

KNEE BIOMECHANICS

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Introduction

- What kind of joint is it?
- Limits of motion
- Normal kinematics of a step
- Plateau & condyles
- Patello Femoral articulation
- Menisci
- Medial, lateral and anterior stability
- ACL & PCL

Knee joint

- Ginglymus (hinge) ?
- Arthodial (gliding) ?
- 6 degrees of freedom
 - 3 rotations
 - 3 translations

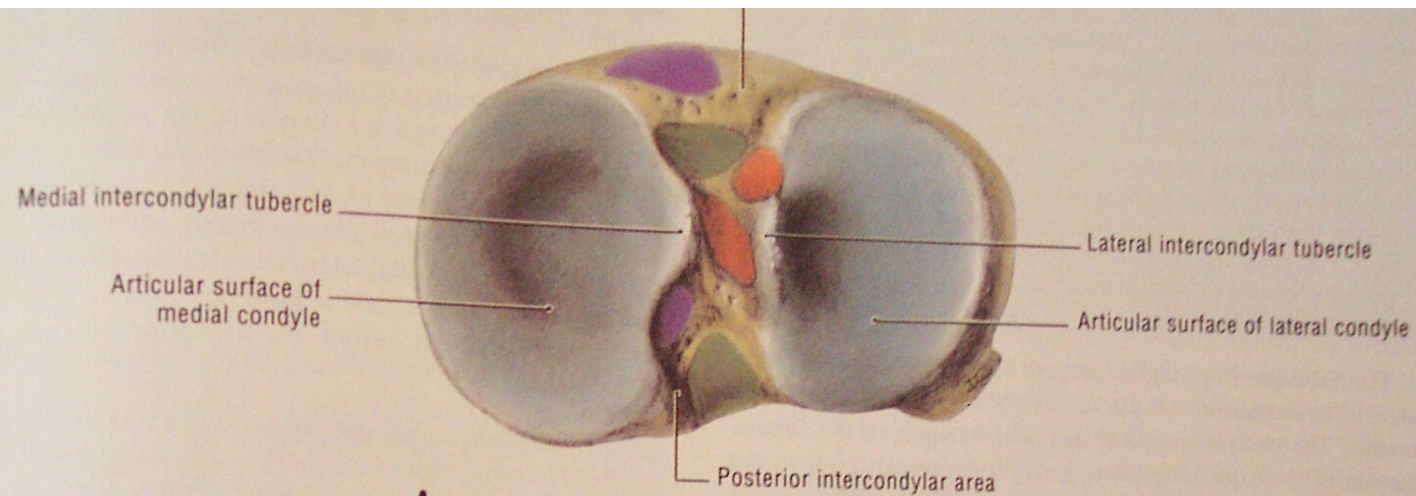
- Rotations
 - flex/ext - -15 to 140 deg
 - varus valgus - 6-8 deg in extension
 - int/ext rotation - 25 - 30 deg in flexion

