wires und…

Brooks–Jenkins technique of atlantoaxial fusion. A, Insertion of wires under atlas and axis. B, Wires in place with graft being inserted. C and D, Bone grafts secured by wires

2. Atlanto-axial rotatory subluxation

- m/c cause of children torticollis
  - Subluxation & torticollis are usually temporary
- Cause
  - Inflammation/trauma → alar & transverse ligament & capsular structure의 laxity ↑
  - Upper respiratory tract infection related
  - Trauma-related

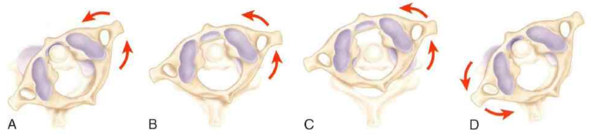
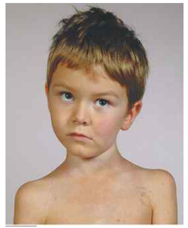
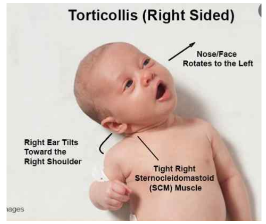


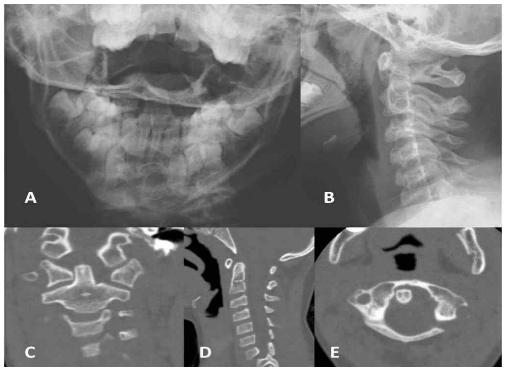
FIGURE 43-38 Fielding and Hawkins classification of rotatory displacement. A, Type I, simple rotatory displacement without anterior shift; odontoid acts as pivot. B, Type II, rotatory displacement with anterior displacement of 3 to 5 mm; lateral articular process acts as pivot. C, Type III, rotatory displacement with anterior displacement of more than 5 mm. D, Type IV, rotatory displacement with posterior displacement.

AARF	Muscular torticollis
Not caused by primary overactivity of SCM, by pathologic stickiness within C1-C2 joint	No pathology in C1-C2 joint
SCM spasm on side of chin 이차성, reflexive (attempt to correct deformity)	SCM spasm on opposite side of chin





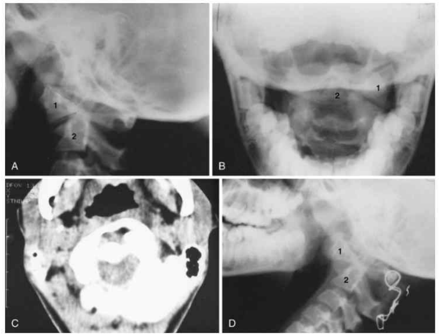
- Radiographic findings
  - Open-mouth odontoid view
  - Lateral view
  - CT & 3D



- Treatment : According to symptom duration
  - Symptom < 1 week
    → Soft collar & Analgesics & Bed rest for 1 week
    → If no spontaneous reduction : hospitalization + halo reduction
  - Symptom : 1 week ~ 1 month
    → Hospitalization & Cervical collar & head-halter for 4-6 weeks
  - Symptom > 1 month
    → Hospitalization & Cervical collar & halo traction for 4-6 weeks

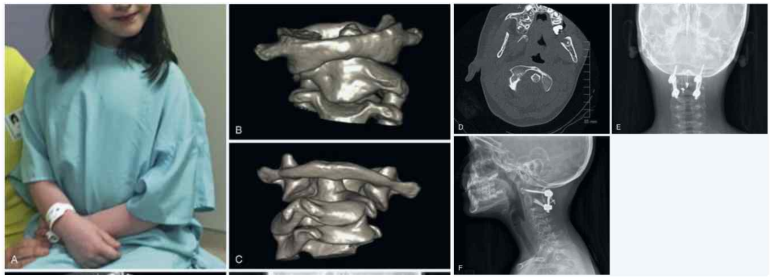
- Indication for Operative treatment
- C1-2 Posterior fusion (Fielding)
  - Neurologic involvement
  - Anterior displacement
  - Failure to achieve and maintain correction of deformity that exists longer than 3 months
  - Recurrence of deformity after an adequate trial of conservative management consisting of at least 6 weeks of immobilization

- C1-C2 posterior Fusion
  - Preoperative traction for 2-3 weeks
  - Halo immobilization is continued for 6 weeks postoperatively



Atlantoaxial rotatory fixation. A, Lateral radiograph shows wedge-shaped mass anterior to odontoid. B, Open-mouth odontoid view. C, CT scan. D, After C1-2 in situ fusion.

- C1-C2 fusion with Harms technique
  - Avoid use of a halo immobilization



A, Child with rotary subluxation of C1 on C2. Note the direction of head tilt and rotation of the neck. B and C, CT posteroanterior and anteroposterior reconstructions documenting rotary subluxation. D, CT showing subluxation. E and F, After posterior C1-C2 fusion.

3. Basilar impression

- Indention of the skull floor by the upper cervical spine
- The tip of the odontoid is more cephalad than normal

- Primary (congenital structural abnormality)
  - Klippel-Feil syndrome
  - Arnold-Chiari malformation
  - Syringomyelia
  - Hypoplasia of the atals
  - Bifid posterior arch of the atlas

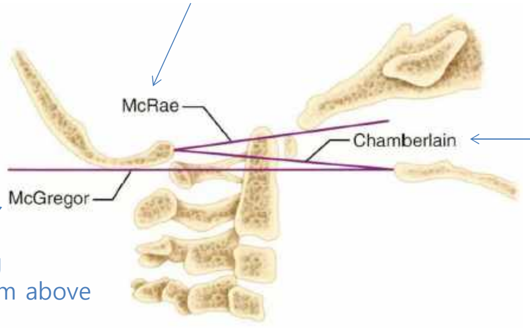
- Secondary (acquired deformity of skull)
  → softening of osseous structures of base of skull
  - Paget disease
  - Osteomalacia/Rickets
  - Osteogenesis imperfecta (mainly type 3, 4)
  - Rheumatoid arthritis
  - Neurofibromatosis
  - Ankylosing spondylitis

- Mechanism
  - Odontoid protrude into the foramen magnum
  - Vertebral a. compromise
  - CSF flow impairment

- Symptoms/Signs
  - Short necks, asymmetry, torticollis – not specific
  - Pure basilar impression : primarily motor & sensory disturbance
  - Lower cranial n. (trigeminal, vagus, glossopharyngeal, hypoglossal n.)
  - Sexual disturbance
  - Vertebral a. insufficiency : dizziness, seizure, mental deterioration, syncope

- Radiographic findings

Clinical significance (significant한 Sx. 생기기 시작)

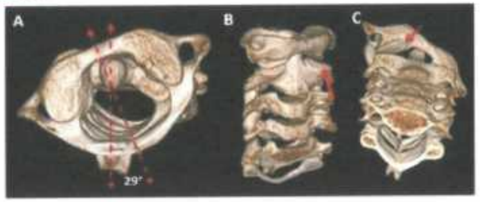


Symptoms occur

Routine screening
Abnormal – 4.5mm above

- Treatment
  - Conservative treatment : no neurological symptoms
  - Surgical treatment
    1) Symptoms caused by anterior impingement from the odontoid
       → Stabilization in extension by an occipital C1-2 fusion
    2) Symptoms & Impingement persist
       → Anterior excision of the odontoid after posterior stabilization
    3) Posterior impingement
       → Suboccipital craniectomy & laminectomy of C1 and possibly C2
       (to decompress the brainstem and spinal cord)
       → Posterior fusion is recommended in addition (for stability)

1. 내원 3주 전부터 경추부 통증과 사경을 호소하는 5세 남아가 사진과 같은 영상 소견을 보일 때 가장 적절한 치료는? 21B2/18B2/16I



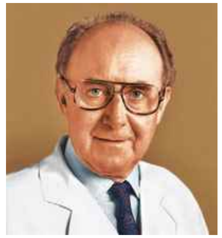
㉮ 연성 보조기 착용 및 진통제 투여
㉯ 1주간 침상안정 및 연성 보조기 착용
㉰ 홀터 견인 및 정복 후 연성 보조기 4-6주 착용
㉱ 골견인으로 정복 후 연성 보조기 4-6주 착용
㉲ 관혈적 정복술 및 고정술

Total Knee Arthroplasty
- Biomechanics -

명지병원 정형외과
23.09.04
R1. 정승호

Campbell's operative orthopedics, 14th

History of Arhtoplasty



- Hip arthroplasty
  - 1st developed arthroplasty
  - Anatomical reconstruction
  - **John Charnley**
- **Knee arthroplasty**
  - Fusion as alternative - developed lately
  - **Gunston from Canada and Insall from New York**
  - 1st modern prosthesis
- Ankle, shoulder arthroplasty

History of Arthroplasty

- **Knee arthroplasty**
  - **Imitating** the knee
  - Hinge models – failure
  - Studies progressed of knee biomechanics
- Anatomical reconstruction of knee joint
  - Progressive

Biomechanics

- Knee motion during normal gait is **complex** than simple flexion
- Knee motion during gait : "**triaxial motion**"
  → flexion & extension,
  abduction & adduction,
  rotation around the long axis of the limb

FIGURE 7-12 Motion in knee occurs in three separate planes during course of normal gait cycle and is referred to as "triaxial motion."

Biomechanics

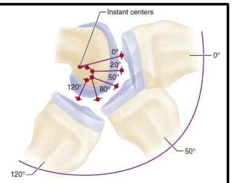
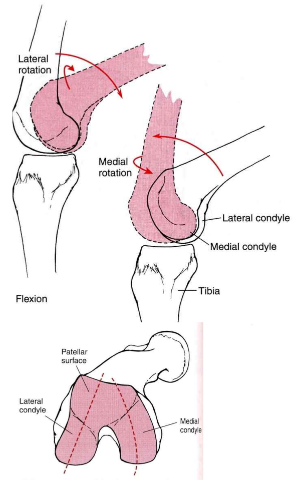
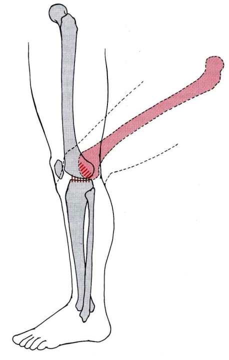


FIGURE 7-13 Transverse axis of flexion and extension of knee constantly changes and describes J-shaped curve around femoral condyles.

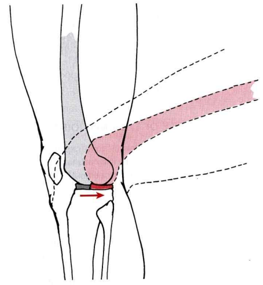
- Knee flexion
  - occurs around a **varying transverse axis**
  - function of the **articular geometry** of the knee and the **ligamentous restraints**
  - Dennis et al.
    → average 5 mm of medial condylar translation and 17 mm of lateral condylar posterior translation

- **Screw-home mechanism**
  - Medially based pivoting → ER of tibia during **extension**, IR of the tibia during **flexion**





Rolling



Gliding

Biomechanics

- Many current prosthesis designs attempt to **reproduce normal knee** kinematics closely

- Use of gait laboratories, biomechanical models, and fluoroscopic analyses
  → important tool in prosthesis design and functional evaluation of TKA patients

- **Normal gait** required
  - **67 degrees** of flexion during the swing phase,
  - **83 degrees** for stair climbing,
  - **90 degrees** for descending stairs

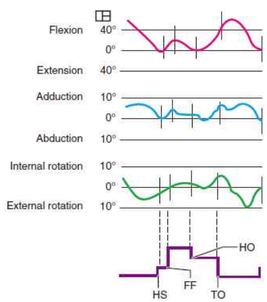
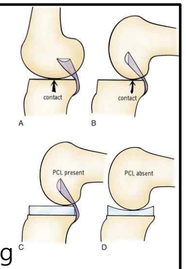


FIGURE 7-14 Triaxial motion of normal knee during walking, as measured by electrogoniometer. Flexion and extension are about 70 degrees during swing phase and 20 degrees during stance phase. About 10 degrees of abduction and adduction and 10 to 15 degrees of internal and external rotation occur during each gait cycle. *FF*, Flatfoot; *HO*, heel-off; *HS*, heel-strike; *TO*, toe-off.

Biomechanics

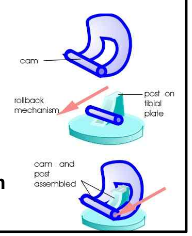


ROLE OF THE POSTERIOR CRUCIATE LIGAMENT IN TOTAL KNEE ARTHROPLASTY

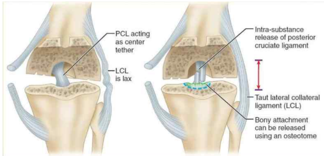
- Concurrent development of PCL-retaining and PCL-substituting prostheses → relative merits of each design have been **debated**

- **PCL retaining**
  → increased potential ROM by effective **femoral rollback**

- **PCL substitution**
  → achieves femoral rollback by a tibial **post** and femoral **cam mechanism**



Biomechanics



- When PCL is retained
  - needs to be **partially released or recessed** to allow adequate flexion esp. in the varus deformed knee
    (since it is a **more medial anatomical structure** and may be involved in the **coronal plane deformity**)

- PCL-substituting designs
  - resultant **stress borne** by the prosthetic construct and transferred to the **bone-cement interface**
  - recent study from the Mayo Clinic
    - compared 5389 cruciate-retaining TKAs to 2728 posterior stabilized TKAs and found **15-year survivorships of 90% and 77%**, respectively, a statistically significant difference.
    - support the theory that **higher transfer of stress to the implant** interface of some **posterior-stabilized designs** may decrease their longevity

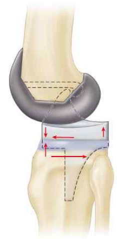
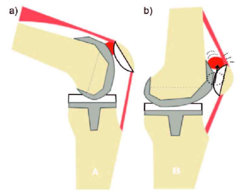


FIGURE 7-15 One argument against posterior cruciate ligament substitution is that added prosthetic constraint may ultimately transfer more stress to prosthesis-bone interface.

Biomechanics

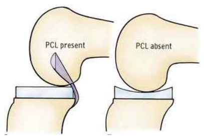
- **PCL retaining prosthesis**
  - Better ROM
  - More symmetrical gait
  - Less femoral bone resection required
  - PCL needs to be accurately balanced



- **PCL substituting prosthesis**
  - Easier surgical exposure
  - Posterior tibial component displacement
  - Lower tibial polyethylene contact stress
  - Patella clunk syndrome
    (fibrous nodule of scar tissue at the posterior surface of the distal quadriceps tendon/superior patellar pole catching on the box of the femoral component during knee extension)

Biomechanics

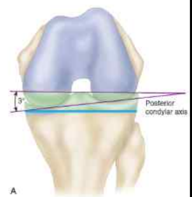
- **Polyethylene wear** is affected by <u>prosthesis design</u> and by its in <u>vivo kinematics</u>



- **PCL-retaining** prostheses → typically **less conforming** to the femoral component in the sagittal plane to allow <u>femoral rollback</u>
- Less-conforming geometry → **higher tibial polyethylene contact stresses** → accelerated polyethylene wear
- Can be compounded by **tight PCL** → **increase the contact stress in flexion** → femoral condyles to override the posterior edge of the tibial polyethylene → accelerated posterior wear

- **Tibial post** on many **PCL-substituting** designs has been shown to be a <u>site of wear</u> and occasional <u>breakage</u>
  1) femoral component is implanted in a flexed position,
  2) when the tibial component is implanted with a greater posterior slope,
  3) when the knee hyperextends

Biomechanics



- Rotation alignment of the femoral component
  - **Rotation** of the **femoral** component effects
    balancing of the flexion space and **patellofemoral tracking**

  - Proximal **tibial** cut is made <u>perpendicular</u> to the mechanical axis of the limb instead of in the anatomically correct **3 degrees of varus**
  - Rotation of the **femoral** component also must be altered from its anatomic position to create a <u>symmetric flexion space</u>
  - To create this **rectangular flexion space**, with **equal tension** on the medial and lateral collateral ligaments, the <u>femoral component is externally rotated</u> an **average of 3 degrees** relative to the posterior condylar axis

Biomechanics

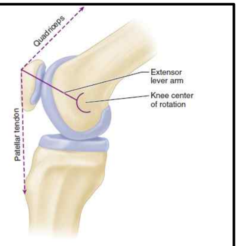


FIGURE 7-21 Patella acts to lengthen extensor lever arm by displacing force vectors of quadriceps and patellar tendons away from center of rotation (COR) of knee. Length of extensor lever arm changes with varying amounts of knee flexion.

PATELLOFEMORAL JOINT BIOMECHANICS AND FUNCTIONAL ANATOMY

- Primary function of the **patella**
  → increase **lever arm** of **extensor mechanism** around the knee
  → improving the <u>efficiency</u> of quadriceps contraction

- Patella acts to **lengthen extensor lever** arm by **displacing force vectors of quadriceps and patellar tendons** away from **center of rotation (COR)** of knee.
- This displacement or lengthening of the <u>extensor lever arm</u> **changes** throughout the **arc of knee motion**
- The extensor lever arm is **greatest at 20 to 30 degrees of flexion**

Biomechanics

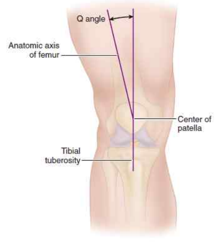


FIGURE 7-22 Q angle, as described by Hvid, is angle between extended anatomic axis of femur and line between center of patella and tibial tubercle.

- Patellofemoral stability → **combination** of the **articular surface geometry** and **soft-tissue restraints**
- **Quadriceps** acts in line with the anatomic axis of the femur
  - With the exception of the **vastus medialis** obliquus, which acts to **medialize the patella in terminal extension**
  - Because the patella **does not contact** the trochlea until **early flexion** → lateral subluxation of the patella in this range is **resisted primarily** by the **vastus medialis** obliquus fibers

- **Q angle** is the angle between the **extended anatomic axis of the femur** and the line between the **center of the patella** and the **tibial tubercle**
- Larger Q angles → tendency for **lateral patellar subluxation**
- Angle of flexion increases → bony and subsequent prosthetic constraints play a dominant role in preventing subluxation

Biomechanics

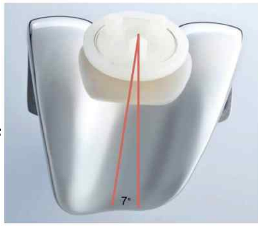


FIGURE 7-23 Built-in trochlear groove angle up to 7 degrees enhances patellar mechanics and patellar tracking.

- In most current femoral component designs, the **lateral flange of the trochlea** has been made **more prominent**, producing a more anatomic reconstruction

- Many designs add a built-in **trochlear groove** angle of up to **7 degrees** to enhance <u>patellar mechanics and tracking</u>

- 1) Trochlear enhancements and attention to 2) femoral component rotation, 3) reproduction of preoperative patellar thickness, and 4) maintenance of joint line height have <u>improved</u> **patellofemoral stability** and have <u>decreased</u> the rate of **lateral patellar retinacular release** significantly

Biomechanics

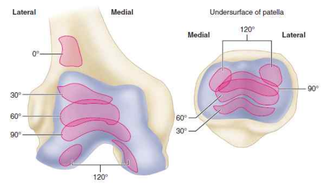


FIGURE 7-24 Patellofemoral contact zones change with knee flexion.

- The **inferior articular surface of the patella** first contacts the **trochlea** in approximately <u>20 degrees of knee flexion</u>

- The **midportion** of the patella articulates with the **trochlea** in approximately **60 degrees of flexion**, and the **superior portion** of the patella articulates at **90 degrees of flexion**

- In **extreme flexion, beyond 120 degrees**, the patella articulates <u>only medially and laterally</u> with the **femoral condyles**, and the quadriceps tendon articulates with the trochlea

Total Knee Arthroplasty
- Alignment -

Introduction

- In past, several reports have indeed been published, demonstrating the adverse effect of **inadequate restoration of neutral leg alignment** on implant survivorship
- Therefore the **current general consensus** is that an overall **mechanical femorotibial alignment (MFTA)** of 0 ± 3 degrees should be the target to aim for to avoid implant failure at medium or long term

Introduction

- Femur의 anatomical axis는 vertical axis에 대해 9 degrees of valgus
- Femur의 anatomical axis는 mechanical axis에 대해 6 degrees of valgus
- Tibia의 anatomical axis는 vertical axis에 대해 3 degrees of varus
- Tibial component placed varus > 5′
  → subside into more varus
  → consequently, tibial components are implanted **perpendicular** to the mechanical axis of tibia
- Femoral components
  → implanted in **5-7 degrees of valgus**
  → **neutral** mechanical axis

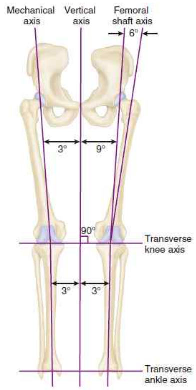


FIGURE 7-18 Mechanical axis of lower limb extends from center of femoral head to center of ankle joint and passes near or through center of knee. It is in 3 degrees of valgus from vertical axis of body. Anatomic axis of femur is in 6 degrees of valgus from mechanical axis of lower limb and 9 degrees of valgus from true vertical axis of body. Anatomic axis of tibia lies in 2 to 3 degrees of varus from vertical axis of body.

Traditional Alignment Principles

- **Insall and Freeman** → most common strategy to achieve neutral alignment "classical alignment"
- Aims at obtaining a **perpendicular implant position** in reference to the **mechanical axis** of both the femur and tibia
- As such, a minor deviation from the natural anatomy is induced
  - The physiologic (natural) **joint line is oriented on average 3 degrees** instead of perpendicular (0 degrees) to the overall mechanical leg axis
- Proximal tibial joint line
  - average of 87 degrees (**3 degrees varus**) → 90 degrees (**neutral**)
- Distal femoral joint line
  - 87 degrees (**3 degrees valgus**) → 90 degrees (**neutral**)

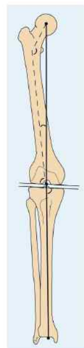


FIG 148.2 The normal joint line is on average 3 degrees inclined to the mechanical axis of the leg. In the traditional way of performing TKA with perpendicular mechanical cuts on both the femur and tibia, this inclination is lost and becomes perpendicular.

Traditional Alignment Principles

- The classical model of restoring neutral mechanical
  - **Perpendicular cuts** on the mechanical axis of the femur and tibia
- 3-degree varus position of the tibial component

  +

  3-degree valgus position of the femoral component

  → **overall neutral mechanical alignment**

- **Perpendicular mechanical cut** on femur → remove approximately 7 mm in the unworn knee, which is replaced by a 9-mm-thick metal component → **distalizing the lateral femoral joint** line with 2 mm
- This is **compensated by the perpendicular tibial resection**, which removes an equal amount of additional bone that is replaced by the tibial implant

- The result is an **unphysiologic obliquity of the joint line**, with **distalization on the lateral side**

FIG 148.1 Restoration of neutral mechanical alignment according to the "classical" alignment philosophy. However, as a consequence, the physiologic joint obliquity is lost, with distalization on the lateral side (see contralateral knee for comparison).

- As a consequence, <u>**patellofemoral mechanics**</u> may become distorted
  - potentially leading to **pain or discomfort** with a sensation of **anterior tightness** in flexion

- Another concern with traditional mechanical alignment restoration is the **lack of an individual, patient-specific strategy**

- Relatively poor performance of current TKA designs, which lack the ability to reproduce physiologic knee kinematics
  - led to an increased interest towards patient-specific, anatomic restoration

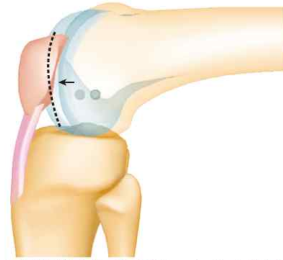


FIG 148.3 Distalization of the joint line on the lateral side leads to distorted patellofemoral mechanics, which can be a cause of pain or discomfort with a sensation of anterior tightness in flexion.

Constitutional Alignment

- A number of patients exist for whom **neutral mechanical alignment** is **abnormal**
- Patients with so-called **constitutional varus** knees have had **varus alignment** since their **end of growth**

- **Restoring neutral alignment in these cases would be abnormal** for them and would almost require some degree of **medial soft tissue release**

- At the same time, anatomic restoration of these knees would lead to a mechanical alignment in varus**,** which could jeopardize the long-term survivorship

- The surgeon is therefore confronted with a **strategic dilemma** in these patients with <u>constitutional varus</u>
  - Either neutral mechanical alignment restoration while realizing that this is abnormal for that specific patient or anatomic restoration and accepting varus mechanical alignment

Constitutional Alignment

- Until recently **no data** were available on the question whether **constitutional varus (or valgus)** <u>really exists</u> in the normal population, and if so in what percentage of healthy individuals it occurs
- It was also unclear how these patients could be identified during surgery

- Interestingly, as high as **32% of males and 17% of females** had **constitutional varus knees** with <u>a natural mechanical alignment ≥3 degrees varus</u>

- The average mechanical **hip and knee angle (HKA)** in the male knees was 1.9 degrees varus, and in the female knees it was 0.8 degrees varus
  - HKA −3 ~ +3 degrees : 165 (66%) of the male and 200 (80%) of the female
  - HKA ≥ +3 degrees : Five (2%) of the male and seven (2.8%) of the female
  - Number of patients with **constitutional varus** : (**32% of males; 17% of females**) may at first sight seem relatively high

Constitutional Alignment

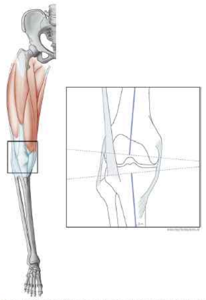


FIG 148.4 Patients with constitutional varus knees have varus alignment since they reached skeletal maturity. Restoring neutral alignment in these cases may indeed be abnormal and undesirable and would almost per definition require some degree of medial soft tissue release. (From Bellemans J, Colyn W, Vandenneucker H, Victor J: The Chitranjan Ranawat Award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. *Clin Orthop* 470:45–53, 2012.)

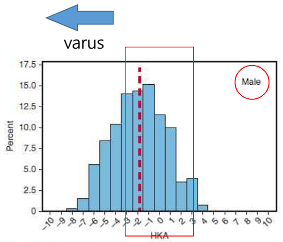


FIG 148.5 Histogram depicting the large variability in natural alignment in healthy male individuals, which contradicts the general belief that normal alignment is zero. Large variability exists between individuals. *HKA*, Hip and knee angle. (From Bellemans J, Colyn W, Vandenneucker H, Victor J: The Chitranjan Ranawat Award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. *Clin Orthop* 470:45–53, 2012.)

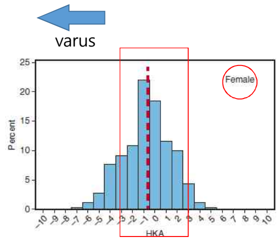


FIG 148.6 Histogram depicting the large variability in natural alignment in healthy female individuals. *HKA*, Hip and knee angle. (From Bellemans J, Colyn W, Vandenneucker H, Victor J: The Chitranjan Ranawat Award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. *Clin Orthop* 470:45–53, 2012.)

Constitutional Alignment

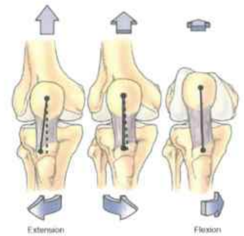
- The association of constitutional varus alignment with increased physical activity during growth has been raised by other authors before
- Witvrouw et al. have noted that **intense sports activity** during growth leads to the **development of varus knees**
  - and this phenomenon occurs **especially towards the end of the growth spurt**
- **Restoring the alignment to neutral** in patients with constitutional varus would indeed be **abnormal** and **unnatural** for them
  - It would implicate an **overcorrection** towards their natural situation in which they had spent their life since skeletal maturity
- A strategy where the natural "constitutional" alignment of the patient is determined and subsequently reproduced seems therefore much more logical

FIG 148.7 Restoration of "constitutional" alignment. The knee is restored to its natural 3-degree varus alignment for this patient (see contralateral knee for comparison).

Summary

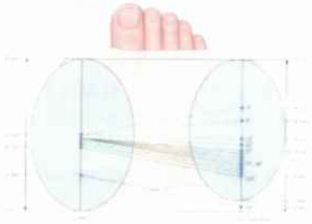
- Restoration of neutral mechanical limb alignment is traditionally considered one of the prerequisites for successful total knee replacement and is currently for **most surgeons still the gold standard**
- However, newer insights have taught us that, for a significant proportion of the population, **neutral alignment is not normal**, and restoring these patients to neutral may not be the best available option
- As a consequence, the concept of **restoring constitutional** rather than mechanical alignment has gained interest
- In this philosophy the natural alignment of the knee is **restored to its original state that was reached at skeletal maturity**, before the disease or damage had occurred

1. 슬관절의 생역학에서 대퇴내과 관절면의 전후방 길이가 외과의 길이보다 길어 슬관절의 굴곡 신전 종말에 발생하는 다음 그림과 같은 현상은? 16B/16I



㉮ 과신전(hyperextension)
㉯ 구르기와 미끄러짐(rolling and gliding)
㉰ 나사회전 운동(screw-home movement)
㉱ 대퇴 후방 굴림(posterior femoral rollback)
㉲ 전후방 전이운동(anteroposterior translation)

1. 우측 슬관절 관절 운동 중 근위 경골에 대한 대퇴내, 외과의 상대적인 움직임을 나타낸 그림이다. 슬관절 굴곡시 대퇴골 외과에서 일어나는 현상은? 21B2/15I



㉮ 대퇴후방굴림(posterior femoral rollback)
㉯ 대퇴전방굴림(anterior femoral rollback)
㉰ 경골후방굴림(posterior tibial rollback)
㉱ 경골전방굴림(anterior tibial rollback)
㉲ 내측 선회(medial pivot)

J Shoulder Elbow Surg (2022) 31, 591–600

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Bony increased-offset reverse shoulder arthroplasty vs. metal augments in reverse shoulder arthroplasty: a prospective, randomized clinical trial with 2-year follow-up

Madeleine L. Van de Kleut, PhD[a,b,c], Xunhua Yuan, PhD[a], Matthew G. Teeter, PhD[a,c,d,e], George S. Athwal, MD[c,e,f,*]

[a]*Imaging Research Laboratories, Robarts Research Institute, London, ON, Canada*
[b]*School of Biomedical Engineering, Western University, London, ON, Canada*
[c]*Lawson Health Research Institute, London, ON, Canada*
[d]*Department of Medical Biophysics, Schulich School of Medicine and Dentistry, Western University, London, ON, Canada*
[e]*Division of Orthopaedic Surgery, Department of Surgery, Schulich School of Medicine and Dentistry, Western University, London, ON, Canada*
[f]*Roth|McFarlane Hand and Upper Limb Center, St Joseph's Health Care, London, ON, Canada*

2023.08.08
명지병원 정형외과
R2. 우창우

Introduction

- Reverse shoulder arthroplasty is being used as the standard surgical procedure for a rapidly growing number of shoulder pathologies
  Jain NB. JSES 2014
- Glenoid preparation and implantation remains challenge due to varying glenoid wear patterns
  Jean K, J Orthop Surg 2013
- Excessive reaming may lead to medialization of the glenohumeral joint's center of rotation and exacerbate scapular notching
  Boileau P, JSES 2005

Introduction

- For this reason, glenoid lateralization is recommended
- Lateralization by addition of a structural bone autograft underneath the baseplate
  - Problems concerning bone graft healing
  - Baseplate stability
  - Increased operative time
- Metal augmented baseplates marketed to address glenoid deficiencies
  - Problems concerning fixation and survivorship

Purpose

- **Compare the migration between autograft and metal augmentation of glenoid**

Materials & Methods

Study design

- Retrospective randomized clinical trial

- 39 patients (41 shoulder, 20 male)
Shoulder arthrosis requiring
reverse shoulder arthroplasty

Table I Patient demographic characteristics (mean ± SD)

	BIO-RSA (n = 20)	Augment (n = 21)	*P* value
Age, yr, mean ± SD	75 ± 9	70 ± 9	.096
Sex, male/female, n	11/9	11/10	.867
BMI, mean ± SD	30 ± 6	32 ± 7	.335
Walch classification			
A1	3	2	.985
A2	1	3	
B2	2	5	
B3	3	1	
Favard classification			
E0	6	8	.197
E2	2	2	
E3	3		
Indication			
OA	7	10	.535
CTA	9	6	
MRCT	2	4	
OA + RCT	1	1	
RA	1		

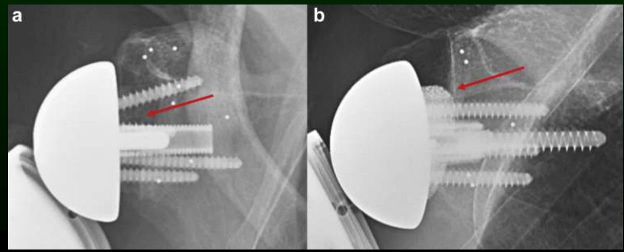
OA, osteoarthritis; *CTA*, cuff tear arthropathy; *MRCT*, massive rotator cuff tear; *RCT*, rotator cuff tear; *RA*, rheumatoid arthritis; *BIO-RSA*, bony increased-offset reverse shoulder arthroplasty.

