

# Anatomy and pathophysiology of meniscus

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손 목 진

## 1. Introduction

- meniscus: functionless remains of leg muscle  
→ integral part of the complex, biomechanics of the knee
- injury incidence  
850,000 pt/yr (AAOS, 1998)  
10만명당 60~70/years (Hede A et al. Act orthop Scandinavia, 1990)  
male/female = 25/1~4/1
- arthroscopy of meniscus 1960s, Japanese surgens(Ikeuchi)

## 2. Gross anatomy

- C-shaped fibrocartilage capsule
- peripheral margin:  
convex and fixed joint capsule except popliteus tendon area.
- inner edge: concave, thin and unattached.
- superior surface: concave so that it serves to deepen the fossa
- inferior surface: flat

## 3. Medial meniscus

- shape: semicircular ( C-shape )
- length: 3.5 cm
- attach: ant. horn: 6~8 mm ant. to ACL  
post. horn: ant to PCL
- ant. horn > post. horn
- excursion: average 5 mm
- articular cartilage의 1/2을 덮고 있다.

## 4. Lateral meniscus

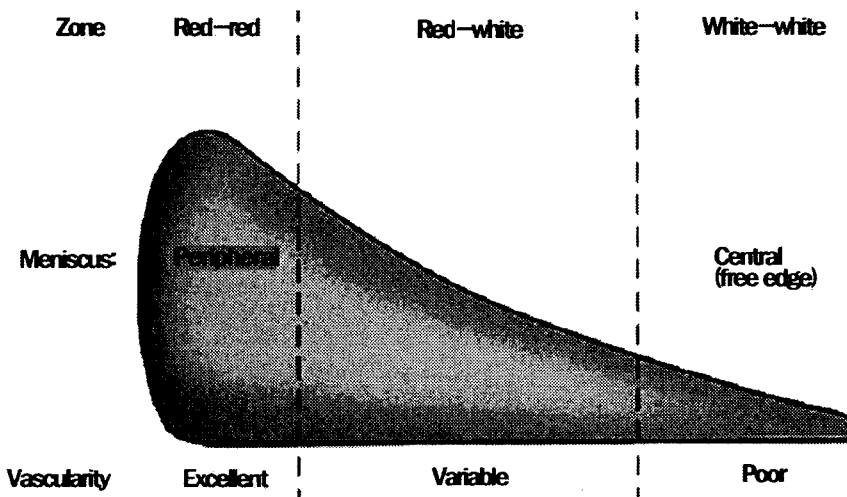
- shape: nearly circular ( O-shape )

- length: medial meniscus보다 작다.
- articular cartilage의 2/3을 덮고 있다.
- attach: ant. horn - ant to lat. tibial spine  
 post. horn - ant. to med meniscus post. horn
- popliteus를 위한 hiatus가 있다.
- menisiofemoral lig. (Wrisberg and Humphrey)  
 : pull the post. horn of lat. meniscus in ant. direction

### 5. Vascular anatomy

- peripheral capsule and ant. horn:  
 med. and lat., inf. and sup. genicular artery
- post. horn: middle genicular artery

### 6. Zone of meniscal vasculature



### 7. Neural system of meniscus

- only peripheral area: peripheral tear 시 symptomatic central tear 시 symptom free. but, traction 되면 pain 야기
- proprioception and pain 담당.

## 8. microanatomy of meniscus

- composition: collagen fiber (75%) - type I collagen이 90%.  
non-collagenous protein (8~13%) - glycosaminoglycan, glyco-protein, elastin etc.

