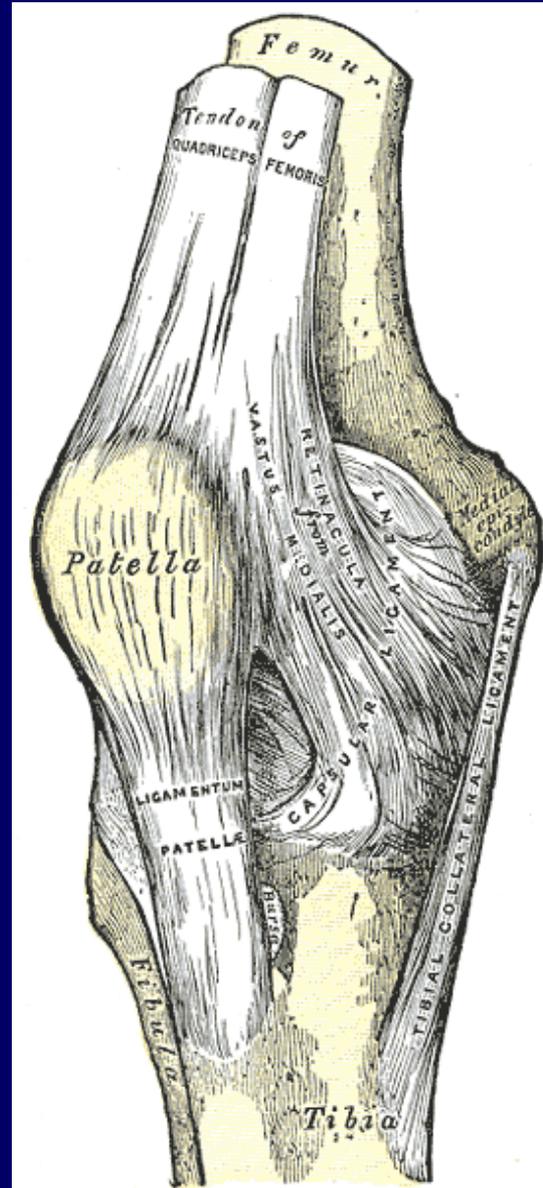
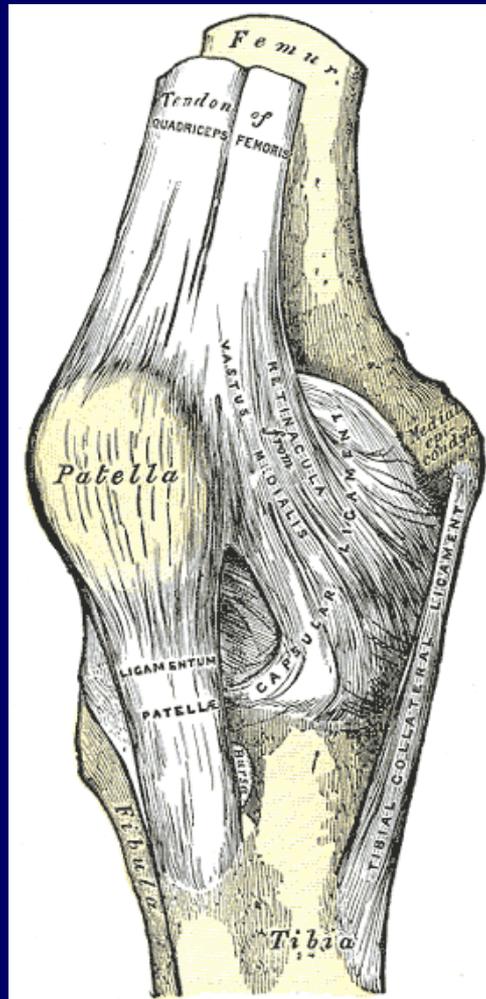


The Medial Support System of the Knee

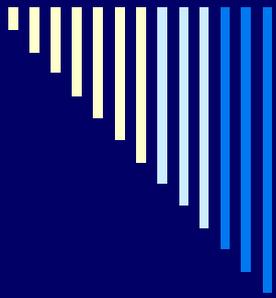


Stephanie D Casey

The Knee



- Three articulations
- The bones are connected together by the following ligaments:
- The Articular Capsule
- The Anterior Cruciate
- The Ligamentum Patellæ
- The Posterior Cruciate
- The Oblique Popliteal
- The Medial and Lateral Menisci
- The Tibial Collateral
- The Transverse
- The Fibular Collateral
- The Coronary.



The Origin of the Lecture Topic



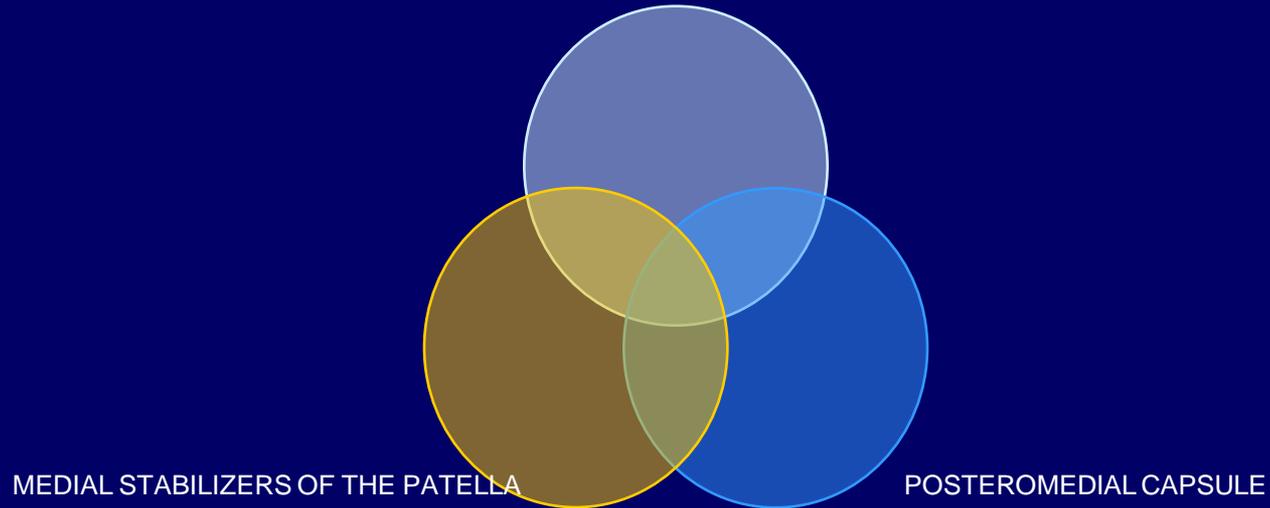
MINI PATHRIA

Overview

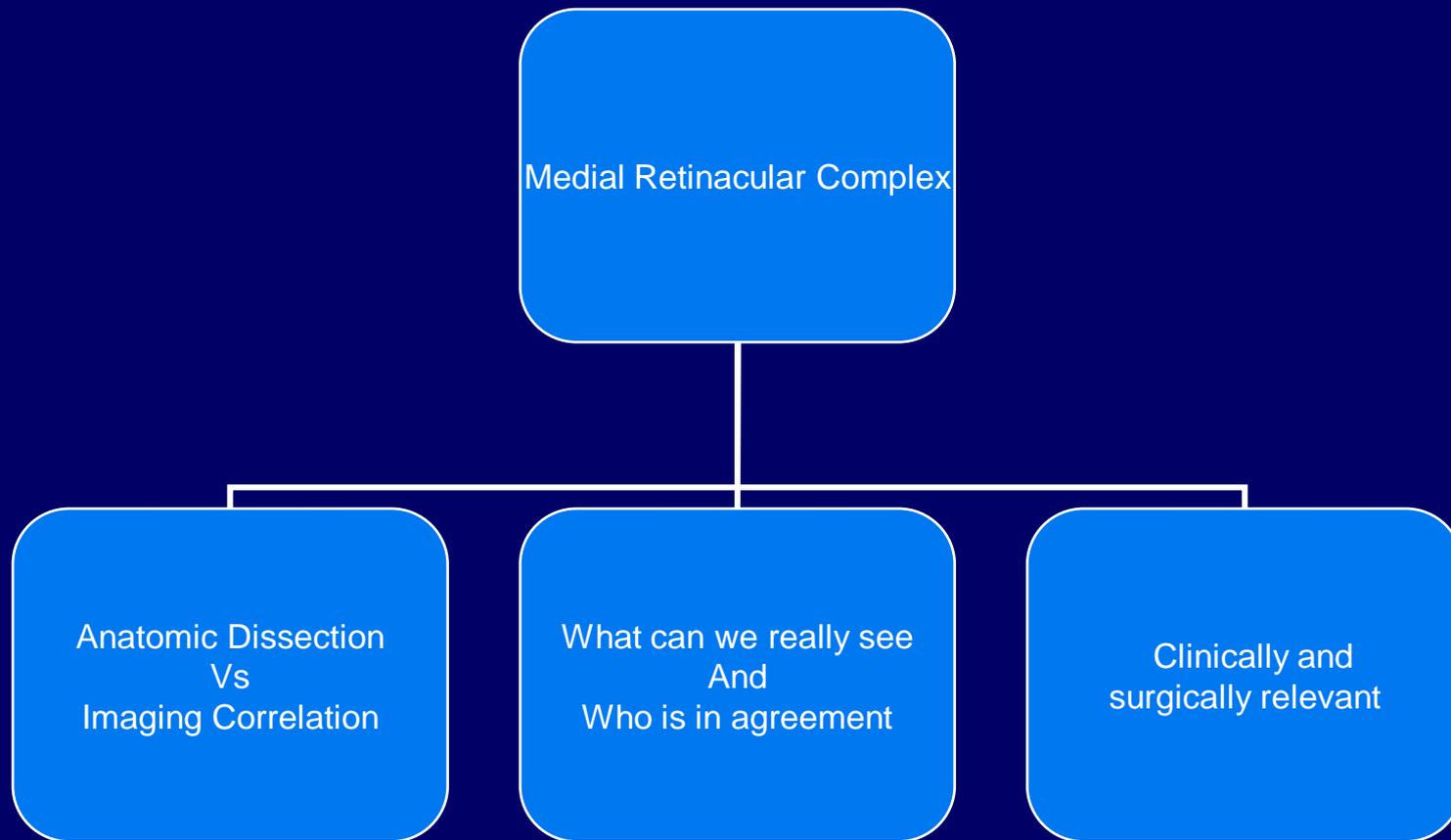
- ❑ MEDIAL CAPSULOLIGAMENTOUS COMPLEX
 - ❑ Anatomy
 - ❑ Surgical
 - ❑ MRI
- ❑ MEDIAL STABILIZERS OF THE PATELLA
 - ❑ Medial retinacular complex (MRC)
 - ❑ Anatomy
 - ❑ Surgical
 - ❑ MRI
 - ❑ Pathology
- ❑ LAGNIAPPE

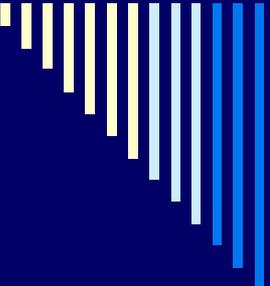
Medial Support System of the Knee The Big Picture