Materials & Methods

Surgical technique

- Autobone graft
  - 10mm thickness and diameter of humeral head harvested
  - Graft shaped to match each patient's glenoid deficiency

- Metal augment
  - Full wedge (15' slant) augment with diameter of either 25 or 29mm



Materials & Methods

Radiosterometric analysis + clinical outcome

- Examinations at 6weeks, 3 months, 6 months, 1 year, and 2 years.

- Glenoid implant migration measured

- Pateint was evaluated 2 years after operation
  - ROM
  - Pain
  - ASES
  - Constant
  - SSV (Subjective shoulder value)
  - SST (Simple shoulder test)
  - DASH (Disablilities of the arm)

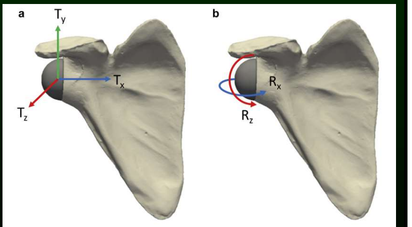


Figure 2 Right-handed coordinate system illustrating (**a**) translational axes and (**b**) rotational axes.

Result

Patient reported outcome measures

Table II Patient-reported outcome measures

	Preoperative			Postoperative (2 yr)			Difference from preoperative		
	BIO-RSA	Augment	*P* value	BIO-RSA	Augment	*P* value	BIO-RSA (*P* value)	Augment (*P* value)	Absolute difference in gain between cohorts
Forward elevation (°)	62 ± 31	80 ± 26	**.047**	125 ± 17	129 ± 18	.484	+63 (**<.001**)	+49 (**<.001**)	14
Lateral abduction (°)	56 ± 22	71 ± 26	.062	108 ± 22	113 ± 23	.489	+52 (**<.001**)	+42 (**<.001**)	10
External rotation (°)	24 ± 19	26 ± 23	.838	43 ± 15	32 ± 13	**.036**	+19 (**.003**)	+6 (.267)	13
Internal rotation (1-6)*	3 ± 1	3 ± 2	.281	4 ± 2	5 ± 1	.468	+1 (**.004**)	+2 (**.011**)	1
Pain (0-10)	7.0 ± 2.2	6.9 ± 2.4	.896	1.4 ± 1.5	1.1 ± 1.6	.324	–5.5 (**<.001**)	–5.8 (**<.001**)	0.3
SSV (0-100)	33 ± 21	29 ± 22	.715	90 ± 9	82 ± 19	.117	+57 (**<.001**)	+53 (**<.001**)	4
ASES (0-100)	34 ± 14	34 ± 19	.895	83 ± 14	84 ± 16	.724	+49 (**<.001**)	+50 (**<.001**)	1
SST (0-12)	2 ± 1	3 ± 2	.075	8 ± 3	9 ± 3	.852	+6 (**<.001**)	+6 (**<.001**)	0
DASH (0-100)	57 ± 15	52 ± 16	.322	20 ± 18	15 ± 17	.378	–37 (**<.001**)	–37 (**<.001**)	0
Constant (0-100)	23 ± 9	30 ± 15	.074	67 ± 9	70 ± 14	.259	+44 (**<.001**)	+40 (**<.001**)	4

SSV, Subjective Shoulder Value; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *SST*, Simple Shoulder Test; *DASH*, Disabilities of the Arm, Shoulder, and Hand; Constant, Constant Shoulder score; *BIO-RSA*, bony increased-offset reverse shoulder arthroplasty.
Values are mean ± standard deviation.
* Based on the landmarks from Constant Shoulder score: 1 = lateral thigh, 2 = buttock, 3 = lumbosacral junction, 4 = waist, 5 = T12, 6 = T7 or interscapular.
Bold values are statistically significant.

Result

Translation and rotational migration

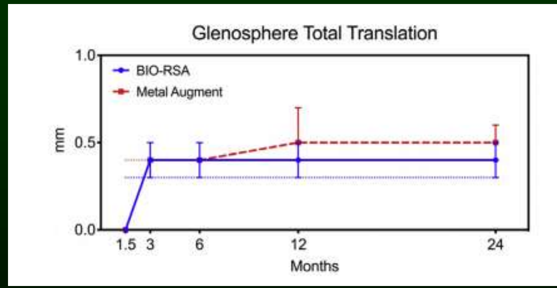
Table IV Translational (mm) and rotational (°) migration values

	BIO-RSA	Metal augment	*P* value
Medial-lateral (T_x)			
3 mo	0.0 ± 0.3	0.0 ± 0.2	>.999
6 mo	0.1 ± 0.3	0.0 ± 0.2	.625
1 yr	0.1 ± 0.2	0.1 ± 0.2	>.999
2 yr	0.1 ± 0.3	0.0 ± 0.3	>.999
Superior-inferior (T_y)			
3 mo	0.0 ± 0.2	−0.1 ± 0.3	>.999
6 mo	0.0 ± 0.2	0.1 ± 0.2	>.999
1 yr	0.0 ± 0.1	0.0 ± 0.3	>.999
2 yr	0.0 ± 0.2	0.0 ± 0.3	>.999
Anterior-posterior (T_z)			
3 mo	0.1 ± 0.4	0.0 ± 0.4	>.999
6 mo	0.0 ± 0.3	0.0 ± 0.4	>.999
1 yr	0.1 ± 0.3	0.0 ± 0.5	>.999
2 yr	−0.1 ± 0.3	−0.2 ± 0.4	>.999
Total translation (T_r)			
3 mo	0.4 ± 0.3	0.4 ± 0.3	>.999
6 mo	0.4 ± 0.2	0.4 ± 0.2	>.999
1 yr	0.4 ± 0.2	0.5 ± 0.3	.629
2 yr	0.4 ± 0.2	0.5 ± 0.3	.784
Anteversion-retroversion (R_x)			
3 mo	−0.1 ± 0.8	0.0 ± 0.7	>.999
6 mo	−0.1 ± 0.8	−0.3 ± 0.5	.885
1 yr	−0.2 ± 0.9	0.1 ± 0.5	.785
2 yr	−0.3 ± 0.8	0.0 ± 0.4	>.999
Declination-inclination (R_z)			
3 mo	0.1 ± 0.6	0.1 ± 0.6	>.999
6 mo	−0.2 ± 0.8	−0.3 ± 0.7	>.999
1 yr	−0.1 ± 0.7	0.4 ± 0.6	.175
2 yr	−0.2 ± 0.8	0.1 ± 0.9	.477

BIO-RSA, bony increased-offset reverse shoulder arthroplasty.
Values are mean ± standard deviation.

Result

Glenosphere total translation + scapular notching



- Grade 1 scapular notching in 3 cases out of 41
: 2 with porous metal wedge patients

Discussion

- No statistically significant differences in migration were observed along any translation or rotation axis at any time point between groups
- Some minute migration occurred as the implant baseplates integrated with the reamed glenoid in the first few months postoperatively

Discussion

- Both cohorts improved in all functional metrics 2 years postoperatively, with the exception of external rotation in the metal augment cohort
- This may be a result of the metal augment's geometry
  - Single geometry (15 full wedge, Aequalis PerFORMþ Reversed) was used for all patients in the metal-augmented cohort regardless of glenoid erosion pattern
  - Whereas the bone graft was shaped to address patient-specific glenoid defect
- By choosing an appropriate augment for the suggested indication, this may provide superior patient outcomes

Discussion

- The incidence of scapular notching was minimal in both cohorts (7%), supporting the use of both glenosphere lateralization techniques for impingement-free range of motion
- Lower than previously reported (40%) for reverse shoulder arthroplasty of autobone graft

  Athwal GS, JSES 2015
- Likely a result of combining glenosphere lateralization with more acute humeral neck-shaft angle

Conclusion

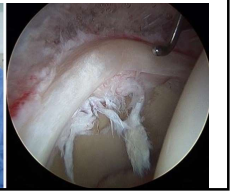
- At 2-year follow-up, our results indicate both autograft and porous metal wedge augmented baseplates provide initial, stable fixation, with no substantial difference in clinical outcome measures

Hip arthroscopy

2023.06.14.
정형외과 R2. 김수영

Introduction

- First described in 1931 by Burman
- **Surgical procedure** that viewing the hip joint **without making a large incision** through the skin and other soft tissues.
- Used to **diagnose and treat** a wide range of hip problems



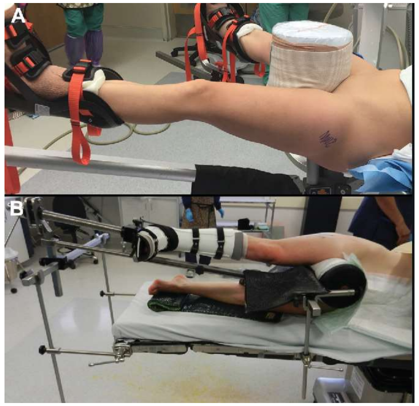
Indications

- **Labral tear (m/c)**
- **Removal of loose bodies**
- **Femoral acetabular impingement**
- **Chondral lesions**
- **Synovial abnormalities**
- **Rupture of Ligamentum teres**
- **Snapping hip syndromes**
- **Joint sepsis**
- **Extra-articular lesion**

  chronic trochanteric bursitis, gluteus medius & minimus tear, piriformis syndrome, calcific tendinitis..

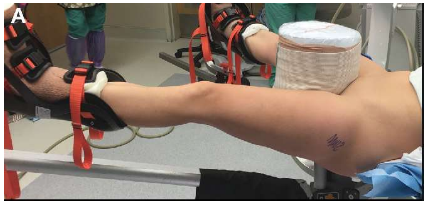
Position

- **Supine position**
- **Lateral position**



Supine position

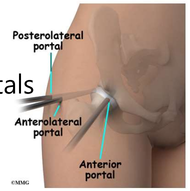
- Hip joint **extension,** 25 dgr **abduction**, **neutral state**
- Traction within **2hr**, at least **8-10mm** space needed between acetabulum and femoral head
- Avoid to injury **pudendal n. by padding**



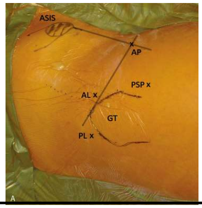
Lateral position

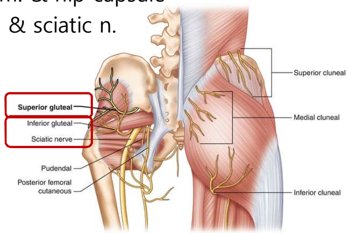
- 0-20 dgr **abduction**, 10-20 **flexion**, slightly **ext. rotation**

Portal

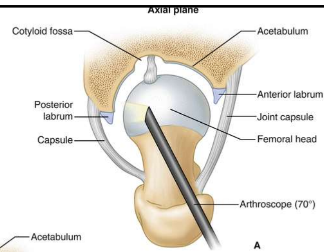


- Supine position uses three standard portals
  AL portal, PL portal, Anterior portal
- **AL portal**
  - 1cm superior and anterior to the ant. edge of GT
  - passing through Gluteus medius m. & hip capsule
  - can be damage to sup. Gluteal n. & sciatic n.



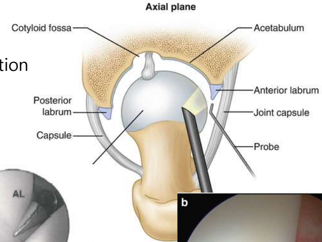


Portal



- **AL portal**

  well finding structure : ant. wall & ant. labrum
  cotyloid fossa
  acetabular ridge
  mid-posterior portion



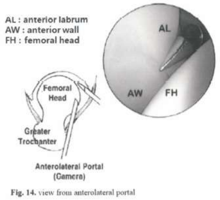
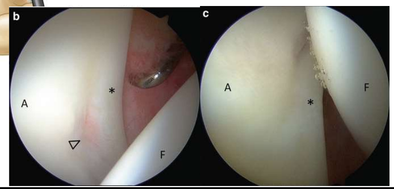
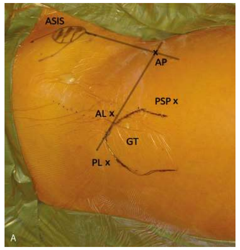


Fig. 14. view from anterolateral portal



Portal

- **PL portal**
  - 1cm posterior and superior to the GT
  - passing through Gluteus medius m. & minimus m.
  - can be damage to sciatic n.
  - well finding structure : post. wall & post. labrum



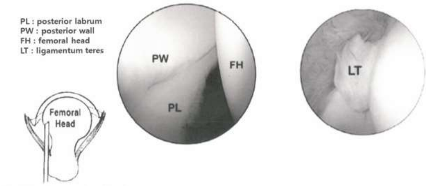
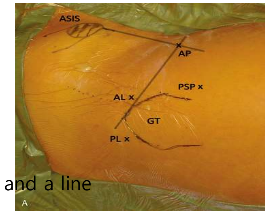


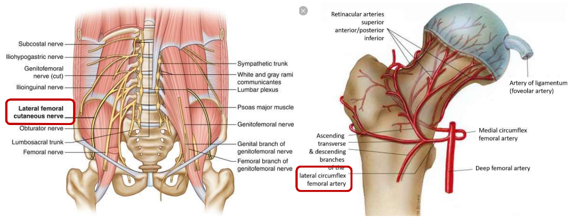
Fig. 17. view form posterolateral portal

Portal

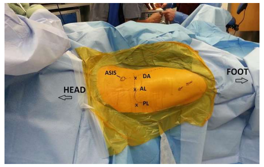


- **Anterior portal**

Intersection of a line drawn from the tip of the GT and a line extending inferiorly from the ASIS
(치골 결합 부위에서 측면으로 뻗은 수평선과 ASIS에서 아래로 이어 진 수직선의 교차점)
Passing through Sartorius & Rectus femoris m. & hip capsule
Caution : lateral femoral cutaneous n. & lateral femoral circumflex a. & femoral a.



Portal



- **Anterior portal**

well finding structure : ant. aspect of femoral neck, superolateral & lateral labrum, stellate crease, ligamentum teres, transverse acetabular ligament

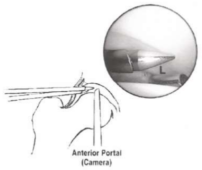
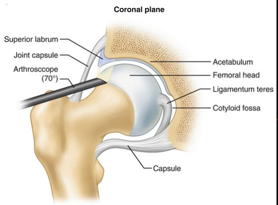
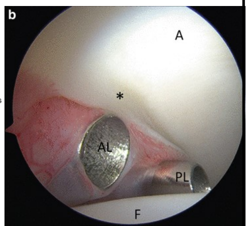
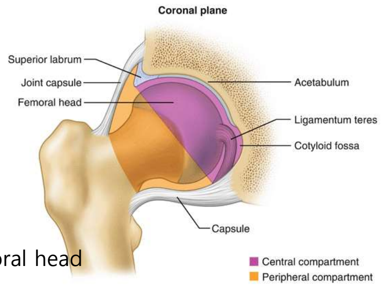


Fig. 12. view from the anterior portal





Compartment

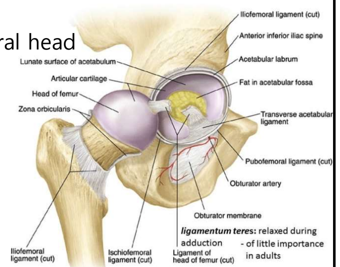


- **Central compartment**

  lunate cartilage
  acetabular fossa
  ligamentum teres
  weight bearing portion of femoral head

- **Peripheral compartment**

  non-weight bearing portion of femoral head
  femoral neck
  medial, anterior, lateral synovial fold
  zona orbicularis
  articular capsule



Compartment

- **Central compartment**
  traction O
  neutral, slight abduction, and neutral rotation at **supine**
  mild abduction, 10-20 dgr flexion, ext. rotation at **lateral**

- **Peripheral compartment**
  traction X, 45 dgr flexion

고관절 관절경 시 Anterior portal을 이용할 때 손상받기 쉬운 해부학적 구조의 명칭 두 개를 쓰시오

고관절 관절경 시 Anterior portal을 이용할 때 손상받기 쉬운 해부학적 구조의 명칭 두 개를 쓰시오

Anterior portal
lateral femoral cutaneous n.
ascending branch of lateral femoral circumflex a.

고관절 관절경술의 적응증이 아닌 것은?

1. Labral tear
2. Chronic trochanteric bursitis
3. Snapping hip syndromes
4. Ligamentum teres rupture
5. ONFH

고관절 관절경술의 적응증이 아닌 것은?

1. Labral tear
2. Chronic trochanteric bursitis
3. Snapping hip syndromes
4. Ligamentum teres rupture
5. ONFH

고관절 관절경술을 받은 환자에게 회음부의 감각 이상이 발생하였다. 수술은 골절 침대에서 환측 고관절을 약 10도 외전시켜 비구와 골두의 간격이 10mm 정도 되도록 견인하였다. 반대편 하지도 골반 경사가 없도록 견인하였으며 견인 시간은 총 60분이었다. 감각 이상의 원인으로 가장 가능성이 높은 것은?

1. 과도한 견인력
2. 과도한 견인시간
3. 하지의 지나친 외전
4. 반대편 하지의 견인
5. 불충분한 회음부 보호

고관절 관절경술을 받은 환자에게 회음부의 감각 이상이 발생하였다. 수술은 골절 침대에서 환측 고관절을 약 10도 외전시켜 비구와 골두의 간격이 10mm 정도 되도록 견인하였다. 반대편 하지도 골반 경사가 없도록 견인하였으며 견인 시간은 총 60분이었다. 감각 이상의 원인으로 가장 가능성이 높은 것은?

1. 과도한 견인력
2. 과도한 견인시간
3. 하지의 지나친 외전
4. 반대편 하지의 견인
5. 불충분한 회음부 보호

Reference

- Campbell, 13th
- 대한정형외과학

The biomechanical effects of acromial fracture angulation in reverse total shoulder arthroplasty

Running title: Effects of acromial fracture angulation on RSA

Jae-Hoo Lee, MD, PhD[a], Seong Hun Kim, MD[b], Gyurim Baek, BS[c], Andrew Nakla, BS[c], Daniel Kwak, BA[c], Michelle McGarry, MS[c], Thay Q. Lee, PhD[c], Sang-Jin Shin, MD, PhD[d]

[a]Department of Orthopaedic Surgery, Inje University, Ilsan Paik Hospital, Goyang-si, Republic of Korea

[b]Department of Orthopaedic Surgery, Ilsan Hospital, National Health Insurance Service, Goyang-si, Republic of Korea

[c]Biomechanics Laboratory, Congress Medical Foundation, Pasadena, CA, USA

[d]Department of Orthopaedic Surgery, Ewha Shoulder Disease Center, Seoul Hospital, Ewha Womans University School of Medicine, Seoul, Republic of Korea

Introduction

- With the increased use of reverse shoulder arthroplasty (RSA), the incidence and clinical interest in postoperative complications are also increasing with greater frequency

  Patterson DC et al., JSES, 2019

- Among complications after RSA, fracture of the acromion or scapular spine deteriorates clinical outcomes

  King JJ et al., BJJ, 2019

- The incidence of acromion and scapular spine fracture after RSA has been reported to range from 0.8 to 15.8%

- The time of onset is relatively broad; however, it is mainly detected within the first 6 months, postoperatively

  Neyton L. et al., JBJS, 2013

Introduction

- The outcomes following postoperative treatment of acromial fractures were different depending on the anatomic location of the fracture

  Polisetty T. et al., JSES, 2022

- Relatively satisfactory outcomes were obtained after conservative treatment in fractures of the acromion tip or the lateral location of the acromioclavicular joint

- For the medial acromial or scapular spine fracture, high nonunion and malunion rates and inferior results in range of motion, and functional outcomes were reported after non-operative treatment

  Levy JC et al., JBJS, 2013

- Fractures of the medial aspect of the acromion or scapular spine cause shortening of arm distalization by angulation of the acromion, which can lead to late complications such as scapular rotation, progressive notching, and osteolysis

  Boltuch A. et al, JSES, 2022

Purpose

- Nevertheless, there has been no study regarding the biomechanical changes induced in RSA according to the degree of acromial fractures angulation

- To analyze the changes in biomechanical properties according to the amount of acromial fracture angulation following RSA

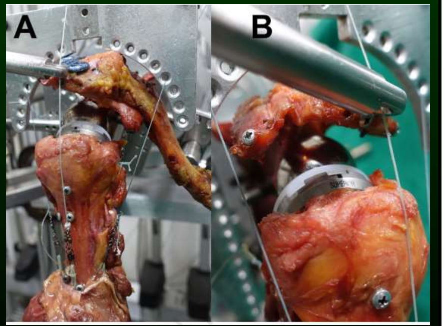
- Our hypothesis was that in acromial fractures after RSA, as the angulation of the fracture site become increases, abduction impingement angle, and forward flexion and abduction capability will also decrease

Materials & Methods

- A total of 9 fresh-frozen cadaveric shoulders
- Mean age : 67.1 ± 2.9 years old
- Male : 7 / Female : 2
- Right : 4 / Left : 5

- Coralis prosthesis (Corentec, Seoul, Korea)

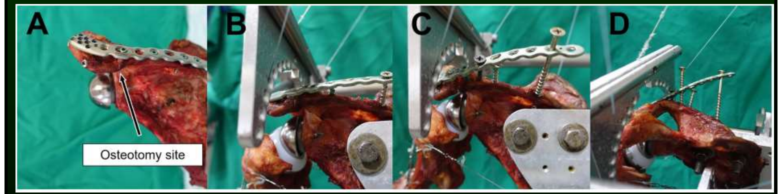
  - Onlay type humeral stem
  - 145' neck-shaft angle
  - Medialized glenoid component with 3.8 mm offset
  - A centric type glenoshere and base plate with a diameter of 36 mm
  - Metal plate fixed using 3 screws and positioned at 20° of anterior tilt



Materials & Methods

- Levy's modified subclassification IIB was reproduced

- An acromial osteotomy performed along the plane parallel to the glenoid surface after reaming for the glenoid base plate



Angulation : 0° 10° 20° 30°

Levy's type II subclassification

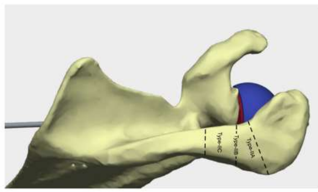


Figure 2 Type II subclassification. Type IIA fractures occur lateral to the glenoid face; type IIB fractures occur at the glenoid face; and type IIC fractures occur medial to the glenoid face.

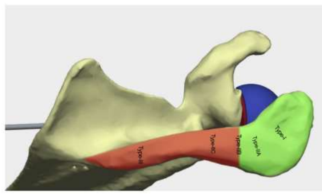


Figure 3 Fracture dichotomy in relation to type II subclassification. Medial fracture types are shaded in *red* and occur at or medial to the glenoid face (IIB, IIC, III). These fractures are expected to have a negative impact on outcomes. Conversely, fractures occurring lateral to the glenoid face (I, IIA) are shaded *green* and have a more limited impact on outcomes.

Results

Table 1. Measured impingement free angle at abduction and forward flexion

Angulation	0°	10°	20°	30°
Abduction (°)	61.8 ± 2.9	55.9 ± 2.8	49.3 ± 2.9	44.2 ± 4.6
Forward flexion (°)	84.2 ± 4.3	75.6 ± 2.7	67.9 ± 3.2	59.8 ± 4.0

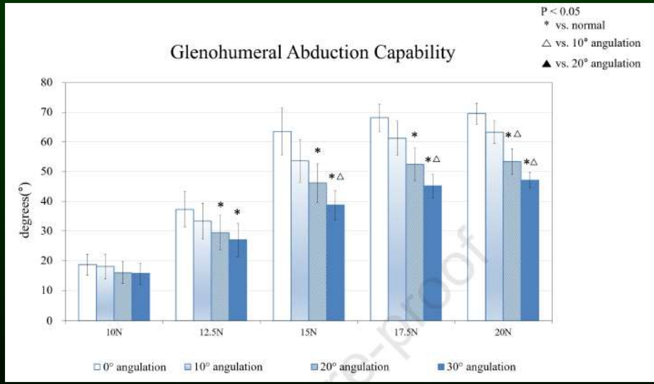
Angulation ↑ ➡ Impingement ↑

Table 2. Measured length of anterior, middle and posterior deltoid

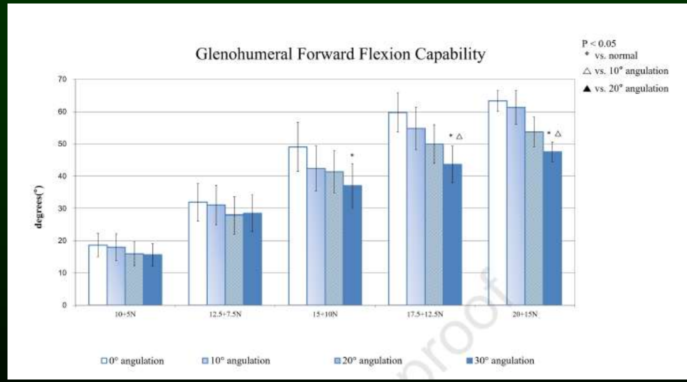
	0°	10°	20°	30°
Anterior (mm)	109.3 ± 3.5	109.1 ± 3.4	108.8 ± 3.3	108.8 ± 3.3
Middle (mm)	131.2 ± 3.4	125.9 ± 3.0	121.4 ± 2.7	117.5 ± 2.7
Posterior (mm)	136.0 ± 3.0	130.7 ± 2.8	128.2 ± 2.7	125.1 ± 2.4

Angulation ↑ ➡ deltoid length (middle & posterior)↓

Results



Results



Discussion

- Crosby's classification and Levy's classification have been used to specify the location of acromial and scapular spine fractures after RSA
  → different criteria for categorization
  → significant difference in the definition of each type I and II
  → there may be a difference in using these classifications together
- Recently, Boltuch et al proposed a subclassification of Levy type II acromial fractures
- Osteotomy performed in the current experiment was at the location corresponding to Levy type IIB
- Our findings suggest that surgical anatomical restoration should be considered because the impingement free angle in forward flexion and abduction is significantly reduced when the angulation of the fracture site is more than 20° in type IIB fracture

Discussion

- Shortening was prominent in the middle and posterior deltoid, however, the anterior deltoid was not affected by angulation
- The angulation of the acromial fracture and the tilting in the sagittal plane together should be indicators for restoration during surgical fixation
- The biomechanical rationale for RSA is to help in recruiting more fibers of the anterior and posterior deltoid to act as abductors
  Boileau P. et al, JSES, 2005
- Recruitment and firing of anterior and posterior muscles through appropriate distalization in RSA are the most important factors for postoperative functional recovery
  Boutsiadis A. et al, JSES, 2022
- Considering that the one of the biomechanical rationale for RSA is distalization, our study found that the more severe the angulation in acromial fractures, the more severe the degradation in range of motion and abduction capability

Discussion

- In addition, scapular tilting, progressive scapular notching, and osteolysis, which threaten the longevity of the RSA, suggest the need for corrective surgery to restore alignment for medial fractures

  Boltuch A. et al, JSES, 2022

- According to a retrospective study, an excessive increase in the deltoid length after surgery was also reported as a risk factor for acromial fracture after RSA

  Cho CH. et al, Clin Shoulder Elb, 2019

- There are insufficient clinical data on how lateralization of RSA contributes to the occurrence of acromial fractures

  Haislup BD. et al, JSES Int., 2022

- It is known that the mechanism of the deltoid moment and strain on scapula spine in lateralization design RSA is different from that in the traditional Grammont style prosthesis

  Kerrigan AM. et al, JSES, 2021

Limitations

- First, only the condition corresponding to Levy's type IIB was tested, and other subtypes were not included
- Second, although the location of the acromial fracture was made constant according to the definition, possible biases were present due to the variation in the size and morphology of cadaveric specimens
- Third, the effect of angulation on acromial fractures under various conditions applying various designs and specifications of RSA could not be analyzed

  → A number of studies have already been conducted on the effect of prosthesis design on the development of acromion fracture

  Haislup BD et al, JSES Int., 2022

  Routman HD et al., JBJS, 2020

- Lastly, the movement of the scapulothoracic joint could not be reproduced, and the experiment was limited to the glenohumeral joint

Conclusion

- In acromial fractures at the plane of glenoid surface, 10° inferior angulation of the acromion did not interfere with abduction and abduction capability
- However, 20° and 30° of inferior angulation caused prominent impingement in abduction and forward flexion, and reduced abduction capability
- In addition, there was a significant difference between 20° and 30°, suggesting that not only the location of the acromion fracture after RSA but also the degree of angulation are important factors for shoulder biomechanics

Femoro-acetabular Impingement Syndrome

명지병원 정형외과

R4. 경태현

Index

Introduction

▣ 젊은 환자들의 고관절 통증과 퇴행성 관절염의 원인

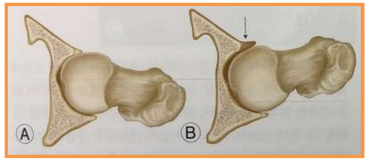
▣ 고관절 굴곡 & 내회전 시, 대퇴 경부와 비구 사이에 비정상적인 충돌 발생
- ▶ 비구 관절연골 분리, 비구순 파열
- ▶ 고관절의 조기 퇴행성 변화

▣ 정상가동범위
- ▶ 굴곡 : 0 ~ 120
- ▶ 신전 : 0 ~ 30
- ▶ 외전 : 0 ~ 45
- ▶ 내전 : 0 ~ 30
- ▶ 내회전 & 외회전 : 0 ~ 45

Types

▣ Cam type / Pincer Type

1. Cam type
   Non-spherical femoral head



① 대퇴골두와 경부 사이 offset의 전상방부가 움폭하게 파이지 않고 평평하거나 볼록하게 과형성되어 돌출된 변형인 두경부 골융기에 의해 발생

② 방사선 전후면 사진상 근위부 대퇴골의 모양이 마치 권총손잡이
→ Pistol grip deformity

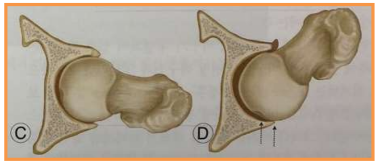
③ 대퇴골두 골단 분리, Legg-Calve-Perthes 병, 대퇴경부 골절 부정유합

Types

▣ Cam type / Pincer Type

2. Pincer type

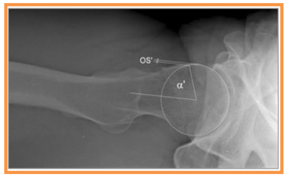
Excessive acetabular covering



① 비구의 외연이 대퇴 골두를 과도하게 감싸는 변형에 의해 발생

② 고관절 운동 시, 대퇴 경부와 비구의 전상방부가 충돌하게 되고
초기 충돌로 인해 골두가 하외측으로 아탈구 되면서
후하방부 비구 연골을 가격하여 연골분리 재차 발생

③ Coxa profunda, acetabular retroversion



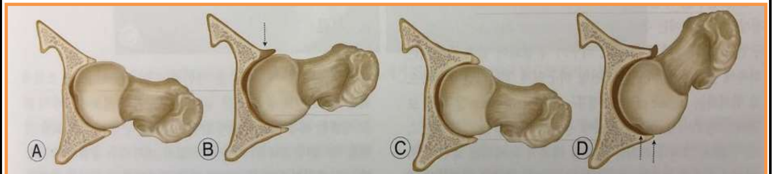


그림 IV-42. 대퇴비구 충돌 증후군의 유형. (A, B) Cam형 충돌 모식도. 고관절 굴곡 시 대퇴골두와 경부 사이에 과형성된 골 조직(bump)이 전방 비구연에 부딪힌다(화살표). (C, D) Pincer 형 충돌 모식도. 비구의 외연이 대퇴골두를 과도하게 감싼 상황에서 고관절을 굴곡할 때 전방 비구연에 충돌이 발생하고 이어 골두가 하외측으로 밀려나면서 후방 비구 연골을 가격한다(2개의 화살표).