## 9. Collagen fiber

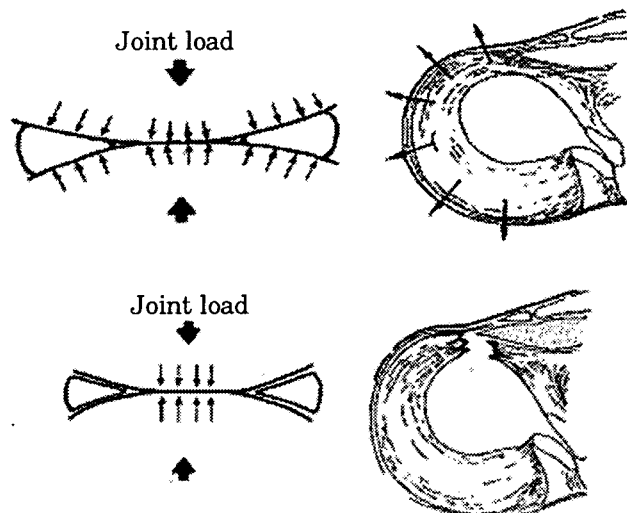
- longitudinal fiber: peripheral area에 많다.
- radial + longitudinal fiber: post. half of meniscus에 분포  
→ great load transmission.
- radial fiber: central portion( middle perforating )
- \* lateral meniscus의 central portion은 radial fiber가 풍부하지만, longitudinal fiber가 적어서 radial tear나 horizontal cleavage tear가 잘 생김

## 10. Mechanical function of meniscus

- load distribution
- shock absorption
- improved joint stability
- joint lubrication
- prevent capsular and synovial impingement of flexion and extension.

## 11. Load distribution

- axial load  
→ tensile load
- Hoop tension



- \* extension: 50% of compression load
- flexion: 85% of load transmission

## 12. Shock absorption

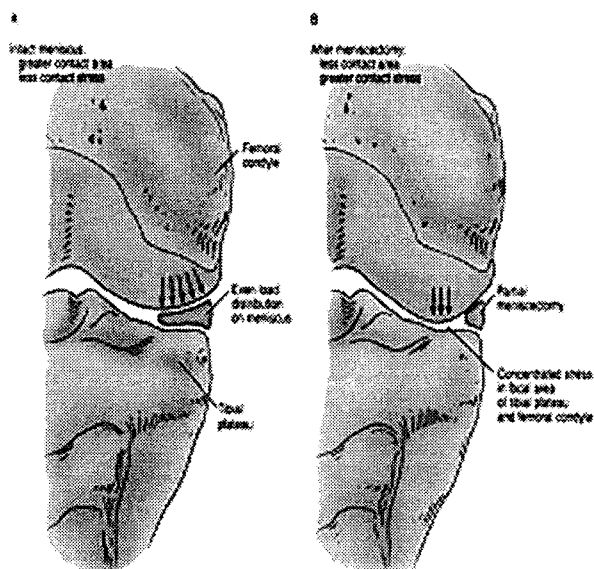
- permeability: articular cartilage 1/6
- compression stiffness: articular cartilage one-half
- compressive load → early deformed → forcing interstitial flow  
→ articular cartilage protect
- \* standing: wt.의 40 ~ 60% 담당

## 13. Joint stability

- wedge shape
- med. meniscus post. horn이 가장 중요한 역할
- meniscal mobility and viscoelasticity
- frictionless supf. surface