MEDIAL CAPSULOLIGAMENTOUS COMPLEX

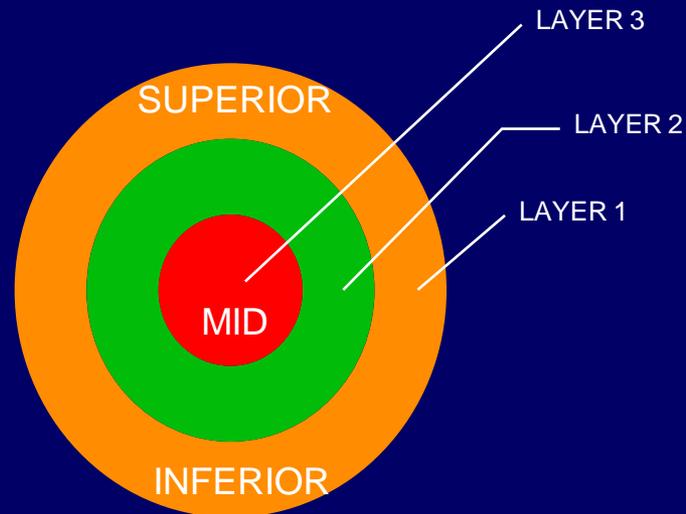


MEDIAL STABILIZERS OF THE PATELLA



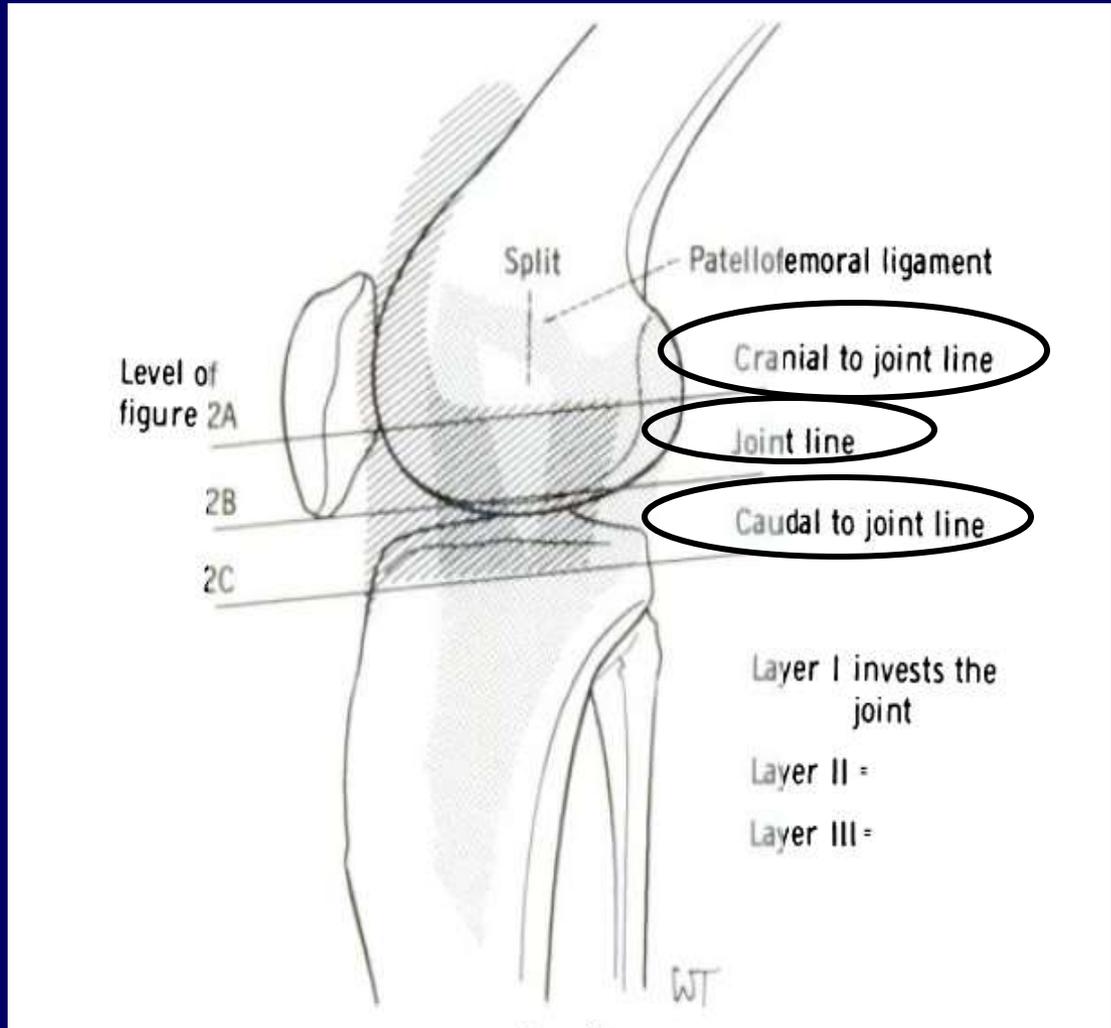
- 
- The layer approach presented here emphasizes anatomical relationships which have been established
 - The layer concept is stressed because the ligaments of the medial side of the knee are condensations within tissue planes and not discrete structures such as the anterior cruciate ligament
 - Any description of a ligament should specify its location within a plane, otherwise its relationship to the other structures will be confusing
 - In order to locate all structures in their appropriate planes, it is helpful to think in terms of the three layers and the patterns by which they merge anteriorly and posteriorly
-

The Supporting Structures and Layers on the Medial Side of the Knee

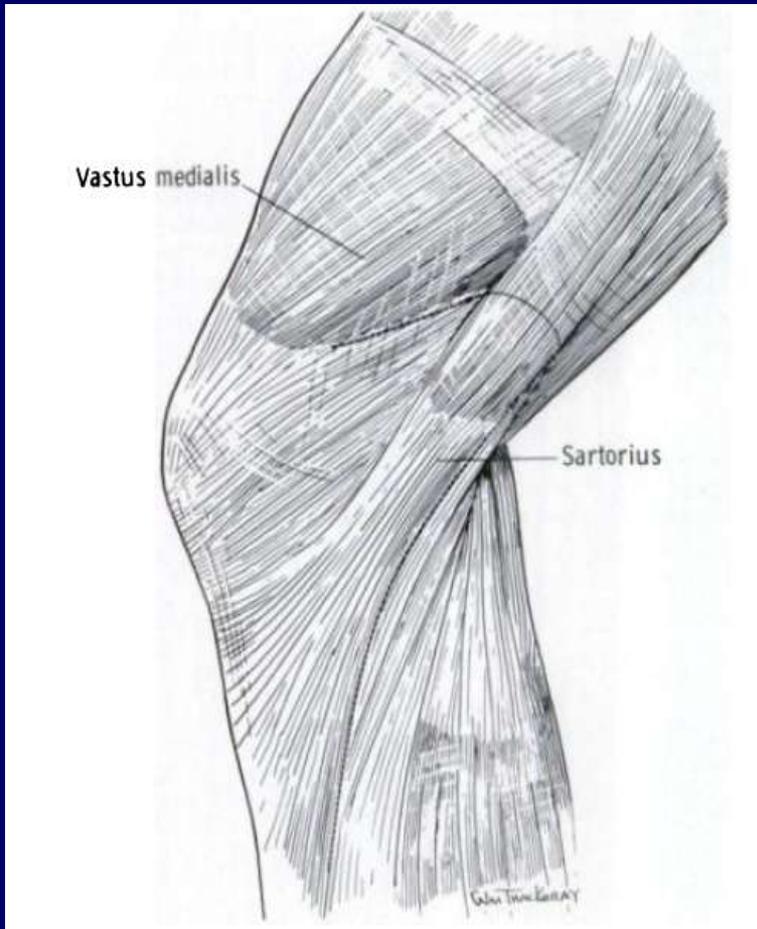


Warren J. Bone Joint Surg. Am. 61:56-62, 1979

Surgical Anatomy



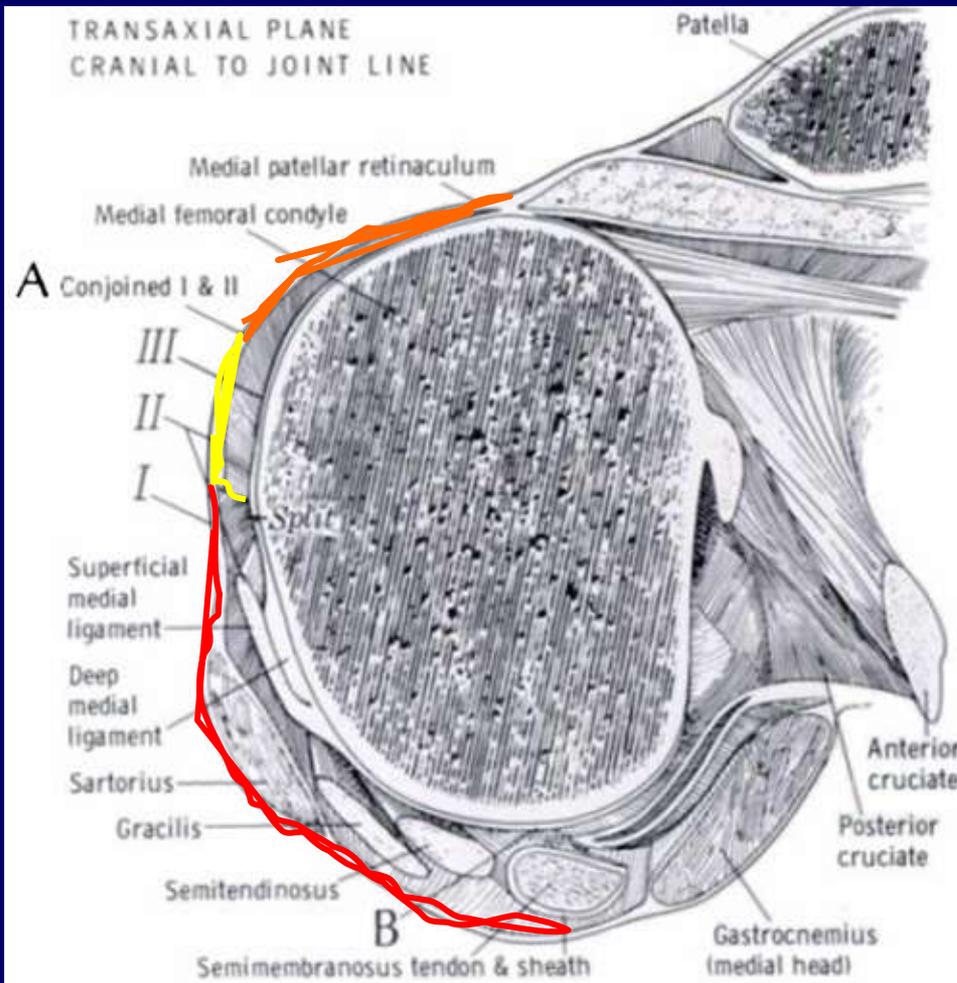
Layer I



- Deep or crural fascia – invests satorius fascia
- between the patella and its tendon anteriorly and the mid line of the popliteal fossa posteriorly
- Proximally – continuous with the fascia overlying the quadriceps muscle
- Posteriorly – deep fascia of lower extremity and can be traced upward and downward
- Inferiorly – joins periosteum of tibia at tibial insertion of satorius tendon

MEDIAL CAPSULOLIGAMENTOUS COMPLEX

CRANIAL TO JOINT LINE

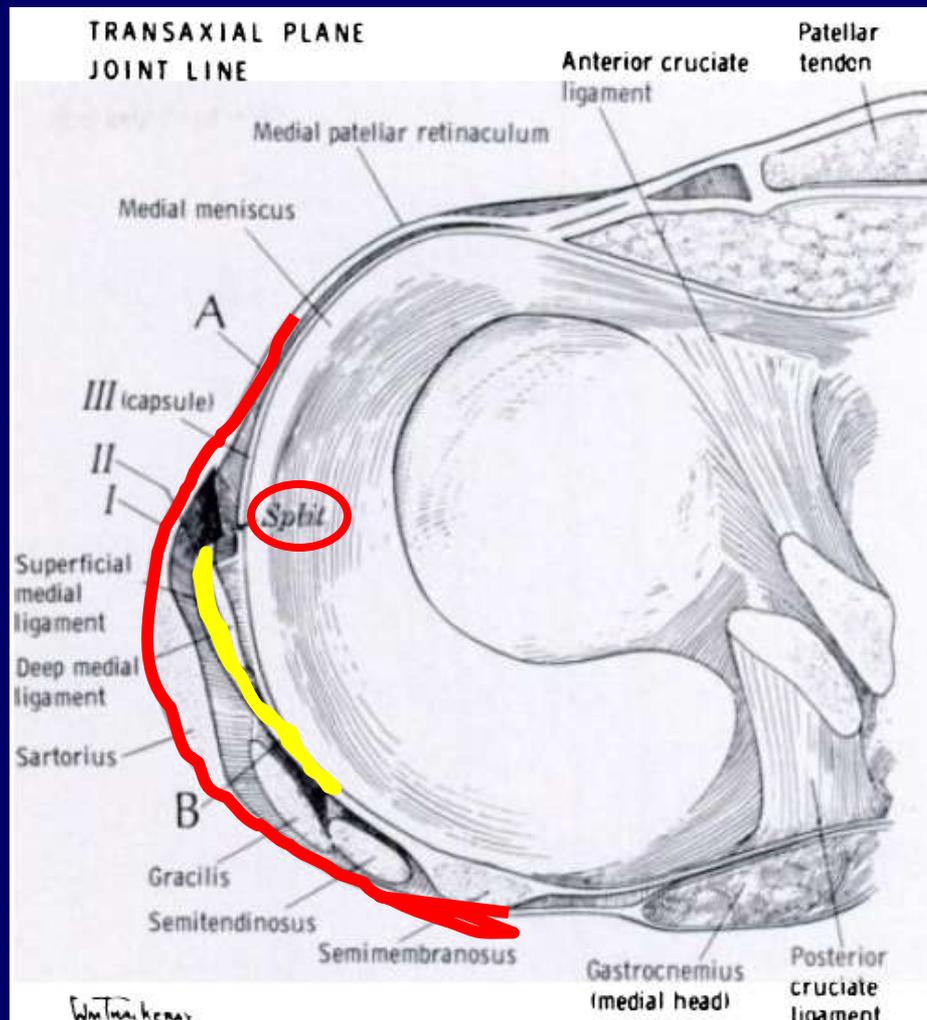


■ LAYER I

- Anterior to superficial medial ligament
- Layer I joined Layer II to contribute to form parapatellar retinacular fibers