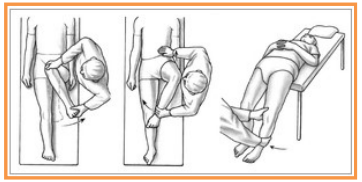
Symptoms

▣ 임상소견

1. 대부분의 환자들은 고관절의 굴곡와 내회전 제한을 보이며
쪼그려 앉는 동작을 힘들어 함

2. 서서히 발생하는 서혜부 통증

3. Anterior impingement test
① 굴곡, 내전, 내회전 시킬 때
(FADDIR) 통증 유발
② 고관절의 전상부에서 충돌이 있을 때



4. Posterior impingement test
① 신전, 외전, 외회전 시킬 때 통증 유발
② 고관절의 후방부 충돌이 있을 때

Diagnosis

▣ 진단

1. X-ray

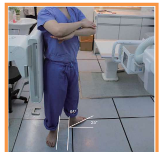


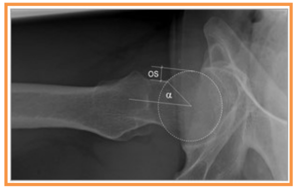
Fig. 5. Positioning for false-profile view. The pelvis is rotated 65° relative to the bucky wall stand, with the foot on the affected side parallel to the radiographic cassette.

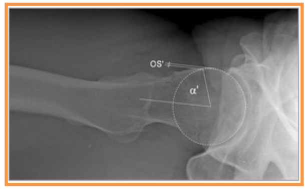
False profile view of hip on plain radiography

A false profile view of the hip using plain radiographs as pictured above provides a good view of the posterior femoroacetabular joint (arrows).

① 골반 전후면 사진(비구 전염 여부 판단)
고관절 측면 사진(α각)
False profile 사진(관절후방부의 상태 확인)

② Cam type
▶ α각 측정 도움
▶ 대퇴골두 중심에서 시작하여 대퇴경부 축에 평행하는 선과
대퇴골두 중심으로부터 head-neck junction을 잇는 선이 이루는 각도
▶ α각이 55도 이상일 경우 Cam type 의심





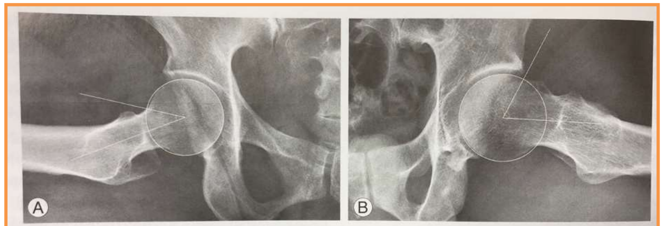
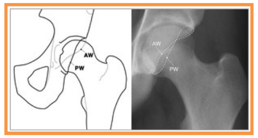


그림 IV-43. α각도. (A) α각이 33.7도로 정상 범위이다. (B) α각이 65.7도로 증가되어 있다.

Diagnosis



▣ 진단

③ Pincer type

▶ 정상적인 경우, 전방 비구연이 후방 비구연보다 내측에 존재

▶ 외측에 있던 후방 비구연이 전방 비구연과 엇갈리면서 내측으로 위치

→ Figure of eight sign , crossover sign

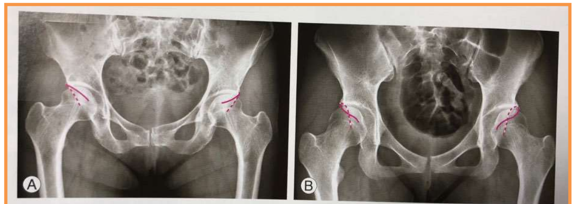


그림 IV-44. 비구 후염. (A) 정상의 경우 비구 전연이 내측에 비구 후연이 외측에 위치한다. (B) 비구 후염의 경우 비구 전연의 상방이 후연보다 외측에 위치해 8자 형으로 보인다(figure of eight 혹은 crossover 징후).

Diagnosis

▣ 진단

2. 관절조영 자기공명영상 (MRA)

① Labral tear, Articular cartilage injury 등과 같은 동반 병변을 확인

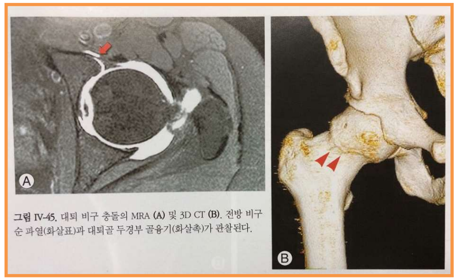


그림 IV-45. 대퇴 비구 충돌의 MRA (A) 및 3D CT (B). 전방 비구순 파열(화살표)과 대퇴골 두경부 골융기(화살촉)가 관찰된다.

Treatment

▣ 치료

1. 비수술적 치료

① 통증을 유발하는 활동을 제한

② NSAIDS, Physical therapy

2. 수술적 치료

① 적응증

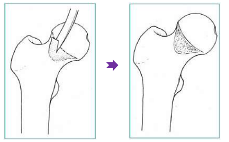
▶ 보존적 치료에 반응 없고
명백한 해부학적 이상이 발견된 경우

Treatment

▣ 치료

② Cam type
▶ 대퇴골두~경부 사이의 오프셋 중 주로 전상방부에 과형성된 골융기를 제거하여 정상적인 offset 복구

③ Pincer type
▶ 과도하게 돌출된 비구 외연을 절제
▶ 비구순 손상이 되지 않은 경우, 비구순을 분리하고 비구외연 절제한 후 재부착



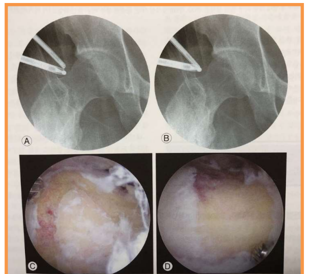


그림 IV-46. 두경부 골융기의 관절경을 이용한 제거술. 제거 전(A, C), 후(B, D)의 방사선 투시기 및 관절경 소견.

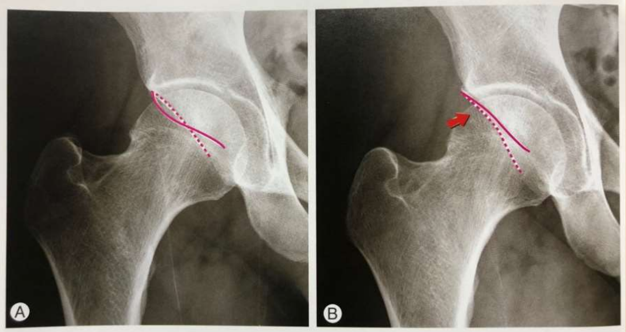


그림 IV-47. 비구 후염에 대한 비구 전연 절제술 전(A), 후(B) 방사선 사진. 돌출된 상부 비구 전연(화살표)이 제거되었다.

Exercise

▣ 문제1.

40세 여자 환자로 1개월 전부터 발생한 우측 둔부 통증으로 내과에서 의뢰되었다.
진찰 소견 상 우측 고관절을 90도 굴곡, 내전, 내회전 하였을 때 운동 범위 감소는 있으나, 통증은 없었다.
진행한 자기 공명 영상 검사 상, 우측 고관절 관절와순 파열과 단순 방사선 사진에서 대퇴 경부의 α 각은 60도와 대퇴 골두와 경부 접합부위에 골 융기 소견이 관찰되었다. 이 환자에서 가장 적절한 치료는?

① 근위 대퇴골 외반 절골술
② 관절경하 관절와순 봉합술
③ 경과관찰
④ 관절경하 골 융기 제거술
⑤ 관절경하 골 융기 제거술 및 관절와순 봉합술

1. 40세 여자 환자로 1개월전부터 발생한 우측 둔부 통증으로 내과에서 의뢰되었다. 진찰 소견상 우측 고관절을 90도 굴곡, 내전, 내회전 하였을 때 운동 범위 감소는 있으나 통증은 없었다. 진행한 자기 공명 영상 검사상 우측 고관절 관절와순 파열과 단순 방사선 사진에서 대퇴 경부의 α각은 60도와 대퇴 골두와 경부 접합 부위에 골 융기 소견이 관찰되었다. 이 환자에게 가장 적절한 치료는? 21B/20B/16B
㉮ 근위 대퇴골 외반 절골술
㉯ 관절경하 관절와순 봉합술
㉰ 경과관찰
㉱ 관절경하 골 융기 제거술
㉲ 관절경하 골 융기 제거술 및 관절와순 봉합술

답: ㉰

<Kim's solution>

환자의 problem list
1) inguinal pain (-). Rt. buttock pain (+)
2) anterior impingement test (-)
3) X-ray : α angle > 55도
4) MRA: Tear. labrum. Rt.
- 영상 검사와 임상 증상이 correlation되지 않는다
- The diagnosis of FAI is primarily made clinically from the patient's history and physical examination and then correlated with the radiographic findings
-> 수술의 indication은 conservative treatment에 반응이 없고 명백한 해부학적 이상이 발견될 경우
-> Accurate diagnosis of the source of pain in young adults or adolescents is crucial in obtaining optimal surgical outcomes with FAI surgery.

Journal of
Clinical Medicine

MDPI

Systematic Review

Conservative vs. Surgical Management for Femoro-Acetabular Impingement: A Systematic Review of Clinical Evidence

Giuseppe Anzillotti [1,2], Alberto Iacomella [1,2,*], Matteo Grancagnolo [1,2], Enrico Maria Bertolino [1,2], Maurilio Marcacci [1,2], Cristiano Sconza [1,2], Elizaveta Kon [1,2] and Berardo Di Matteo [1,2]

1 Department of Biomedical Sciences, Humanitas University, 20072 Pieve Emanuele, MI, Italy
2 IRCCS Humanitas Research Hospital, 20089 Rozzano, MI, Italy
* Correspondence: albertoiacomella96@gmail.com

Abstract: Femoro-acetabular impingement (FAI) syndrome is one of the most studied conditions in sports medicine. Surgical or conservative approaches can be proposed for treating FAI, although the best standard of care is not established yet. Our aim is to provide a comprehensive review of the best treatment for FAI syndrome evaluating differences in outcomes between surgical and non-operative management. A literature search was carried out on the PubMed, EMBASE, Scopus, and PEDro databases, using the following keywords: "femoroacetabular impingement", "FAI", in association with "surgery", "arthroscopy", "surgical" and "conservative", "physiotherapy", "physical therapy", "rehabilitation", "exercise". Only Level I RCTs were included. Four articles were selected for this systematic review. Our analysis showed different therapeutic protocols, follow-up periods, and outcomes; however, three out of the four studies included favored surgery. Our study demonstrates beneficial effects for both arthroscopic treatment and a proper regimen of physical therapy, nevertheless a surgical approach seemed to offer superior short-term results when compared to conservative care only. Further trials with larger sample sizes and longer follow-ups are needed to assess the definitive approach to the FAI condition.

Keywords: femoro-acetabular impingement; hip; arthroscopy; cam; pincer; physical therapy

check for updates

Citation: Anzillotti, G.; Iacomella, A.; Grancagnolo, M.; Bertolino, E.M.; Marcacci, M.; Sconza, C.; Kon, E.; Di Matteo, B. Conservative vs. Surgical Management for Femoro-Acetabular Impingement: A Systematic Review of Clinical Evidence. *J. Clin. Med.* **2022**, *11*, 5852. https://doi.org/

Table 1. Synopsis of the main features of the RCTs included in the systematic review.

Study	Study Design	Treatment Groups	Outcome Measures	Follow-Up	Rehabilitation Program	Main Results	Comments on Results
Griffin et al. [11]	RCT	171 surgical and 177 PT	iHOT-33 EuroQol EQ-5D-5L SF-12	12mo	6 to 10 sessions over 12 to 24 weeks with physiotherapist personalized hip therapy with an assessment of pain, function, and range of hip motion; patient education; an exercise program that has the key features of individualization, progression, and supervision; help with pain relief, which could include one X-ray or ultrasound-guided intra-articular steroid injection	At 12 mo follow-up, there was a mean adjusted difference of 6-8 points in the iHOT-33 score between groups, in favor of hip arthroscopy. This is a statistically significant difference that also exceeded the minimum clinically important difference for iHOT-33.	Hip arthroscopy is more clinically effective than best conservative care
Mansell et al. [12]	RCT	38 surgical and 40 PT	HOS iHOT-33 GRC	24mo	12 sessions over 6 weeks with joint mobilizations, mobilization with motion, therapeutic exercise, soft tissue mobility, stretching, motor control exercises and home exercise program.	There was no significant difference between the surgery and no surgery groups at any time point out to 2 years on the HOS ADL and sport subscales or the iHOT-33. There was a statistically significant improvement from baseline to 1 and 2 years on the HOS ADL subscale and the iHOT-33 in the surgery group only.	Despite improvements over time, no meaningful change was perceived by most patients. A high rate of crossover to the surgery group affected the power of the study and prevents us from making definitive conclusions.
Palmer et al. [15]	RCT	112 surgical and 110 PT	HOS ADL HOS sport NAHS HAGOS OHS iHOT-33 EQ-5D-3L PainDETECT HADS	8mo	Up to 8 physiotherapy sessions over 5 mo with physiotherapist personalized hip therapy, with emphasis on improving core stability and movement control.	The mean HOS ADL in the arthroscopic surgery group was 10.0 points (95% confidence interval 6.4 to 13.6, $p = 0.001$) higher than in the physiotherapy program group at 8mo follow-up.	Patients with FAI syndrome experience a greater improvement in symptoms with arthroscopic hip surgery than with physiotherapy and activity modification at 8mo follow-up.
Hunter et al. [14]	RCT	49 surgical and 50 PT	dGEMRIC score HOAMS iHOT-33 HOOS SF-12 GIS Modified UCLA	12mo	6 PT sessions over 12 weeks. If needed 4 more PT sessions were added between 12 weeks and 6 months. 1. An individualized and progressive exercise program supervised by a physiotherapist. 2. Education about the condition and its Management. 3. Advice regarding pain relief which could include referral to the participants' General Practitioner or ultrasound-guided intra-articular steroid injection.	The primary outcome of hip cartilage metabolism dGEMRIC showed no statistically significant difference Between PHT and arthroscopic hip surgery at 12 months follow-up. the range of secondary outcomes demonstrated statistically and clinically important improvements with significance between group differences favoring surgery.	This trial adds new information that shows the patient reported benefits of surgery are not explained by nor linked to better hip cartilage metabolism at 12 months.

6. Conclusions

Femoro-acetabular impingement syndrome is a common cause of pain and groin dysfunction in young active adults. Both arthroscopic treatment and a proper regimen of physical therapy are effective for pain relief and restoring functional status. However, the surgical approach seems to offer superior short-term results when compared to conservative care only. Further evaluations are needed to clarify whether surgery might prevail even at middle to long-term follow-up.

Reference

▣ 정형외과학 제 8판

▣ Imaging evaluation of the painful hip in adults
Authors : Cecilia Matilda Jude, MD, Shahla Modarresi, MD

▣ Plain Radiography of the Hip: A Review of Radiographic Techniques and Image Features / Hip & Pelvis
Seung-Jae Lim, MD, Yoon-Soo Park, MD

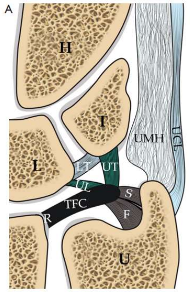
▣ Anzillotti G, Iacomella A, Grancagnolo M, Bertolino EM, Marcacci M, Sconza C, Kon E, Di Matteo B. Conservative vs. Surgical Management for Femoro-Acetabular Impingement: A Systematic Review of Clinical Evidence. J Clin Med. 2022 Oct 2;11(19):5852. doi: 10.3390/jcm11195852. PMID: 36233719; PMCID: PMC9572846.

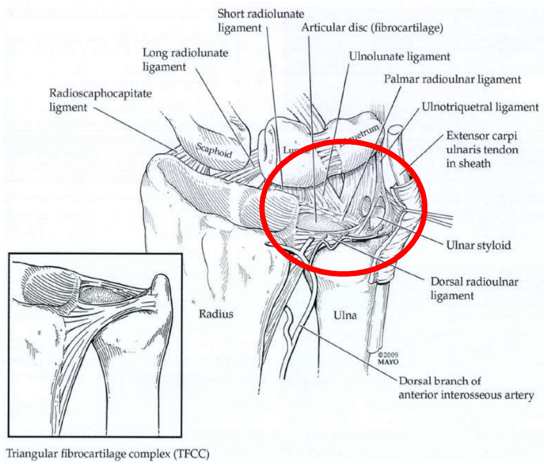
TFCC injury

Triangular Fibrocartilage Complex

2023.08.25
R3. 이준우

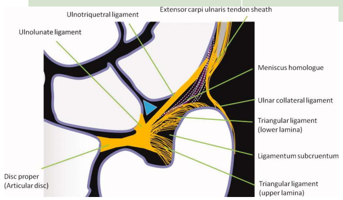
Anatomy

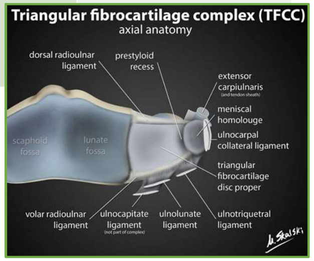




Anatomy

Volar components	Ulna components	Dorsal components
Volar radioulnar ligament	Triangular ligament	Dorsal radioulnar ligament
Ulnocarpal ligamentous complex	Ulnar collateral ligament	Extensor carpi ulnaris tendon sheath
Ulnotriquetral ligament Ulnocapitate ligament Ulnolunate ligament	Meniscal homologue	





Anatomy

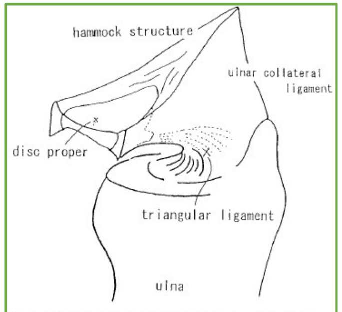


Fig 9 Diagram of the three-dimensional structure of the TFCC.

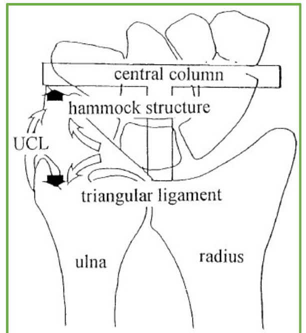
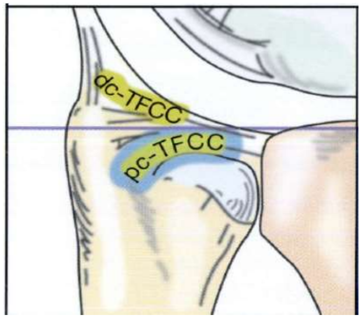


Fig 10 Diagram of structure and function of the TFCC. The TFCC is separated into three components: the proximal triangular ligament, the distal hammock structure, and the ulnar collateral ligament (UCL). These three components of the TFCC suspend each other and the loose internal structure of the TFCC absorbs the strain so that both stability and mobility of the ulnar side of the wrist can be achieved.

Anatomy

- **Only distal TFCC** is ruptured
  : ulnar wrist pain만!!

- **Proximal TFCC** is ruptured
- : ulnar wrist pain
- + reduced grip strength
  + decreased forearm rotation
  + DRUJ instability…



Triangular Fibrocartilage Complex

▣ **Function**

▶ Main stabilizer of distal radioulnar joint (DRUJ)
→ DRUJ에서 척골 두가 회전 운동을 하는 동안 DRUJ의 안정성을 제공
▶ Buttress to support the proximal carpal row
→ 수근골들이 척골 및 DRUJ와 조화롭게 움직일 수 있도록 하는 역할
▶ Shock absorber across the ulno-carpal joint
(Allowing for transmission of a portion of the axial load from the carpus to the ulna)

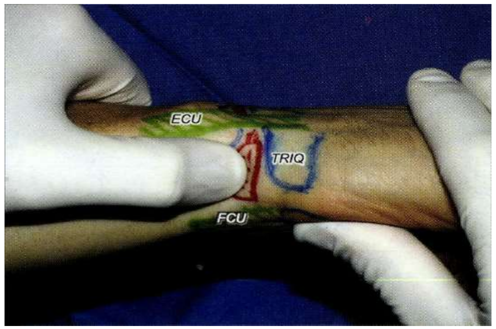
Diagnosis

▣ **신체검진**

▶ 척측 손목 관절 통증
▶ 전완부 ROM시, Ulnar deviation시 소리가 나는 증상 (clicking)
▶ 골절이 동반되지 않은 TFCC의 손상의 경우 심한 부종은 드묾

Diagnosis

▣ **Foveal test**
▶ FCU, ECU 사이의 척측 snuff box를 검사자가 누를 때 통증이 발생하는지 검사



Diagnosis

▣ **Press test**

▶ Sensitive

▶ 앉은 자세에서 Ulnar deviation 상태에서 축 방향 하중을 주어서 손목에 힘을 주어서 시행

Diagnosis

▣ **Ulnar impaction test**

▶ 손목의 ulnar deviation 상태에서 axial loading이 가해졌을 때 통증 호소

Diagnosis

▣ **Ballottement test**

▶ Distal ulna 를 dorsal / palmar direction으로 움직였을 때 통증 및 laxity 보임

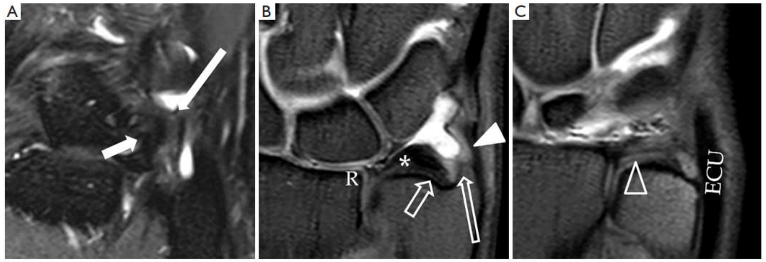
Diagnosis

▣ **Piano key test**

▶ 손목을 회내전 (pronation) 상태에서 불안정한 척골이 후방으로 전위될 수 있는데, 검사자가 엄지로 후방 전위되는 척골을 누를 때 정복되는 검사

Wrist MRI

- High rate of false finding in wrist MRI



(A) Ulnotriquetral (long solid arrow) and ulnolunate ligaments (short solid arrow);
(B) TFC (asterisk) with radial attachment (R), foveal attachment (short block arrow), ulnar styloid process attachment (long block arrow), meniscal homologue attachment (arrowhead);
(C) most dorsal aspect of TFCC with dRUL (block arrowhead) and ECU tendon sheath attachment (ECU).

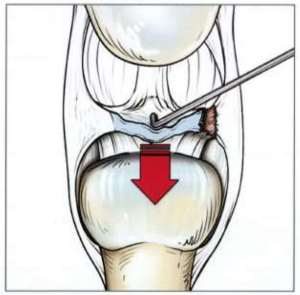
Wrist arthroscopy

A/S Diagnosis

▣ **Trampoline test**

▶ Probe를 가지고 원판의 중심을 눌렀을 때 정상의 경우는 팽팽한 느낌

▶ TFCC의 파열의 경우는 느슨하며 반발이 되지 않음

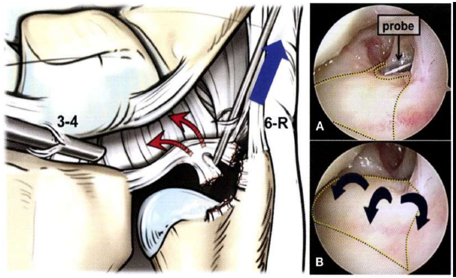


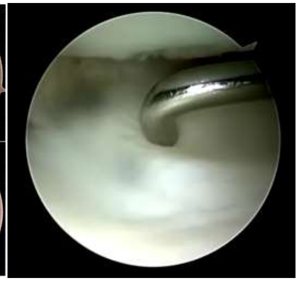
A/S Diagnosis

▣ **Hook test : (positive = foveal detachment of TFCC)**

▶ Probe를 가지고 원판의 척측부를 중심부를 향해 당겨보았을 때 정상의 경우는 저항이 느껴짐

▶ 원위 요척관절 심부인대의 척측와 견열 파열이 있는 경우, 저항 없이 중심부를 향해 당겨짐





Classification & Treatment

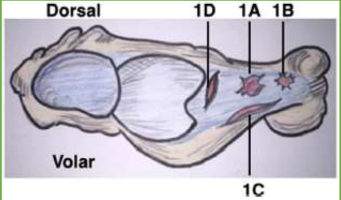


Table 1. Palmer classification categorizing TFCC lesions

Class 1: traumatic injury
1A: central perforation
1B: ulnar avulsion with or without distal ulnar fracture
1C: distal avulsion
1D: radial avulsion with or without sigmoid notch fracture

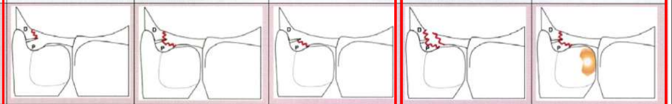
TFCC, triangular fibrocartilage complex.
Cited from the article of Palmer and Werner (J Hand Surg Am. 1981;6:153-62).[1)]

Table 9-1 Palmer Classification of TFCC Lesions

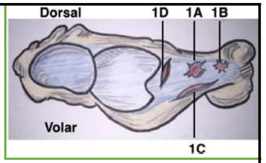
Class	Subtype	Description
1 (Traumatic)	A	Central Perforation
	B	Ulnar Avulsion
	C	Distal Avulsion
	D	Radial Avulsion
2 (Chronic)	A	TFCC Wear
	B	TFCC Wear with lunate and/or ulnar head chondromalacia
	C	TFCC Perforation with lunate and/or ulnar head chondromalacia
	D	Type 2C with lunotriquetral ligament perforation
	E	Type 2D with ulnocarpal arthritis

Sub-classification of 1B tear (by Atzei)

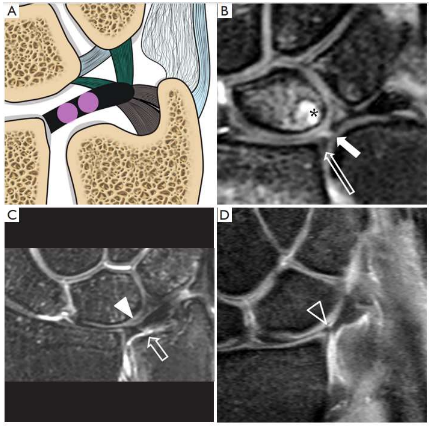
Table 11-1 Classification of TFCC Peripheral Tears Modified from Atzei[15]

	Class 1 Repairable Distal Tear	Class 2 Repairable Complete Tear	Class 3 Repairable Proximal Tear	Class 4 Nonrepairable Tear	Class 5 Arthritic DRUJ
					
Clinical DRUJ Instability	None/Slight	Mild/Severe		Severe	Mild/Severe
Appearance of TFCC Distal Component (RC Arthroscopy)	Torn	Torn	Intact	Torn	Variable
Status of TFCC Proximal Component (Hook test/DRUJ arthroscopy)	Intact	Torn	Torn	Torn	

Classification & Treatment



▣ **Palmer class 1A**



(B) full thickness tear with a small gap filled with fluid (short solid arrow).

(C) partial thickness tear at the undersurface of the TFC (short block arrow).

(D) contour irregularity (block arrowhead) of the TFC is also a sign of TFC tear

Classification & Treatment

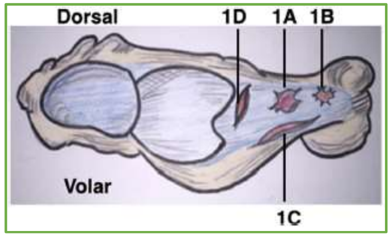
▣ **Palmer class 1A**

▶ Non-operative measures initially

▶ If significant symptoms persist, arthroscopic debridement may provide relief

▶ TFCC 중앙의 조직은 혈관 공급과 신경 분포가 없으므로,

불안정한 파열판을 제거하고 안정적인 조직이 나타날 때까지 변연절제술을 시행

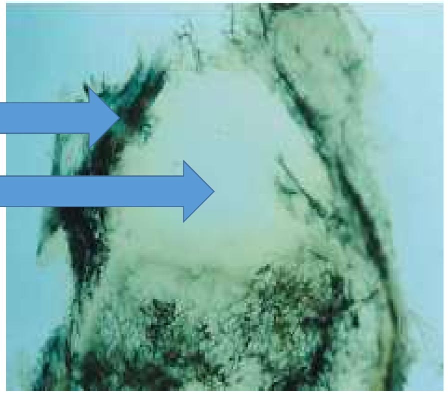


Majority of the central portion can be removed without risk of instability

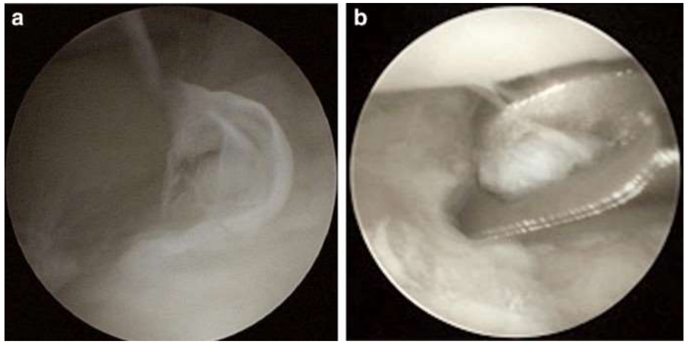
* Blood supply

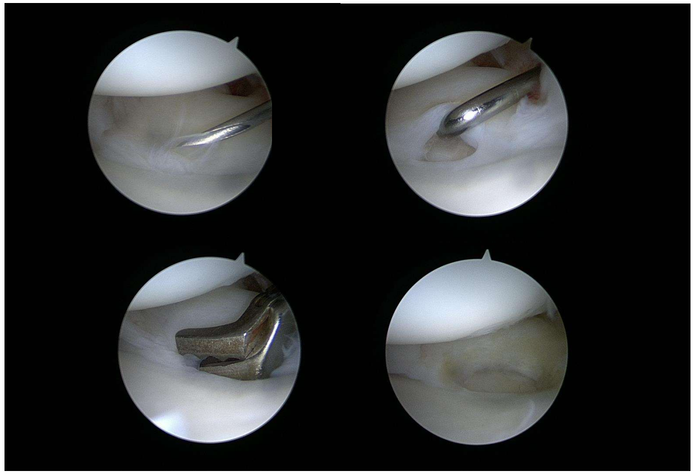
Peripheral : rich

central : poor

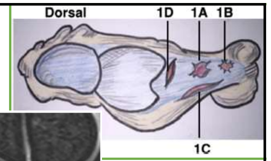


Classification & Treatment

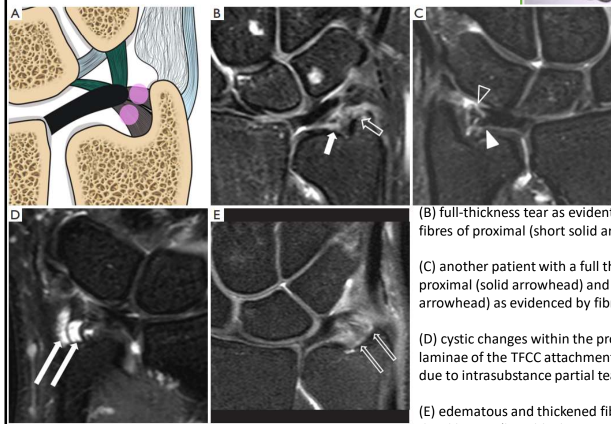




Classification & Treatment



▣ **Palmer class 1B**



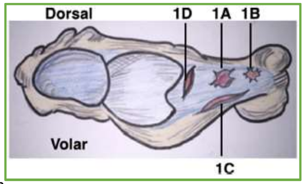
(B) full-thickness tear as evident by complete loss of fibres of proximal (short solid arrow)

(C) another patient with a full thickness tear at the proximal (solid arrowhead) and distal laminae (block arrowhead) as evidenced by fibre discontinuity

(D) cystic changes within the proximal and distal laminae of the TFCC attachments (long solid arrows) due to intrasubstance partial tear

(E) edematous and thickened fibres of the proximal and distal lamina (long block arrows) due to high grade partial tear. Overall lamina continuity seems to be maintained.