- Translations
 - AP 5 - 10mm
 - comp/dist 2 - 5mm
 - medio-lateral 1-2mm

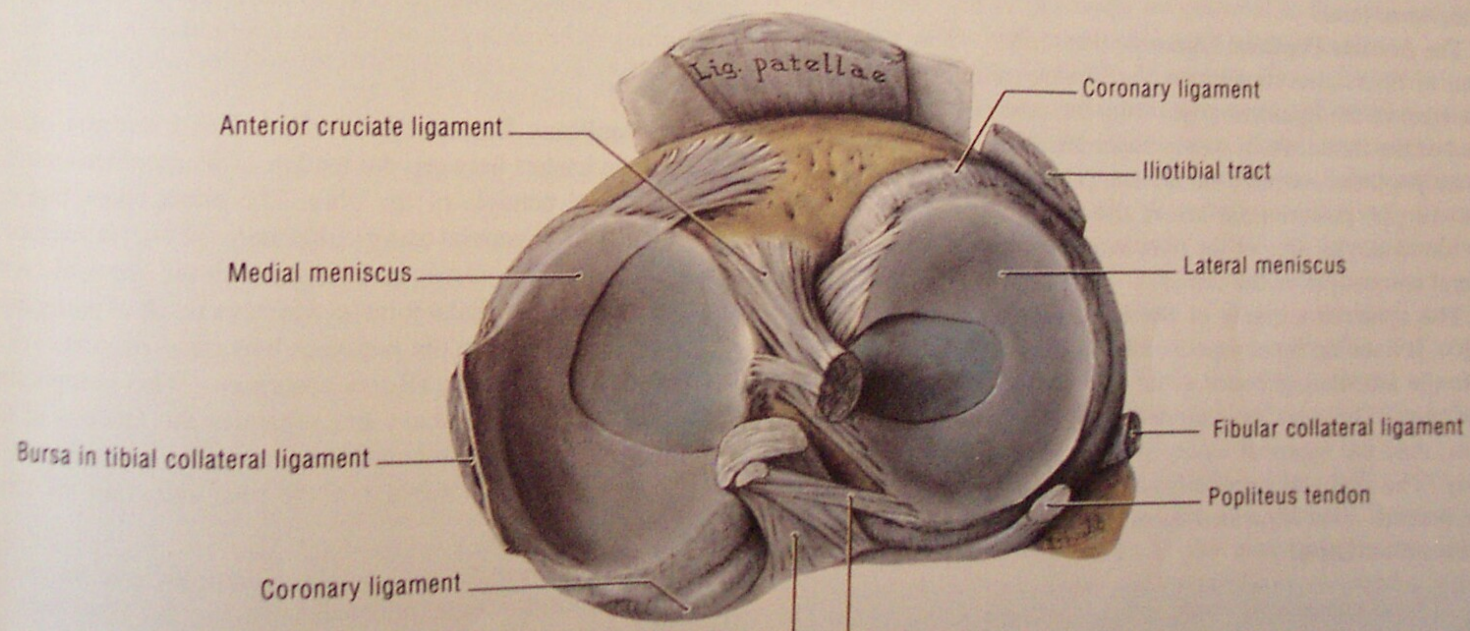
Taking a step

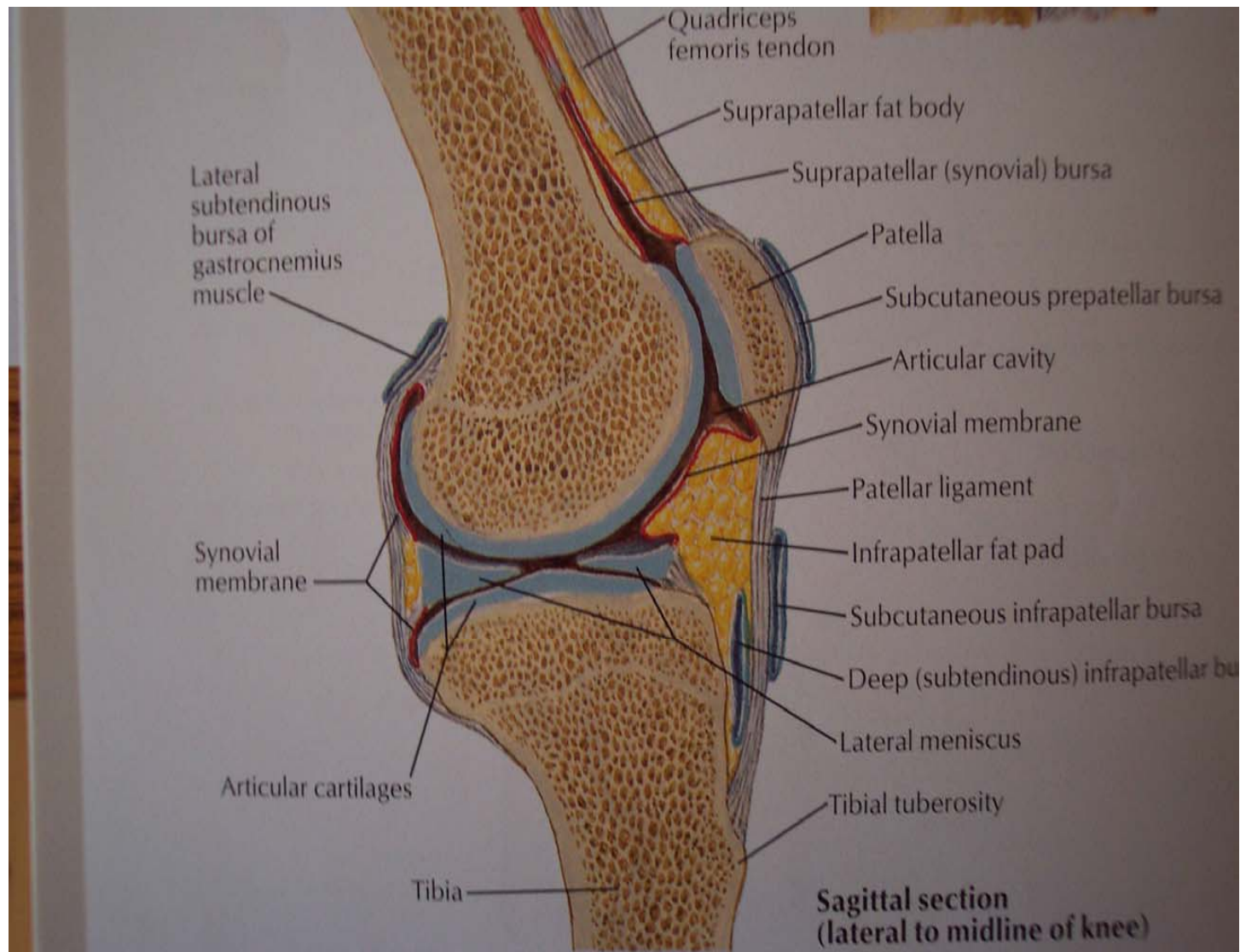
- Just prior to heel strike - max extension & max external rotation
- heel strike - max valgus
- flat foot - flexion & intrenal rotation progress
- swing phase - internal rotation continues, max flexion, max anterior translation.

Condyles and plateau



A





Patellofemoral articulation

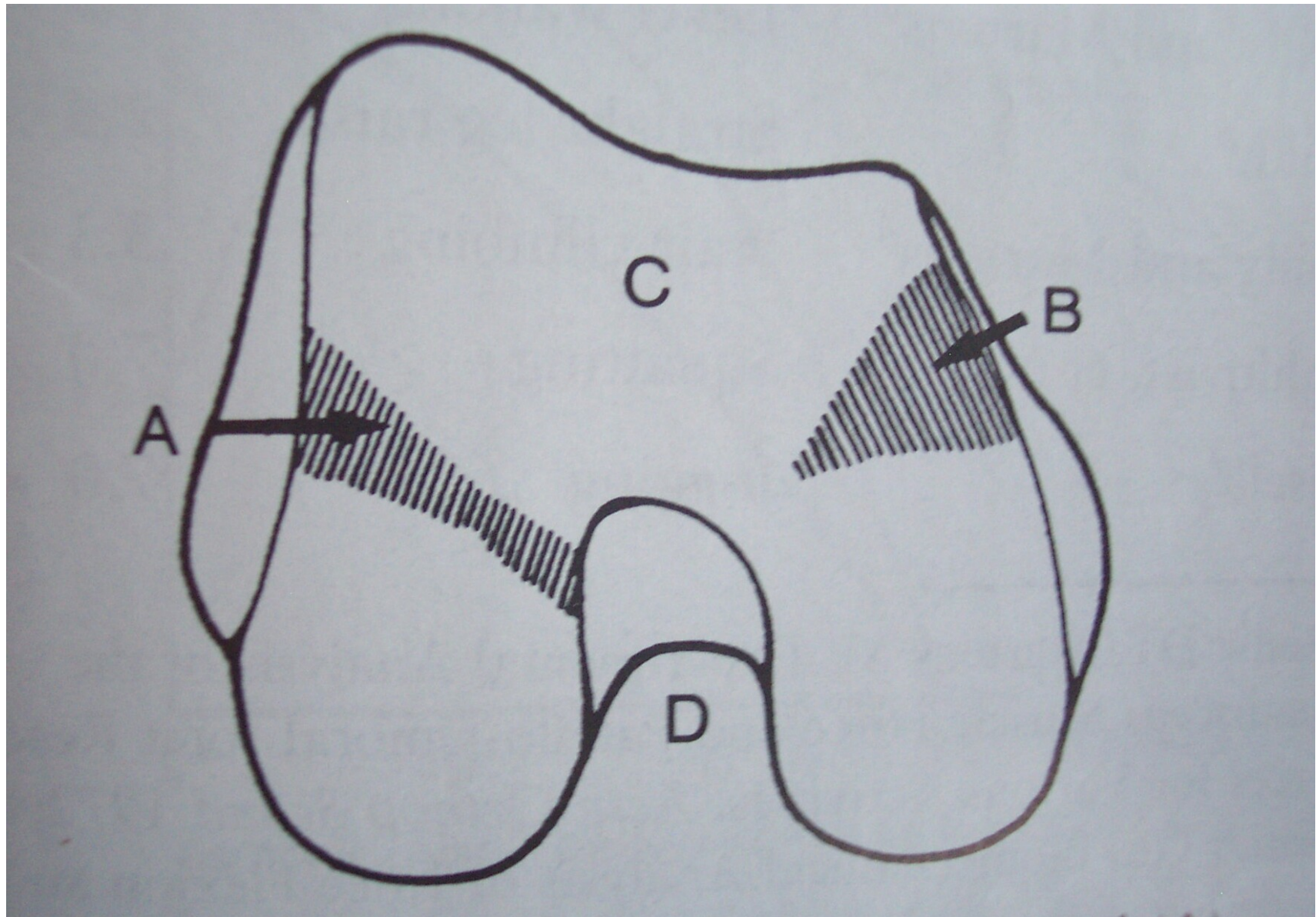
- Shape/anatomy of patella
- Anatomy of intercondylar groove
- direction of force
- PFJR vs flexion angle and quads force
- Contact area vs PFJR and stress
- chondromalacia of patella