MEDIAL CAPSULOLIGAMENTOUS COMPLEX

JOINT LINE

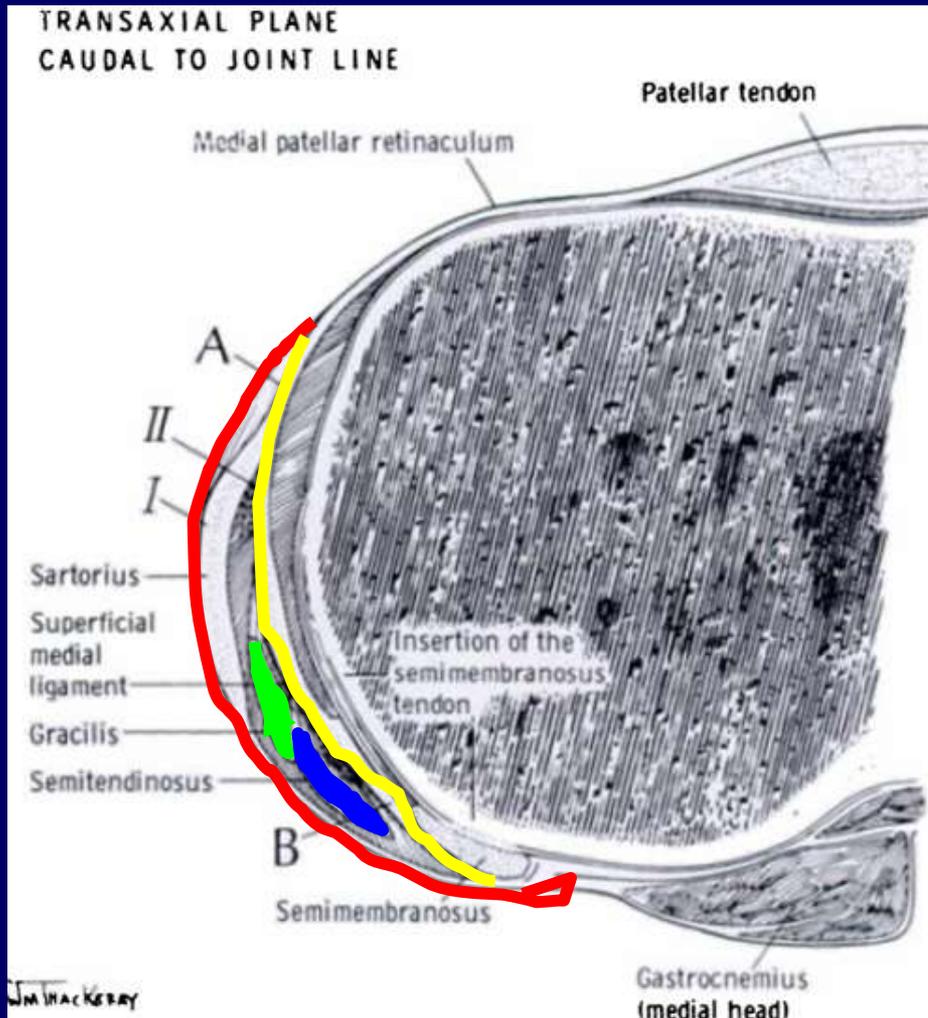


□ Layer I

□ Split in Layer II – fibers leaving Layer II and the superficial medial ligament to join layer I

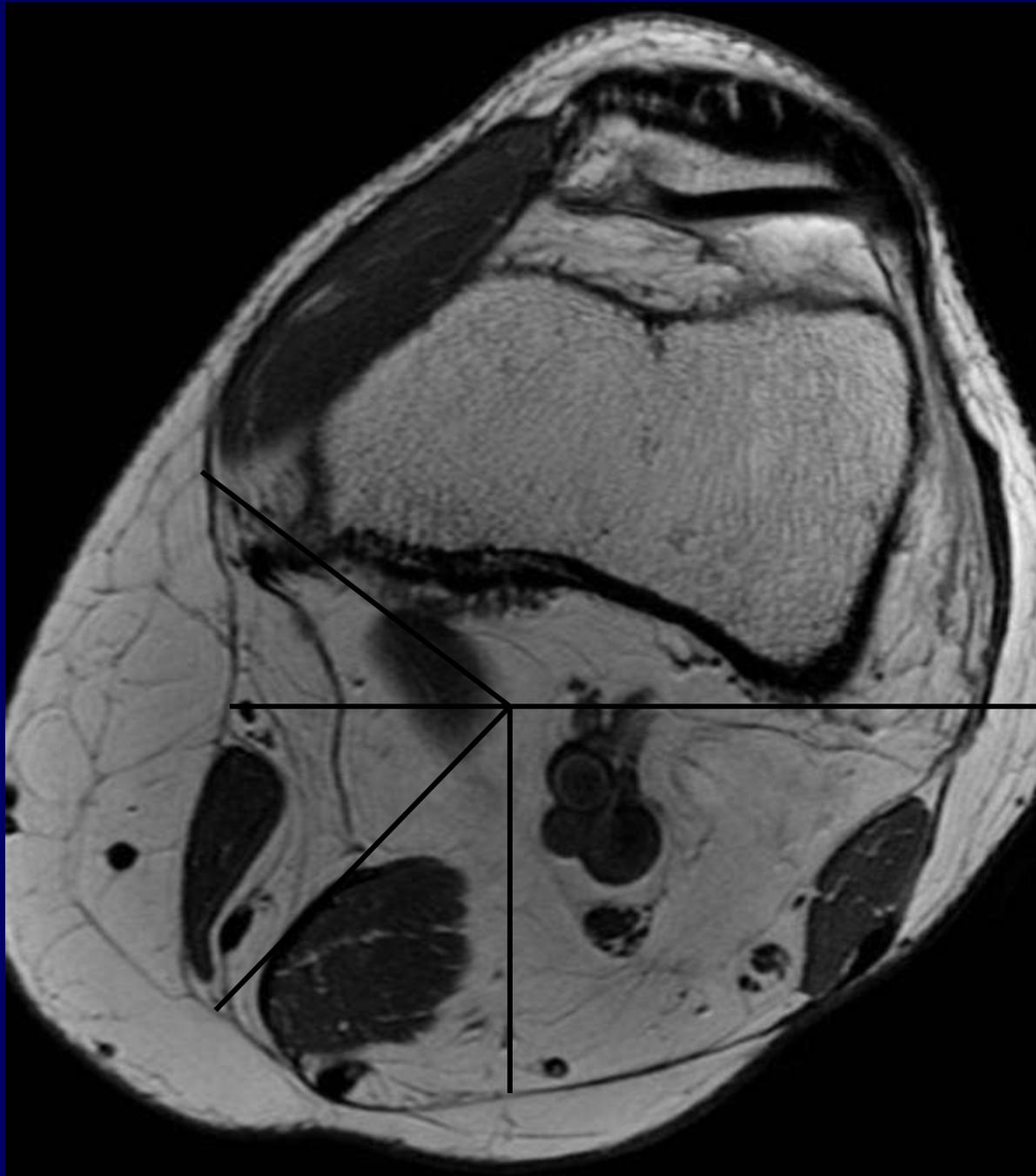
MEDIAL CAPSULOLIGAMENTOUS COMPLEX

CAUDAL TO JOINT LINE



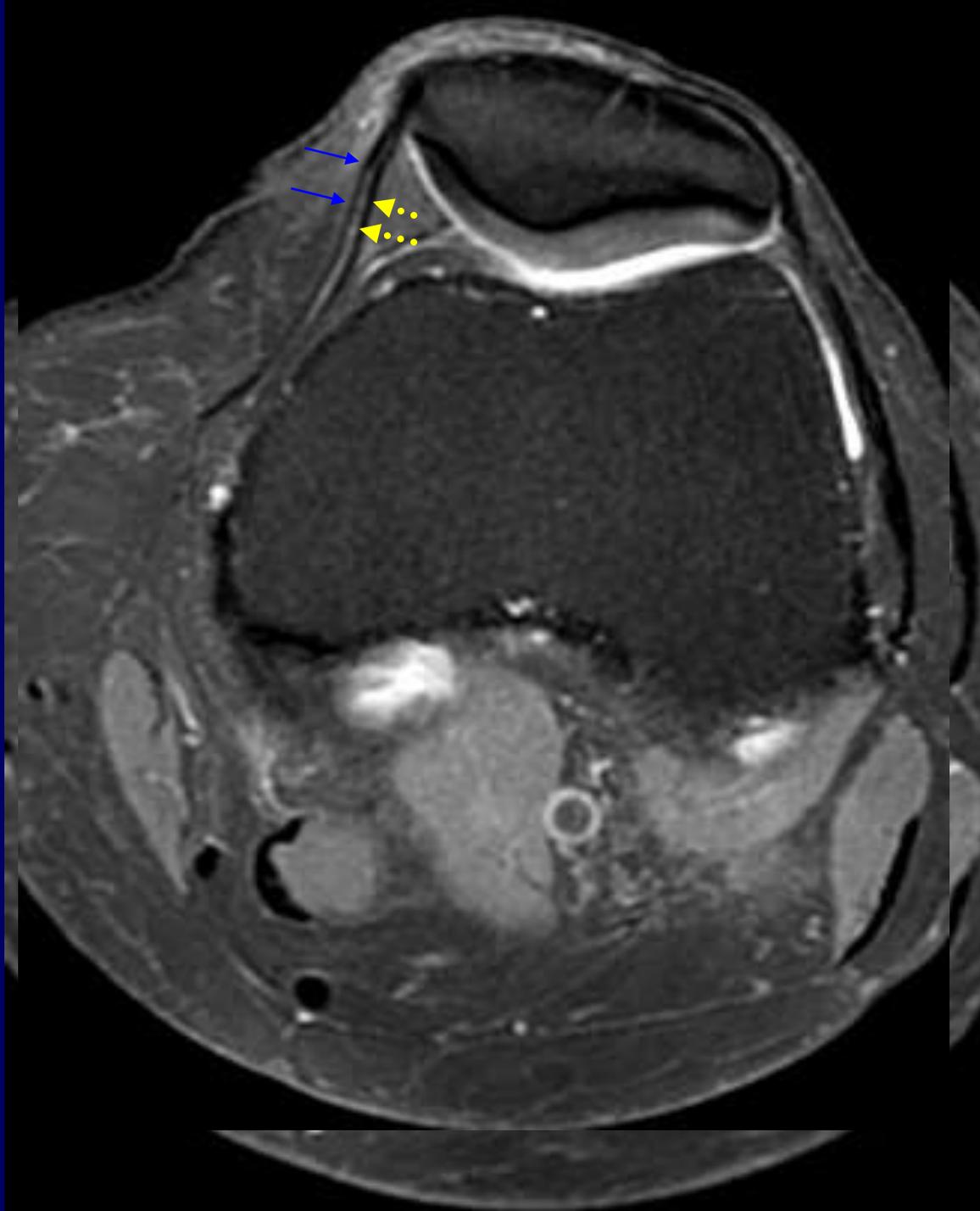
- Layer I
- Layer I and II separated by ST and Gracilis tendons
- Distally joins periosteum of tibia at satorius insertion