Classification & Treatment



▣ Palmer class 1B

▶ Associated with late instability in a younger population

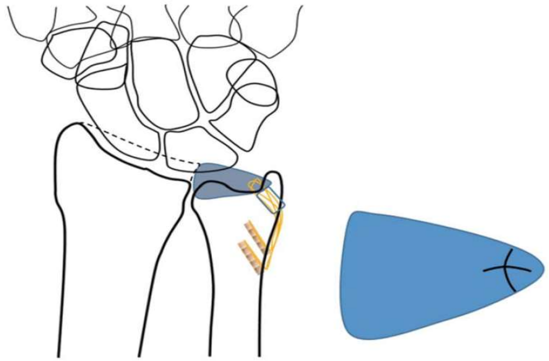
▶ Immobilization for 6 weeks followed by rehabilitation may be sufficient

▶ Persistent Sx / DRUJ instability → **A/S repair**
(수술을 시행하게 되는 가장 흔한 손상 기전)

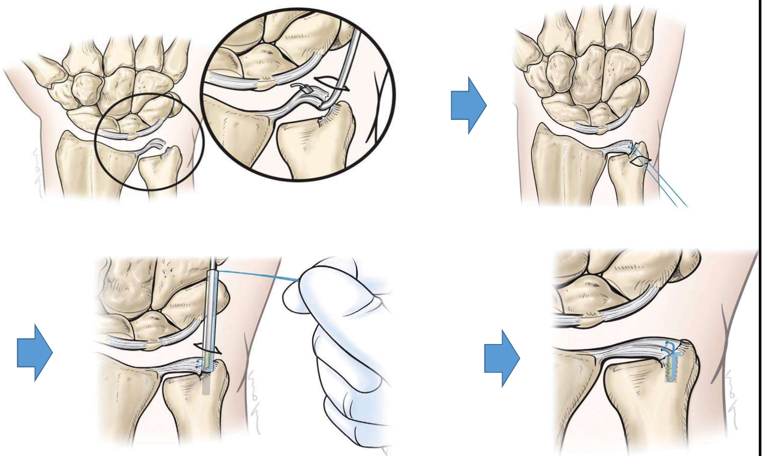
▶ Treatment

- Arthroscopic transosseous repair
- Arthroscopic knotless repair
- Atzei technique (repair through direct foveal portal)
- Outside-in repair of stable peripheral TFCC tear
: No single tech. has been to shown to be superior

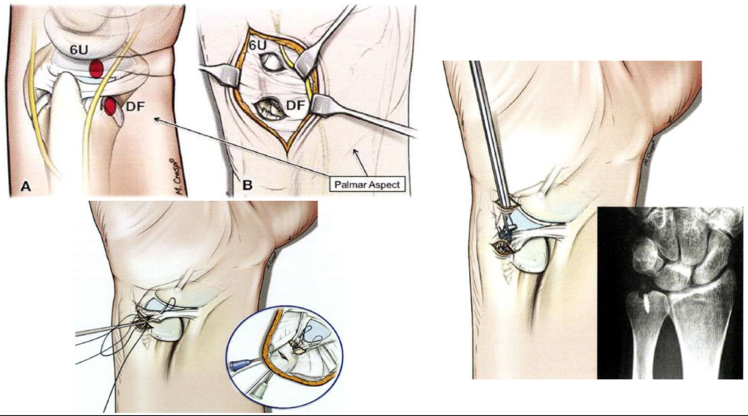
Arthroscopic transosseous repair



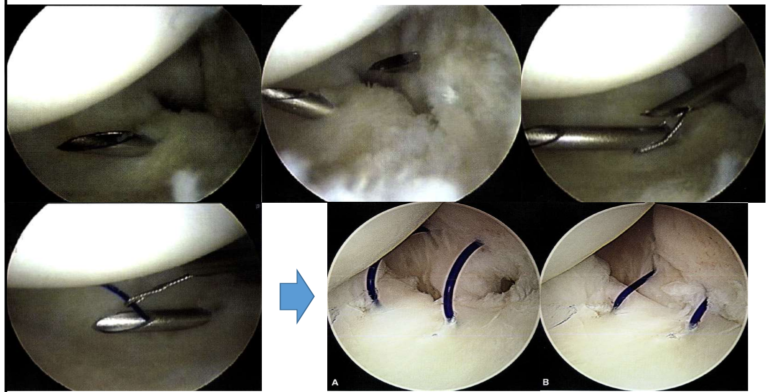
Arthroscopic knotless repair



Atzei technique (repair through direct foveal portal)

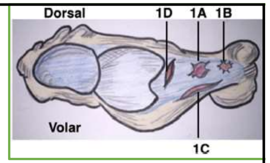


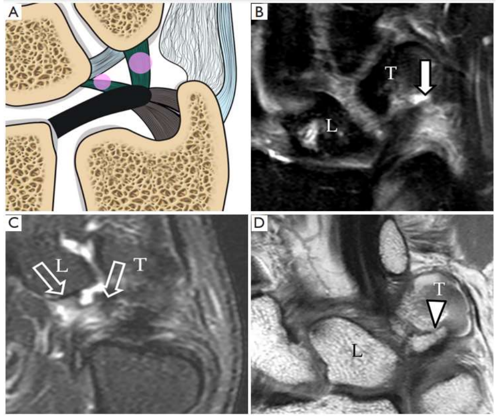
Outside-in repair
(stable peripheral TFCC tear)



Classification & Treatment

▣ **Palmer class 1C**





(B) severe edematous change with thickening at the ulnotriquetral ligament (short solid arrow) consistent with a intrasubstance partial tear of this ligament

(C) another patient shows severe oedematous change with thickening at the ulnolunate ligament (short block arrows) attaching to proximal lunate (L) consistent with an intrasubstance partial tear

(D) another patient shows avulsion fracture of proximal triquetrum (T) at the attachment of the ulnotriquetral ligament (solid arrowhead).

Classification & Treatment

▣ **Palmer class 1C - rare**

▶ Rupture along volar attachment of TFCC and UC ligaments

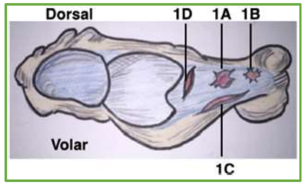
→ Suture tied over capsule

▶ Longitudinal split tear of ulnotriquetral ligament

→ Arthroscopic suture

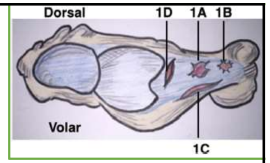
▶ Distal transverse tear or avulsion of UT ligament

→ Open reapir



Classification & Treatment

▣ **Palmer class 1D**



(B) Avulsion tear present at the radial attachment (short solid arrow).
Peripheral retraction of the TFCC is noted (short block arrow)

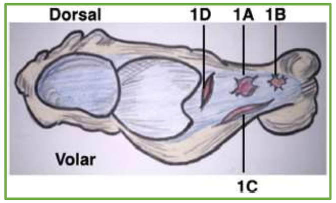
(C) Another patient showed avulsion tear at the radial attachment (solid arrowhead) associated with peripheral retraction of the TFC leaving a gap filled up with fluid (block arrowhead).

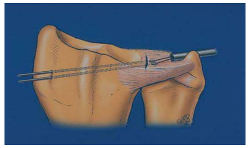
Classification & Treatment

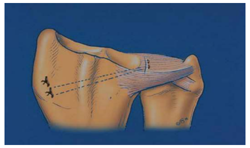
▣ **Palmer class 1D**

Tear with stable DRUJ
→ Similar to type 1A tear
→ Arthroscopic debridement

Tear with unstable DRUJ
→ Repair to sigmoid notch







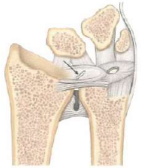
▣ 24세 남자가 내원 3개월 전에 손을 짚고 넘어지면서 우측 손목 통증이 발생하였다. 보존적 치료에 호전이 없었으며, 신체검사에서 손목을 척측변위하여 회전시킬 때 통증이 유발되었다. 방사선 소견은 정상이었다. MRI 와 관절경 소견이 다음과 같을 때 가장 적절한 치료는?

① TFCC 부분절제술
② TFCC 관절막 봉합술
③ TFCC fovea 봉합술
④ 원위요척인대 재건술
⑤ Sauve-Kapanji 술식

답: 3

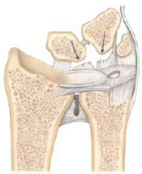
1. 다음 TFCC의 tear의 형태 중 ulna styloid process fracture와 잘 동반되며, 젊은 환자들에게 있어서 치료를 방치할 경우 DRUJ instability로 이어질 수 있는 가장 관계 깊은 tear의 형태는? 13B2

㉮



㉯

㉰



㉱

답: 나

Reference

▣ Functional anatomy of the triangular fibrocartilage complex
▶ T Nakamura 1 , Y Yabe, Y Horiuchi
▶ J Hand Surg. Br 1996 Oct;21(5):581-6.

▣ TFCC injuries: How we treat?
▶ Akram Jawed
▶ Journal of Clinical Orthopaedics and Trauma 2020.06

▣ Campbells Operative Orthopaedics,13ed

L-HNP
Diagnosis & Radiologic evaluation & Treatment

Myong-ji Hospital
Orthopedics

Introduction

▣ **Epidemiology**

▶ Peak incidence : 30 ~ 50
▶ Lifetime prevalence : 10%
▶ Affecting about 5% of the population
▶ Male : Female = 3:1
▶ 95% involve L4-5 or L5-S1 levels

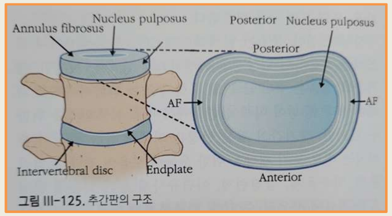


그림 III-125. 추간판의 구조

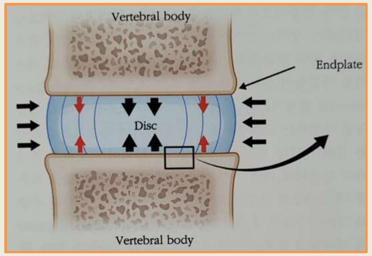
Anatomy

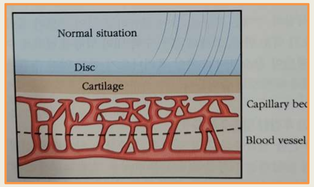
▣ **Intervertebral disc**
▶ Fibrous cartilaginous complex
▶ Annulus fibrosis + Nucleus pulposus + Cartilage endplate(hyaline cartilage)

▣ **Nucleus pulposus**
▶ 40%, Composed of type II collagen, proteoglycans, elastin fiber, water
▶ Characterized by Compressibility
→ Low collagen / high proteoglycan ratio (high % dry weight of proteoglycans)
→ Proteoglycans interact with water and resist compression

▣ **Annulus fibrosis**
▶ Above 20 lamellar structures + Sharpey's fiber
▶ Composed of type I collagen, proteoglycans, water
▶ Characterized by Extensibility and Tensile strength
→ High collagen / low proteoglycan ratio (low % dry weight of proteoglycans)

Anatomy





Anatomic classification

▣ **Protrusion**

▶ Eccentric bulging with an intact annulus

▣ **Extrusion**

▶ Disc material herniates through annulus but remains continuous with disc space
→ Subligamentous extrusion
→ Transligamentous extrusion

▣ **Sequesteration**

▶ Disc material herniates through annulus + No longer continuous with disc space

Anatomic classification

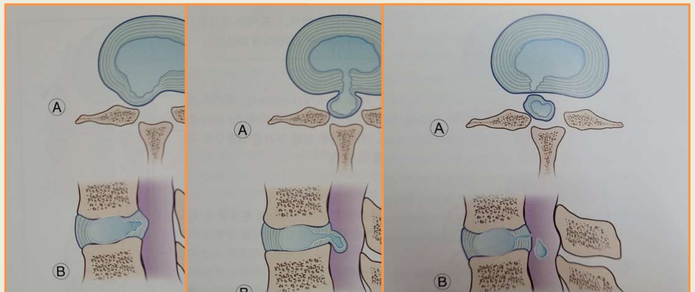


그림 III-129. (A, B) 추간판 돌출: 추간판이 원 며, 아직 외부 섬유륜의 일부가 파열되지 않아 수 이다.

그림 III-130. (A, B) 추간판 탈출: 추간판 섬유륜 전 가 섬유륜의 균열을 통해 완전히 빠져나온 상태이다.

그림 III-131. (A, B) 추간판 격리(유리): 탈출된 추간판 혹은 수핵이 모체와 연결이 단절되어 유리된 상태를 말한다.

Location classification

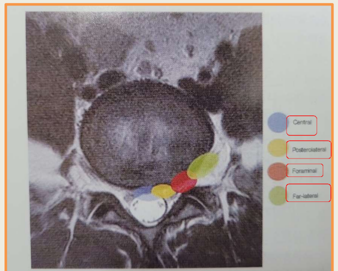


그림 III-132. 추간판 탈출증의 위치에 따른 분류.

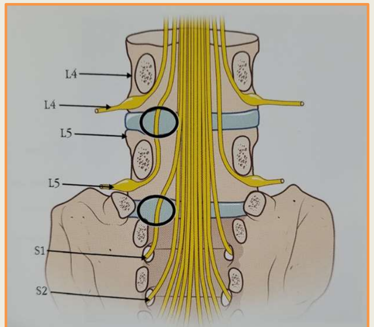


그림 III-128. 일반적으로 요추 추간판 탈출증에서 중심성, 혹은 후외측으로 탈출된 추간판은 추간판을 가로지르는 신경(제 4-5요추간 탈출 시 제 5신경근)을 압박한다. 하지만, 극외측 추간판 탈출증은 한 분절 위의 신경(제 4-5요추간 탈출 시 제 4신경근)을 압박한다.

Location classification

▣ **Central (30%)**
▶ Often associated with back pain only
▶ Present with cauda equina syndrome which is a surgical emergency

▣ **Posterolateral (paracentral) (60%)**
▶ Most common
▶ Affects the traversing/descending/lower nerve root
→ at L4/5 affects L5 nerve root

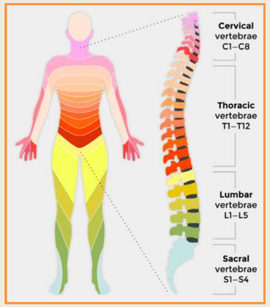
▣ **Foraminal (far lateral) (10 %)**
▶ Less common (5~10 %)
▶ Affects exiting/upper nerve root
→ at L4/5 affects L4 nerve root
▶ Herniated disc material directly compresses dorsal root ganglion

Symptoms

▣ Axial back pain (low back pain)
- ▶ May be discogenic or mechanical in nature
- ▶ Snapping sensation, Catching sensation

▣ Radicular pain (buttock, leg pain)
- ▶ Often worse with sitting, improves with standing
- ▶ Symptoms worsened by coughing, valsalva, sneezing

▣ Cauda equina syndrome
- ▶ Bilateral leg pain
- ▶ Lower extremities weakness
- ▶ Saddle anesthesia
- ▶ Bowel / bladder symptoms



Physical exam.

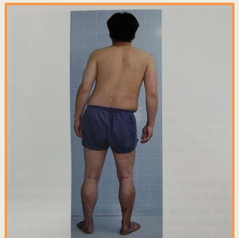


그림 III-133. 추간판 탈출증으로 인한 측만 현상(trunk list). 특발성 척추측만증에서 볼 수 있는 보상(compensation)현상이 없어 이와 감별을 요한다.

▣ Shoulder type
- ▶ 신경근의 외측으로 탈출된 경우
- ▶ 탈출되어 나온 반대쪽으로 몸을 기울여 무의식적으로 신경근의 자극을 피함

▣ Axillary type
- ▶ 신경근의 내측으로 탈출된 경우
- ▶ 탈출되어 나온 쪽으로 몸을 기울임

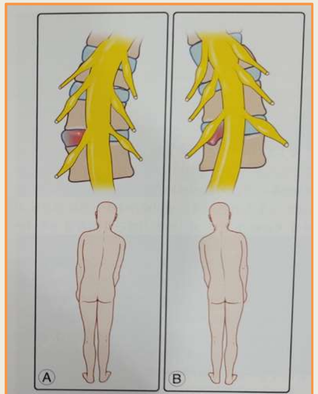


그림 III-134. 추간판 탈출의 위치에 따른 척추 측만의 방향. (A) 신경근의 외측으로 돌출되면 반대편으로 편향됨. (B) 신경근의 내측으로 돌출되면 같은 쪽으로 편향됨.

Physical exam.

	Primary motion	Primary Muscles	Sensory	Reflex
L2, 3	Hip flexion	Iliopsoas	Anterior & inner thigh	None
	Hip adduction	Hip adductors		
L4	Knee extension	Quadriceps	Lateral thigh, anterior knee & medial leg	Patella
L5	Ankle dorsiflexion	tibialis anterior	Lateral leg & dorsal foot	None
	Foot inversion	tibialis posterior		
	Toe dorsiflexion	EHL, EDL		
	Hip extension	hamstrings & gluteus max		
	Hip abduction	gluteus medius		
S1	Ankle plantarflexion	gastroc-soleus	Posterior leg	Achilles
	Foot eversion	peroneals		

Physical exam.

▣ Straight leg raise test
- ▶ Tension sign for L5, S1 nerve root
- ▶ Reproduces pain and paresthesia in leg at 30~70 degrees hip flexion

▣ Femoral nerve stretching test
- ▶ Tension sign for L2, L3, L4 nerve root

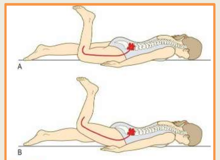


Fig. 14.26 Stretch test: femoral nerve. (A) Pain may be triggered by knee flexion alone. (B) Pain may be triggered by knee flexion in combination with hip extension.

▣ Bowstring sign
- ▶ SLR aggravated by compression on popliteal fossa

▣ Kernig test
- ▶ Pain reproduced with neck flexion, hip flexion, and leg extension

Imaging

▣ **Radiographs**

▶ Degenerative changes

▣ **MRI without gadolinium**

▶ Ability to image the nerve root in the foramen
→ infection (IV drug user)
→ tumor (Cancer)
→ trauma (Car accident or fall)
→ cauda equina syndrome (Bowel/bladder changes)

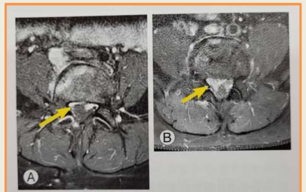


그림 III-138. 재발성 추간판 탈출증(A)과 반흔 조직 유착(B)의 gadolinium 증강 MRI 사진. 재발성 탈출증(A)은 탈출 추간판 조직 주변의 조영증강(rim enhancement)을 볼 수 있으나, 반흔 조직(B)은 전체적으로 조영증강을 나타낸다.

▣ **MRI with gadolinium**

▶ HIZ (high-intensity zone) : annulus fibrosis
→ Post-surgical fibrosis (enhances with gadolinium)
→ Recurrent herniated disc (does not enhance with gadolinium)

Imaging

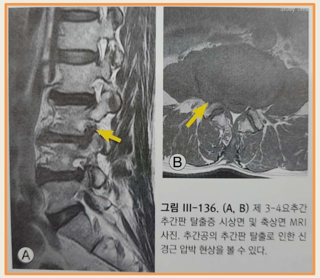


그림 III-136. (A, B) 제 3-4요추간 추간판 탈출증 시상면 및 축상면 MRI 사진. 추간공의 추간판 탈출로 인한 신경근 압박 현상을 볼 수 있다.

그림 III-137. MRI 촬영 시 T2 강조 영상에서 섬유륜 후방에 국소적으로 영상이 증강된 고강도대(HIZ)가 관찰된다.

Treatment

▣ **Non-operative (6 weeks)**

▶ Rest and physical therapy and antiinflammatory medications
→ 1st line of treatment for most patients with disc herniation
→ 90% improve without surgery

▶ Selective nerve root corticosteroid injections

Treatment

Figure 1. (A, B, C) Demonstrative cas

Figure 2. (A, B, C) Demonstrative case (4 months later).

Treatment

▣ Non-operative (6 weeks)

▶ Retraction of the protruded disc

▶ Disc regression is due to gradual dehydration and contraction
→ Dehydration within the nucleus pulposus caused extruded material to retract back into the annulus fibrosus

▶ Enzymatic degradation and phagocytosis of disc tissue due to inflammatory reaction and neovascularization
→ Autoimmune system recognizes extruded disc material as a "foreign body" in the epidural vascular space of the vertebra

Treatment

▣ Indication

▶ 보존적 치료를 6 ~12주 하여도 효과가 없는 참기 힘든 통증
▶ 하지마비가 초래되어 호전되지 않거나 진행되는 경우
▶ 대,소변 장애가 초래되는 경우
▶ 통증이 자주 재발하여 일상 생활이 어렵고 여가 선용에 지장이 있는 경우
▶ Cauda equina syndrome

▣ Operative

▶ Discectomy
▶ Far lateral microdiscectomy
→ For far-lateral disc herniations
▶ Laminotomy

Treatment

▣ 추간판 절제술 후 유합을 고려하는 경우

▶ 척추 분리증과 같은 선천적인 기형이 있을 때
▶ 척추 전위증
▶ 심한 퇴행성 변화가 동반되어 있을 때
▶ 술 후 심한 노동에 종사해야 하는 경우
▶ 만성적인 요통이 주증상 일 때
▶ 신경근이나 후근 신경절의 완전한 감압을 위해 후관절 돌기 등을 제거하는 경우

▣ Complications

▶ Dural tear (3%)
▶ Recurrent HNP
▶ Discitis (1%)
▶ Chronic low back pain
▶ Vascular catastrophe

Exercise

▣ 30세 남자로 요통으로 수개월 보존적 치료하다 이사짐 나르고 난 이후 악화된 요추부 통증 및 대소변 장애로 내원하였다. 시행한 MRI 상에서 추간판 탈출증이 요추 제 5요추 – 제 1 천추간 구간에 있으며, 척추관의 90%를 차지하고 있었다. 치료로 적절한 것은?

① 6주간 절대안정과 침상에서의 골반 견인
② 조기 보행, 투약 및 보조기 착용
③ 후궁절제술
④ 추간판 제거술
⑤ 인공디스크 치환술

Exercise

▣ 30세 남자로 요통으로 수개월 보존적 치료하다 이사짐 나르고 난 이후 악화된 요추부 통증 및 대소변 장애로 내원하였다. 시행한 MRI 상에서 추간판 탈출증이 요추 제 5요추 – 제 1 천추간 구간에 있으며, 척추관의 90%를 차지하고 있었다. 치료로 적절한 것은?

① 6주간 절대안정과 침상에서의 골반 견인
② 조기 보행, 투약 및 보조기 착용
③ 후궁절제술
④ 추간판 제거술
⑤ 인공디스크 치환술

Reference

▣ 정형외과학 제 8판
P1136 ~ 1146

▣ Spontaneous regression of herniated nucleus pulposus. Medicine
Okan Turk, Mda etc. Medicine (2019) 98:8(e14667)

▣ https://www.orthobullets.com/spine/2035/lumbar-disc-herniation

SLAC & SNAC

Scaphoid Lunate Advanced Collapse
Scaphoid Nonunion Advanced Collapse

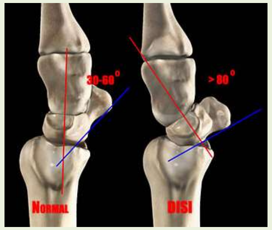
Myong-ji Hospital
Orthopedics
2023.08.18
R2. 김수영

SLAC

▶ Specific pattern of degenerative arthritis
seen in **Chronic dissociation between the scaphoid and lunate**

▶ Chronic SL ligament injury creates a DISI deformity
→ resultant scaphoid volar-flexion and lunate dorsi-flexion

▶ Affects the radioscaphoid joint and progresses to capitolunate joint
→ the radiolunate joint is spared



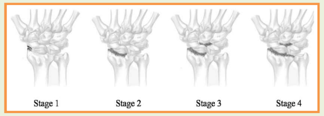
Classification

▣ **Watson Classification**

▶ Predictable progression of degenerative changes
Radial styloid to the entire scaphoid facet → unstable capitolunate joint
(Radiolunate joint is spared)

▶ Stage I : Arthritis between scaphoid and radial styloid
▶ Stage II : Arthritis between scaphoid and entire scaphoid facet of the radius
▶ Stage III : Arthritis (additional) between capitate and lunate

▶ Stage IV
: Pancarpal arthritis observed in rare cases where radiolunate joint is affected



Diagnosis

▣ **Sx.**

▶ Difficulty bearing weight across wrist
▶ Localize pain in region of scapholunate interval
▶ Progressive weakness of affected hand
▶ Wrist stiffness

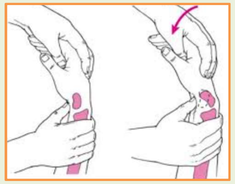
▣ **Pex.**

▶ Tenderness directly over scapholunate ligament dorsally
▶ Decreased wrist ROM
▶ Weakness of grip strength
▶ Watson scaphoid shift test (scapholunate instability check)

Watson scaphoid shift test

▣ Watson's test

- ▶ Use evaluate scaphoid stability (scaphoid & lunate)
- ▶ Place a thumb over patient's scaphoid tuberosity (distal pole of the scaphoid in the volar side)
- ▶ Other fingers are placed dorsally behind the radius
- ▶ Pt : ulnar deviation and extension slightly / Ex : radially and flexed slightly
- ▶ Pressure
  → the scaphoid is pushed dorsally out of the radial fossa
  → pain and a clunk
- ▶ Scaphoid Shift Test is positive when the proximal pole of the scaphoid shifts to the dorsal rim of the scaphoid fossa, subluxate, and bump against the examiner's index finger

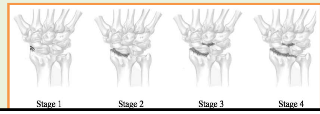


Radiograph

▣ PA radiograph

- ▶ Reveal greater than 3mm diastasis between the scaphoid and lunate

- ▶ Stage I SLAC wrist
  : Radial styloid beaking, sclerosis and joint space narrowing between scaphoid and radial styloid
- ▶ Stage II SLAC wrist
  : Sclerosis and joint space narrowing between scaphoid and the entire scaphoid fossa of distal radius
- ▶ Stage III SLAC wrist
  : Sclerosis and joint space narrowing between the lunate and capitate, and the capitate will eventually migrate proximally into the space



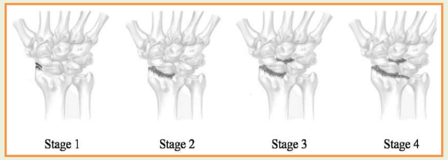
- ▶ Radial styloid beaking
- ▶ Entire scaphoid fossa of distal radius
- ▶ Lunate and capitate capitate will eventually migrate proximally

Treatment

▣ Treatment

▶ Non-op
→ NSAIDs, wrist splinting, corticosteroid injections

▶ Op
→ Radial styloidectomy and Limited intercarpal fusion (I)
→ Proximal row carpectomy (II)
→ Scaphoid excision and four corner fusion (II or III)
→ Wrist fusion (III)



Operation

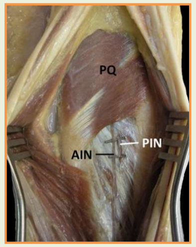
▣ Radial styloidectomy and Limited intercarpal fusion (I)

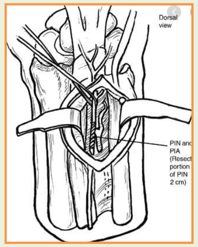
- Prevents impingement between proximal scaphoid and radial styloid
- May be performed open or arthroscopically via 1,2 portal for instrumentation

Operation

▣ PIN and AIN denervation

- Since posterior and anterior interosseous nerve only provide proprioception and sensation to wrist capsule at their most distal branches, they can be safely dennervated to provide pain relief
- Used in combination with below procedures for Stage II or III





Operation

▣ Proximal row carpectomy (II)

- <u>Young patient who cannot operate arthrodesis</u> d/t wrist mobility
- Lunate fossa (radius) & Prox. Articular surface (capitate) intact
- Excising entire proximal row of carpal bones (scaphoid, lunate and triquetrum) while preserving radioscaphocapitate ligament
  (to prevent ulnar subluxation after proximal row carpectomy)

Operation

▣ Scaphoid excision and four corner fusion (II or III)

- Provides relative preservation of strength and motion
- Wrist motion occurs through the preserved articulation between lunate and distal radius (lunate fossa)

Operation

▣ Wrist fusion (III)

- ▶ Any form of pancarpal arthritis
- ▶ Wrist fusion gives best pain relief and good grip strength at the cost of wrist motion

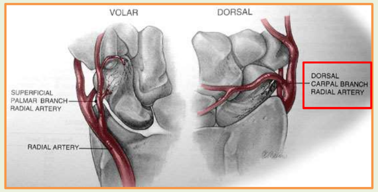
SNAC

▶ A condition characterized by advanced collapse and progressive arthritis of the wrist that results from a **Chronic scaphoid non-union**

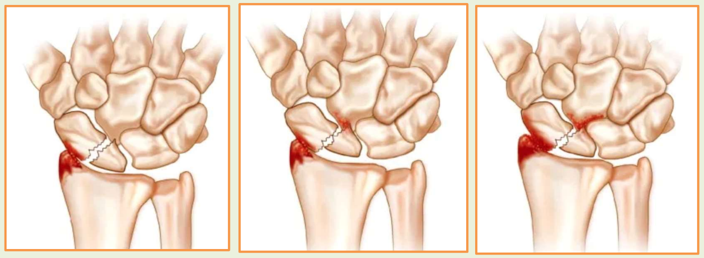
▣ Classification

- ▶ Stage I : Arthrosis localized to the radial side of the scaphoid and radial styloid
- ▶ Stage II : Scaphocapitate arthrosis in addition to Stage 1
- ▶ Stage III : Periscaphoid arthrosis (proximal lunate and capitate may be maintained)

(Stage IV: diffuse arthritis of carpus)



Classification



Diagnosis

▣ Sx.