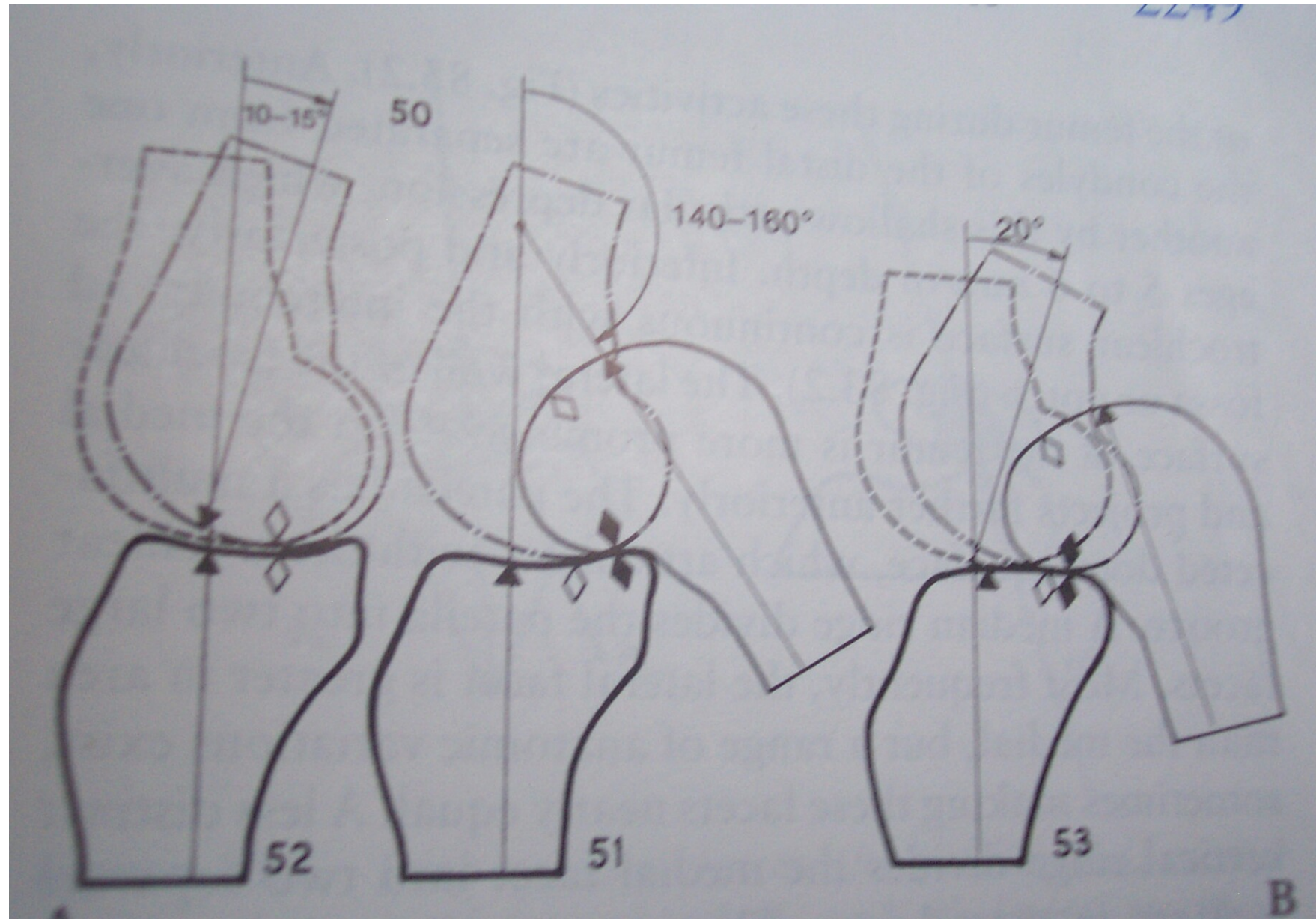
- Patella functions
 - Increases moment arm (increases rotational torque) 0 - 45 deg
 - lever at > 45 deg
- Patellectomy?