Layer 1
Cranial



Layer 1

Cranial to joint line



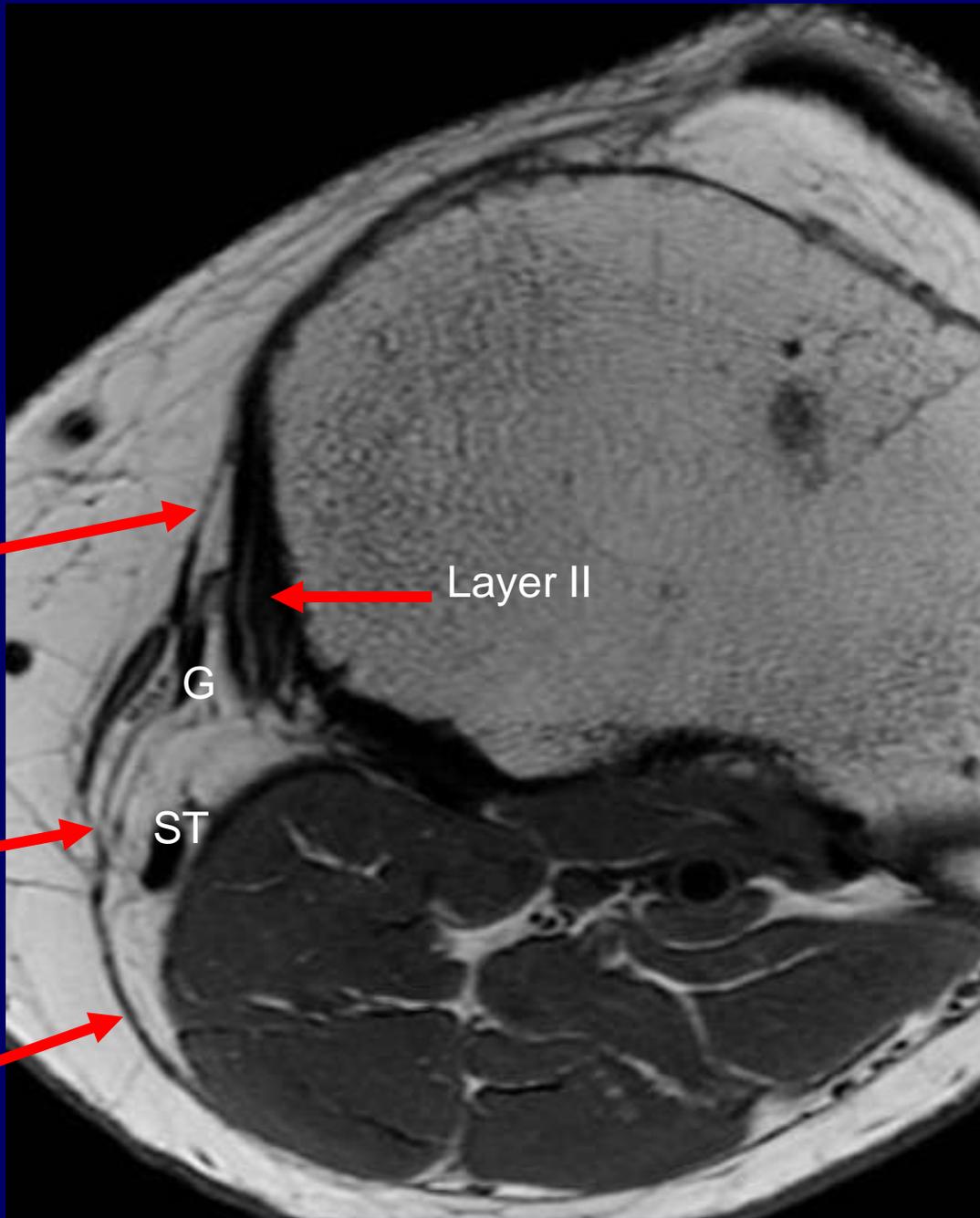
Caudal to Joint Line

Layer I

Layer II

G

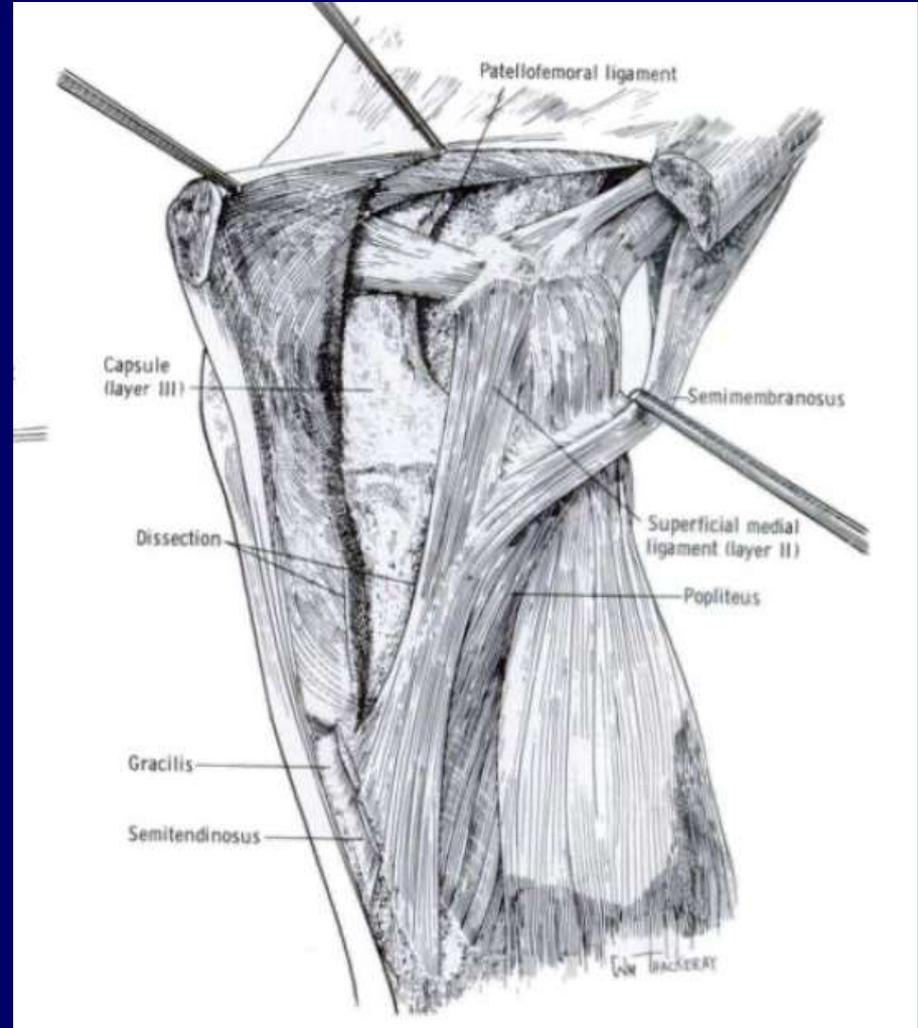
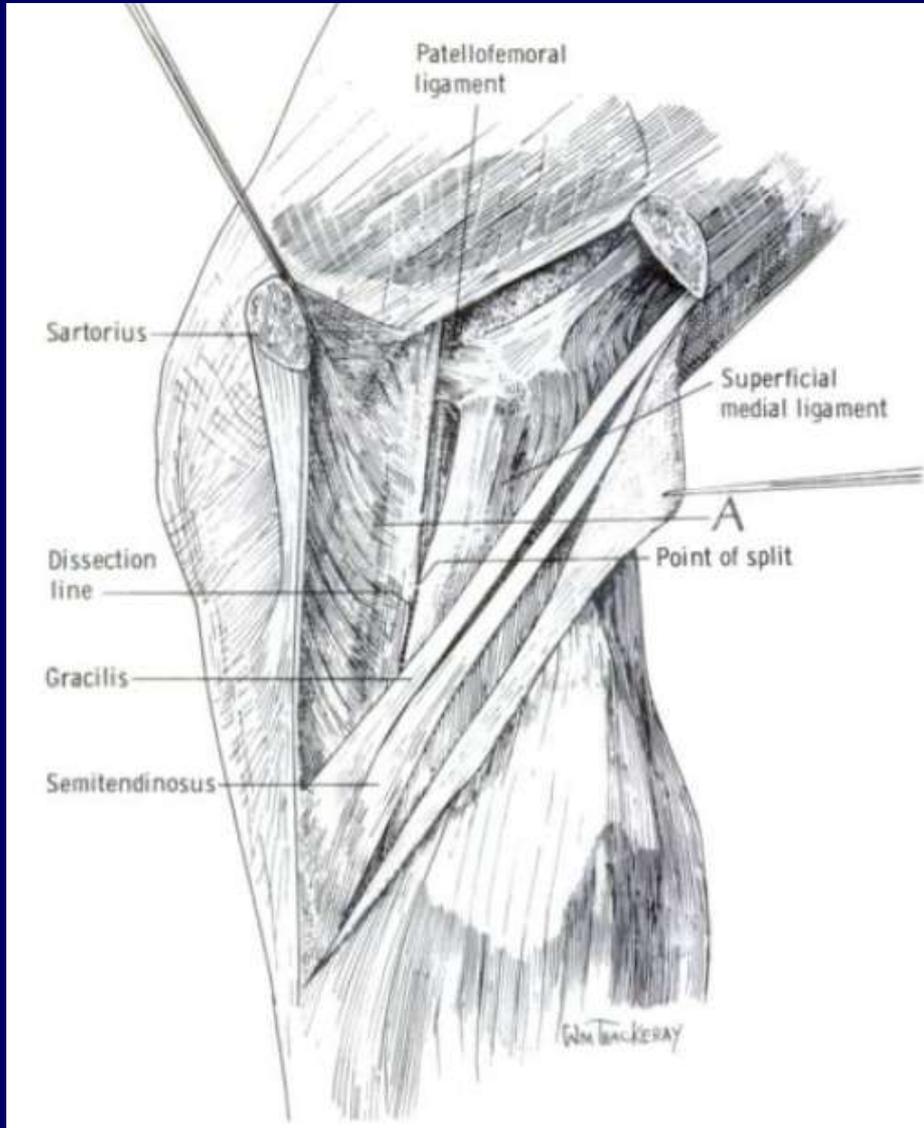
ST



LAYER II

Contents

- Superficial Medial Ligament
 - Longitudinal (parallel) fibers
 - Oblique fibers
- Vertical Split
- Anterior to Split – Layer I + Layer II (LF)
- Posterior to Split – Layer II (OF) + Layer III + Tendon Sheath of Semimembranosus

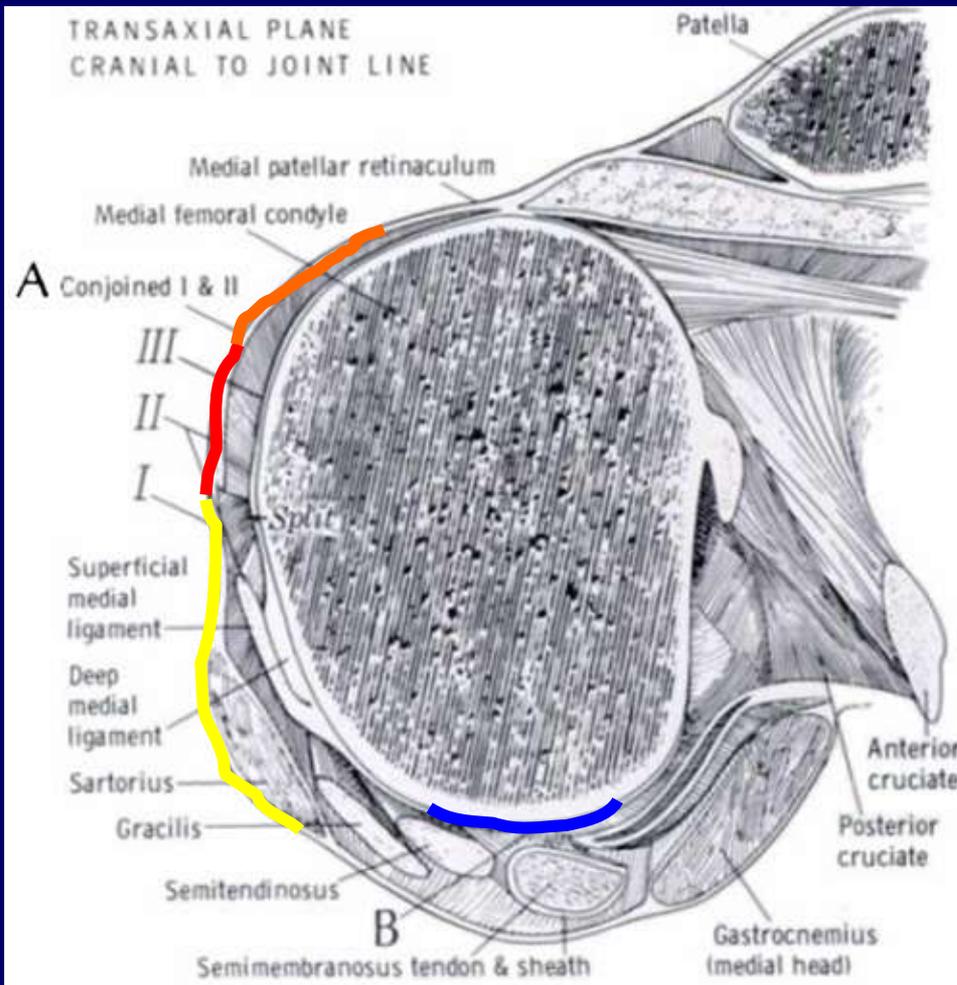


Layer II - Levels

- **Proximal** – Medial femoral condyle
 - Posterior to split –
 - From femoral condyle – transverse fibers form MPFL
- **Mid** – vertical split
 - Anterior to split – cephalic extension of longitudinal fibers to vastus medialis to join layer 1 and form parapatellar retinaculum
 - PMC - Oblique fibers merge with Layer III
 - Semimembranosus sheath and its extensions
- **Distal** – Tibia