- ▶ Weakness (reduced grip and pinch strength)
- ▶ Stiffness (extension and radial deviation)

▣ Pex.

- ▶ Palpation (localized tenderness of the radioscaphoid articulation)
- ▶ Motion (decreased wrist motion on extension and radial deviation)

Treatment

■ Treatment

▶ Non-op
→ Observation alone (low functioning patients only)

▶ Op
→ Radial styloidectomy + BG of scaphoid
→ Radial styloidectomy + excision of prox. fragment
→ Scaphoid excision + proximal row carpectomy (II)
→ Scaphoid excision + four corner fusion (II or III)
→ Wrist arthrodesis (III)

Exercise # 1.

■ 45세 환자가 손목 통증을 주소로 내원하였다. 진찰 소견에서 손목 요측 변위 시에 통증 및 관절 운동 범위의 감소가 있었다. 방사선 소견에서 주상골 요부의 불유합이 있었고, 요골 경상 돌기 주변에 골극이 많이 생겨 있었다. 다른 관절에 관절염은 없었다. 가장 옳은 치료는 ?

① 주상골 골 이식술
② 요골 경상돌기 절제술
③ 요골 경상돌기 절제술 및 주상골 골이식술
④ 주상골 절제술 및 four corner fusion
⑤ 주상골 절제술

Exercise # 1.

■ 45세 환자가 손목 통증을 주소로 내원하였다. 진찰 소견에서 손목 요측 변위 시에 통증 및 관절 운동 범위의 감소가 있었다. 방사선 소견에서 주상골 요부의 불유합이 있었고, 요골 경상 돌기 주변에 골극이 많이 생겨 있었다. 다른 관절에 관절염은 없었다. 가장 옳은 치료는 ?

① 주상골 골 이식술
② 요골 경상돌기 절제술
③ 요골 경상돌기 절제술 및 주상골 골이식술
④ 주상골 절제술 및 four corner fusion
⑤ 주상골 절제술

환자의 problem list
1) 45세
2) 주상골 요부의 불유합
3) 요골 경상돌기 주변의 골극
-> SNAC stage I
-> 본환자는 비교적 젊은 나이로 요골 경상돌기 절제술 단독보다는 주상골 골 이식술과 요골 경상돌기 절제술을 함께 시행하거나 근위 수근열 절제술 (proximal row carpectomy)을 고려할 수 있다

요골 경상돌기 절제술 단독은 경상돌기 주변에 골극이 많이 생겨 손목의 운동범위가 줄어들거나, 요측 변위시에 통증이 있을 때 적응증이 되나 이 술식의 단독 이용은 일시적인 증상 완화만을 일으킬 따름이며, 퇴행성 변화는 계속 빠른 상태로 진행하게 되므로, 노년층에서만 아주 제한적으로 시행되거나 다른 술기와 함께 사용하는 것으로 알려져 있다. 요골 경상돌기를 1cm 이상을 절제하면, 수근 관절의 전방 안정성에 매우 중요한 요주상유두인대 (radioscaphocapitate ligament)의 부착부에 손상을 줄 수 있으므로 주의를 요한다.

Exercise # 2.

▣ 44세 남자가 3년 간 손목 관절의 통증을 호소하였으며, 사진과 같은 소견을 보였다. 가장 적절한 치료는 ?

① Triscaphe fusion
② Silastic scaphoid replacement
③ Proximal row carpectomty
④ Four corner fusion with scaphoid excision
⑤ Total wrist fusion

Exercise # 2.

▣ 44세 남자가 3년 간 손목 관절의 통증을 호소하였으며, 사진과 같은 소견을 보였다. 가장 적절한 치료는 ?

① Triscaphe fusion
② Silastic scaphoid replacement
③ Proximal row carpectomty
④ Four corner fusion with scaphoid excision
⑤ Total wrist fusion

환자의 problem
- SLAC stage III
-> scaphoid excision과 four corner fusion이 함께 시행되야 한다

Exercise # 3.

▣ 50세 남자호 수년전 손목 부위를 수상 한 뒤, 특별한 치료 없이 지냈다고 하며, 이후로 점차 손목 부위 통증이 심해져 내원하였다. 사진은 다음과 같다. 적절한 치료는?

① Scapholunate ligament reconstruction
② Proximal row carpectomy
③ STT fusion
④ SC fusion
⑤ Radial styloidectomy

Exercise # 3.

▣ 50세 남자호 수년전 손목 부위를 수상 한 뒤, 특별한 치료 없이 지냈다고 하며, 이후로 점차 손목 부위 통증이 심해져 내원하였다. 사진은 다음과 같다. 적절한 치료는?

① Scapholunate ligament reconstruction
② Proximal row carpectomy
③ STT fusion
④ SC fusion
⑤ Radial styloidectomy

☞ 환자의 problem list

1) 50세 남자. Chronic wrist pain after injury

2) X-ray: radiograph shows sclerosis and joint space narrowing between scaphoid and the entire scaphoid fossa of distal radius and S-L gap widening

-> SLAC stage II

-> scaphoid excision + four corner fusion or proximal row carpectomy

Reference

▣ Campbells Operative Orthopaedics,14ed

Seminars in Arthroplasty 33 (2023) 352–359

Available online at www.sciencedirect.com
ScienceDirect

ELSEVIER

www.jsesarthroplasty.org

Seminars in Arthroplasty: JSES

The role of center of rotation on subscapularis biomechanics in reverse shoulder arthroplasty: a simulation study

Morgan Everly, MS[a], Jay M. Levin, MD, MBA[b], Oke Anakwenze, MD, MBA[b], and Katherine R. Saul, PhD[a,*]

[a]North Carolina State University, Raleigh, NC, USA
[b]Duke University, Durham, NC, USA

Introduction

- Reverse shoulder arthroplasty (RSA)
  - Gold standard for surgical management of rotator cuff arthropathy
    - Eno et al.
  - Risk of limited functional internal rotation(IR) postoperatively
    - Levy et al.
  - IR is critical in enabling activities of daily living, and thus is an area of considerable interest
    - Acklnad et al.

Introduction

- Glenoid lateralization
  - Various factors including glenoid lateralization, humeral neck shaft angle, humeral retroversion, glenosphere diameter, subscapularis repair have been associated with improved functional IR after RSA
    - Gruber et al.
  - Virtual range of motion (ROM) analyses which have shown improved impingement-free ROM with glenoid lateralization
    - Arenas-Miquelez et al.
  - Higher active IR in patients with increased glenoid lateralization
    - Werner et al.

Purpose

- To use a validated computational musculoskeletal model of the shoulder to examine the influence of glenosphere lateralization and superoinferior placement on subscapularis strength

- Hypothesis
  - Glenosphere lateralization will result in a more anatomic muscle-tendon length of the subscapularis and a larger capacity to generate IR torque across the glenohumeral joint

Materials and Methods

- Simulation performed using an existing computational shoulder model
- Glenohumeral COR and humeral head position were translated medially for the native COR position along the scapular spine axis
  - -10mm (lateralized glenoid)
  - -20mm
  - -30mm (medialized glenoid)
- COR shifted 10mm superior and inferior to native COR

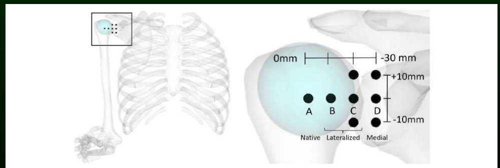


Figure 1 – Location of simulated centers of rotation. The medial RSA COR (location D) is located 30 mm medial to the native location (COR –30 mm) (location A) based on reports by Saltzman et al[13] Additional simulated locations representing various degrees of lateralization are placed at 20 mm (COR –20 mm) and 10 mm (COR –10 mm) medial to native COR. These points are labeled B and C. COR change was accomplished by shifting the center of rotation of the shoulder joint (coincident with the center of the humeral head in the native intact model, and the center of the glenosphere in the RSA model), effectively displacing the COR and the humeral position in the direction desired.

Materials and Methods

- Various factors computed over -40° to 40° shoulder axial rotation (IR = positive) in neutral abduction
  - Subscapularis IR torque
  - Moment arm
  - Force-generating capacity
  - Muscle-tendon length

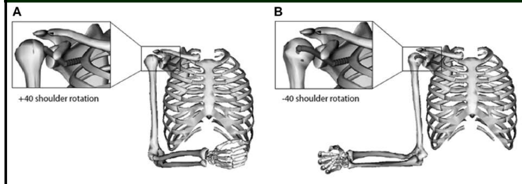


Figure 2 – Musculoskeletal model of the upper limb; only subscapularis muscle is visualized for visibility. Each RSA COR was simulated with elbow flexion at 90° with outcomes simulated through a shoulder rotation range of –40° (external rotation, B) to 40° (IR, A).

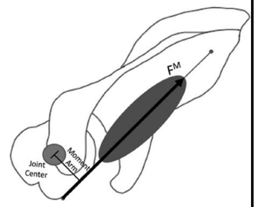
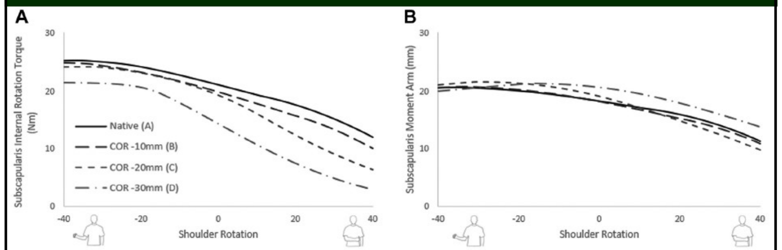
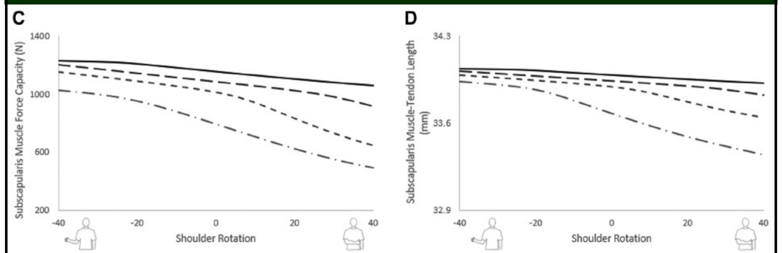


Figure 3 – Visual representation of the moment arm, the perpendicular distance from the muscle force (F^M) to the joint center.

Result



Result



Result

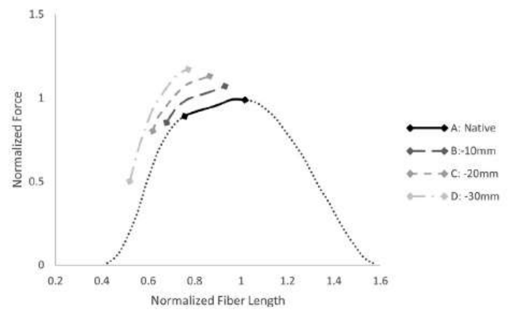


Figure 5 – Normalized force vs. normalized fiber length. As the COR placement becomes more medial (native COR, —), closer to the most medial RSA placement (light grey), the fiber length excursion range shifts to the left, resulting in lower possible forces.

Result

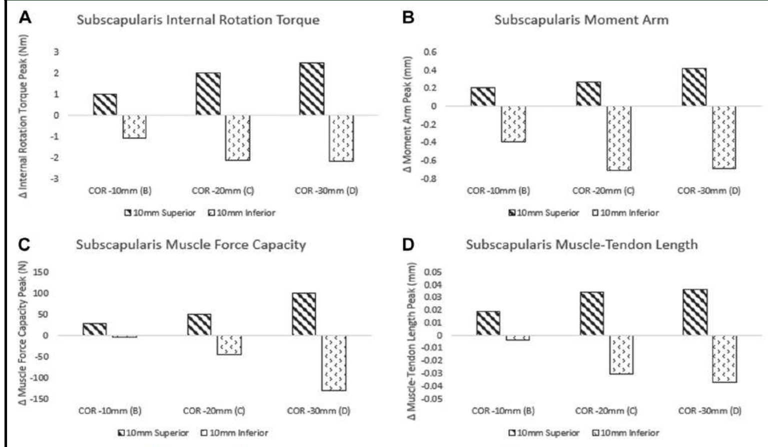


Figure 6 – Change in subscapularis IR torque (A), moment arm (B), muscle force (C), and muscle-tendon length (D) peaks for COR −30 mm, −20 mm, and −10 mm locations (c.f. Fig. 1) for inferior and superior placement. Striped bar indicates translation of the COR 10 mm superior and the dotted bar 10 mm inferior.

Discussion

- More lateralized glenosphere results in increased subscapularis IR torque
- Although the subscapularis moment arm, or mechanical advantage to drive IR, is mostly unaffected by mediolateral glenosphere placement, the force-generating capacity decreases with medicalization due to muscle slackening in accordance with the force-length behavior of muscle
- Up to 15% reduction in subscapularis IR torque when choosing the most medial glenosphere position (COR -30mm)
- Minimal loss of IR torque in lateralized COR (COR -20mm or -10mm)

Limitation

- Musculoskeletal model represents a 50th percentile healthy male and does not explicitly capture variability within the human population or alterations to muscle structure associated with shoulder pathology
- This study is designed to isolate the effect of glenosphere position on subscapularis, without concomitant effects of various other surgical or implant characteristics
- This study only evaluated IR in a neutral abduction posture

Conclusion

- Medializing the glenosphere contributes to reduced subscapularis IR torque, primarily due to muscle-tendon slackening in accordance with muscle force-length behavior

- These results support use of a lateralized glenosphere to improve subscapularis strength, and thus potentially increase functional IR after RSA

TKA surgical approach & Bone preparation

명지병원 정형외과

R2. 우창우

Case

- **1301961 우석재 F/63**

▣ **Chief Complaint**
- Rt. knee pain

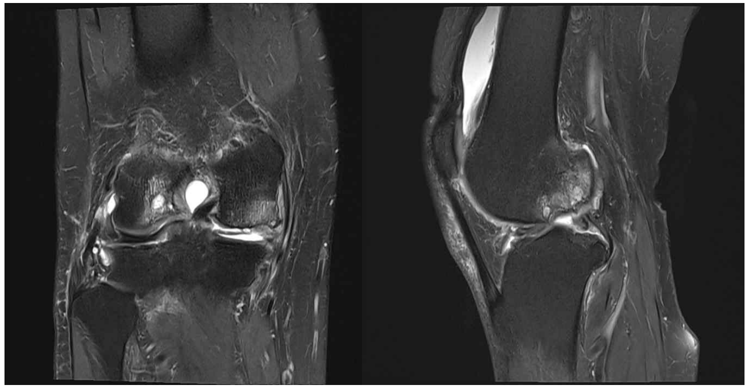
▣ **Medical history**
- 69세 여자환자 내원 5년 전 특이 외상력 없이 발생한 Rt. knee pain을 주소로 외래 경유 입원함.

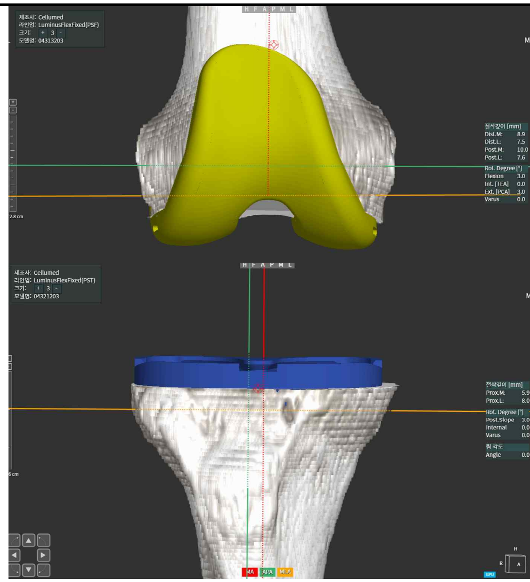
▣ **Height/Weight (BMI)** : 158cm/58kg (23.2)

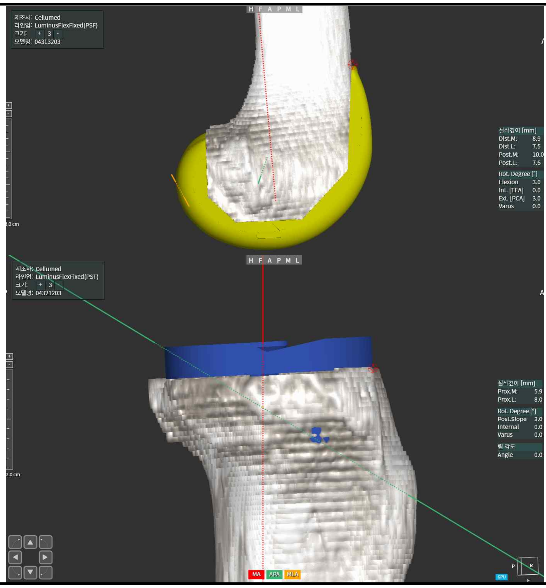
▣**OP Hx** -

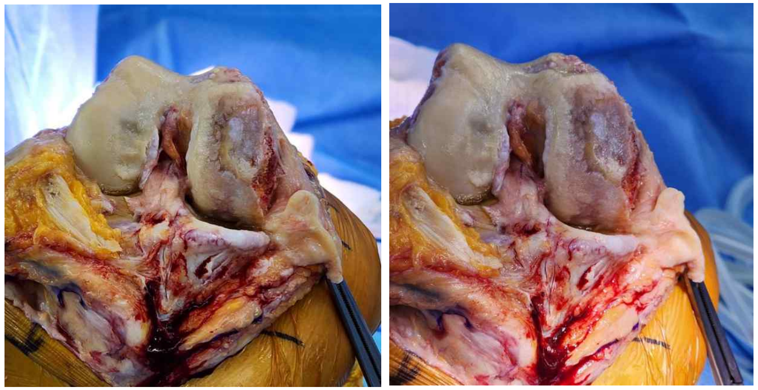
▣ **Admission date :** 2023.08.31

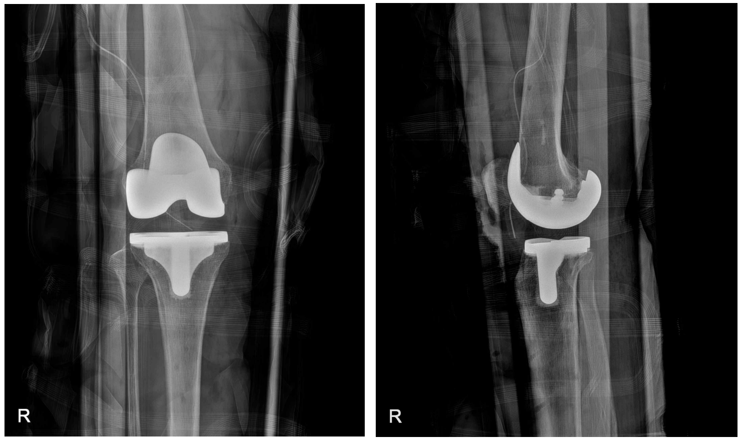
▣ **Operation date :** 2023.09.01











Index

▣ Surgical approach

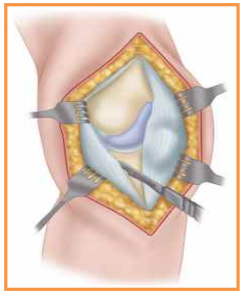
▣ Bone preparation

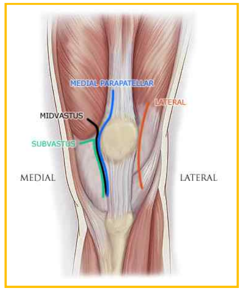
Surgical approach

▣ Skin incision

Surgical approach

▣ Medial parapatellar retinacular approach
- ▶ Standard retinacular incision
- ▶ Along quadriceps tendon leaving 3-4mm tendon
- ▶ Medial side of the patella,
  3-4cm extending to anteromedial surface of tibia

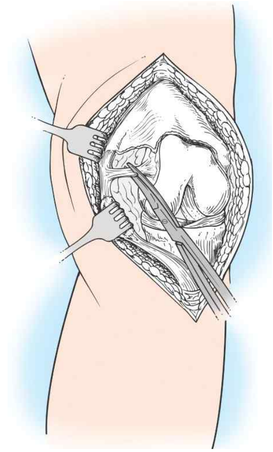




Surgical approach

▣ Medial parapatellar retinacular approach

▶ Lateral patellofemoral plicae excision for extensor mechanism mobilization



Surgical approach

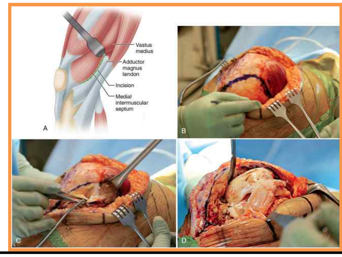
▣ Subvastus approach

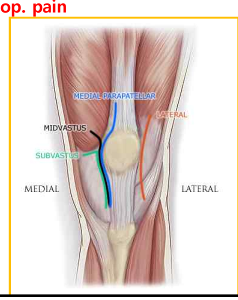
▶ Lift **entire extensor mechanism** off **medial intermuscular septum** and **subluxing it laterally** for exposure

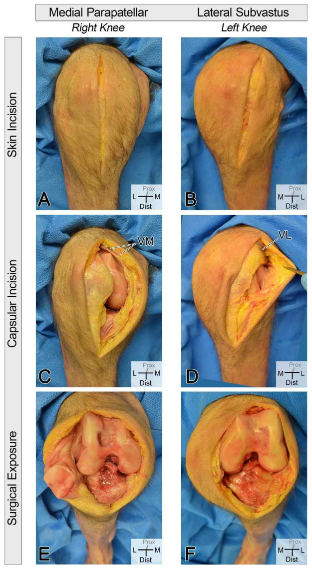
▶ Reduces patellofemoral complication & expedite the return of quadriceps function

▶ Improves patient satisfaction through **reducing post op. pain**

▶ Exposure can be limited







Surgical approach

▣ Midvastus approach

▶ **Vastus medialis splitted** in line with its fibers

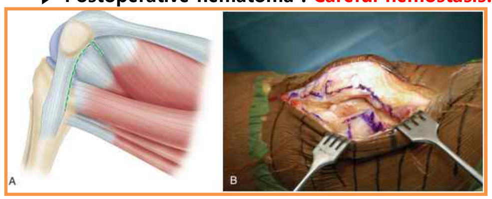
▶ Safe zone of 4.5cm of the vastus medialis sharply splitted (Cooper et al, 1999)

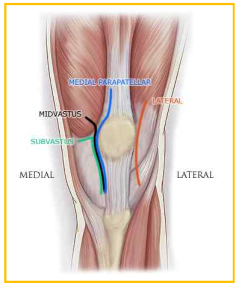
▶ Bluntly dissected further

▶ Preserves the **superior medial genicular artery**

Subvastus & Midvastus approach

▶ Postoperative hematoma : **Careful hemostasis!**





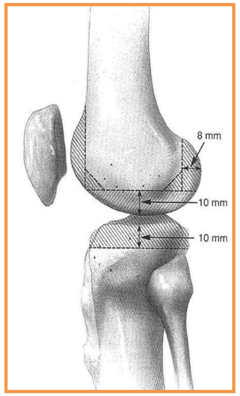
Surgical approach

▣ Quadriceps sparing approach (MIS)
- ▶ first introduced in 2003 by Tria to find a less invasive approach
- ▶ typically 4 to 6 inches versus 8 to 10 inches for traditional TKR
- ▶ curved medial incision from the superior pole of the patella and ends just below the tibiofemoral joint line
- ▶ special modified instruments are used to complete the TKA
- ▶ In "difficult" knees can be extended and converted either in MPP or midvastus/subvastus

Bone preparation

▣ Principle
- ▶ Appropriate component sizing
- ▶ Alignment of components to restore mechanical axis
- ▶ Equal soft tissues balancing in flexion & extension
- ▶ Optimal patellar tracking

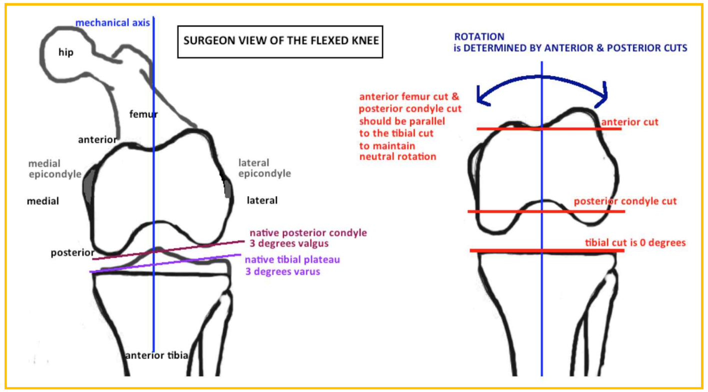
▣ Technique
- ▶ Measured technique
  - → Prosthesis 두께에 따라 bone resection
  - → Ligament balancing
- ▶ Gap technique
  - → Ligament balancing
  - → Flex. & Ex. Gap 에 따라 bone resection
- ▶ Measured & Gap technique



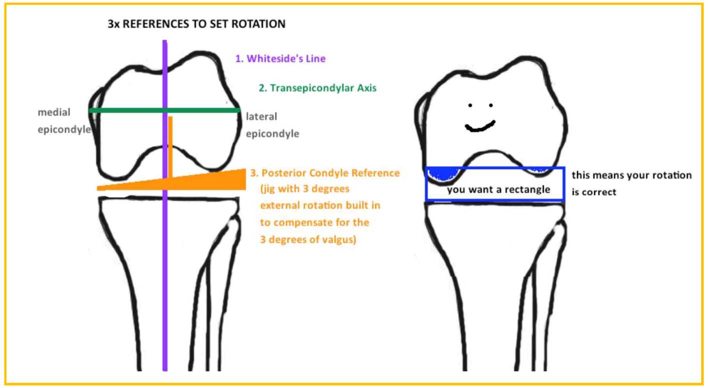
Distal femoral cutting

▣ Perpendicular to mechanical axis of the femur
- ▶ Valgus 6 degrees to anatomical axis
- ▶ Amount of bone removed = thickness of femoral component
- ▶ Significant pre-op flexion contracture
  - → Additional bone resection needed to aid in correction of extension gap

Distal femoral cutting



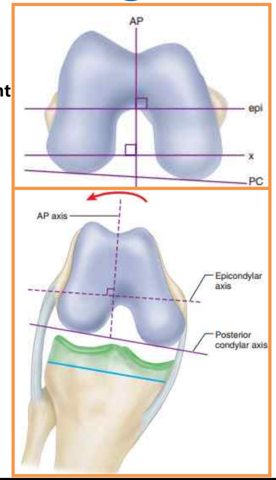
Distal femoral cutting



Distal femoral cutting

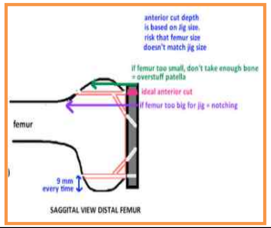
▣ Anterior & posterior femoral cutting
  ▶ Determine the rotation of the femoral component
  → ER : medial flexion gap ↑ → flexion instability
  → IR : lateral patellar tilt or medial side tightness

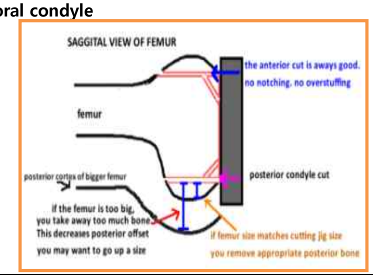
  ▶ Femoral component rotation
  → Transepicondylar axis
  → Anteroposterior axis
  → Posterior femoral condyles
    3 degrees of ER
    Femoral component IR in valgus knee
    d/t LFC hypoplasia
  → Cut surface of proximal tibia
    Parallel to the proximal tibia cut
    (Extension, After soft tissue balancing)



Posterior condyle resection

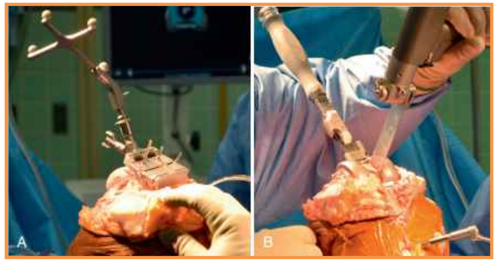
▣ Posterior referencing
  ▶ Direct measure the thickness of the posterior condyle
  ▶ More accurate in recreating the original dimensions of the distal femur
▣ Anterior referencing
  ▶ Measure AP dimension of the femoral condyles
    anterior cut based off the anterior femoral cortex
    ~ Articular surface of posterior femoral condyle
  ▶ Anterior femoral cortex notching ↓





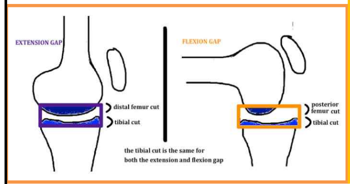
Ant. & post. chamfer cuts

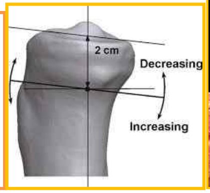
▣ Completion of the distal femoral preparation for CR type prosthesis
▣ Remove the bone for the intercondylar box to accommodate the housing for the post and cam mechanism for PS type

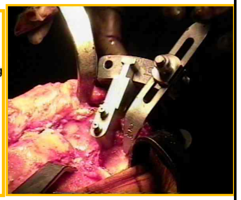


Proximal tibia cutting

▣ Perpendicular to the mechanical axis with the cutting block oriented by cutting guide
▣ Affects both the flexion and extension gap
▣ Posterior slope: 3 degrees, mostly
▶ Amount depends on the individual implant system (0~5′)
▣ The amount of tibial resection depends on which side of the joint(more or less arthritic) is used for reference.
▶ Arthritic side is referenced : 2mm or less
▶ Unaffected side is referenced : 8-10mm (close to implant size)

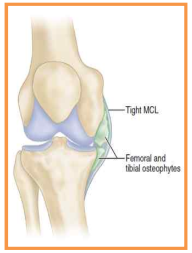


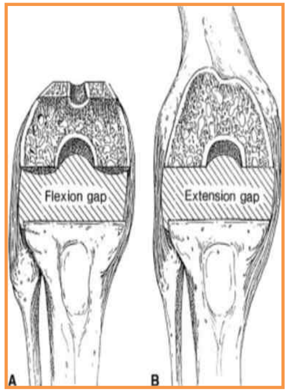




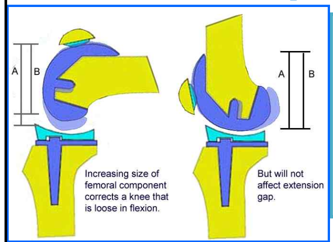
Gap technique

▣ Balancing flexion & extension gaps
▶ By placing spacer blocks or tensioner
▣ Varus / Valgus balance
▶ Medial or Lateral release
▣ Osteophyte removal before soft tissue release
▣ Flexion gap = Extension gap

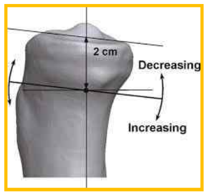


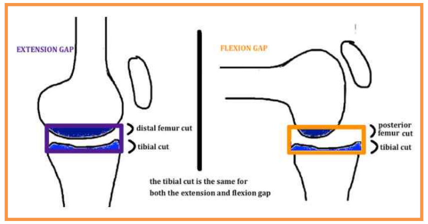


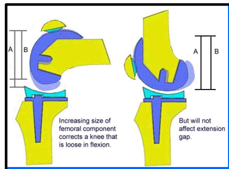
Gap technique



		Extension gap	Flexion gap
Femoral component (anterior reference system)	Upsizing	-	↓
	Downsizing	-	↑
Distal femur manipulation	Augmentation	↓	-
	Resection	↑	-
PE insert(Spacer)	Thinner	↑	↑
	Thicker	↓	↓
Proximal tibia manipulation	Resection	↑	↑
	Posterior slope↑	-	↑
	Posterior slope↓	-	↓







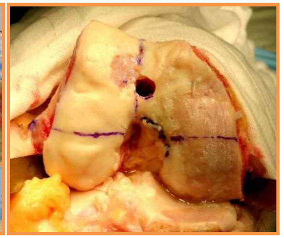
Gap technique

		flexion gap		
		Loose	Ok	Tight
Extension gap	Loose	Thicker PE	I) augment femur II Down size femur + thicker PE	I) Down size femur + thicker PE II) resect prox. tibia + augment distal femur
	Ok	I) Resect distal femur + thicker PE II) Release post. capsule + thicker PE	No change	I) Down size femur II) tibia post. slop 증가
	Tight	I) Resect distal femur + thicker PE II) Release post. capsule + thicker PE	I) post. condylar osteophyte remove II) Resect distal femur III) Release, post. capsule	I) Thinner PE II) Resect tibia

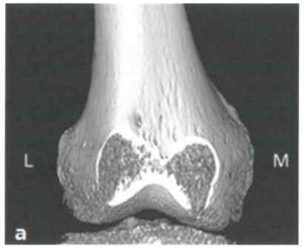
Intra. & extramedullary alignment instrumentation

▣ Femoral side entry point
- ▶ Medial to the midline, anterior (1cm) to the origin of the PCL
- ▶ Preoperative radiographic evaluation
  - → Wide canal
  - → Excessive femoral bowing
- ▶ Intramedullary alignment instrumentation

▣ Tibial side entry point
- ▶ Extramedullary



1. 슬관절 전치환술을 시행할 때 원위 대퇴골 전면의 골 절제면 모습은 그림과 같다. 이러한 모양일 때 발생할 수 있는 문제점으로 적절한 것은? 20B2



㉮ 슬관절 굴곡시 외측 관절 간격 협소
㉯ 슬관절 굴곡시 내측 관절 간격 협소
㉰ 슬관절 신전시 외측 관절 간격 협소
㉱ 슬관절 신전시 내측 관절 간격 협소
㉲ Q 각 감소

답 : 나

1. 인공 슬관절 치환술 중 골절제를 시행하고 대퇴 및 경골 치환물을 삽입 후 10mm PE를 삽입하고 굴곡, 신전 운동을 시켜보았다. 슬관절 굴곡 시에는 적절하였으나 신전 시에는 10도 정도 완전히 신전되지 않았다. 어떤 조치가 적당한가? 15B

㉮ 2mm 추가 원위 대퇴골 절제를 시행한 뒤 8mm PE를 삽입한다.
㉯ 2mm 추가 근위 경골 절제를 시행한 뒤 10mm PE를 삽입한다.
㉰ 후방 관절막을 유리한 뒤 10mm PE를 삽입한다.
㉱ Anterior reference system을 이용하여 더 큰 대퇴 치환물을 넣은 뒤 10mm PE를 삽입한다.
㉲ Posterior reference system을 이용하여 더 큰 대퇴 치환물을 넣은 뒤 12mm PE를 삽입한다.