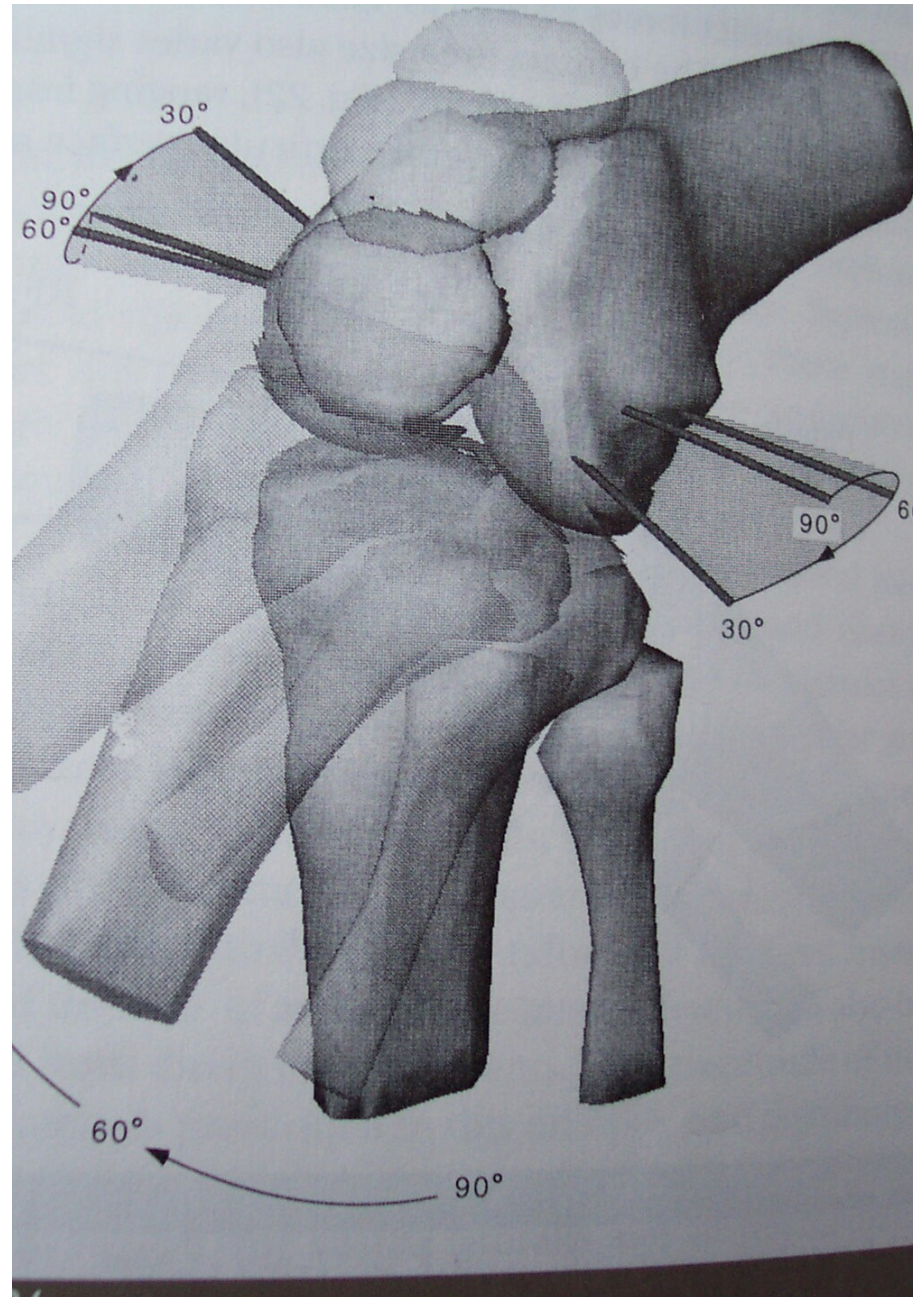
Table 83.2. Patellofemoral Joint Reaction Force

<i>Source</i>	<i>Activity</i>	<i>× Body weight (BW)</i>
Reilly and Martens ^a	Level walking	0.5 × BW
Smidt ^b	Straight leg raise	2.6 × BW
Reilly and Martens ^a	Stair climbing	3.3 × BW
Dahlqvist, et al. ^c	Squatting	7.0 × BW
Nisell ^d	Jogging	7.0 × BW

^a Reilly DT, Martens M. Experimental Analysis of the Quadriceps Muscle Force and Patello-femoral Joint Reaction