MEDIAL CAPSULOLIGAMENTOUS COMPLEX

CRANIAL TO JOINT LINE



□ LAYER II

□ Anterior to superficial medial ligament

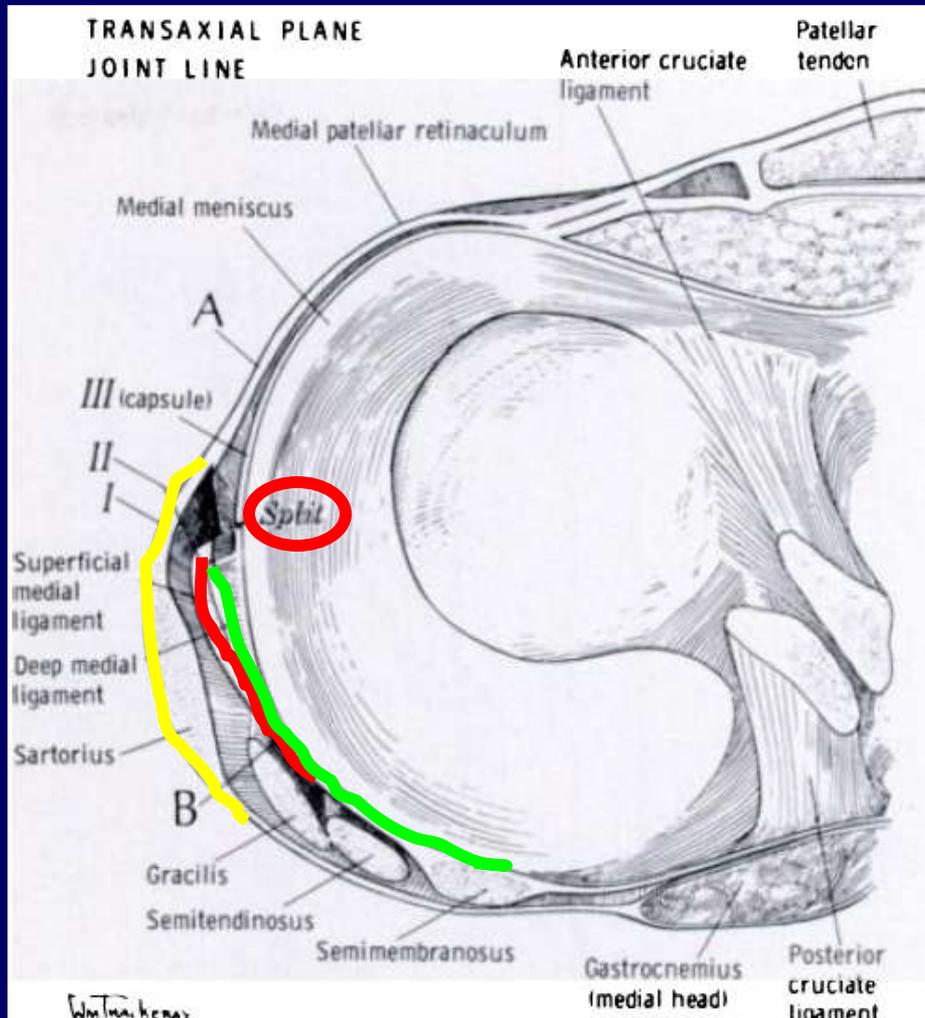
Layer I joined Layer II to contribute to form parapatellar retinacular fibers

□ Posterior

- Layer II (POF) join Layer III + sheath of SMT

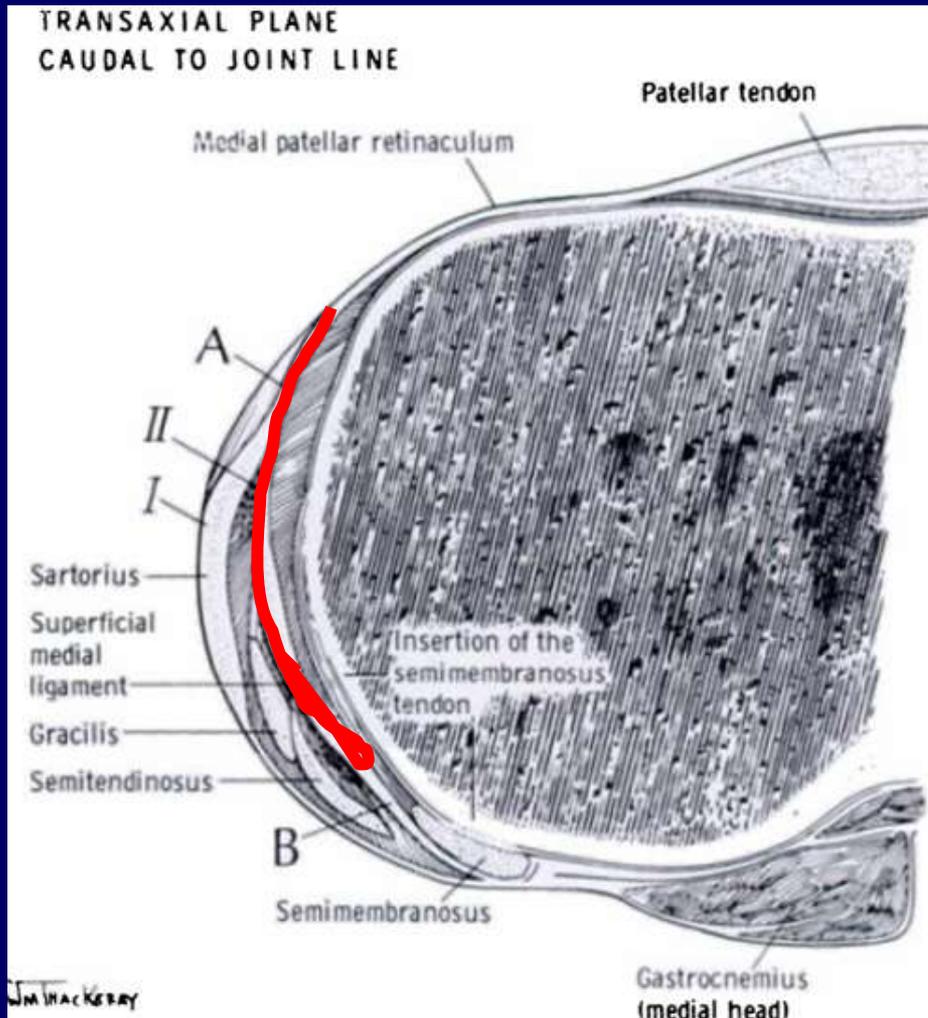
MEDIAL CAPSULOLIGAMENTOUS COMPLEX

JOINT LINE



- Layer II
- Split in Layer II – fibers leaving Layer II and the superficial medial ligament to join layer I
- Posterior Oblique Ligament
 - Layer II (POF) join Layer III + sheath of SMT