## 14. Biomechanics as related to meniscal compromise

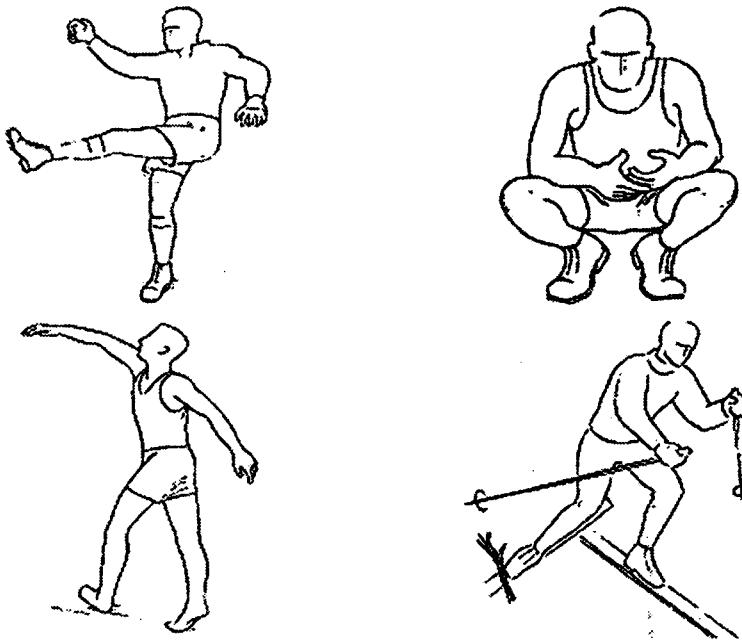
- Increased contact stress
- partial menisectomy (15 ~ 34% ↑): contact stress 65% ↑



- total menisectomy: contact stress 40 ~ 700% ↑
- Compromized joint stability
- Ant. tibial translation: 50% ↑ increased (Levy et al. JBJS.1989)

### 15. Factors which increase vulnerability

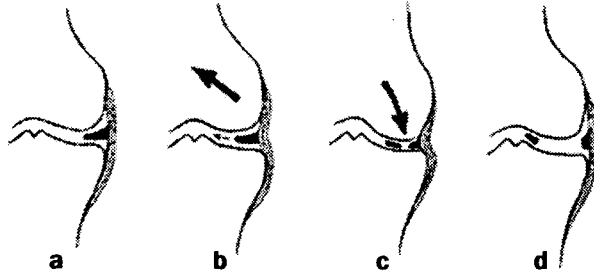
- constitutional and congenital variation
- ligament damage:
  - acute ACL injury는 lateral meniscus injury를 잘 동반
  - chronic ACL injury는 medial meniscus injury를 잘 동반
- degenerative change



- specific activity

### 17. Mechanism of injury

- the menisci follow the tibial condyle during flexion and extension but, during rotation they follow the femur and move on the tibia: consequently the med. meniscus becomes distorted. → it is likely to be injured during rotation



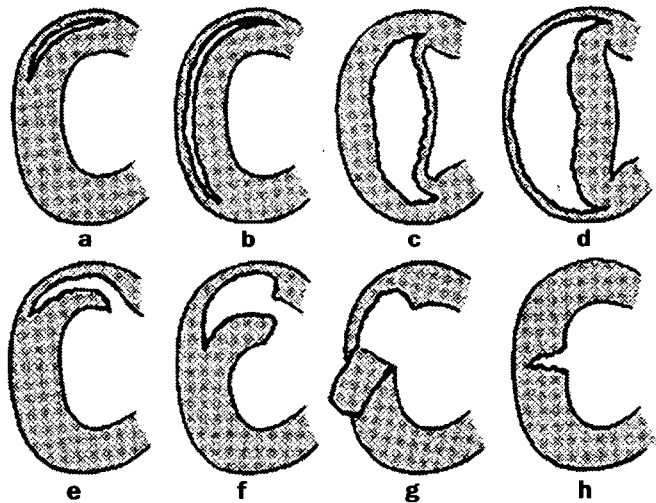
- lat. meniscus가 med. meniscus에 비해 손상이 적은 이유:  
lat. meniscus is smaller in diameter, thicker in periphery, wider in body, more mobile injury mechanism이 external rotation and abduction이 많다.
- lat. meniscus는 both cruciate lig, meniscomfemoral lig., popliteus m.과 attach 되어있다.

### 18. Tear patterns classification

- location with reference to the blood supply
- orientation and appearance of the tear.