답 : 다

Reference

▣ Campbells Operative Orthopaedics, 14th edition
P. 436 ~ 443

▣ Lateral subvastus approach: A cadaveric examination of its potential for total knee arthroplasty THE KNEE panelBrent A. Lanting a, Josée A. Legault b, Marjorie I. Johnson b, Steven J. MacDonald a, Tyler S. Beveridge b

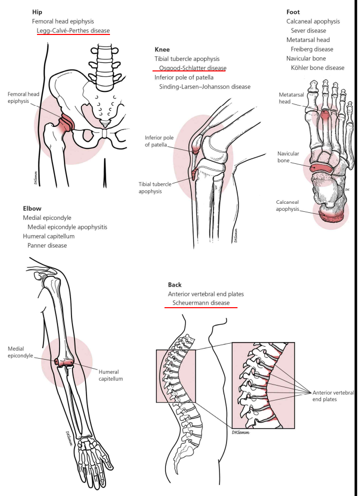
Osteochondrosis

2023.09.15
R2. 우창우

Osteochondrosis

- 골성장이 일어나는 부위에서의 Osteogenesis 혹은 Chondrogenesis의 부전
- 소아기에 시작, epiphysis나 apophysis에 형성
- 부위 : 하지에 80%, 그 중 족부에 28%로 가장 많음

Ex> Legg-Calve perthes disease (hip)
Osgood schlatter disease (knee)
Scheuermann disease (spine) etc



Iselin disease

- **Traction epiphysitis of the base ot 5th MT**
  - German literature 1912, Iselin
  - Young adolescents, coinciding with proximal epiphysis of the 5th MT
- **Anatomy : secondary ossification center**
  - Slightly oblique to metatarsal shaft, located on lateral plantar aspect of tuberosity
  - Peroneus brevis insertion
  - Seen on oblique view
- **Onset Age**
  - **F : 10 / M : 12**
  - **Fusion in 2 years**

FIGURE 32-1 Ossification of epiphysis on fifth metatarsal shaft.

Iselin disease

- **Symptom**
  - Weight bearing cause pain over lateral aspect of foot
  - Inversion stresses on the forefoot cause pain
    - Sports requiring running, jumping
- **Clinical sign**
  - Tenderness at peroneus brevis insertion
  - Eversion and extreme plantar flexion and dorsiflexion of the foot elicit pain
- **Radiographs**
  - Enlargement and often fragmentation of the epiphysis
  - Technetium-99m bone scanning
  - Nonunion of the fifth metatarsal in adults as result of Iselin disease

FIGURE 32-2 Enlargement and fragmentation of epiphysis

FIGURE 32-3 Nonunion of fifth metatarsal as result of Iselin disease.

Iselin disease

- **DDX**
  - Fracture
  - Os vesalianum

FIGURE 32-4 Os vesalianum must be distinguished from Iselin disease.

- **Treatment**
  - Prevention of recurrent symptoms
  - Conservative Tx.
    - Immobilization, cast apply, ice bag
  - Internal fixation of epiphysis not indicated

Freiberg infraction

- **Usually occurs in the head of the 2nd MT**
  - Also may occur in the 3rd, 4th, 5th MT
  - 2nd toe longest and least mobile
  - Compression, repetitive microfracture makes LOM

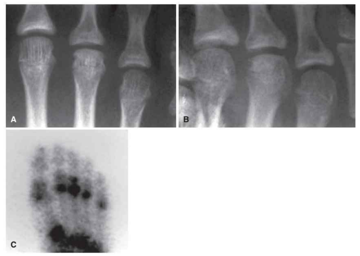


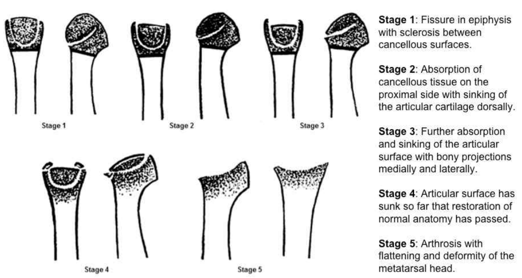
FIGURE 32-5 **A** and **B,** Condensation and sclerosis in third metatarsal compared with second and fourth metatarsals indicate early acute Freiberg disease in 11-year-old girl. **C,** Bone scan shows increased uptake in metatarsal head, indicating Freiberg disease; increased uptake in metatarsal neck would indicate stress fracture.

FIGURE 84.61 Freiberg infraction. Note flattening of second and third metatarsal heads and irregularity and separated bone fragment *(arrows)*. (Courtesy of Steve Ikard, MD.)

Freiberg infraction

- **Symptom**
  - Pain on weight bearing
  - MP joint tenderness & swelling
  - LOM

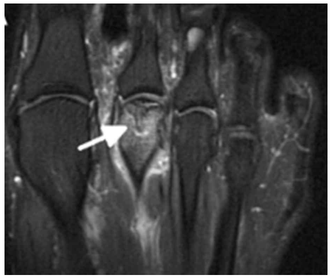
- **Smillie classification**



Smillie's classification

Freiberg infraction

- **Smillie classification**
  - Stage 1 : Subchondral fracture visible only on MRI
  - Stage 2 : Dorsal collapse of articular surface on plain radiographs



Freiberg infraction

- **Smillie classification**
  - Stage 3 : Collapse of dorsal MT head, with plantar articular portion intact
  - Stage 4 : Collapse of entire MT head, joint space narrowing

Freiberg infraction

- **Smillie classification**
  - Stage 5 : Severe arthritic changes and joint space obliteration

Freiberg infraction

- **Treatment**
- Surgery is not recommended during the acute stage
  - May persist for 6 months to 2 years

- **Surgery**
  - Pain, deformity, disability

Freiberg infraction

- **Surgery**
  - Loose body removal
  - Smillie procedure
    - Scraping sclerotic area and replacing with cancellous bone & osteochondral plug transplantation

FIGURE 32-6 Freiberg infraction of second metatarsal with two loose bodies.

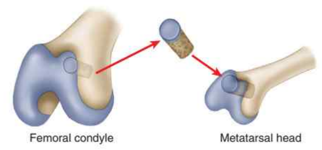


FIGURE 32-7 **Diagram of harvested osteochondral plug from a non–weight-bearing site on the upper lateral femoral condyle of the ipsilateral knee, and transplantation of the plug to the bone in the second metatarsal head.** (Redrawn from Miyamoto W, Takao M, Uchio Y, et al: Late-stage Freiberg disease treated by osteochondral plug transplantation: a case series, *Foot Ankle Int* 29:950, 2008.)

Freiberg infraction

- **Surgery**
  - Dorsal wedge osteotomy
  - Total joint arthroplasty

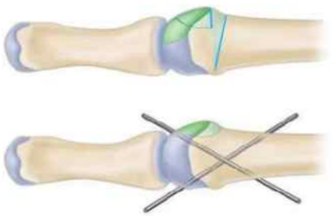


FIGURE 32-8 Osteotomy for Freiberg infraction. A, Osteotomy of bony wedge. B, Closure and fixation of osteotomy.

Köhler disease

- **Osteochondrosis of tarsal navicular**
  - Köhler in 1908
  - Abnormal ossifying nuclei are more common in late-appearing ossification centers of the navicular
- **Delayed ossification**
  - Subjects it to more pressure than the bony structures can withstand
  - Abnormal ossification may be a response of the unprotected, growing nucleus to normal stresses of weight bearing
  - Vessel compression
    - Ischemia results and leads to reactive hyperemia and pain

Köhler disease

- **Diagnosis**
  - **Sclerotic navicula**
  - **Diminished size of bone**

FIGURE 32-9 Lateral (A) and oblique (B) radiographs show smaller and more sclerotic navicular characteristic of Köhler disease.

Köhler disease

- **Treatment**
  - Conservative Tx. : Cast immobilization
  - Usually self-limiting condition : Surgery rarely indicated
- **Surgery**
  - Persistent disabling Sx. : Arthrodesis is only valuable procedure
  - Calcaneocuboid joint is included
    - Most of its function is lost when the talonavicular joint is fused

Sever's disease

- **Calcaneus apophysis**
  - **M > F / 7-10세**
  - **후족부 동통 : heel 하단부, Weight bearing 시 악화**
- **Radiograph**
  - Calcaneus apophysis 사이 간격 증가
  - Apophysis의 sclerosis, segmentation. irregularity
- **Treatment**
  - Self limiting
  - Rest, Heel lift, cushion heel
  - Achilles tendon stretching
  - 심하면 waking cast

1. 11세 여자가 2주전부터 발생한 우측 제 3 중족 족지 관절의 통증을 주수로 내원하였다. 체중 부하시에 통증을 호소하고, 제 3 중족 골두 부위에 압통이 있었다. 치료로 적절한 것은? 13B2

㉮ short leg walking cast
㉯ metatarsal head resection
㉰ metatarsal head의 dorsal closing wedge osteotomy
㉱ joint debridement and metatarsal head remodelling
㉲ transplantation of an osteochondral plug from the ipsilateral knee

Reference

Campbell 14th edition part XI Pg1262 - 1266

TKR : Ligament Balancing & Patellofemoral tracking

명지병원 정형외과
R3. 이 준 우

Ligament balancing

Ligament balancing

- Correction of
  - Varus & valgus deformity
  - Flexion contracture
  - Recurvatum
  - Balancing of posterior cruciate ligament
- Essential to providing a stable joint after TKA

Correction of varus deformity

- Most common deformity of the osteoarthritic knee
- Regardless of the techniques used, we have to understand which anatomic structures affect the extension & flexion gap
  - Extension gap
    - Posterior oblique ligament
    - Posterior capsule
    - Semimembranosus insertion
  - Flexion gap
    - Anterior half of MCL
    - Pes anserinus insertion

Correction of varus deformity

- Posterior stabilized TKA in varus knee
  ① Deep MCL
  ② Bone cut
  ③ Remove osteophytes
  ④ PCL release (before balancing)
  ⑤ Check flexion & extension gap
    - If both extension & flexion gap are tight
      - Superficial MCL
    - If extension gap is tight
      - POL → semimembranosus → posteromedial capsule
    - If flexion gap is tight
      - Superficial MCL, pes anserinus insertion
      - After entire soft tissue sleeve is released and the medial gap is still tight, consider advancing the LCL

Correction of valgus deformity

- Valgus deformity is common in patients with
  - Rheumatoid & inflammatory arthropathies
  - Hypoplastic lateral femoral condyle

Correction of valgus deformity

- Technique
  ① Bone cut
  ② Osteophyte removal
  ③ Order of soft tissue release on the lateral side of the knee varies
    - If both extension & flexion gaps are tight
      - Release LCL from lateral epicondyle (leave the insertion of the popliteus tendon intact)
    - If only extension gap is tight
      - Release the iliotibial band by Z-lengthening or pie crusting
      - Evaluate the biceps aponeurosis (whether involving in contracture)
      - Posterior capsule off the lateral epicondyle → lateral head of gastrocnemius
      - Releasing PLC can effectively increase the extension space
    - If only flexion gap is tight,
      - Popliteus tendon

  → If the knee is still not balanced, consider releasing MCL

Correction of valgus deformity

- Pie crusting technique
  - Technique used for soft tissue balancing
  - Allow surgeon to direct the lengthening of soft tissue supporting structure
  - Multiple stabs with scapel or large needle parallel to the joint line

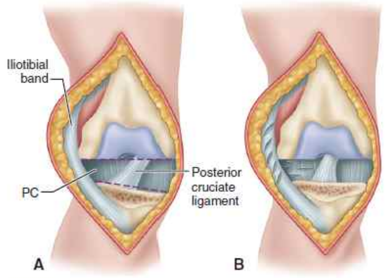


FIGURE 7-44 Pie-crusting technique. A, Knee with valgus deformity before intraarticular release of posterolateral aspect of capsule (PC). Note trapezoidal extension gap. B, Correction of deformity after release of posterolateral aspect of capsule and pie-crusting of iliotibial band. Note resulting rectangular extension gap.

Correction of valgus deformity

- Severe valgus + flexion contracture
  → acute correction can cause stretching of the peroneal nerve
  - If neurologic sign presents after surgery, flexion of knee should be initiated
  - Or post-operatively immobilizing knee in flexion and gradual extension can be helpful

Correction of valgus deformity

- Attenuation of the MCL
  - Constrained condylar type prosthesis
  - MCL advancement

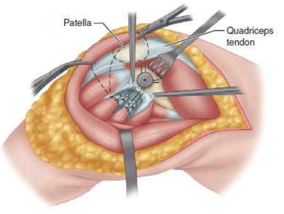


FIGURE 7-45 Advancement of femoral origin of medial collateral ligament and fixation in medial epicondyle with screw and washer.

Correction of flexion contracture

- Most pre-operative flexion deformities improve with appropriate soft tissue balancing for coronal plane deformity
  →If flexion contracture persists,
  - Shortened posterior structures must be lengthened
  - Joint line may need to be elevated by increasing the amount of distal femoral resection
    - With severe contracture elevation more than 4mm should be avoided (→ mid-flexion instability) and increase in implant constraint may be necessary

Correction of flexion contracture

- Technique
  - Bone cut & ligament balancing
  - To recreate normal posterior capsular recess
    → strip the adherent posterior capsule proximally off the femur above the femoral condyles
    - Should be carried out carefully not to injure middle genicular artery
  - Remove all posterior condylar osteophytes
  - Release the posterior capsule more proximally and release tendinous origins of gastrocnemius muscles if necessary
    - Releasing of posterior capsule off the proximal tibia can be considered
      - Be careful not to injure neurovascular structure
  - Increase distal femoral cut by 2mm (maximum 4mm) and check mid-flexion instability

Correction of flexion contracture

- Distal femoral cutting
  - Flexion contracture persists after posterior capsular release & posterior osteophyte removal
  - Joint line elevation
    - With excessive distal femoral cutting to obtain full extension, knee may be stable in full extension (d/t posterior tension band effect)
    - → but with slight flexion, the knee may lack valgus-varus stability
    - → Constrained condylar type prosthesis
  - The need to correct flexion contractures fully at the time of surgery is controversial

Correction of recurvatum

- Rare in patients who have TKA
- Often occurs in conjunction with a valgus knee deformity caused by hypoplastic lateral femoral condyle
- Neuromuscular disease or any quadriceps weakness that may be the cause of the recurvatum deformity
  - → Hinged implant with an extension stop may be needed to compensate for the loss of quadriceps power

Correction of recurvatum

- Recurvatum deformity without neuromuscular weakness
  - Operative procedure must be planned to prevent recurrent deformity after TKA
  - Simply adding height to the tibia will also tighten the flexion space and possibly decrease the amount of flexion after surgery
  - Preferable technique
    - Moving the joint line distally
    - Using a smaller femoral component
    - With anterior referencing

Patellofemoral tracking

Patellofemoral tracking

- Patellofemoral tracking is affected by multiple factors
  - Q angle increasing can cause lateral maltracking of the patella
  - Internal rotation of tibial component
    - Increase Q angle by lateralizing tibial tubercle
  - Internal rotation or medial translation of femoral component
    - By moving trochlea medially increase patella lateral subluxation

Patellofemoral tracking

- Patellofemoral tracking is affected by multiple factors
  - If patella is to be resurfaced, the prosthetic patella should be medialized to approximate the median eminence of the normal patella, rather than centering the prosthetic button
    - Higher Q angle if centered

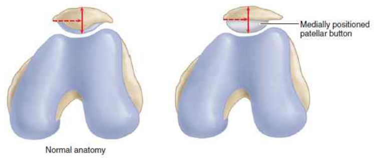


FIGURE 7-53 The patellar button should be positioned medially to re-create the location of the apex of the native patella and improve tracking. Care should be taken not to "overreplace" the patella, which will increase the height and the possibility of tilt and/or lateral subluxation and patellar maltracking.

Patellofemoral tracking

- Increasing the anterior displacement of the patella during knee motion also can lead to patellar instability or limited flexion
  - Factors
    - Placing the trochlea too far anterior with an oversized femoral component
    - Underresection of the patella (increase patella thickness)

FIGURE 7-54 Inadequate resection of patellar bone.

Patellofemoral tracking

- "No thumb" test of patellar tracking should be used as a guide of adequate patellar stability
  - If the patellar button tracks congruently with minimal or no pressure applied to the lateral side of the patella, patellofemoral tracking is adequate.

Patellofemoral tracking

- "No thumb" test of patellar tracking should be used as a guide of adequate patellar stability
  - If none of above factors is identified, lateral retinacular release may be necessary
    - By cutting the synovium & retinaculum longitudinally
    - Gerdy's tubercle (distally) ~ muscle fibers of the vastus lateralis (proximally)

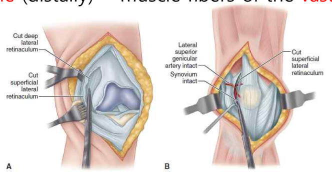


FIGURE 7-55 A, Lateral retinacular release can be done from inside out, which releases synovial layer and lateral retinaculum but can expose joint to subcutaneous tissue. Release is made from vastus lateralis muscle fibers proximally and distally to Gerdy's tubercle if necessary. B, Outside-in technique also can be used, which allows synovial membrane to remain intact, leaving layer between subcutaneous tissue and intraarticular space. This also allows identification of lateral geniculate artery, which can be preserved.

Patellofemoral tracking

- Lowering the tourniquet and reassessing patellar tracking before lateral retinacular release have been shown to avoid an unnecessary lateral retinacular release

Patellofemoral tracking

- Problems with lateral retinacular release
  - The greatest risk in lateral release is devascularization of the patella caused by interruption of the superior lateral geniculate artery.
    - Located musculotendinous junction of vastus lateralis
  - Increased prevalence of patella fracture also has been correlated with lateral release
  - Post op swelling, pain, slow rehabilitation, increased wound problem, etc.
  - Nevertheless, the potential complications of lateral release are far outweighed by the detrimental effect of patellar subluxation

Reference

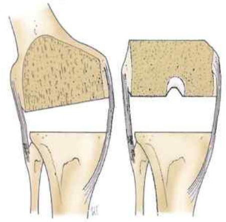
- Chapter 7. Arthroplasty of the knee. Part III. RECONSTRUCTIVE PROCEDURES OF THE KNEE IN ADULTS. Campbell's Surgical Orthopedics. 13th edition. p.431-440

기출문제

Quiz #1

- 외반 변형을 보이는 환자의 슬관절 전치환술에서 굴곡과 신전 시 내측부와 외측부의 간격 gap은 다음 그림과 같았다. 이를 교정하기 위해 다음 단계로 유리시켜야할 구조물은?

① 반막양근
② 대퇴이두근
③ 내측 측부 인대
④ 외측 측부 인대
⑤ 장경대

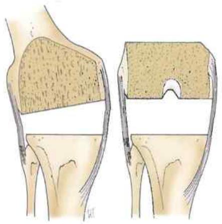


Quiz #1

- 외반 변형을 보이는 환자의 슬관절 전치환술에서 굴곡과 신전 시 내측부와 외측부의 간격 gap은 다음 그림과 같았다. 이를 교정하기 위해 다음 단계로 유리시켜야할 구조물은?

① 반막양근
② 대퇴이두근
③ 내측 측부 인대
④ 외측 측부 인대

⑤ 장경대



Correction of valgus deformity

- Technique
  ① Bone cut
  ② Osteophyte removal
  ③ Order of soft tissue release on the lateral side of the knee varies
    - During exposure, release the lateral capsule from tibia
    - If both extension & flexion gaps are tight
      - Release LCL from lateral epicondyle (leave the insertion of the popliteus tendon intact)
    - If only extension gap is tight
      - Release the iliotibial band by Z-lengthening or pie crusting
      - Evaluate the biceps aponeurosis (whether involving in contracture)
      - Posterior capsule off the lateral epicondyle → lateral head of gastrocnemius
      - Releasing PLC can effectively increase the extension space
    - If only flexion gap is tight,
      - Popliteus tendon

Quiz #2

- 인공슬관절 치환술 후 신전하였을 때 신전제한이 발생하였다. 그 외 인대의 불안정 소견이나 전후 불안정없고, 굴곡시 간격은 적당하였다. 원인은? (2가지)
  ① 불충분한 후방막 유리
  ② 불충분한 대퇴원위 절제
  ③ 대퇴 치환물의 내회전
  ④ 대퇴 치환물의 외회전
  ⑤ 경골 치환물의 외회전
  ⑥ 경골 치환물의 내회전
  ⑦ 불충분한 대퇴 원위부 절제
  ⑧ Superficial MCL 전방부의 불충분한 유리

Quiz #2

- 인공슬관절 치환술 후 신전하였을 때 신전제한이 발생하였다. 그 외 인대의 불안정 소견이나 전후 불안정없고, 굴곡시 간격은 적당하였다. 원인은? (2가지)
  ① 불충분한 후방막 유리
  ② 불충분한 대퇴원위 절제
  ③ 대퇴 치환물의 내회전
  ④ 대퇴 치환물의 외회전
  ⑤ 경골 치환물의 외회전
  ⑥ 경골 치환물의 내회전
  ⑦ 불충분한 대퇴 원위부 절제
  ⑧ Superficial MCL 전방부의 불충분한 유리

Correction of flexion contracture

- Technique
  - Bone cut & ligament balancing
  - To recreate normal posterior capsular recess → strip the adherent posterior capsule proximally off the femur above the femoral condyles
    - Should be carried out carefully not to injure middle genicular artery
  - Remove all posterior condylar osteophytes
  - Release the posterior capsule more proximally and release tendinous origins of gastrocnemius muscles if necessary
    - Releasing of posterior capsule off the proximal tibia can be considered
      - Be careful not to injure neurovascular structure
  - Increase distal femoral cut by 2mm (maximum 4mm) and check midflexion instability

Quiz #3

- 슬관절 전치환술 후 발생할 수 있는 슬개-대퇴 불안정성 (patellofemoral instability)의 가능성이 가장 높은 것은?

  ① 대퇴 치환물의 외회전
  ② 경골 치환물의 외회전
  ③ 슬개골 치환물의 내측이동
  ④ 슬개골의 내측 과다 절제
  ⑤ 대퇴 치환물의 내측이동

Quiz #3

- 슬관절 전치환술 후 발생할 수 있는 슬개-대퇴 불안정성 (patellofemoral instability)의 가능성이 가장 높은 것은?

  ① 대퇴 치환물의 외회전
  ② 경골 치환물의 외회전
  ③ 슬개골 치환물의 내측이동
  ④ 슬개골의 내측 과다 절제
  ⑤ 대퇴 치환물의 내측이동

Patellofemoral tracking

- Patellofemoral tracking is affected by multiple factors
  - Q angle increasing can cause lateral maltracking of the patella
  - Internal rotation of tibial component
    - Increase Q angle by lateralizing tibial tubercle
  - Internal rotation or medial translation of femoral component
    - By moving trochlea medially increase patella lateral subluxation

Patellofemoral tracking

- Patellofemoral tracking is affected by multiple factors
  - If patella is to be resurfaced, the prosthetic patella should be medialized to approximate the median eminence of the normal patella, rather than centering the prosthetic button
    - Higher Q angle if centered

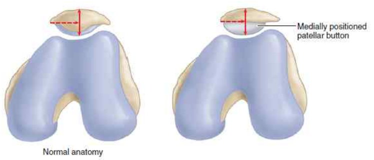


FIGURE 7-53 The patellar button should be positioned medially to re-create the location of the apex of the native patella and improve tracking. Care should be taken not to "overreplace" the patella, which will increase the height and the possibility of tilt and/or lateral subluxation and patellar maltracking.

Subacromial notching after reverse total shoulder arthroplasty

Hyeon Jang Jeong, MD, PhD[a], Sang Woo Kim, MD[b], Sung-Min Rhee, MD, PhD[c], Ji Hyun Yeo, MD[d], Kang Heo, MD[e], Joo Han Oh, MD, PhD[a,*]

[a]Department of Orthopaedic Surgery, Seoul National University College of Medicine, Seoul National University Bundang Hospital, Seongnam, Republic of Korea
[b]Department of Orthopaedic Surgery, Nalgae Hospital, Seoul, Republic of Korea
[c]Department of Orthopaedic Surgery, Kyung Hee University College of Medicine, Kyung Hee University Medical Center, Seoul, Republic of Korea
[d]Department of Orthopaedic Surgery, Hanam S Hospital, Hanam, Republic of Korea
[e]Department of Orthopaedic Surgery, Chambaro hospital, Seoul, Republic of Korea

2023.09.19
명지병원 정형외과
R2. 김수영

Introduction

- Grammont : Medicalization of center of rotation(COR) and distalization of the humerus
  - Several complications : loss of shoulder contour, implant instability, weakness of ER, IR power, scapular notching
  - Concept of lateralized rTSA has been suggested

Introduction

- Lateralized rTSA
  - Improves shoulder contour, enhances stability, restores rotational power, and reduces scapular notching

  However

  - Acromiohumeral distance (AHD) - significantly narrower
  - Could provoke impingement between the greater tuberosity and acromial undersurface during abduction (abduction impingement)

  → Might induce subacromial erosion : Subacromial notching(SaN)

Introduction

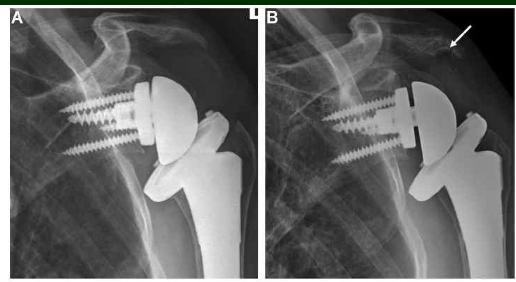


Figure 1 (**A**) Subacromial erosion was not observed in this postoperative radiograph 3 months after reverse total shoulder arthroplasty (RTSA). (**B**) Subacromial notching after lateralized RTSA was seen in this postoperative radiograph 2 years after RTSA. Bone erosion with a sclerotic margin *(white arrows)* was observed at the undersurface of the acromion.