MEDIAL CAPSULOLIGAMENTOUS COMPLEX CAUDAL TO JOINT LINE



- Layer II
- Tibial insertion 5 cm below joint line

Cranial to Joint Line

Layer II



Posterior to the split



Superficial MCL Fibers



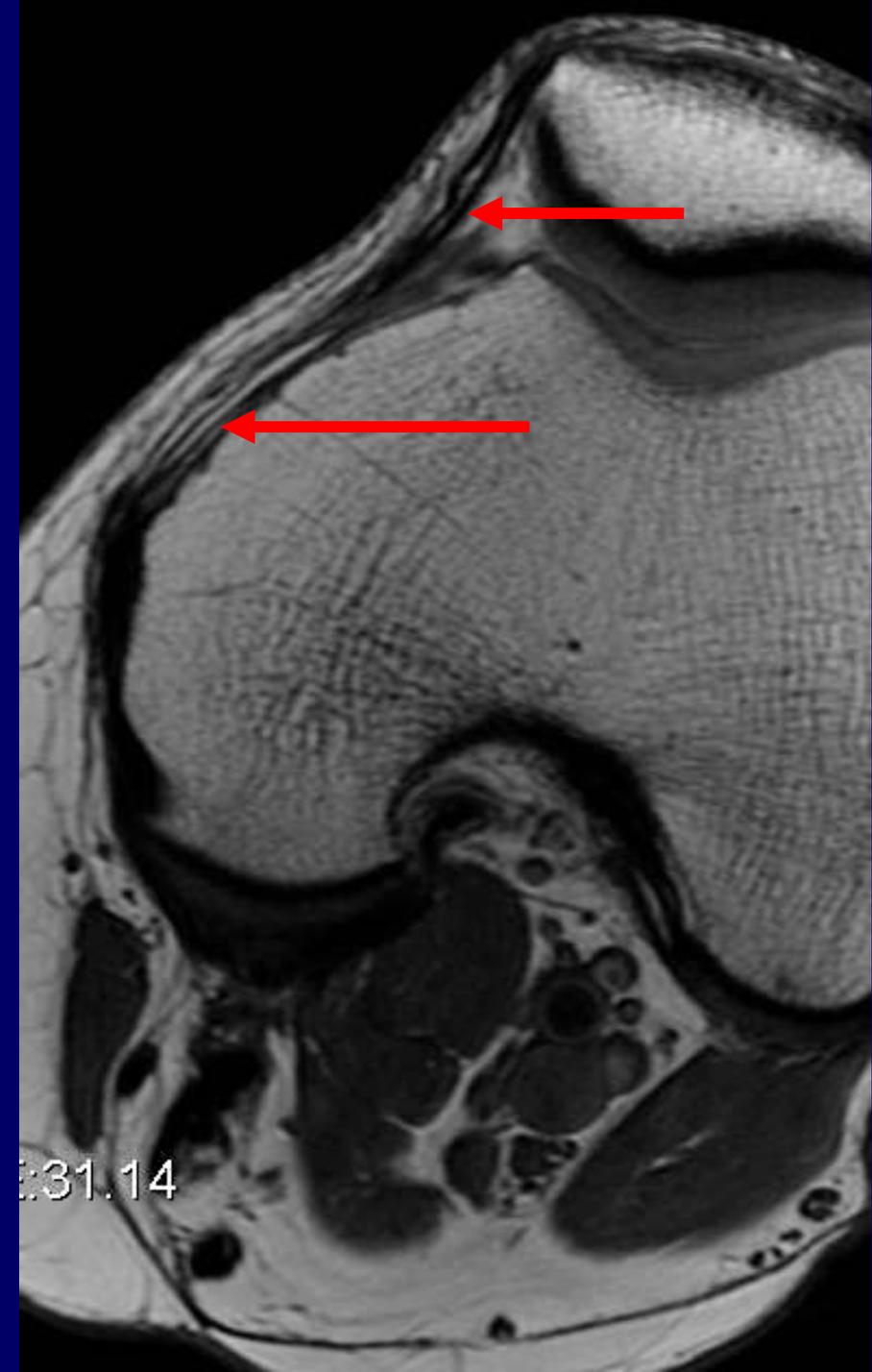
Cephalic Extension



Transverse fibers



MPFL



Cranial to Joint Line

Layer I+II



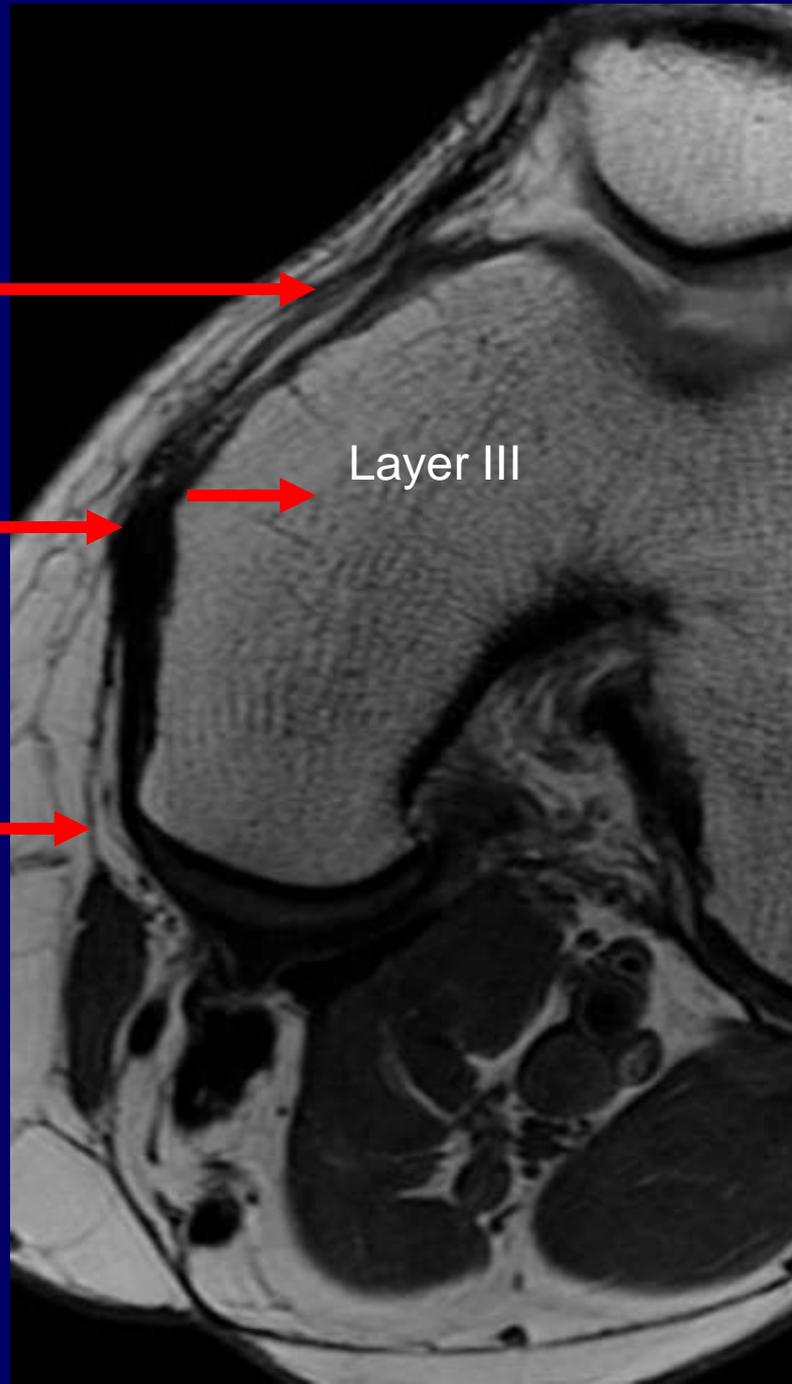
Layer II



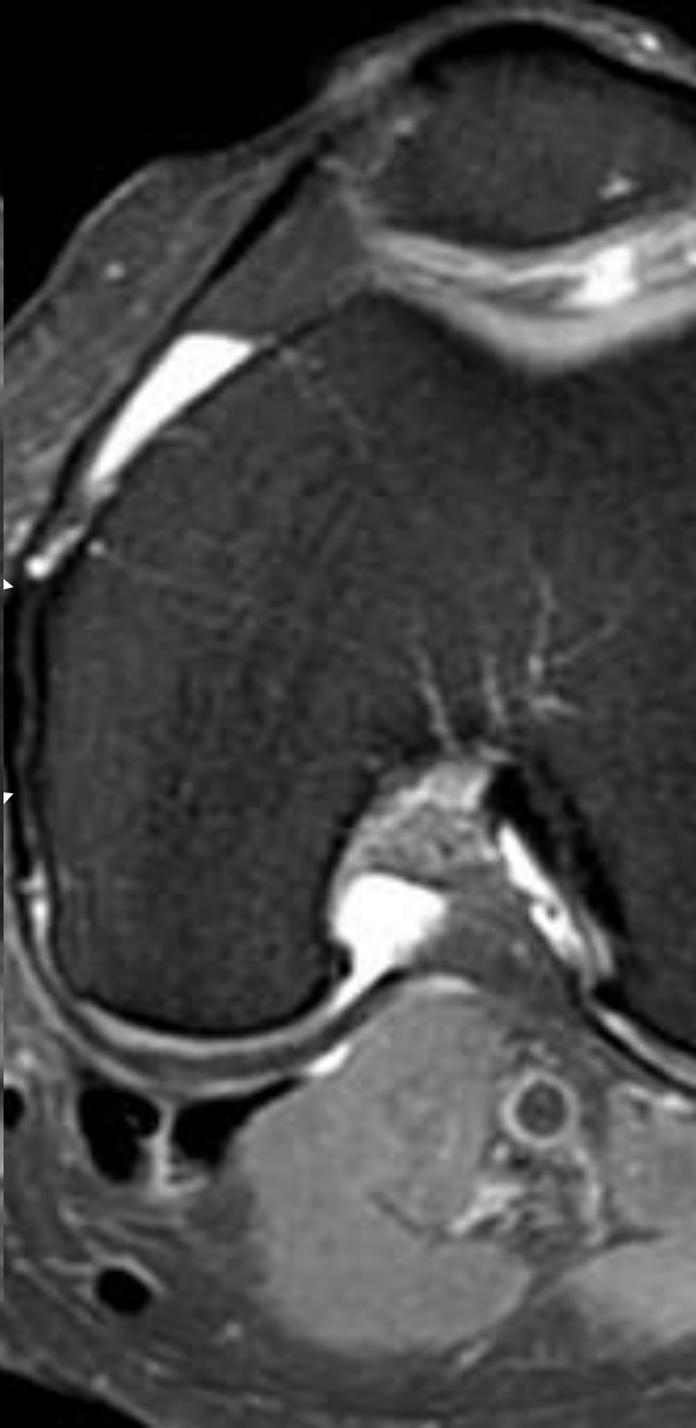
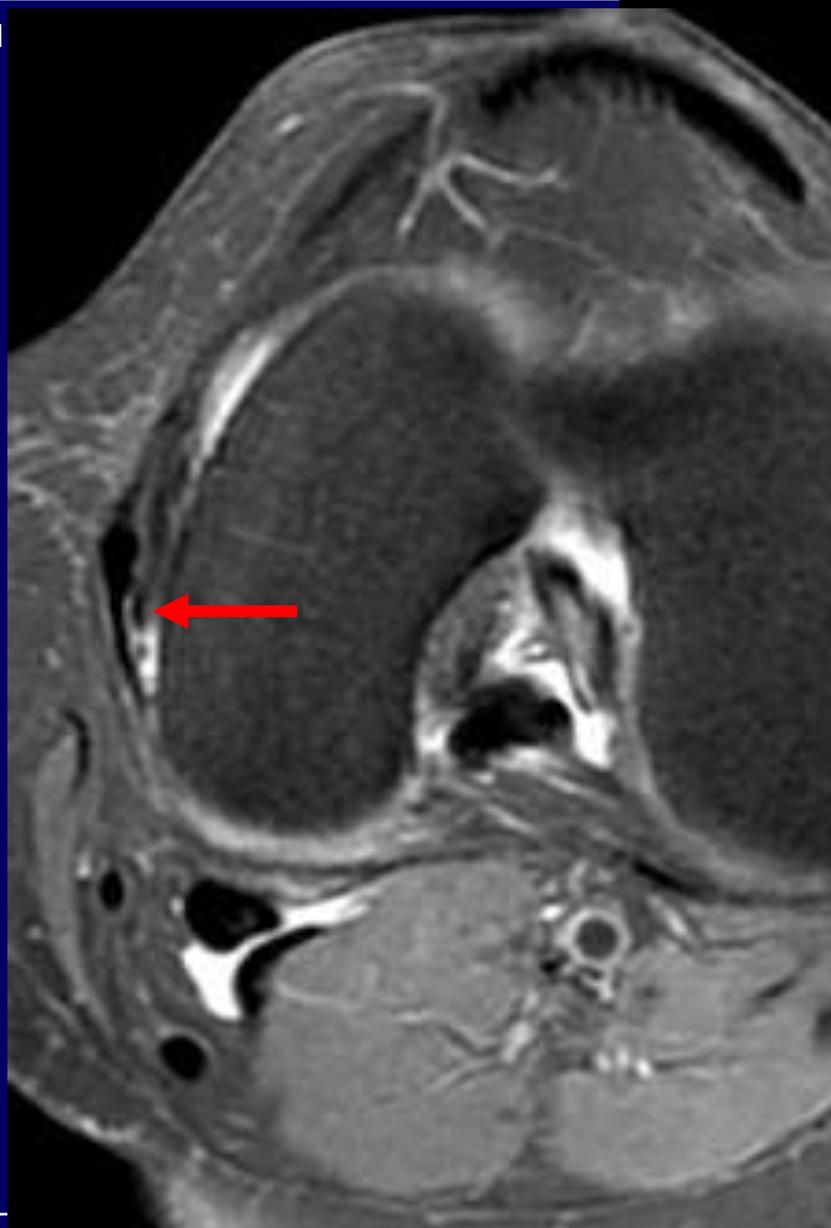
Layer III