### 19. Longitudinal tear

- peripheral aspect
- young, active pt.
- post horn에서 시작
- bucket - handle tear:  
locking and post.  
spring sign



## 20. Radial tear

- lateral aspect of lat. meniscus
- pain/tenderness at lat. joint line ant. to LCL
- root tear

## 21. Horizontal tear

- most commonly tear pattern
- old pt.
- cleavage
- flap tear

## 22. Stable versus unstable meniscal tissue

- stable:
  - peripheral full thickness tear: 5 mm ↓
  - partial thickness tear: 10 mm ↓
  - cannot be displaced more than 3 mm

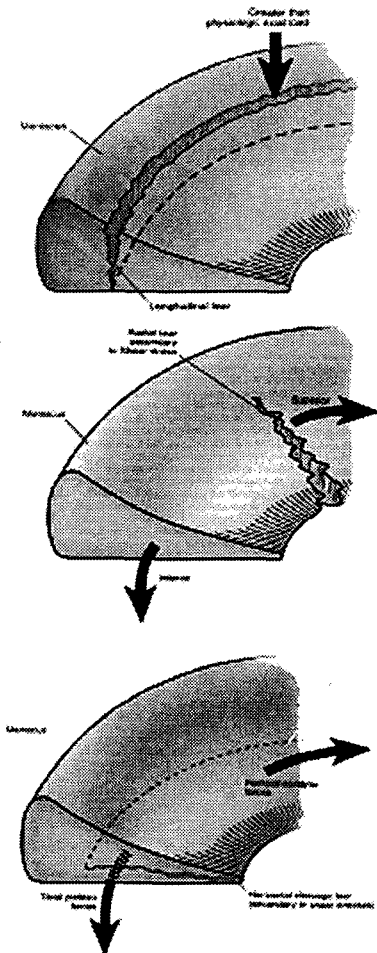
## 23. Evaluation of meniscus pathology

### (1) History

- the knee does not feel right  
something is wrong  
something is jumping in and out of place
- knee pain, swelling: tear 초기에는 나타나지 않을 수 있음.
- locking, givingway, pinching, catching

### (2) Physical examination

- quadriceps atrophy: 특히 vastus medialis.
- joint line tenderness( Weinstable et al.): 74% sensitivity  
50% positive predictive value
- McMurray's test: 98% specificity, 15% sensitivity
- Steinmann's test



- Apley's test
- square test

(3) Imaging study

- plain radiographs: A-P weight bearing view
- 45-degree flexed P-A view
- lateral view
- Merchant view

- Arthrography

- MRI

meniscal signal

grade I patchy area of increased signal

grade II a linear configuration

grade III a linear configuration contacts of articular surface: meniscal tear 를 의미.

- \* accuracy

93 ~ 98% med. meniscus tear

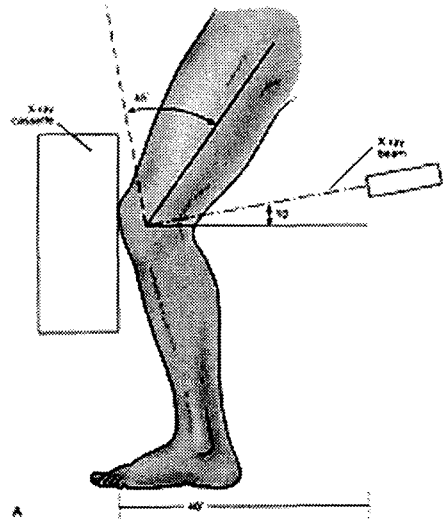
90 ~ 96% lat. meniscus tear

- Arthroscopy

med. meniscus tear: 95% sensitivity, 72% specificity

lat. meniscus tear: 88% sensitivity, 92% specificity

- \* med. meniscus의 ant. horn은 fat pad에 의해 가려지는 경우가 많다.



## 24. Differential diagnosis

- articular cartilage compromise
- patellofemoral symptom
- synovial plica
- osteonecrosis

- \* failed meniscectomy의 most common 이유

young pt. : patellofemoral problem

old pt. : arthritic change