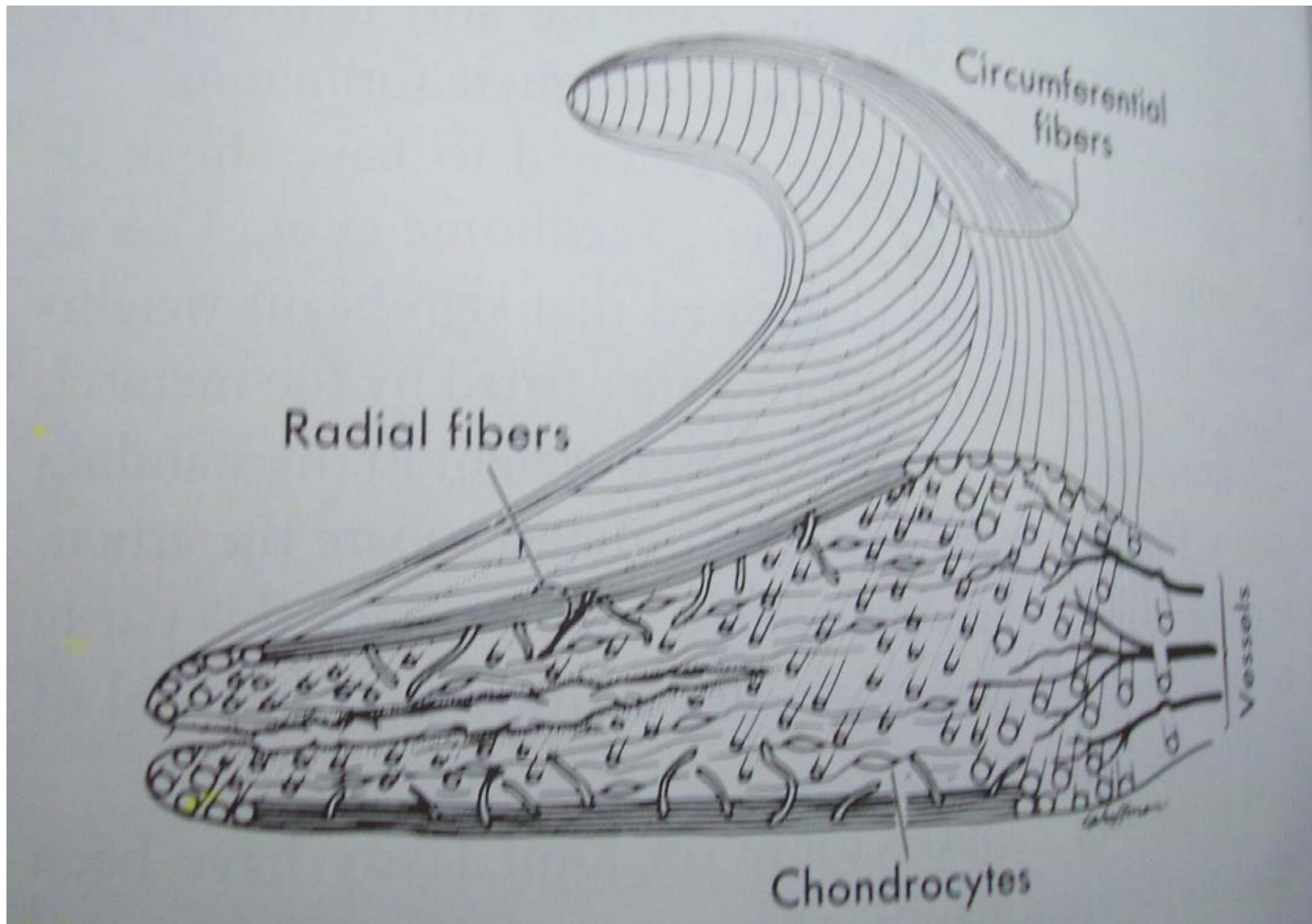


Menisci

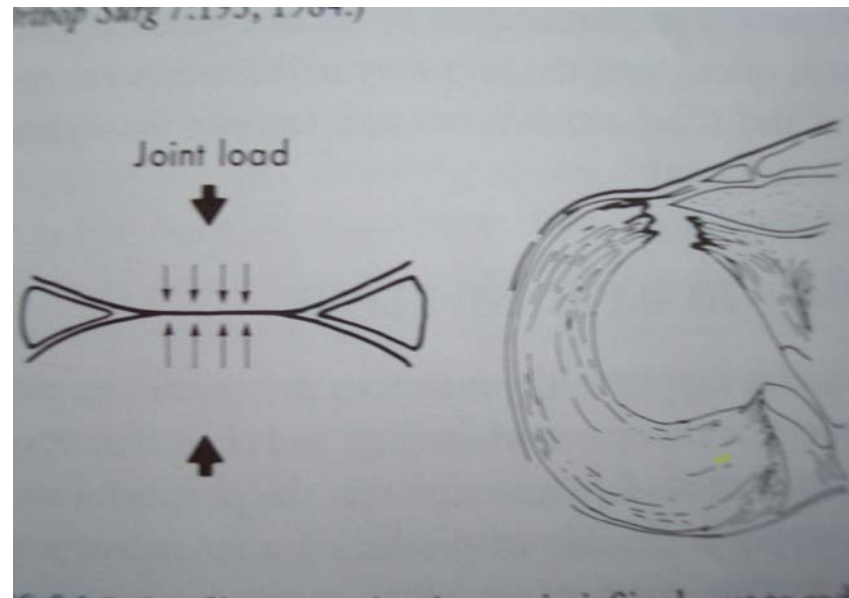
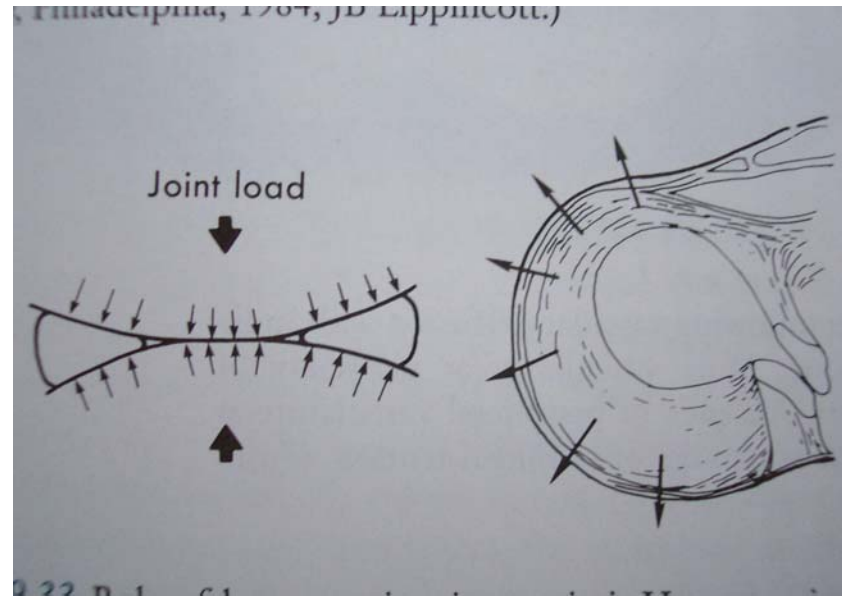
- Fairbank - 1948
- late 60's - poor results of minisectomy
- mid 70's - load transmission confirmed
 - 40-60% load is on meniscus
 - lateral > medial

- 2 functions
 - load bearing
 - stability
 - also, joint lubrication
 - prevent capsule, synovial impingement
 - shock absorbers

Load bearing -composition;