Layer I

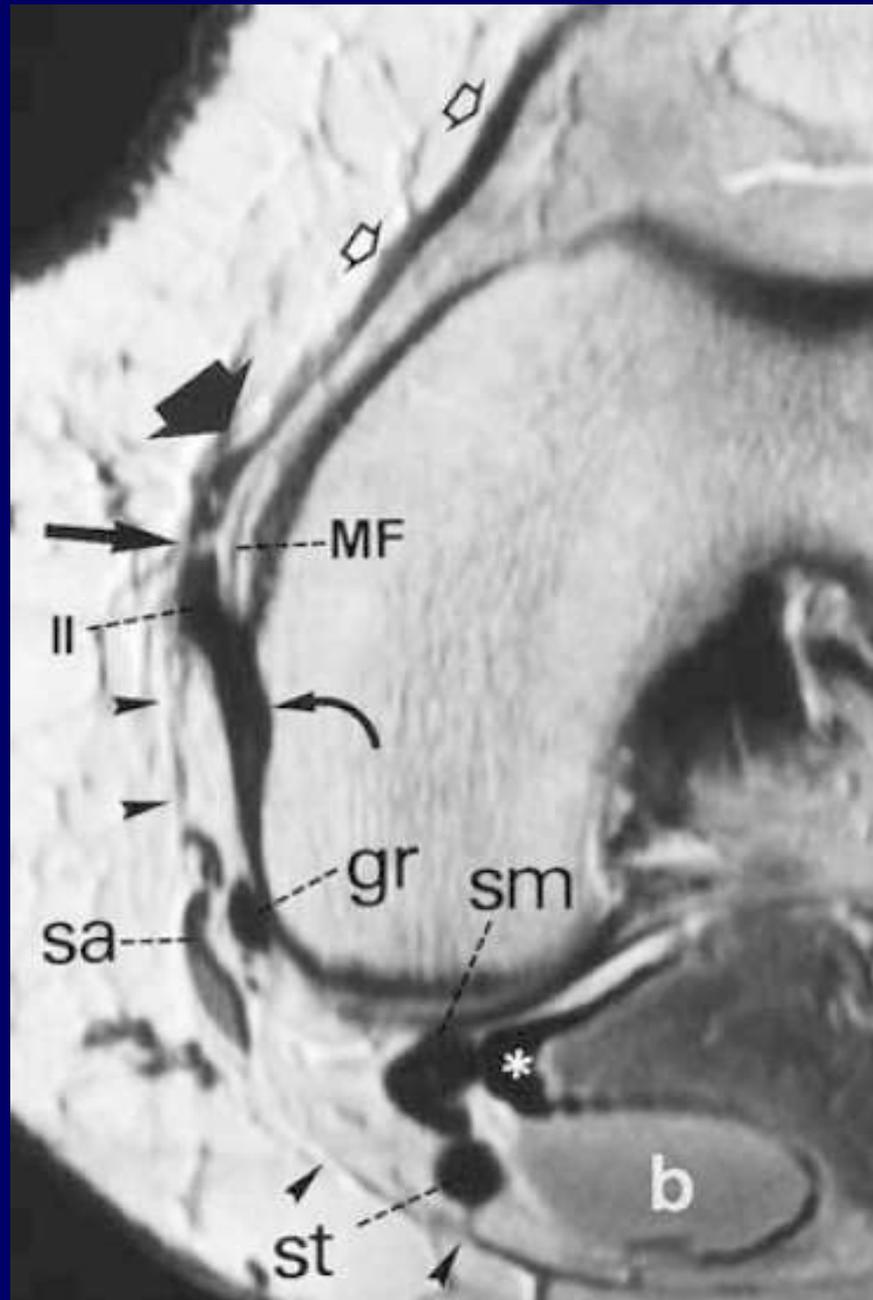


Joint Line



Joint Line

Split in Layer II



De Maeseneer
RadioGraphics 2000;
20:S83-S89

Layer I + II



Split in Layer II



Layer II + III

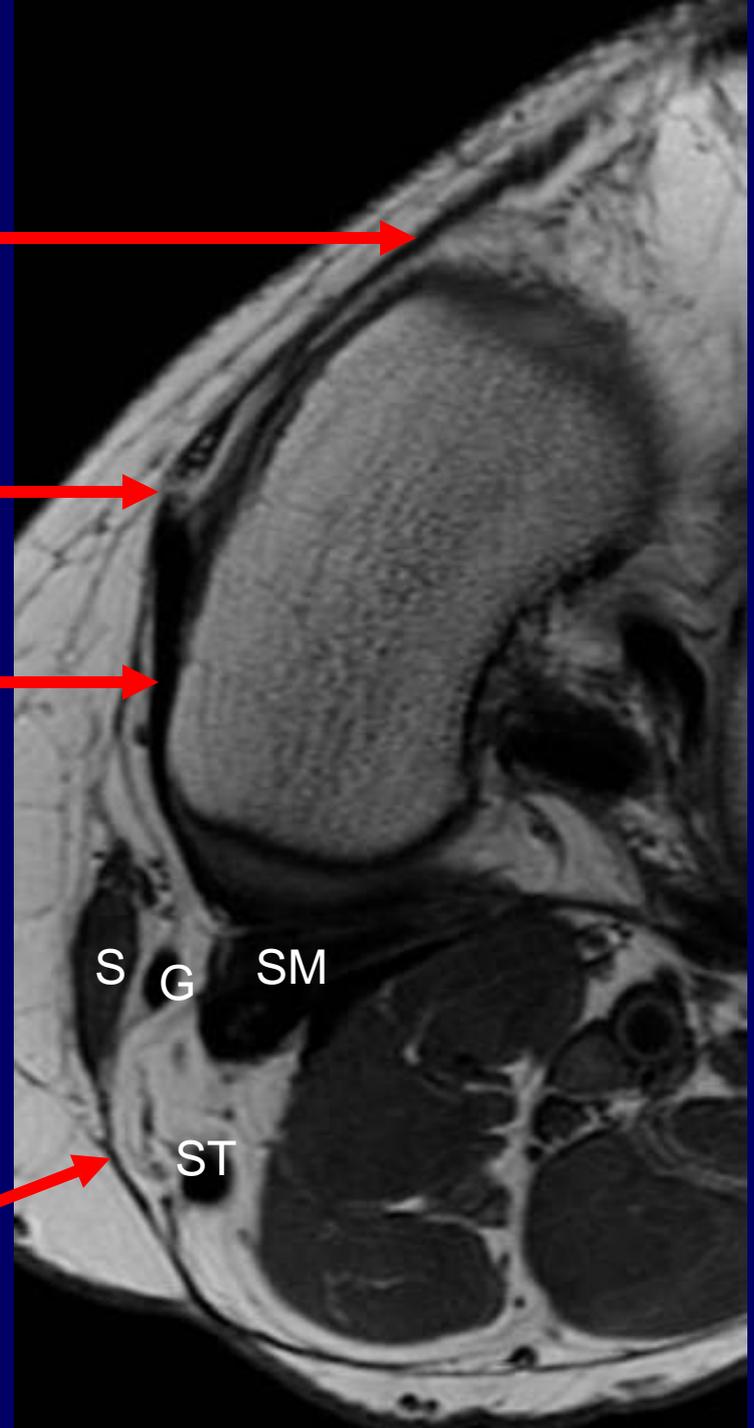


Layer I

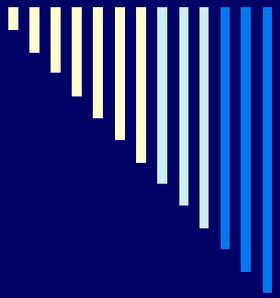


S G SM

ST



Caudal to joint line



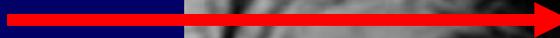
Layer I



Layer II



SM Tendon

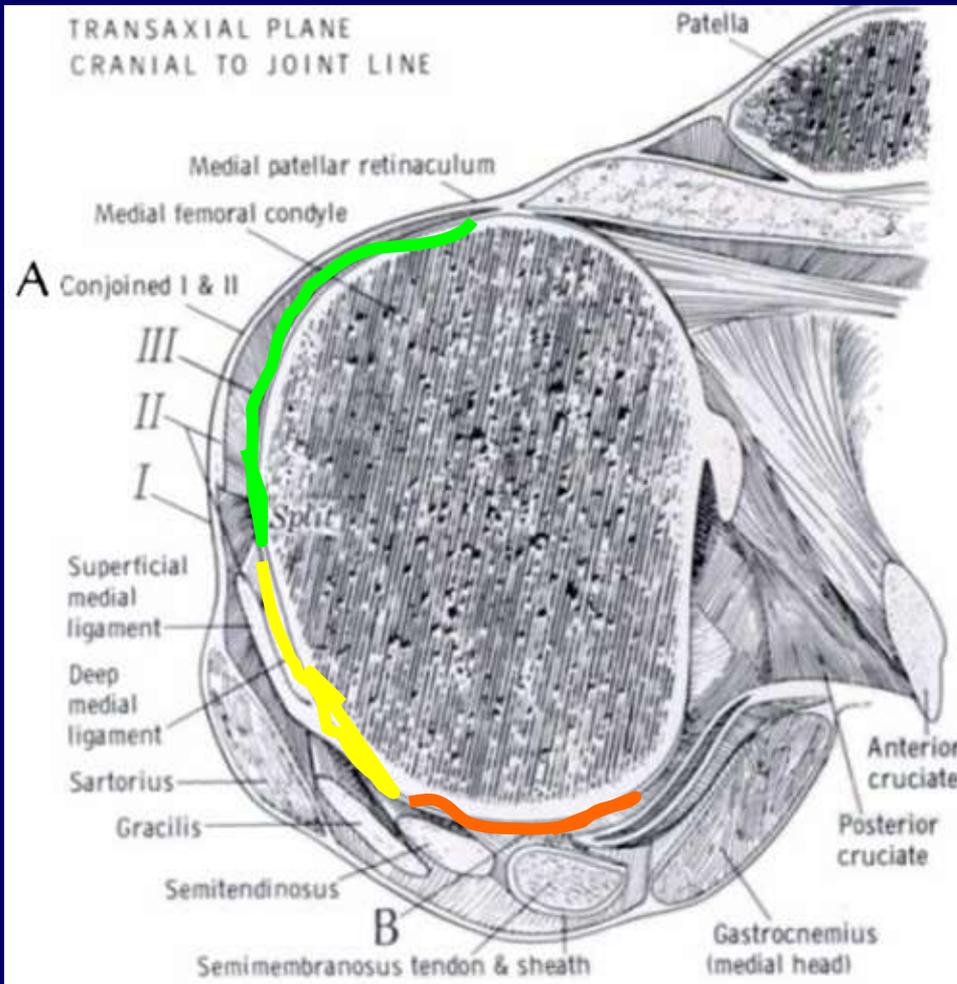


Layer III Contents

- Capsule of the Knee joint
- **Proximal extent** – follows contour of suprapatellar pouch and articular cartilage
- **Distal extent** – meniscotibial ligament and articular cartilage
- **Anterior:** capsule and patellomeniscal ligament
- **Mid:** Deep fibers of MCL
 - Menisconfemoral ligament
 - Meniscotibial ligament
- **Posterior:** Posteromedial capsule

MEDIAL CAPSULOLIGAMENTOUS COMPLEX

CRANIAL TO JOINT LINE



□ LAYER III

□ Capsule

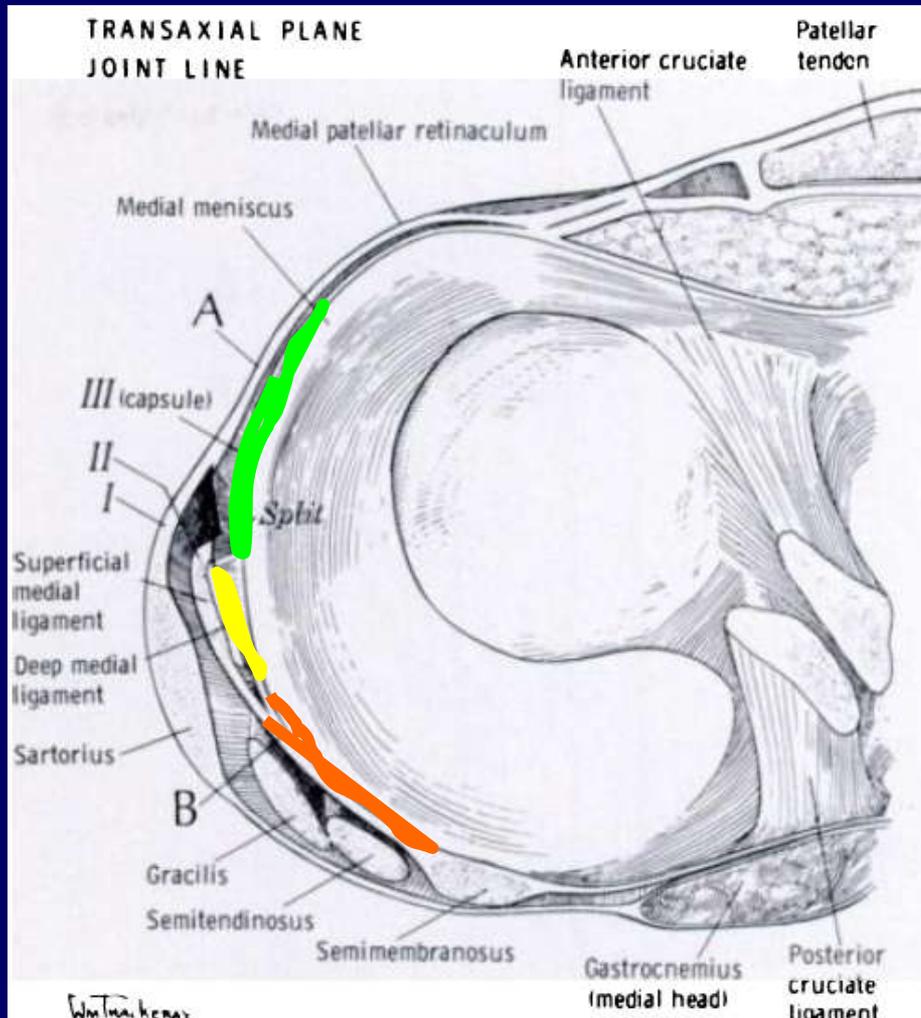
□ Meniscoefemoral ligament

□ Posterior

- Layer II (POF) join Layer III + sheath of SMT

MEDIAL CAPSULOLIGAMENTOUS COMPLEX

JOINT LINE



- Layer III-Capsule
- Meniscotibial Ligament
- Posterior Oblique Ligament
 - Layer II (POF) join Layer III + sheath of SMT