Introduction

- There have been no studies regarding SaN in clinical situations
- Aimed to evaluate the risk factors and prognosis of SaN
- Hypothesis : The occurrence of SaN might be affected by the patient's native anatomy and/or postoperative implant position, and the prognosis might be worse than that in RTSA cases without SaN

Materials/Method

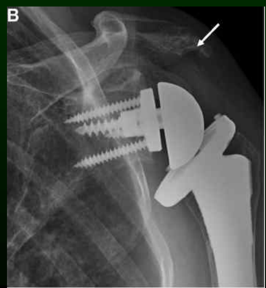
- Consecutive 191 RTSA cases performed by a single surgeon (J.H.O.) between March 2014 and May 2017 were retrospectively reviewed
- Included
  - Primary RTSA cases for cuff tear arthropathy or irreparable rotator cuff tear using the Comprehensive System (Zimmer-Biomet)
  - Consists of 16 mm of lateral offset glenoid and 15 mm of lateral offset humerus implants - reduce heterogeneity based on the different arthroplasty designs
- Excluded
  - other RTSA systems (n = 32), revision arthroplasty (n = 2), indications different from cuff tear arthropathy and/or irreparable rotator cuff tear including sequelae of pyogenic arthritis (n = 5), proximal humeral fracture (n = 14), followup less than 2 years (n = 13)
  - Total 125 RTSA cases

Materials/Method

- Patient demographics : age at operation, sex, operation side [dominant or nondominant arm], and bone mineral density
- Functional outcomes : visual analog scale of pain [pVAS], active range of motion [ROM] including forward flexion, external rotation of the arm at the side, internal rotation of the arm at the back, and the American Shoulder and Elbow Surgeons [ASES] standardized shoulder assessment form
- Radiologic parameters

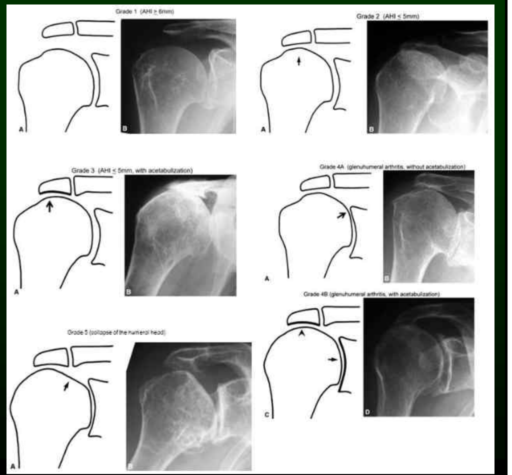
Materials/Method

- Radiologic parameters : Grashey view of plain radiographs preoperatively, 3 months after surgery, and at the final follow-up
- Subacromial notching : defined as subacromial bony erosion that presented the radiolucent lesion with a sclerotic margin on the Grashey view of the plain radiograph
- Patients were divided into 2 groups
  - Presence of SaN
  - Absence of SaN



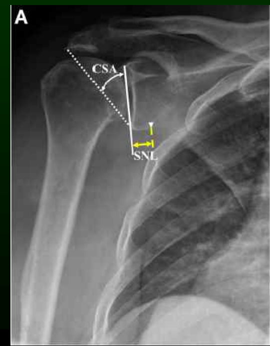
Materials/Method

- Hamada classification



Materials/Method

- Critical shoulder angle : Angle between the glenoid surface line
- Scapular neck length : distance between the inferior pole of the glenoid and the inflection point at which the scapular lateral border began

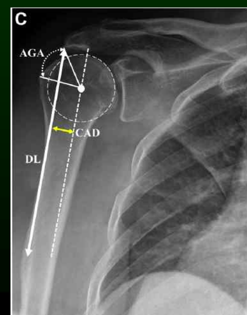


Materials/Method

- Glenoid surface-humerus offset (GH) : the distance from the glenoid surface line to the lateral edge of the greater tuberosity of the humerus
- Glenoid surfaceacromion offset (GA) : the distance from the GSL to the lateral edge of the acromion
- Humerus lateralization offset (HL) : the distance between the GA and GH
- Acromion index (AI) : the percentage of the value that GA divided by GH

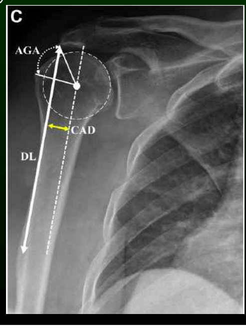
Materials/Method

- COR : the center of the best-fit circle overlay on the articular surface of the humeral head
- Deltoid length (DL) : the distance between the acromion's inferolateral tip and the deltoid tuberosity's midpoint
- COR-acromion distance (CAD) : the distance between the DL and COR



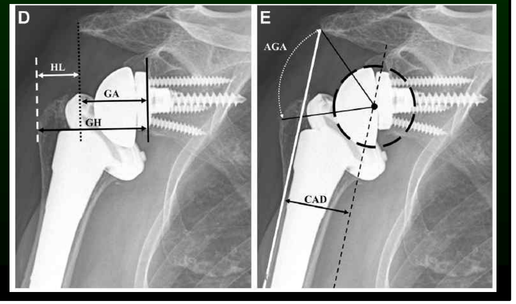
Materials/Method

- Deltoid length (DL) : the distance between the acromion's inferolateral tip and the deltoid tuberosity's midpoint
- COR-acromion distance (CAD) : the distance between the DL and COR
- Acromion-greater tuberosity angle (AGA) : the angle between the line connecting the lateral edge of the acromion to the COR and the line connecting the lateral tip of the greater tuberosity to the COR



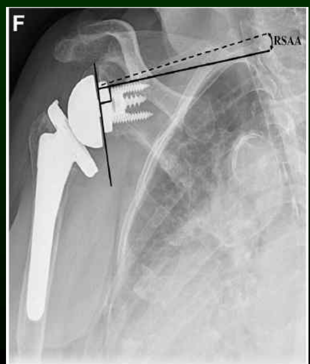
Materials/Method

- Measured the radiologic parameters using X-ray at 3 months after surgery,
- Postoperative AI, GH, GA, HL, and DL : similarly to those in the preoperative workup
- Postoperative COR, CAD, and AGA : differently according to the transition of COR from the center of the humeral head to the center of the glenosphere after RTSA



Materials/Method

- RSAA : the angle between the supraspinatus fossa line and the line perpendicular to the baseplate was measured only after surgery to evaluate the inclination of the baseplate



Results

Table I Demographics and functional status at preoperative workup and final follow-up

Variables	SaN+	SaN−	*P* value
Follow-up duration, mo	59.8 ± 16.2	49.4 ± 16.2	.051
Age, y	71.3 ± 7.1	71.8 ± 6.6	.793
Sex, male:female	2:14	22:87	.735
Hand dominance, D:ND	10:6	87:22	.194
Bone mineral density, T-score†	−1.7 ± 1.4	−2.2 ± 1.2	.176
Pain, VAS			
Preoperative	6.2 ± 2.5	6.4 ± 2.3	.599
Final follow-up	1.8 ± 2.1	0.6 ± 1.3	.010*
P value	.002*	<.001*	
Forward flexion, °			
Preoperative	119.7 ± 45.3	106.1 ± 49.5	.338
Final follow-up	135.5 ± 15.1	142.6 ± 15.0	.179
P value	.992	<.001*	
External rotation, °			
Preoperative	34.7 ± 19.3	37.3 ± 21.3	.638
Final follow-up	50.9 ± 14.5	50.6 ± 18.3	.960
P value	.049*	<.001*	
Internal rotation, VL			
Preoperative	T10.7 ± 3.0	T12.3 ± 3.4	.084
Final follow-up	T9.5 ± 1.4	T9.4 ± 1.8	.969
P value	.266	<.001*	
ASES score			
Preoperative	40.3 ± 13.3	39.1 ± 18.6	.711
Final follow-up	80.4 ± 15.3	89.5 ± 14.3	.040*
P value	.001*	<.001*	

SaN+, presence of subacromial notching; *SaN−*, absence of subacromial notching; *D*, dominant arm; *ND*, non-dominant arm; *VAS*, visual analog scale; *VL*, vertebral level; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form.
Data are presented as mean ± standard deviation or ratio.
* Statistically significant.
† measured using dual-energy X-ray absorptiometry.

Results

Table II Interobserver reliability of radiologic measurement

Radiographic parameters	κ or ICC	*P* value
Hamada grade	0.862	<.001
Critical shoulder angle	0.912	<.001*
Glenoid surface-upper border angle		
Preoperative	0.851	<.001*
Postoperative	0.791	<.001*
Glenoid surface-lower border angle		
Preoperative	0.880	<.001*
Postoperative	0.823	<.001*
Scapular neck length	0.849	<.001*
Glenoid surface-humerus offset	0.896	<.001*
Glenoid surface-acromion offset	0.865	<.001*
Humerus lateralization offset	0.966	<.001*
Deltoid length	0.954	<.001*
Center of rotation-acromion distance		
Preoperative	0.848	<.001*
Postoperative	0.852	<.001*
Acromion-greater tuberosity angle		
Preoperative	0.886	<.001*
Postoperative	0.874	<.001*
Reverse shoulder arthroplasty angle	0.824	<.001*

κ, interobserver reliability for categorical variables; *ICC*, interclass correlation coefficient for continuous variables.
* Statistically significant.

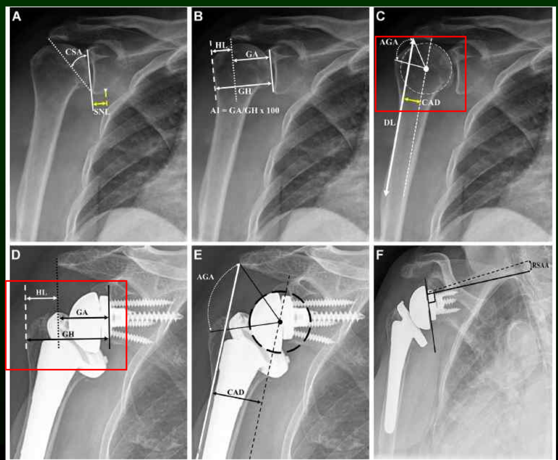
Results

Table III Radiographic parameters at preoperative work-up and 3-months after surgery

Radiographic parameters	SaN+	SaN−	*P* value
Hamada grade, 1:2:3:4A:4B:5	0:9:0:6:0:1	8:54:15:13:7:12	.055
CSA, °	35.0 ± 4.4	35.1 ± 4.1	.924
SNL, mm	10.6 ± 1.0	10.9 ± 1.0	.754
AI, %			
Preoperative	69.8 ± 8.0	74.4 ± 13.6	.079
Postoperative	62.9 ± 8.9	71.2 ± 8.5	.001*
GH, mm			
Preoperative	48.4 ± 4.1	47.4 ± 5.9	.331
Postoperative	55.3 ± 4.7	54.1 ± 4.4	.290
GA, mm			
Preoperative	33.6 ± 3.2	35.1 ± 2.9	.069
Postoperative	34.7 ± 4.2	38.3 ± 4.2	.004*
HL, mm			
Preoperative	14.8 ± 4.4	12.2 ± 6.5	.088
Postoperative	20.7 ± 5.6	15.8 ± 5.4	.001*
DL, mm			
Preoperative	163.0 ± 10.3	167.5 ± 9.2	.079
Postoperative	179.9 ± 11.2	178.8 ± 21.3	.766
CAD, mm			
Preoperative	16.3 ± 4.2	13.3 ± 2.0	<.001*
Postoperative	39.4 ± 4.5	38.8 ± 4.3	.642
AGA, °			
Preoperative	32.2 ± 13.5	41.2 ± 12.2	.010*
Postoperative	52.6 ± 5.4	51.2 ± 5.9	.394
RSAA, °			
Postoperative	2.6 ± 2.2	3.9 ± 2.6	.075

SaN+, presence of subacromial notching; *SaN−*, absence of subacromial notching; *CSA*, critical shoulder angle; *SNL*, scapular neck length; *AI*, acromial index; *GH*, glenoid surface-humerus offset; *GA*, glenoid surface-acromion offset; *HL*, humerus lateralization offset; *DL*, deltoid length; *CAD*, center of rotation-acromion distance; *AGA*, acromion-greater tuberosity angle; *RSAA*, reverse shoulder arthroplasty angle.
Data are presented as ratio or mean ± standard deviation.
* Statistically significant.

Results



Discussion

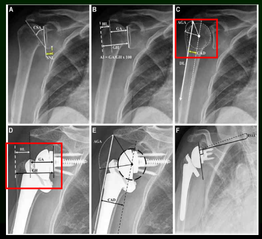
- Greater preoperative CAD and postoperative were correlated with the occurrence of SaN, and the pVAS and ASES score were significantly worse in the SaN + group at the final follow-up
- Lateralization
  - Reduces the moment arm of the deltoid and increases the amount of muscle force needed for abduction.
  - Increases the shear forces at the glenoid baseplate interface, which increases the risk of aseptic glenoid implant loosening.
  - Stress fracture of the acromion and/or scapular spine
- There is still debate over the optimal RTSA design, especially regarding medial and lateral designs.

Discussion

- Subacromial notching, a concept opposite to scapular notching, might be another weakness of lateralized RTSA
- Decreased AHD of the lateralized RTSA provoked impingement between the lateralized humeral GT and the acromial undersurface during shoulder abduction. This may cause pain and abduction ROM limitations, persists for a long time, erosion of the acromial undersurface may occur

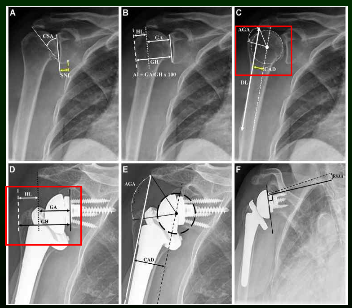
Discussion

- Postoperatively, patients with a greater HL had SaN more frequently.
- It represents the relative lateral protrusion of the humeral GT from the acromion, and postoperative HL reflects the degree of humeral lateralization after RTSA.
- Although we could not modify the native anatomy of the patients, we could control the degree of lateralization.



Discussion

- In higher risk patients with preoperative CAD greater than 14.0 mm, the medialized humeral and/or glenoidal implant might be utilized to prevent subacromial notching.



Discussion

- Pain and ASES score were worse in the SaN+ group.
- Theoretically, impingement between the implant and bony structure accelerated the wear of the polyethylene insert, and the wear debris could induce an inflammatory reaction.
- Therefore, the worse postoperative pain and ASES score in the SaN+ group might be originated from the inflammatory reaction of the subacromial impingement.

Conclusion

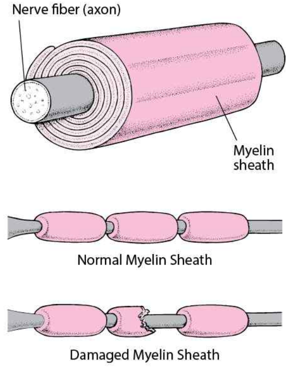
- Subacromial notching might adversely affect postoperative clinical outcomes.
- As subacromial notching correlated with patients' anatomical characteristics and degree of lateralization during RTSA, the implant's degree of lateralization should be adjusted according to the patient's own anatomical characteristics.

Charcot-Marie-Tooth disease

2023.09.01. R1 김현진

Charcot-Marie-Tooth disease

- The most common neuromuscular dis ease causing pes cavus.
- Neural protein mutations affecting per ipheral nerve conduction through axon or myelin irregularities.



Classification

- C-M-T type 1
  - 신경 속도의 감소가 뚜렷한 Demyelinated neuropathy
  - PMP22 gene
- C-M-T type 2
  - 신경 속도는 정상이거나 약간 느려지는 axonal neuropathy

TABLE 35.3

Classification of Hereditary Motor Sensory Neuropathies

TYPE	NAME(S)	INHERITANCE
I	Peroneal atrophy, Charcot-Marie-Tooth disease (hypertrophic form), Roussy-Lévy syndrome (areflexic dystasia)	Autosomal dominant
II	Charcot-Marie-Tooth disease (neuronal form)	Variable
III	Dejerine-Sottas disease	Autosomal recessive
IV	Refsum disease	
V	Neuropathy with spastic paraplegia	
VI	Optic atrophy with peroneal muscle atrophy	
VII	Retinitis pigmentosa with distal muscle weakness and atrophy	

Pes cavus

- It is defined primarily by the elevation of the longitudinal arch of the foot: a high arched foot.

- Result in <u>muscle imbalance</u> affecting the lateral and a nterior muscle compartments.

- Weakness of the <u>tibialis anterior</u> while sparing the <u>peroneus longus</u>
- <u>*-> plantar flexed first metatarsal !!*</u>

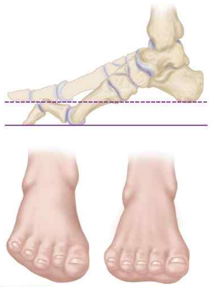


FIGURE 87.14 Lateral and frontal view of plantarflexed first ray as seen in Charcot-Marie-Tooth disease as compared with normal.

- <u>peroneus brevis</u> weakness countered by the near nor-mal <u>tibialis posterior</u> strength
- <u>*-> inversion of the midtarsal joints and hindfoot varus deformity !!*</u>

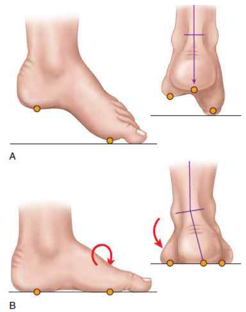
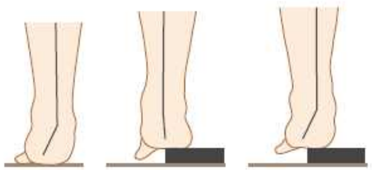


FIGURE 87.15 A and B, When plantarflexed, first ray strikes the ground (A), heel is forced into varus (B).

Coleman block test

- If heel varus corrects while the patient is standing on the block, hindfoot is considered flexible.
- If hindfoot is rigid, then surgical correction of both forefoot & hindfoot are required



Foot deformities in CMT

Deformity	Weak Agonist Muscle(s)	Intact Antagonist Muscle(s)	Action
Equinus	Tibialis anterior	Gastrocnemius –soleus complex (triceps-surae)	Plantar flexion
Adduction and hindfoot varus	Peroneus brevis	Tibialis posterior	Adducts the foot, inverts the subtalar joint
Plantar flexion of the first ray	Tibialis anterior	Peroneus longus	Plantar flexes the first ray, creates a secondary forefoot cavus
Toe deformities	Foot intrinsics	Long toe flexors	Clawing occurs as the extrinsic forces are unmodified by the intrinsics; also depresses the metatarsal heads and accentuates cavus
Hallux claw toe	Foot intrinsics	EHL and FHL	Severe hallucal clawing occurs when a spared EHL is used to assist a weak tibialis anterior dorsiflex the foot

EHL, extensor hallucis longus; *FHL*, flexor hallucis longus.

PHYSICAL FINDINGS

- Plantar flexion of the metatarsals
- Hyperextension of the metatarsophalangeal joints
- Hyperflexion at the interphalangeal joints

- *-> toe clawing*

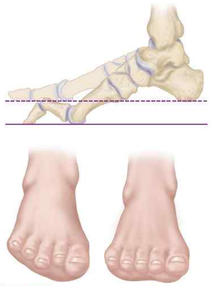
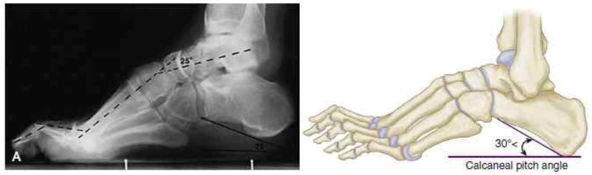


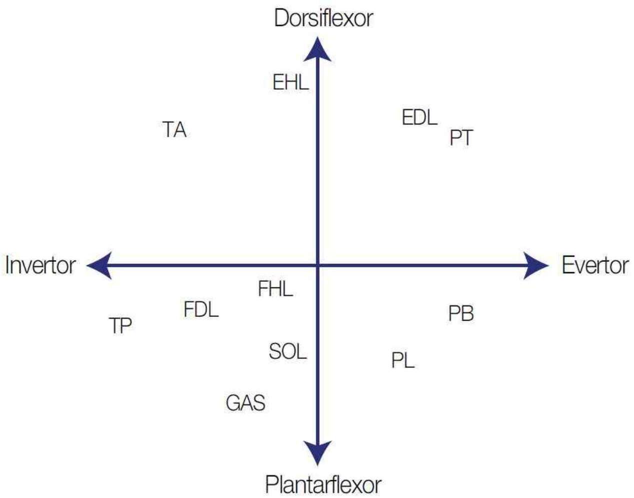
FIGURE 87.14 Lateral and frontal view of plantarflexed first ray as seen in Charcot-Marie-Tooth disease as compared with normal.

Hindfoot varus

- A hindfoot cavus

-> 30 degree of calcaneal pitch





ORTHOPAEDIC TREATMENT

- Surgical procedures are of three types
  - Soft tissue for flexible deformities
    - (plantar fascia release, tendon release or transfer)
  - Osteotomy for stiffer flexible or rigid deformities
    - (metatarsal, midfoot, calcaneal)
  - Joint stabilizing for completely rigid deformities
    - (Triple arthrodesis)

TABLE 35.4

Types of Foot Deformities in Charcot-Marie-Tooth Disease and Recommended Treatment

TYPE	FEATURES	PROCEDURES
A.	Normal foot	Observation
B.	Plantarflexed 1st metatarsal Mild cavovarus Fully flexible hindfoot	Soft-tissue procedures Possible 1st metatarsal osteotomy
C.	Increased plantarflexion 1st metatarsal Increased supination Stiffer hindfoot	1st metatarsal osteotomy Midfoot/hindfoot osteotomies Possible triple arthrodesis
D.	Rigid cavovarus	Triple arthrodesis

From: Louwerens JWK: Operative treatment algorithm for foot deformities in Charcot-Marie-Tooth disease, *Oper Orthop Traumatol* 30(2):130–146, 2018.

1. 18세 남자 환자로 9세경부터 발생한 양측 무릎 이하의 하지 근육 위축, 감각 저하, 뒤꿈치의 내반 변형, 발뒤꿈치 보행 (heel walking)을 주소로 내원하였다. 진행한 신경 전도 검사에서 감각 및 운동 신경 전달 속도의 감소가 관찰되었다. 다음은 상기 환자의 다리 육안 소견이며 가족력이 있을 때 가장 관련있는 유전자의 이상은? 17B2

㉮ COL1A1 gene
㉯ COMP gene
㉰ Neurofibromin
㉱ PHEX gene
㉲ PMP22 gene

정답 : 마

1. Charcot-Marie-Tooth 병으로 진단된 13세 남아에서 요내반족 (pes cavovarus)변형이 관찰되었다. 후족부의 유연성을 판별하는 가장 좋은 진찰 방법은? 09B
㉮ Ober test
㉯ Thomas test
㉰ Coleman block test
㉱ toe raising test
㉲ push-up test

정답 : 다

1. Charcot-Marie-Tooth disease 환자의 intrinsic and extrinsic muscle과 bony structure의 변화로 옳지 않은 것은?
㉮ triceps surae - weakness or contracted
㉯ tibialis post. peroneus longus - weakness
㉰ tibialis ant. - weakness
㉱ 1st ray - plantar flexed
㉲ interossei - weakness

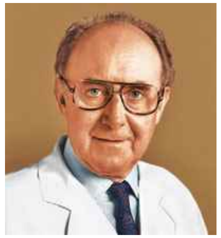
정답 : 나

Total Knee Arthroplasty
- Biomechanics -

명지병원 정형외과
23.09.04
R1. 정승호

Campbell's operative orthopedics, 14th

History of Arhtoplasty



- Hip arthroplasty
  - 1st developed arthroplasty
  - Anatomical reconstruction
  - **John Charnley**
- **Knee arthroplasty**
  - Fusion as alternative - developed lately
  - **Gunston from Canada and Insall from New York**
  - 1st modern prosthesis
- Ankle, shoulder arthroplasty

History of Arthroplasty

- **Knee arthroplasty**
  - **Imitating** the knee
  - Hinge models – failure
  - Studies progressed of knee biomechanics
- Anatomical reconstruction of knee joint
  - Progressive

Biomechanics

- Knee motion during normal gait is **complex** than simple flexion
- Knee motion during gait : "**triaxial motion**"
  → flexion & extension,
  abduction & adduction,
  rotation around the long axis of the limb

FIGURE 7-12 Motion in knee occurs in three separate planes during course of normal gait cycle and is referred to as "triaxial motion."

Biomechanics

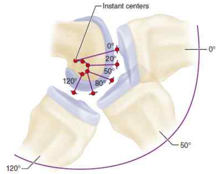
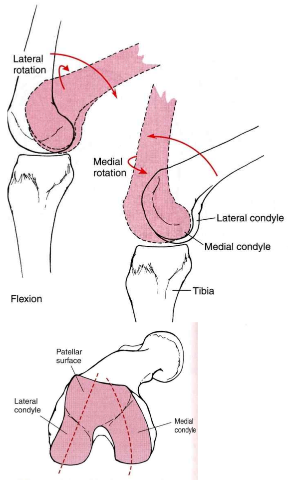
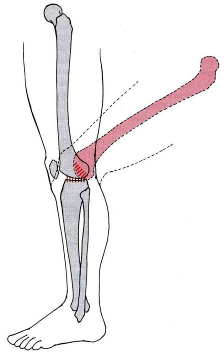


FIGURE 7-13 Transverse axis of flexion and extension of knee constantly changes and describes J-shaped curve around femoral condyles.

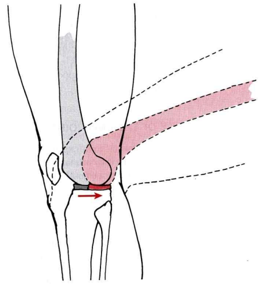
- Knee flexion
  - occurs around a **varying transverse axis**
  - function of the **articular geometry** of the knee and the **ligamentous restraints**
  - Dennis et al.
    → average 5 mm of medial condylar translation and 17 mm of lateral condylar posterior translation

- **Screw-home mechanism**
  - Medially based pivoting → ER of tibia during **extension**, IR of the tibia during **flexion**





Rolling



Gliding

Biomechanics

- Many current prosthesis designs attempt to **reproduce normal knee** kinematics closely

- Use of gait laboratories, biomechanical models, and fluoroscopic analyses
  → important tool in prosthesis design and functional evaluation of TKA patients

- **Normal gait** required
  - **67 degrees** of flexion during the swing phase,
  - **83 degrees** for stair climbing,
  - **90 degrees** for descending stairs

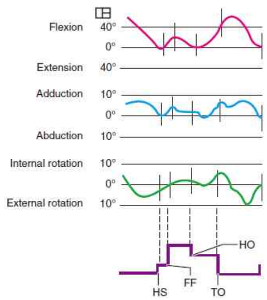
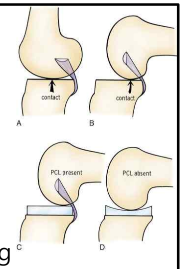


FIGURE 7-14 Triaxial motion of normal knee during walking, as measured by electrogoniometer. Flexion and extension are about 70 degrees during swing phase and 20 degrees during stance phase. About 10 degrees of abduction and adduction and 10 to 15 degrees of internal and external rotation occur during each gait cycle. *FF*, Flatfoot; *HO*, heel-off; *HS*, heel-strike; *TO*, toe-off.

Biomechanics

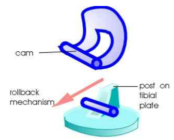


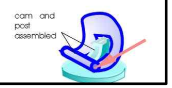
ROLE OF THE POSTERIOR CRUCIATE LIGAMENT IN TOTAL KNEE ARTHROPLASTY

- Concurrent development of PCL-retaining and PCL-substituting prostheses → relative merits of each design have been **debated**

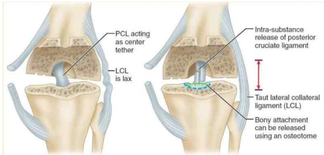
- **PCL retaining**
  → <u>increased potential ROM</u> by effective **femoral rollback**

- **PCL substitution**
  → achieves femoral rollback by a tibial **post** and femoral **cam mechanism**





Biomechanics



- When PCL is retained
  - needs to be **partially released or recessed** to allow adequate flexion esp. in the varus deformed knee
    (since it is a **more medial anatomical structure** and may be involved in the **coronal plane deformity**)

- PCL-substituting designs
  - resultant **stress borne** by the prosthetic construct and transferred to the **bone-cement interface**
  - recent study from the Mayo Clinic
    - compared 5389 cruciate-retaining TKAs to 2728 posterior stabilized TKAs and found **15-year survivorships of 90% and 77%**, respectively, a statistically significant difference.
    - support the theory that **higher transfer of stress to the implant** interface of some **posterior-stabilized designs** may decrease their longevity

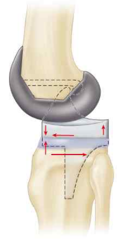
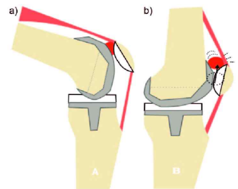


FIGURE 7-15 One argument against posterior cruciate ligament substitution is that added prosthetic constraint may ultimately transfer more stress to prosthesis-bone interface.

Biomechanics

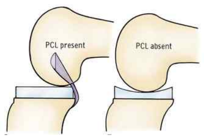
- **PCL retaining prosthesis**
  - Better ROM
  - More symmetrical gait
  - Less femoral bone resection required
  - PCL needs to be accurately balanced



- **PCL substituting prosthesis**
  - Easier surgical exposure
  - Posterior tibial component displacement
  - Lower tibial polyethylene contact stress
  - Patella clunk syndrome
    (fibrous nodule of scar tissue at the posterior surface of the distal quadriceps tendon/superior patellar pole catching on the box of the femoral component during knee extension)

Biomechanics

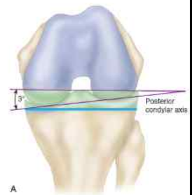
- **Polyethylene wear** is affected by <u>prosthesis design</u> and by its in <u>vivo kinematics</u>



- **PCL-retaining** prostheses → typically **less conforming** to the femoral component in the sagittal plane to allow <u>femoral rollback</u>
- Less-conforming geometry → **higher tibial polyethylene contact stresses** → accelerated polyethylene wear
- Can be compounded by **tight PCL** → **increase the contact stress in flexion** → femoral condyles to override the posterior edge of the tibial polyethylene → accelerated posterior wear

- **Tibial post** on many **PCL-substituting** designs has been shown to be a <u>site of wear</u> and occasional <u>breakage</u>
  1) femoral component is implanted in a flexed position,
  2) when the tibial component is implanted with a greater posterior slope,
  3) when the knee hyperextends

Biomechanics



- Rotation alignment of the femoral component
  - **Rotation** of the **femoral** component effects
    balancing of the flexion space and **patellofemoral tracking**

  - Proximal **tibial** cut is made <u>perpendicular</u> to the mechanical axis of the limb instead of in the anatomically correct **3 degrees of varus**
  - Rotation of the **femoral** component also must be altered from its anatomic position to create a <u>symmetric flexion space</u>
  - To create this **rectangular flexion space**, with **equal tension** on the medial and lateral collateral ligaments, the <u>femoral component is externally rotated</u> an **average of 3 degrees** relative to the posterior condylar axis

Biomechanics

PATELLOFEMORAL JOINT BIOMECHANICS AND FUNCTIONAL ANATOMY

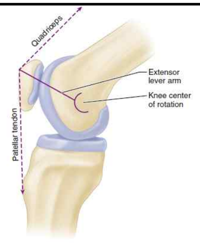


FIGURE 7-21 Patella acts to lengthen extensor lever arm by displacing force vectors of quadriceps and patellar tendons away from center of rotation (COR) of knee. Length of extensor lever arm changes with varying amounts of knee flexion.

- Primary function of the **patella**
  → increase **lever arm** of **extensor mechanism** around the knee
  → improving the <u>efficiency</u> of quadriceps contraction

- Patella acts to **lengthen extensor lever** arm by **displacing force vectors of quadriceps and patellar tendons** away from **center of rotation (COR)** of knee.
- This displacement or lengthening of the <u>extensor lever arm</u> **changes** throughout the **arc of knee motion**
- The extensor lever arm is **greatest at 20 to 30 degrees of flexion**

Biomechanics

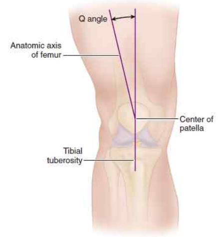


FIGURE 7-22 Q angle, as described by Hvid, is angle between extended anatomic axis of femur and line between center of patella and tibial tubercle.

- Patellofemoral stability → **combination** of the **articular surface geometry** and **soft-tissue restraints**
- **Quadriceps** acts in line with the anatomic axis of the femur
  - With the exception of the **vastus medialis** obliquus, which acts to **medialize the patella in terminal extension**
  - Because the patella **does not contact** the trochlea until **early flexion** → lateral subluxation of the patella in this range is **resisted primarily** by the **vastus medialis** obliquus fibers

- **Q angle** is the angle between the **extended anatomic axis of the femur** and the line between the **center of the patella** and the **tibial tubercle**
- Larger Q angles → tendency for **lateral patellar subluxation**
- Angle of flexion increases → bony and subsequent prosthetic constraints play a dominant role in preventing subluxation

Biomechanics

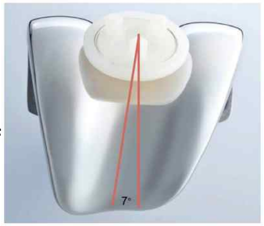


FIGURE 7-23 Built-in trochlear groove angle up to 7 degrees enhances patellar mechanics and patellar tracking.

- In most current femoral component designs, the **lateral flange of the trochlea** has been made **more prominent**, producing a more anatomic reconstruction

- Many designs add a built-in **trochlear groove** angle of up to **7 degrees** to enhance <u>patellar mechanics and tracking</u>

- 1) Trochlear enhancements and attention to 2) femoral component rotation, 3) reproduction of preoperative patellar thickness, and 4) maintenance of joint line height have <u>improved</u> **patellofemoral stability** and have <u>decreased</u> the rate of **lateral patellar retinacular release** significantly

Biomechanics

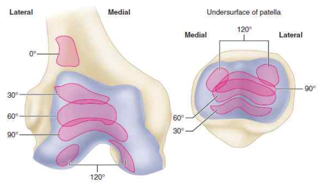


FIGURE 7-24 Patellofemoral contact zones change with knee flexion.