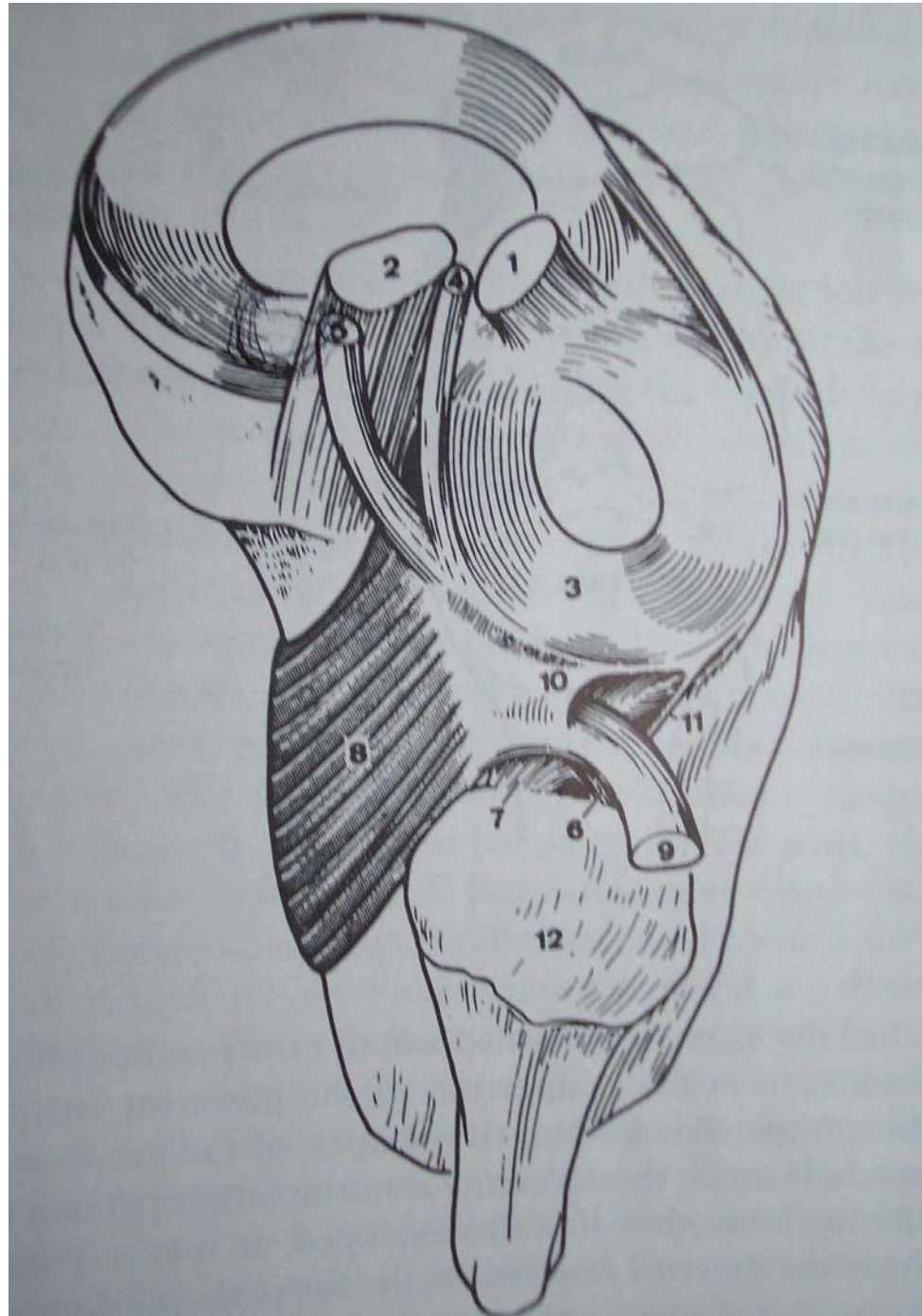


Hoop stress



- Knee joint stability
 - mainly rotational
 - minisectomy +/- ACL and translation
 - why differences in lat vs med ?
 - Structure
 - attachments

Attachment sites

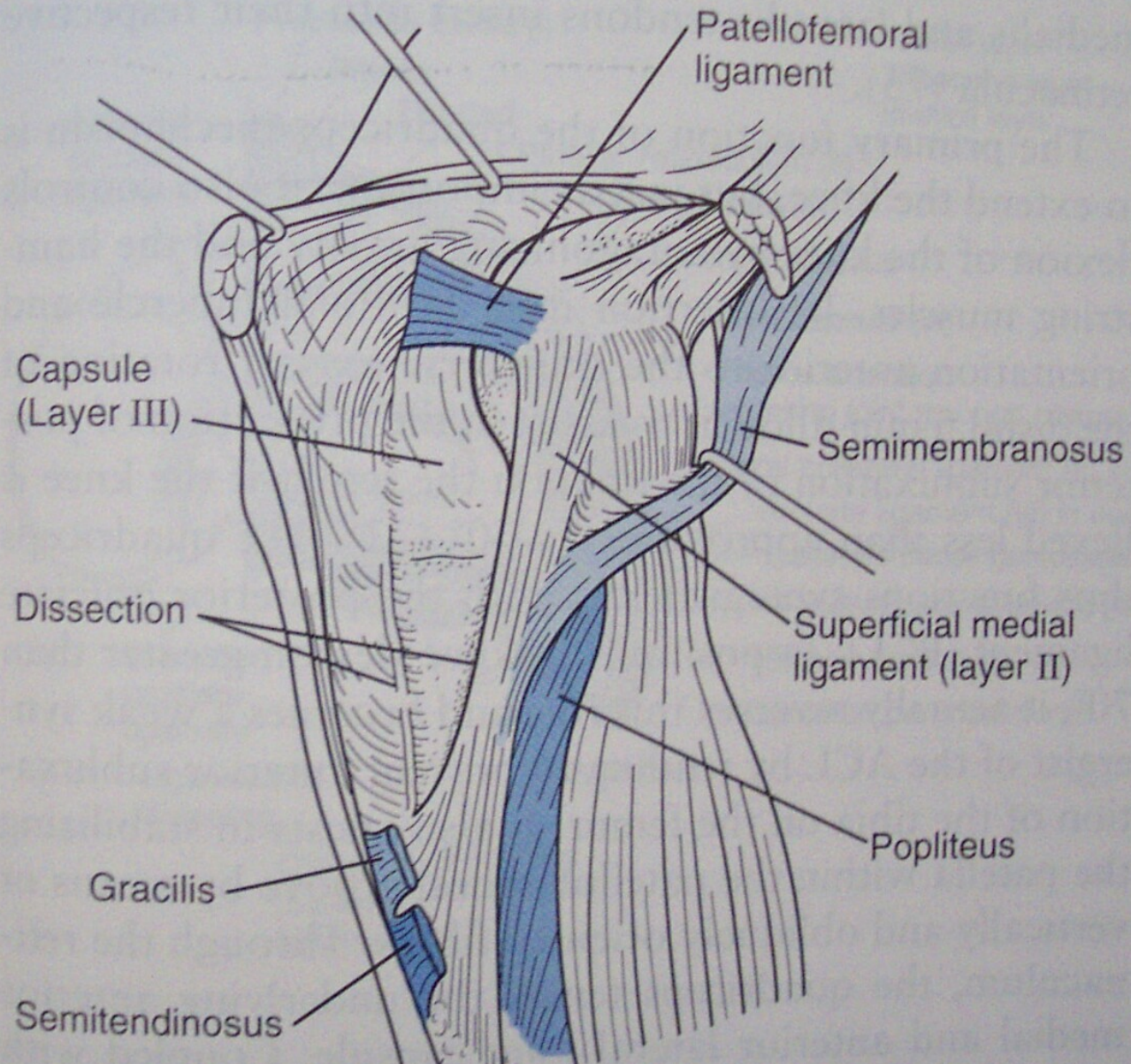


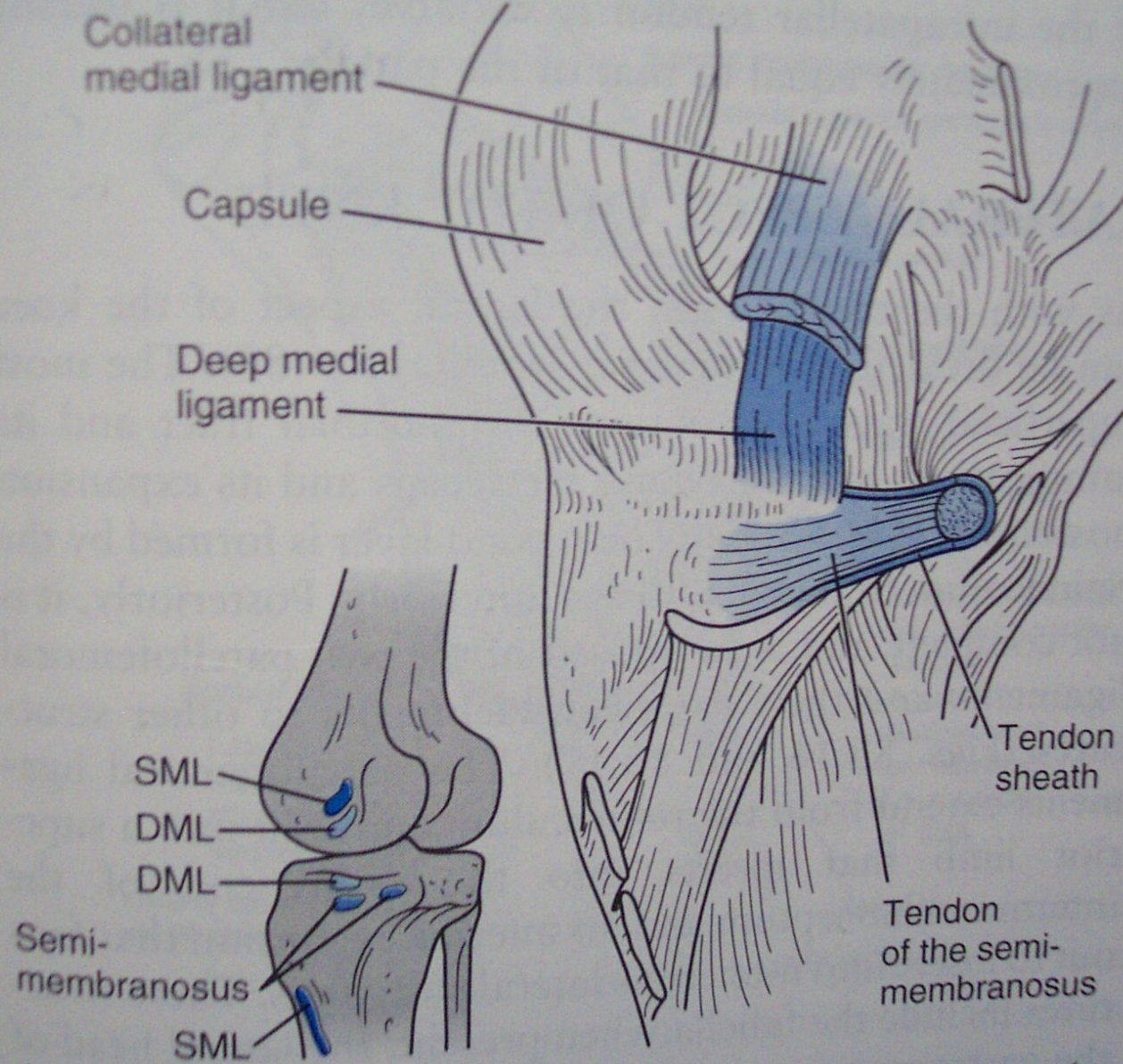
Medial & lateral stabilizers (mostly ligaments)

- Ligaments
 - most important static stabilizers
 - tensile strength - related to composition

Medial side

- Superficial MCL
 - Primary valgus restraint -57-78% restraining moment of knee
 - femoral attachment fans out around axis of rot.
 - Lax in flexion
- Semimembranosis (expansion)
 - internally rot's tib on femur
 - tenses post/med capsular structures that are lax in knee flexion
 - acts with ACL





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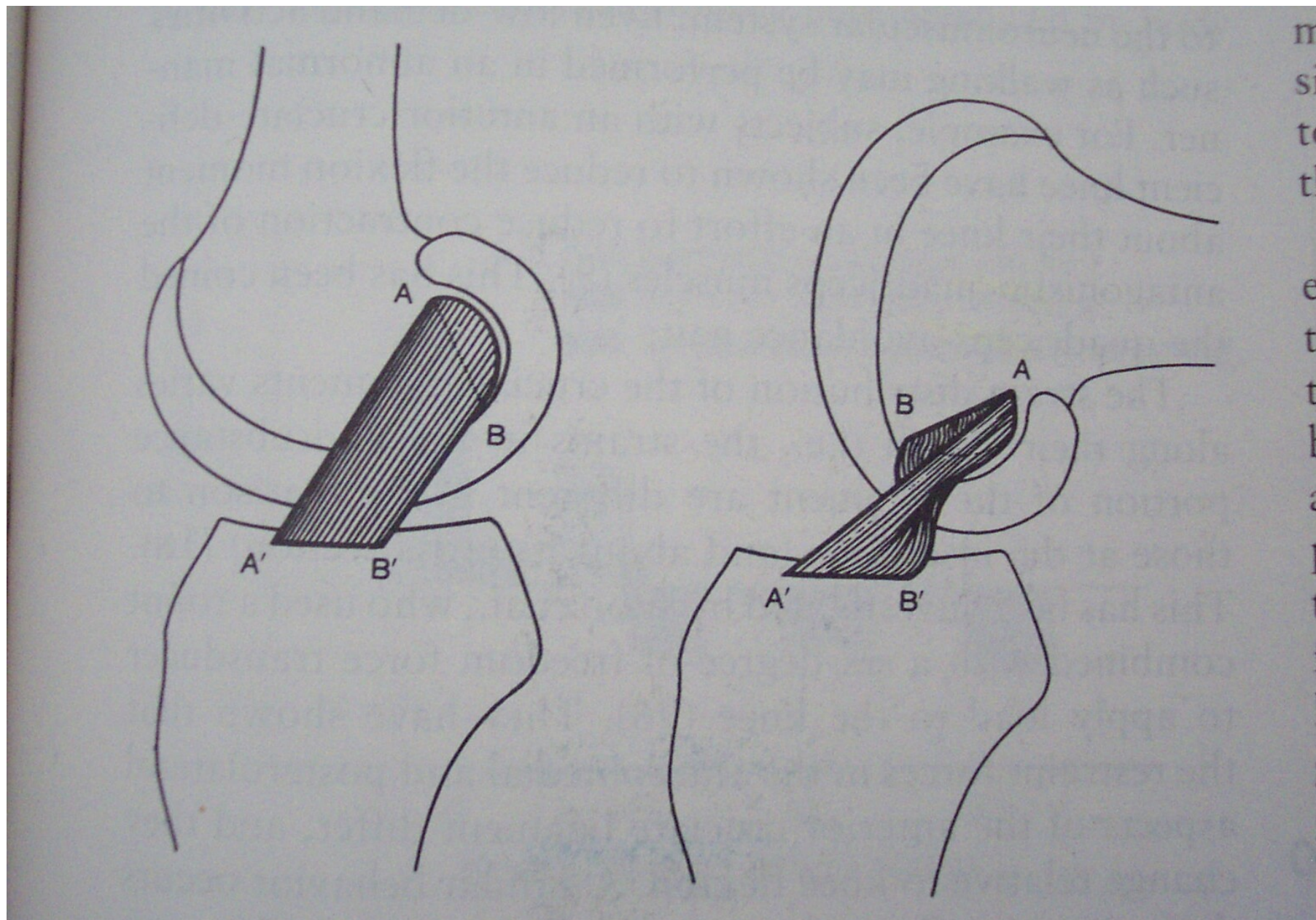
Lateral side