- The **inferior articular surface of the patella** first contacts the **trochlea** in approximately <u>20 degrees of knee flexion</u>

- The **midportion** of the patella articulates with the **trochlea** in approximately **60 degrees of flexion**, and the **superior portion** of the patella articulates at **90 degrees of flexion**

- In **extreme flexion, beyond 120 degrees**, the patella articulates <u>only medially and laterally</u> with the **femoral condyles**, and the quadriceps tendon articulates with the trochlea

Total Knee Arthroplasty
- Alignment -

Introduction

- In past, several reports have indeed been published, demonstrating the adverse effect of **inadequate restoration of neutral leg alignment** on implant survivorship
- Therefore the **current general consensus** is that an overall **mechanical femorotibial alignment (MFTA)** of 0 ± 3 degrees should be the target to aim for to avoid implant failure at medium or long term

Introduction

- Femur의 anatomical axis는 vertical axis에 대해 9 degrees of valgus
- Femur의 anatomical axis는 mechanical axis에 대해 6 degrees of valgus
- Tibia의 anatomical axis는 vertical axis에 대해 3 degrees of varus

- Tibial component placed varus > 5′
  → subside into more varus
  → consequently, tibial components are implanted **perpendicular** to the mechanical axis of tibia
- Femoral components
  → implanted in **5-7 degrees of valgus**
  → **neutral** mechanical axis

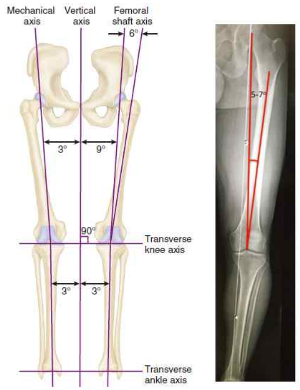


FIGURE 7-18 Mechanical axis of lower limb extends from center of femoral head to center of ankle joint and passes near or through center of knee. It is in 3 degrees of valgus from vertical axis of body. Anatomic axis of femur is in 6 degrees of valgus from mechanical axis of lower limb and 9 degrees of valgus from true vertical axis of body. Anatomic axis of tibia lies in 2 to 3 degrees of varus from vertical axis of body.

Traditional Alignment Principles

- **Insall and Freeman** → most common strategy to achieve neutral alignment "classical alignment"
- Aims at obtaining a **perpendicular implant position** in reference to the **mechanical axis** of both the femur and tibia

- As such, a minor deviation from the natural anatomy is induced
  - The physiologic (natural) **joint line is oriented on average 3 degrees** instead of perpendicular (0 degrees) to the overall mechanical leg axis

- Proximal tibial joint line
  - average of 87 degrees (**3 degrees varus**) → 90 degrees (**neutral**)
- Distal femoral joint line
  - 87 degrees (**3 degrees valgus**) → 90 degrees (**neutral**)

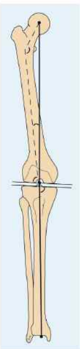


FIG 148.2 The normal joint line is on average 3 degrees inclined to the mechanical axis of the leg. In the traditional way of performing TKA with perpendicular mechanical cuts on both the femur and tibia, this inclination is lost and becomes perpendicular.

Traditional Alignment Principles

- The classical model of restoring neutral mechanical
  - **Perpendicular cuts** on the mechanical axis of the femur and tibia
- 3-degree varus position of the tibial component

  +

  3-degree valgus position of the femoral component

  → **overall neutral mechanical alignment**

- **Perpendicular mechanical cut** on femur → remove approximately 7 mm in the unworn knee, which is replaced by a 9-mm-thick metal component → **distalizing the lateral femoral joint** line with 2 mm
- This is **compensated by the perpendicular tibial resection**, which removes an equal amount of additional bone that is replaced by the tibial implant
- The result is an **unphysiologic obliquity of the joint line**, with **distalization on the lateral side**

FIG 148.1 Restoration of neutral mechanical alignment according to the "classical" alignment philosophy. However, as a consequence, the physiologic joint obliquity is lost, with distalization on the lateral side (see contralateral knee for comparison).

- As a consequence, **patellofemoral mechanics** may become distorted
  - potentially leading to **pain or discomfort** with a sensation of **anterior tightness** in flexion
- Another concern with traditional mechanical alignment restoration is the **lack of an individual, patient-specific strategy**
- Relatively poor performance of current TKA designs, which lack the ability to reproduce physiologic knee kinematics
  - led to an increased interest towards patient-specific, anatomic restoration

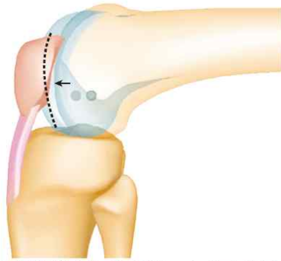


FIG 148.3 Distalization of the joint line on the lateral side leads to distorted patellofemoral mechanics, which can be a cause of pain or discomfort with a sensation of anterior tightness in flexion.

Constitutional Alignment

- A number of patients exist for whom **neutral mechanical alignment** is **abnormal**
- Patients with so-called **constitutional varus** knees have had **varus alignment** since their **end of growth**
- **Restoring neutral alignment in these cases would be abnormal** for them and would almost require some degree of **medial soft tissue release**
- At the same time, anatomic restoration of these knees would lead to a mechanical alignment in varus**,** which could jeopardize the long-term survivorship
- The surgeon is therefore confronted with a **strategic dilemma** in these patients with constitutional varus
  - Either neutral mechanical alignment restoration while realizing that this is abnormal for that specific patient or anatomic restoration and accepting varus mechanical alignment

Constitutional Alignment

- Until recently **no data** were available on the question whether **constitutional varus (or valgus)** really exists in the normal population, and if so in what percentage of healthy individuals it occurs
- It was also unclear how these patients could be identified during surgery
- Interestingly, as high as **32% of males and 17% of females** had **constitutional varus knees** with a natural mechanical alignment ≥3 degrees varus
- The average mechanical **hip and knee angle (HKA)** in the male knees was 1.9 degrees varus, and in the female knees it was 0.8 degrees varus
  - HKA −3 ~ +3 degrees : 165 (66%) of the male and 200 (80%) of the female
  - HKA ≥ +3 degrees : Five (2%) of the male and seven (2.8%) of the female
  - Number of patients with **constitutional varus** : (**32% of males; 17% of females**) may at first sight seem relatively high

Constitutional Alignment

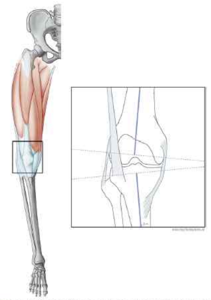


FIG 148.4 Patients with constitutional varus knees have varus alignment since they reached skeletal maturity. Restoring neutral alignment in these cases may indeed be abnormal and undesirable and would almost per definition require some degree of medial soft tissue release. (From Bellemans J, Colyn W, Vandenneucker H, Victor J: The Chitranjan Ranawat Award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. *Clin Orthop* 470:45–53, 2012.)

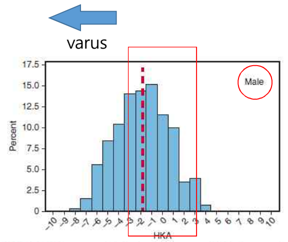


FIG 148.5 Histogram depicting the large variability in natural alignment in healthy male individuals, which contradicts the general belief that normal alignment is zero. Large variability exists between individuals. *HKA*, Hip and knee angle. (From Bellemans J, Colyn W, Vandenneucker H, Victor J: The Chitranjan Ranawat Award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. *Clin Orthop* 470:45–53, 2012.)

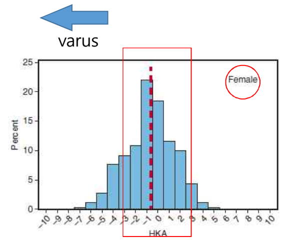


FIG 148.6 Histogram depicting the large variability in natural alignment in healthy female individuals. *HKA*, Hip and knee angle. (From Bellemans J, Colyn W, Vandenneucker H, Victor J: The Chitranjan Ranawat Award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. *Clin Orthop* 470:45–53, 2012.)

Constitutional Alignment

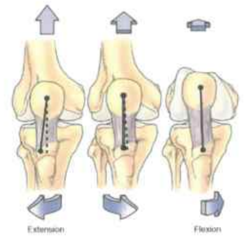
- The association of constitutional varus alignment with increased physical activity during growth has been raised by other authors before
- Witvrouw et al. have noted that **intense sports activity** during growth leads to the **development of varus knees**
  - and this phenomenon occurs **especially towards the end of the growth spurt**
- **Restoring the alignment to neutral** in patients with constitutional varus would indeed be **abnormal** and **unnatural** for them
  - It would implicate an **overcorrection** towards their natural situation in which they had spent their life since skeletal maturity
- A strategy where the natural "constitutional" alignment of the patient is determined and subsequently reproduced seems therefore much more logical

FIG 148.7 Restoration of "constitutional" alignment. The knee is restored to its natural 3-degree varus alignment for this patient (see contralateral knee for comparison).

Summary

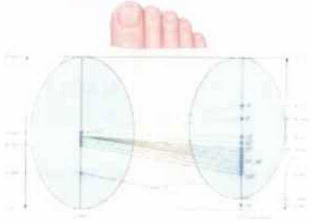
- Restoration of neutral mechanical limb alignment is traditionally considered one of the prerequisites for successful total knee replacement and is currently for **most surgeons still the gold standard**
- However, newer insights have taught us that, for a significant proportion of the population, **neutral alignment is not normal**, and restoring these patients to neutral may not be the best available option
- As a consequence, the concept of **restoring constitutional** rather than mechanical alignment has gained interest
- In this philosophy the natural alignment of the knee is **restored to its original state that was reached at skeletal maturity**, before the disease or damage had occurred

1. 슬관절의 생역학에서 대퇴내과 관절면의 전후방 길이가 외과의 길이보다 길어 슬관절의 굴곡 신전 종말에 발생하는 다음 그림과 같은 현상은? 16B/16I



㉮ 과신전(hyperextension)
㉯ 구르기와 미끄러짐(rolling and gliding)
㉰ 나사회전 운동(screw-home movement)
㉱ 대퇴 후방 굴림(posterior femoral rollback)
㉲ 전후방 전이운동(anteroposterior translation)

1. 우측 슬관절 관절 운동 중 근위 경골에 대한 대퇴내, 외과의 상대적인 움직임을 나타낸 그림이다. 슬관절 굴곡시 대퇴골 외과에서 일어나는 현상은? 21B2/15I



㉮ 대퇴후방굴림(posterior femoral rollback)
㉯ 대퇴전방굴림(anterior femoral rollback)
㉰ 경골후방굴림(posterior tibial rollback)
㉱ 경골전방굴림(anterior tibial rollback)
㉲ 내측 선회(medial pivot)

Osteonecrosis of Femoral Head

명지병원 정형외과
R1. 정승호

Cause

- **Idiopathic (primary) : 10-20%**
- **Secondary :**
  trauma, steroid use, alcohol abuse, smoking, hemoglobinopathies, coagulation disorders, myeloproliferative disorders, HIV infection, pregnancy, rheumatoid disorders, sarcoma, drug intoxication…

Mechanism

- **Infarction :**
  어떤 원인에 의해 골두 공급 혈관이 막히면서 골두의 전외측에 wedge 모양의 괴사가 생기고, 이곳에 혈류가 재생성되면서 괴사 골이 흡수되고 신생 골이 만들어지는데, 이 과정에서 골이 역학적으로 약해져서 함몰된다는 이론.

Mechanism

- **Fat embolism :** 대퇴 골두의 괴사 부위나 연골 하 골 부위에 지방 색전이 관찰되는 것을 근거로 함.
- **Accumulative cell stress :** 여러 원인 인자에 의해 병적 상태에 빠진 골 조직에 추가로 스트레스가 가해지거나, 혹은 잦은 스트레스가 쌓여 선을 넘게 되면 괴사가 일어남.

Mechanism

- **Progressive ischemia :** 단단한 피질골 내 압력이 높아지면서 혈관이 압박되어 혈류가 감소된다는 이론.
- **Coagulopathy :** 골 내의 상대적으로 압력이 낮은 모세혈관에서 시작되는 intravascular coagulation에 의해 괴사가 진행된다는 이론.

Mechanism

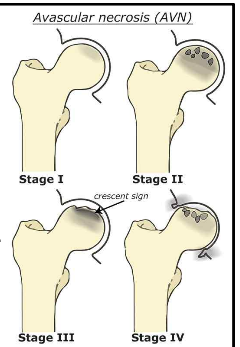
- **Hereditary :** 염색체 12q13에 위치한 제 2형 콜라겐 (COL2AII)과 Vitamin D receptor (VDR) 유전자 이상으로 발생한다는 이론.

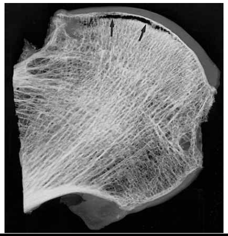
Diagnosis

- **P/Ex. :**
  initially asymptomatic
  groin pain on ambulation
  pain attack when FH(Femoral Head) collapse occur
  Patrick test +
  LOM + **(abduction, IR)**

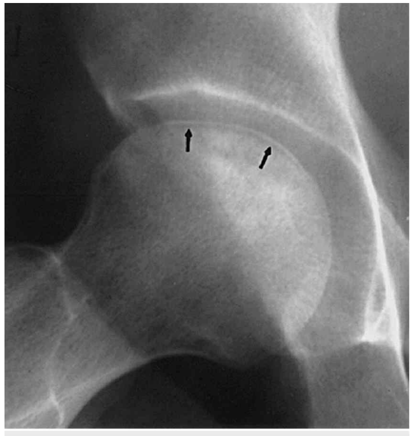
Diagnosis

- **XR :**
  increased density or lucency in the FH
  pathognomonic **Crescent sign** is visible
  FH collapse
  severe arthritic changes





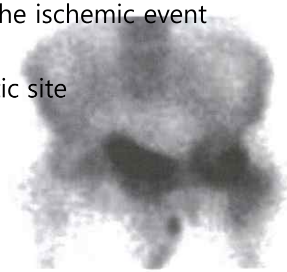
Diagnosis



Diagnosis

- **Bone scan :**

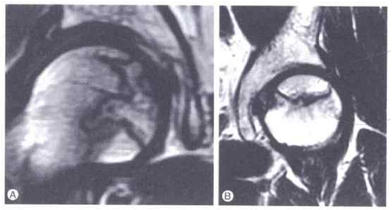
  identify multiple joints involvement
  initial screening test
  Cold in hot lesion
  usually seen 7-10 days after the ischemic event
  cold lesion at necrotic site
  hot lesion surrounding necrotic site



Diagnosis

- **MRI :**

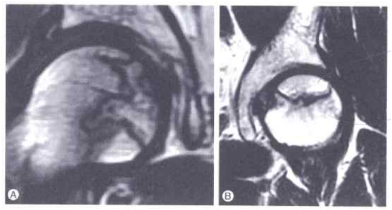
  determine exact stage
  most accurate diagnostic modality
  T1W : decreased marrow signal at necrotic site &
  low-signal band at boundary
  T2W : double line sign



Diagnosis

- **MRI :**

  T2W : double line sign
  inner : high
  -> hyperemic reparative zone (granular tissue)
  outer : low -> normal bone



Differential diagnosis

- Transient osteoporosis
- Stress fractures

Differential diagnosis

- Transient osteoporosis
  XR : diffuse osteopenia c joint preservation
  MR : diffuse edema (T1 low, T2 high)

Differential diagnosis

- Stress fractures

	대퇴골두 연골하 피로 골절	대퇴골두 무혈성 괴사
발생률	드묾	15,000례/연 (미국 통계)
위험 인자	피로 누적형: 갑작스런 활동량 증가 부전 골절형: 골다공증	알코올, 스테로이드, 외상, 장기 이식, 겸상 적혈구증, 고셔병 등
양측성	발생하나 빈도는 알려져 있지 않음	50% 이상에서 양측성
골두 함몰 후 진행	저절로 증상 소실됨	대개 고관절 파괴로 진행
MRI 소견	연골하 골절선(+) 병변과 정상 부위 사이의 반응선(-) 골절선까지 골수 부종(+)	연골하 골절선(+) 병변과 정상 부위 사이의 반응선(+) 괴사 외측에만 골수 부종(+)

no low-signal band & double line sign

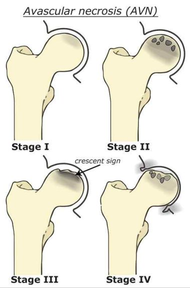
Classification

표 4-1 Ficat and Arlet Classification of Osteonecrosis of the Femoral Head

STAGE	SYMPTOMS	RADIOGRAPHY	BONE SCAN	PATHOLOGICAL FINDINGS	BIOPSY
0	None	Normal	Decreased uptake?		
1	None/mild	Normal	Cold spot on femoral head	Infarction of weight-bearing portion of femoral head	Abundant dead marrow cells, osteoblasts, ostogenic cells
2	Mild	Density change in femoral head Sclerosis or cysts, normal joint line, normal head contour	Increased uptake	Spontaneous repair of infarcted area	New bone deposited between necrotic trabeculae
3	Mild to moderate	Loss of sphericity, collapse	Increased uptake	Subchondral fracture, collapse, compaction and fragmentation of necrotic segment	Dead bone trabeculae and marrow cells on both sides of fracture line
4	Moderate to severe	Joint space narrowing, acetabular changes	Increased uptake	Osteoarthritic changes	Degenerative changes in acetabular cartilage

Classification

- **Ficat & Arlet :**
  I : 일반 촬영 상 정상 소견
  II : 골두 내 경화, 낭종 형성 있으나 연골하 골절 소견 없음
  III : 연골하 골절로 인한 대퇴골두 함몰 소견
  IV : 병변이 비구까지 확장, 고관절 파괴



Treatment

- 질병의 진행을 arrest 하는 방법은 없다
- 예후에서 **stage, size, location**이 중요하다
- 치료방법을 결정하는데 있어서 가장 중요한 것은 **질병의 진행 시기**

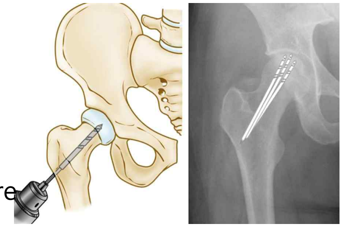
Treatment

- **Observation indications**
  asymptomatic or mild pain
  without FH collapse or less than 2mm collapse at medial or central region
- **Medications**
  bisphosphonate (TOC)
  enoxaparin, warfarin, clofibrate…

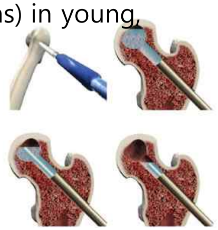
Treatment

- **Operative tx.**
  core decompression
  bone grafting(non-vascularized)
  vascularized fibular grafting
  transtrochanteric rotational osteotomy(Sugioka)
  resurfacing arthroplasty
  THA

Treatment



- **Core decompression**
  decrease intraosseous pressure
  improvement of vascularity
  slowing the progression of the disease
  Indications
  Ficat stage I & IIA(small central lesions) in young,
  who are not taking steroids



Treatment

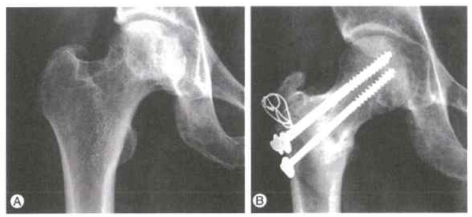
- Bone grafting
- **Vascularized fibular grafting**
  Indications
  age < 50 yrs
  Ficat stage II, III, IV
  doesn't matter taking steroids

Treatment

- **Compared with THA**
  healed FH may allow more activity
  no risk of the presence of foreign body
  possibility of survival of a viable FH
  a longer recovery period (post. Op 6mo partial WB)
  less uniform and less complete relief of pain

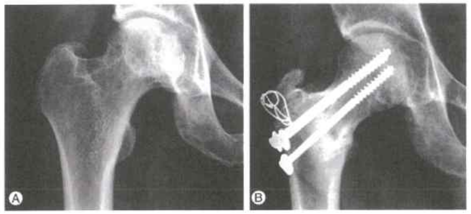
Treatment

- **Transtrochanteric rotational osteotomy(Sugioka)**
  reposition necrotic part to non-weight bearing part
  rotated anteriorly around its longitudinal axis
  weight bearing force is transmitted to
  the posterior articular surface of FH



Treatment

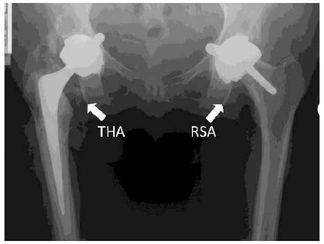
- **Transtrochanteric rotational osteotomy(Sugioka)**
  Indications
  Ficat stage I, II
  age < 55 yrs
  intact posterior articular surface > 0.3



Treatment

- **Resurfacing arthroplasty**
  attractive alternatives for young with advanced necrosis, but recommended only if the avascular segment constitutes **usually < 50%**

- **THA**



Examples

1. 65세 여자가 보존적 치료에 반응하지 않는 고관절 동통을 주소로 내원하였다. 단순 방사선 사진은 다음과 같다. 다음 중 가장 적절한 치료는? 16B2

㉮ 정기적 방사선 검사 추시
㉯ 다발성 천공술
㉰ 근위 대퇴골 절골술
㉱ 인공 고관절 반치환술
㉲ 인공 고관절 전치환술

Examples

1. 65세 여자가 보존적 치료에 반응하지 않는 고관절 동통을 주소로 내원하였다. 단순 방사선 사진은 다음과 같다. 다음 중 가장 적절한 치료는? 16B2

㉮ 정기적 방사선 검사 추시
㉯ 다발성 천공술
㉰ 근위 대퇴골 절골술
㉱ 인공 고관절 반치환술
㉲ 인공 고관절 전치환술

Examples

1. 대퇴골 두 무혈성 괴사의 치료에 대한 설명으로 옳지 않은 것은?

㉮ 질병진행의 rate와 course는 예측 불가능하여 방사선 소견과 임상증상은 일치하지 않을 수도 있다
㉯ 예후에서 staging, size, location이 가장 중요하다
㉰ 치료방법을 결정하는데 있어서 가장 중요한 것은 환자의 나이다
㉱ size가 커짐 (femoral head 면적의 50% 이상 involve)에 따라 83% 이상이 symptomatic ONFH로 간다
㉲ 함몰이 심하고 퇴행성 변화까지 있는 경우는 인공관절 치환술이 도움이 된다

Examples

1. 대퇴골 두 무혈성 괴사의 치료에 대한 설명으로 옳지 않은 것은?

㉮ 질병진행의 rate와 course는 예측 불가능하여 방사선 소견과 임상증상은 일치하지 않을 수도 있다
㉯ 예후에서 staging, size, location이 가장 중요하다
㉰ 치료방법을 결정하는데 있어서 가장 중요한 것은 환자의 나이다
㉱ size가 커짐 (femoral head 면적의 50% 이상 involve)에 따라 83% 이상이 symptomatic ONFH로 간다
㉲ 함몰이 심하고 퇴행성 변화까지 있는 경우는 인공관절 치환술이 도움이 된다

- 치료방법을 결정하는데 있어서 가장 중요한 것은 **질병의 진행 시기**

Chronic instability of DRUJ

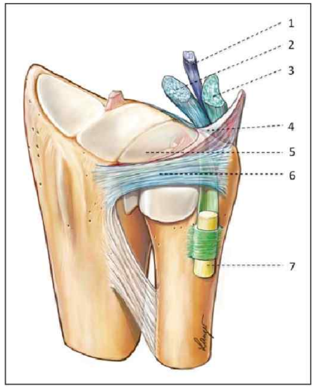
명지병원 정형외과

R3. 이 규 환

2023.09.08

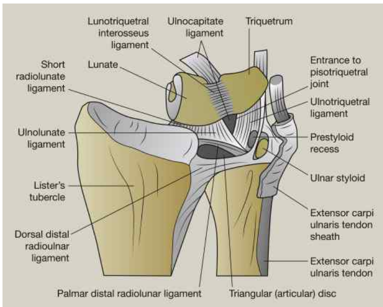
Chronic instability of DRUJ

- Distal radioulnar joint
  - Ulnar head & radius sigmoid notch 로 이루어진 관절
    - Sigmoid notch의 직경이 ulnar head 직경보다 1.5~2배 커서 ulnar head가 전후방으로 움직일 수 있는 불안정한 관절.
    - →따라서 안정성에는 연부조직의 기여가 큼.
  - 회전 운동의 중심이 되는 관절
  - Radius or ulnar fracture와 동반하여 dislocation 및 subluxation이 발생할 수 있음.



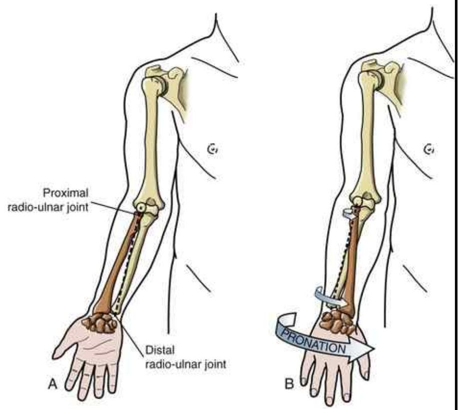
Chronic instability of DRUJ

- Distal radioulnar joint
  - Stability
    - Bony structure : Sigmoid notch
    - Soft tissue : **TFCC**, synovium, ECU & FCU tendon sheath, interosseous membrane, pronator quadratus, etc.



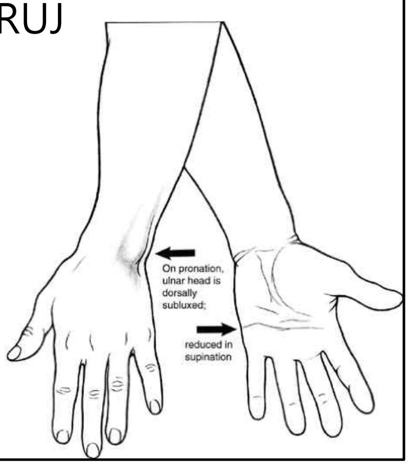
Chronic instability of DRUJ

- Cf. acute DRUJ instability
  - Normal ulnar head translation
    - Pronation : posterior translation
      - 전방탈구일 때 pronation으로 고정
    - Supination : anterior translation
      - 후방탈구일 때 supination으로 고정
  - Cause : 주로 dislocation 후 발생



Chronic instability of DRUJ

- Cf. acute DRUJ instability
  - 대부분 posterior dislocation
    - 손상기전은 wrist extension + pronation +arm stretched
    - Anterior dislocation은 반대로 excessive supination or direct trauma of ulnar head
  - Distal radius Fx가 동반되지 않은 경우에는 reduction 후 stable한 상태를 forearm rotation하면서 찾은 후 그 상태로 3-4주간 long arm splint 유지한다.



Chronic instability of DRUJ

- Chronic DRUJ instability
  - Isolated trauma to the DRUJ
  - After fractures of the distal radius and ulna (malunion, etc)
  - After unsuccessful attempts to repair the TFCC or chronic laxity of TFCC
  - Inflammatory arthritis

Chronic instability of DRUJ

- Symptoms & signs
  - Wrist ulnar side pain
    - 불안정성에 의해 부하를 주면서 forearm rotation 시 통증을 느낌.
  - Limitation of forearm rotation d/t ulnar head subluxation
  - Ulna posterior subluxation(Posteriorly unstable)
    - TFCC의 DRUJ insertion site rupture된 경우
    - Severe ulnar positive variance
    - Distal radius Fx malunion → anterior slope
  - Posterior slope : distal radioulnar joint ulnar anterior subluxation → volar instability

Chronic instability of DRUJ

- Procedures to stabilize the distal radioulnar joint
  - Malunited distal radial Fx.
    - Distal radial osteotomy & bone grafting to **correct shortening and angulation**
  - Ununited, displaced ulnar styloid Fx.
    - O/R & I/F
  - Soft-tissue technique
    - TFCC Repair
    - Reconstruction of TFCC (articular surface & sigmoid notch intact)
    - Reconstruction of the ligaments around the DRUJ (with PL)

Chronic instability of DRUJ

- Procedures to stabilize the distal radioulnar joint
  - Adams 3 category of soft-tissue reconstruction for chronic DRUJ instability

  → Adams emphasized the importance of reconstruction of DRU ligaments **to restore DRUJ stability & to preserve DRUJ motion**
    - Distal ulnar tenodesis with ECU or FCU
    - Ulnocarpal tether
    - Radioulnar tether

Chronic instability of DRUJ

- Trapezoidal osteotomy of distal radius

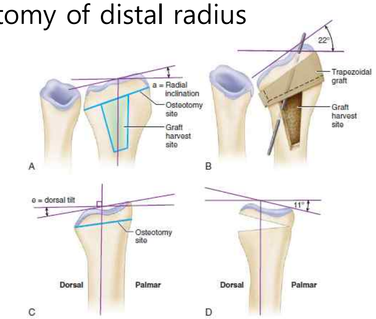
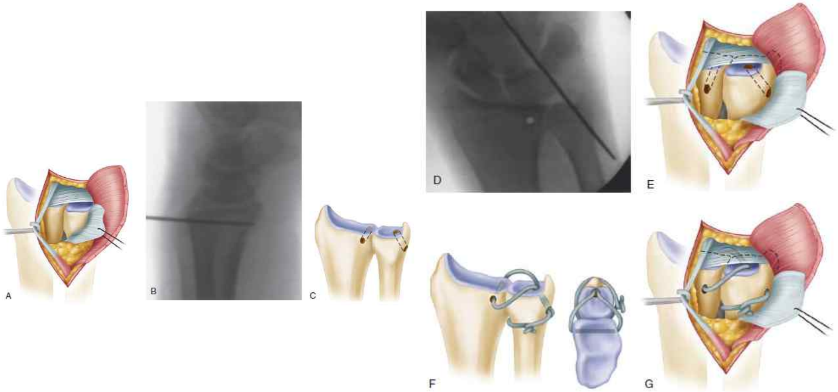
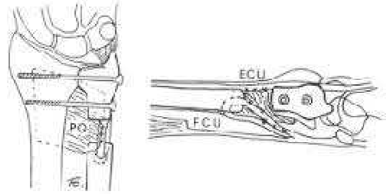


FIGURE 58-38 Trapezoidal osteotomy of distal radius. **A,** Preoperative posteroanterior view with decreased radial inclination; osteotomy and trapezoidal graft site are outlined. **B,** Postoperative posteroanterior view shows normal radial tilt and single "caging" pin. **C,** Abnormal dorsal tilt of radial articular surface reverses all loads across carpals and does not tolerate loading in active patients. **D,** Postoperative lateral view shows restoration of 11 degrees of palmar tilt before insertion of graft.



Chronic instability of DRUJ

- Procedures to stabilize the distal radioulnar joint
  - Salvage procedure : modified Sauve-Kapandji procedure
    - DRUJ arthrodesis with distal ulnar pseudoarthrosis
    - Stable DRUJ with ulnocarpal support is achieved
    - Preserve TFCC & rotation of forearm



Quiz

1. 58세 남자 환자로 2년 전부터 시작된 좌측 손목 척측에 통증이 있어 내원하였다. 신체검사 상 원위 요척관절과 척수근부 부위에 압통이 있었고, 회외전이 제한 되었다. 방사선 검사 상 아래와 같고, 수술적 치료를 고려할 때 가장 적절한 방법은? 17B2/15B2/12I

㉮ 관절경적 삼각섬유연골 봉합술
㉯ 관절경적 wafer 절제술
㉰ 척골 단축술
㉱ Modified Sauve-Kapandji 술식
㉲ Darrach 술식

Quiz

1. 55세 여자환자로 8개월전 손목 수상이후 보존적 치료를 시행하였다. 진찰소견에서 원위 요척관절 부위의 압통과 회전제한이 있었으며 회내전(pronation)시 척골두가 후방으로 돌출되었다. 단순 방사선 검사에서 원위요척관절 부위의 관절염 소견은 없었다. 이 환자에 대한 치료로 적절한 것은? 16B2

㉮ 경과 관찰
㉯ 원위요척관절 인대 재건술
㉰ Modified Sauve-Kapandji 술식
㉱ 원위요척관절 도수정복 및 핀 고정
㉲ wafer 술식