- LCL
 - Primary varus restraint
 - lax in flexion
 - Biceps passes it and blends with insertion
 - maintains tension?

- Biceps
 - flexor(with semimembranosis and pes)
 - externally rotates tibia
 - tenses LCL
 - dynamic assistor of PCL

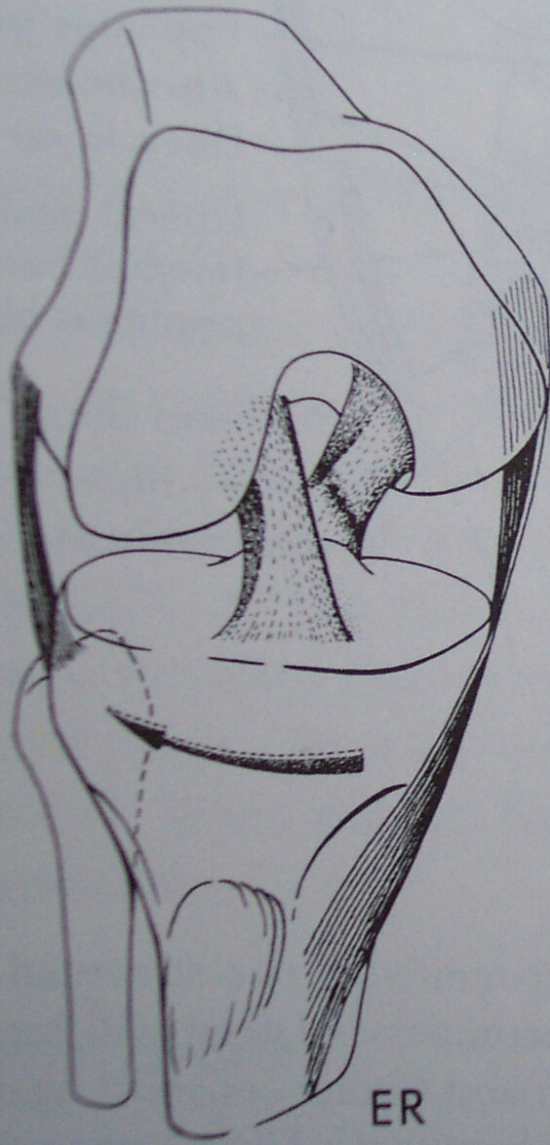
Cruciates

- ACL
 - Primary static restraint to anterior displacement
 - tense in extension, 'lax' in flexion

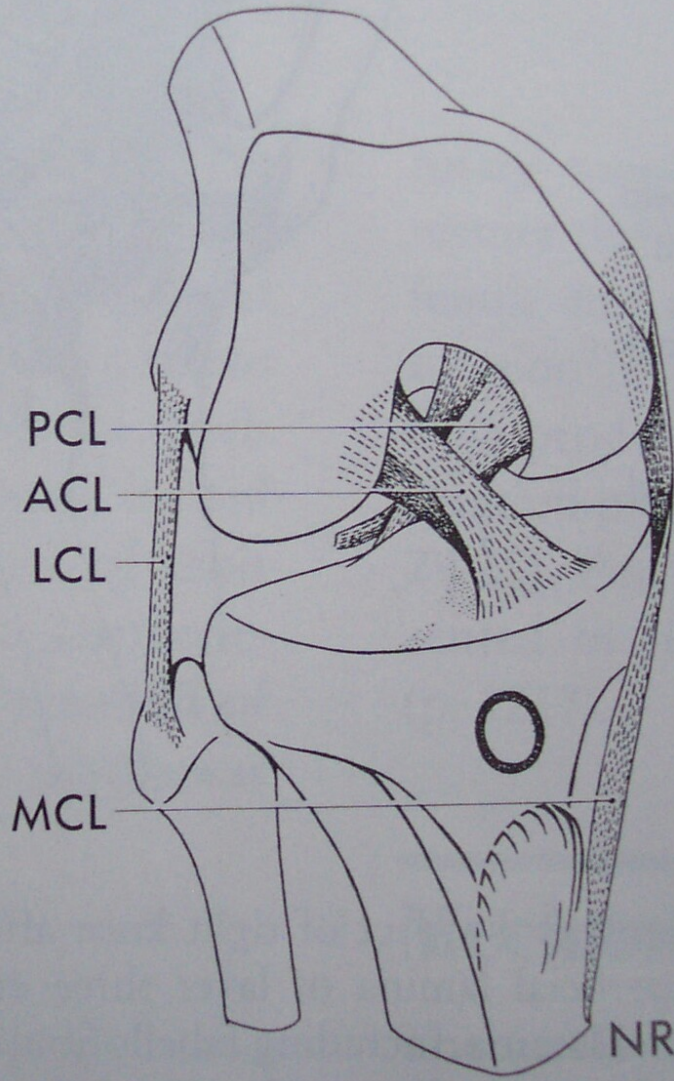


- PCL
 - Primary restraint to post. Displacement - 90%
 - relaxed in extension, tense in flexion
 - reinforced by Humphreys or Wrisberg
 - restraint to varus/valgus force
 - resists rotation, esp.int rot of tibia on femur

A



B



C