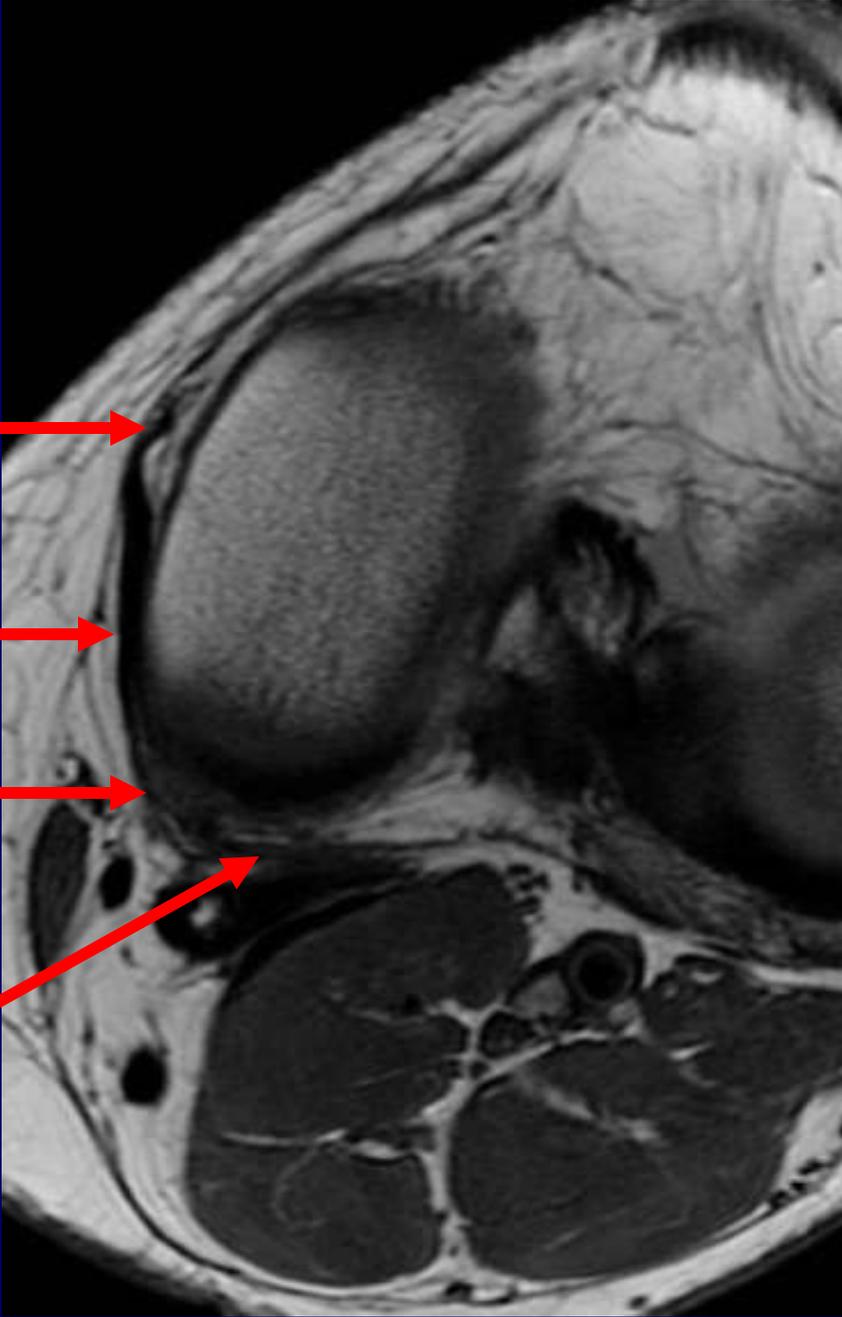
Joint Line

Longitudinal Fibers

Oblique Fibers

Layer II + III

SMT Sheath and POL



Joint Line

Layer II+III

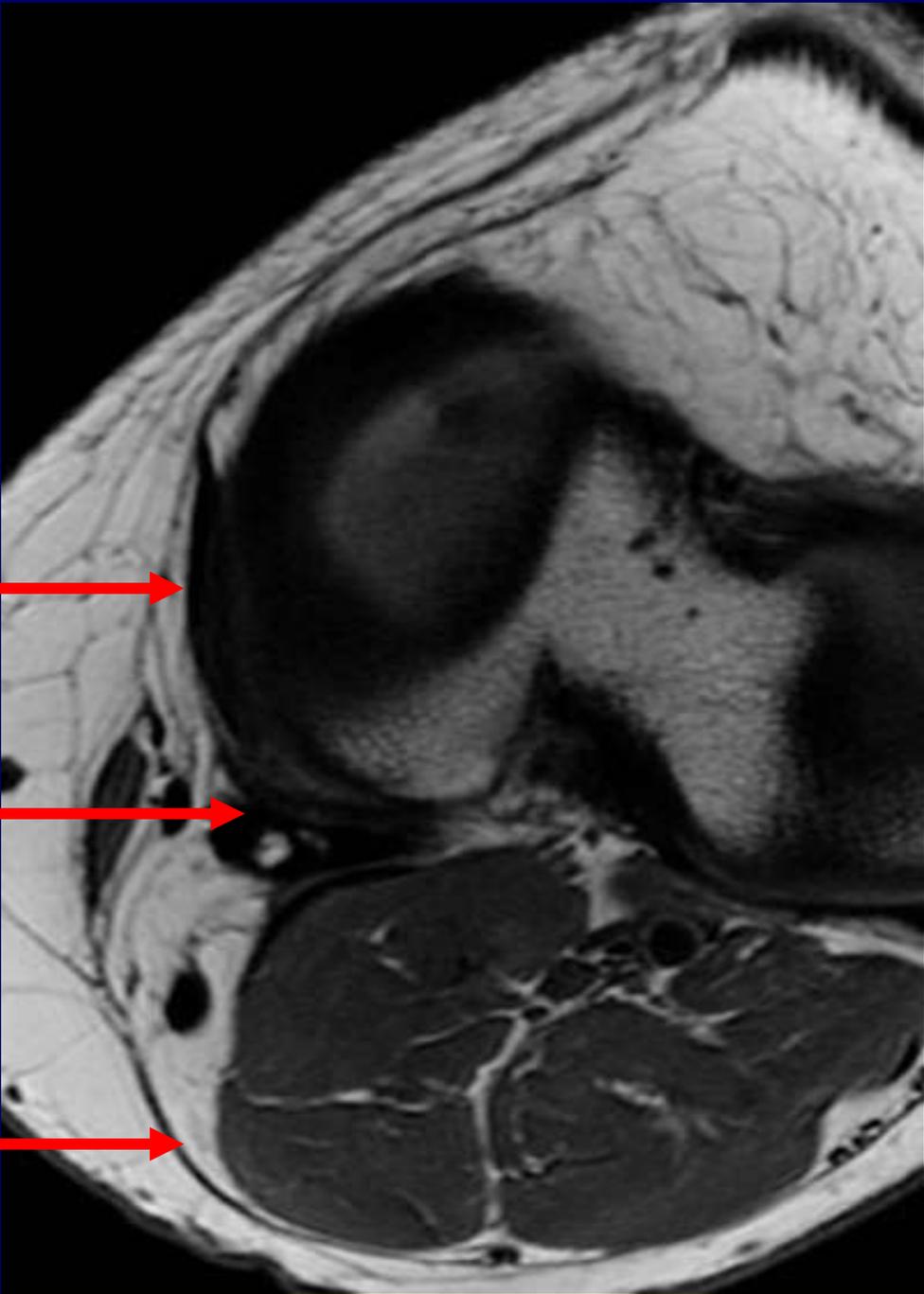


SMT Sheath



POL

Layer I



Layer I+II



Layer III



Layer II



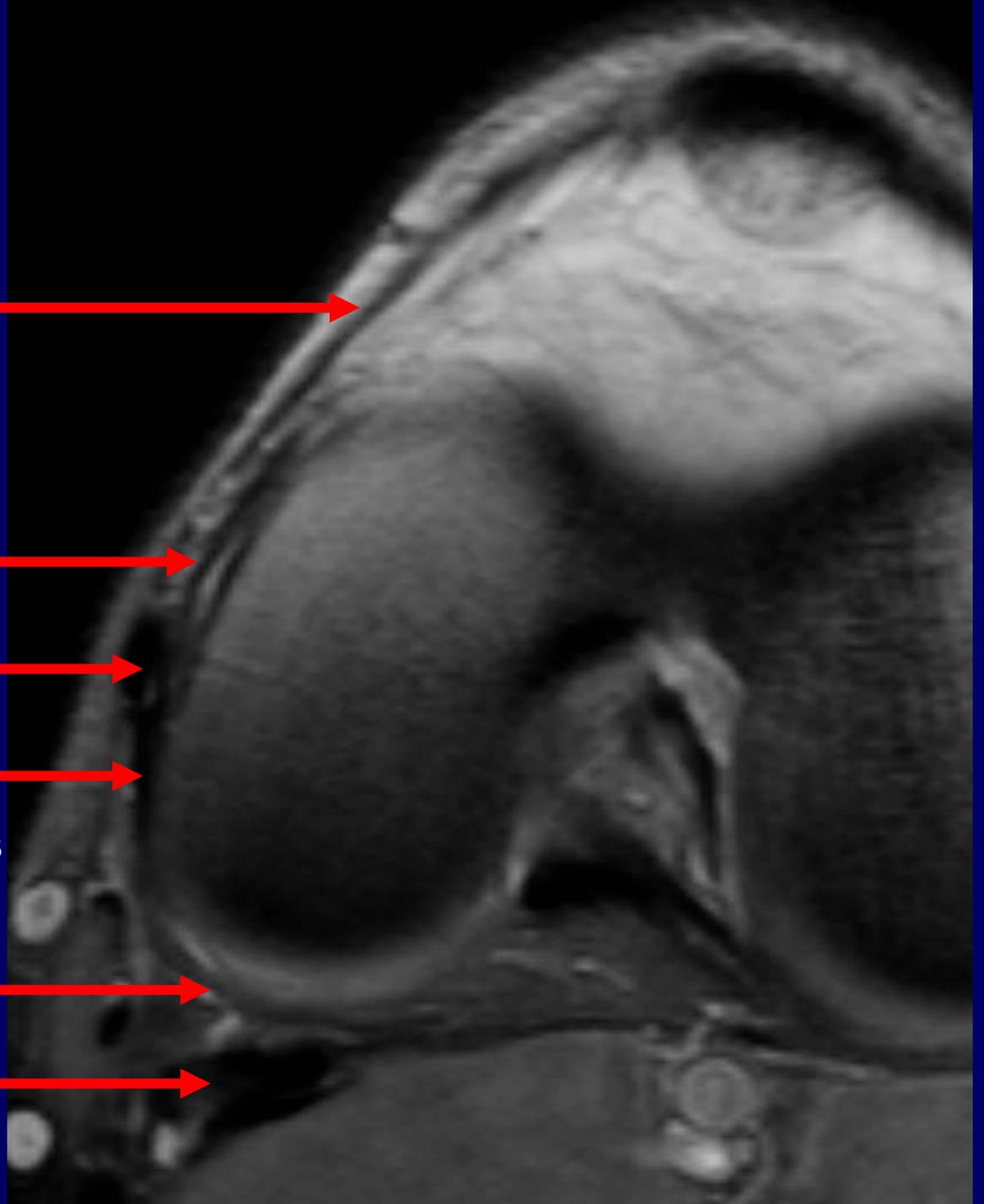
Layer II
Oblique Fibers

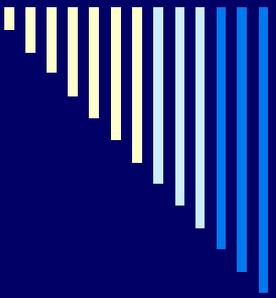


POL



SMT





La
C



Layer I

Layer II

Layer III

Crural fascia



Posteromedial Corner



- Semimembranosus Tendon
 - 5 arms
 - Main insertion on the posteromedial tibial plateau
 - Oblique popliteal ligament

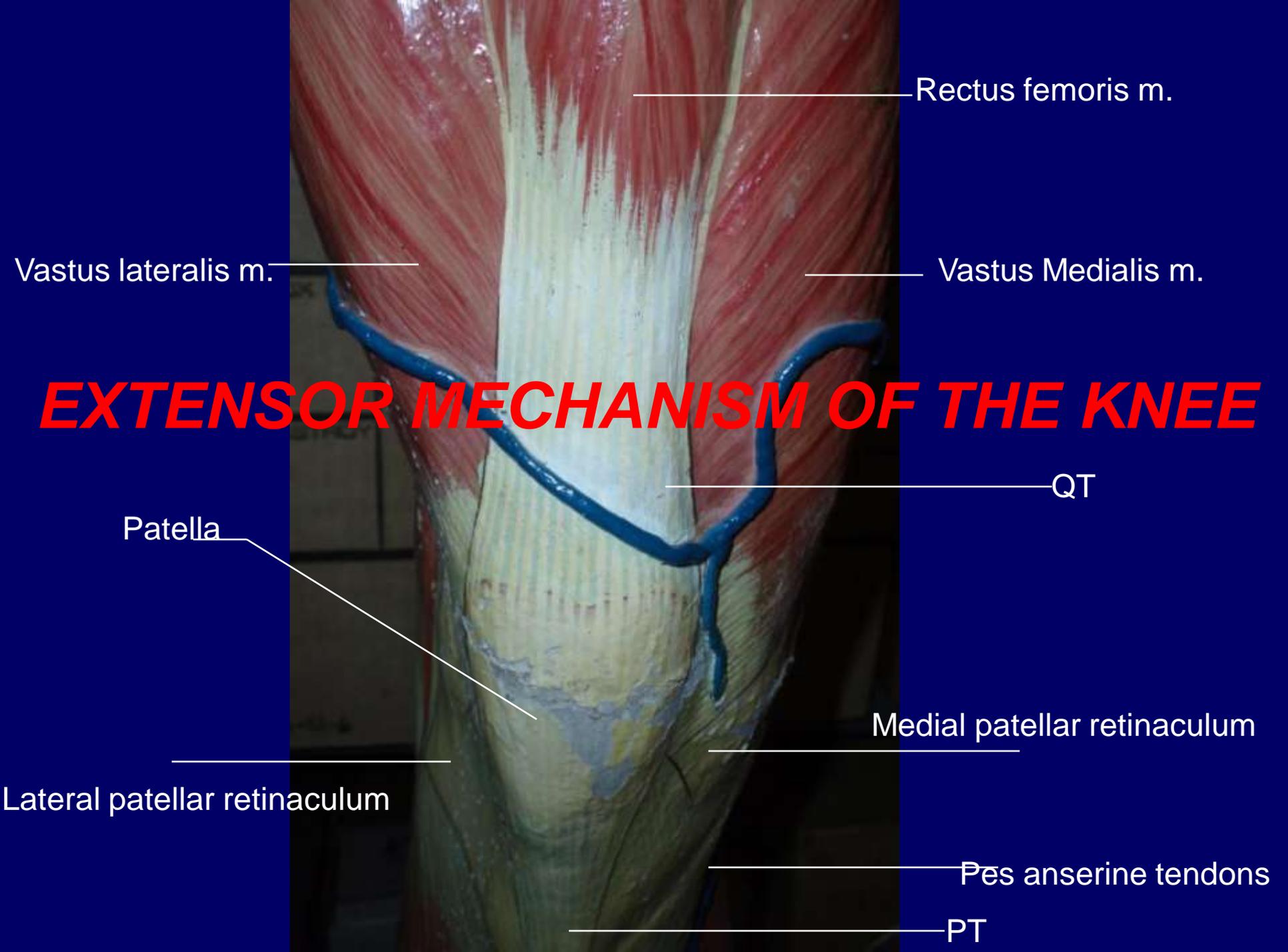
- Semimembranosus Tendon sheath
 - Fibers to Layer II

- Superficial MCL fibers
 - Posterior oblique ligament

- Capsule

WAKE UP





Rectus femoris m.

Vastus lateralis m.

Vastus Medialis m.

EXTENSOR MECHANISM OF THE KNEE

QT

Patella

Medial patellar retinaculum

Lateral patellar retinaculum

Pes anserine tendons

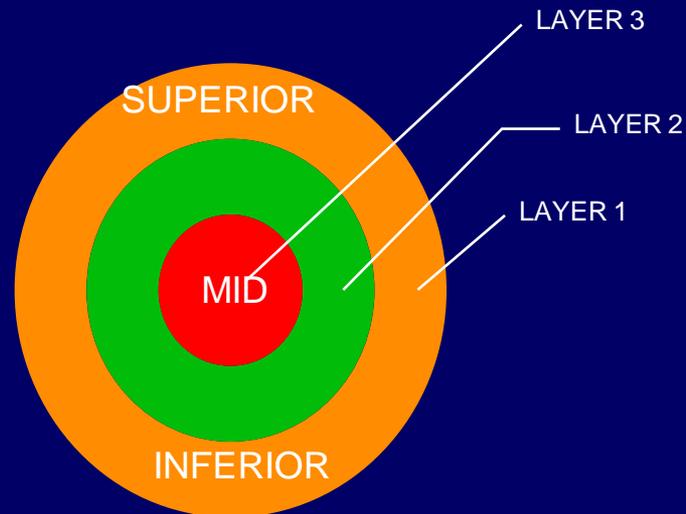
PT

**CONDENSATION OF FIBERS
IN THESE RESPECTIVE TISSUE PLANES**



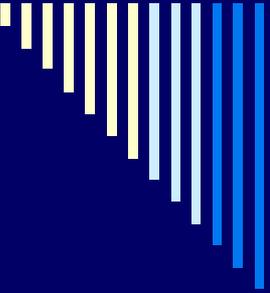
The Supporting Structures and Layers on the Medial Side of the Knee

MEDIAL SOFT TISSUE RESTRAINTS OF THE EXTENSOR MECHANISM



Warren J. Bone Joint Surg. Am. 61:56-62, 1979

***Conlan T etal, J. Bone Joint Surg. Am.* 75:682-693, 1993**



Patella Retinacula

- The retinacula represent condensations in tissue planes rather than discrete structures
 - In the past, the description of these structures has been confusing in part because of their anatomic complexity and also because of variability in descriptive terminology.
 - Although descriptions of retinacular anatomy related to dissection can be found in the orthopedic literature similar descriptions in the radiologic literature have been oversimplified and limited to brief anatomic statements
-

Medial Stabilizers of the Patella

□ 3 Layers

□ 3 Levels

□ 1 - Superficial

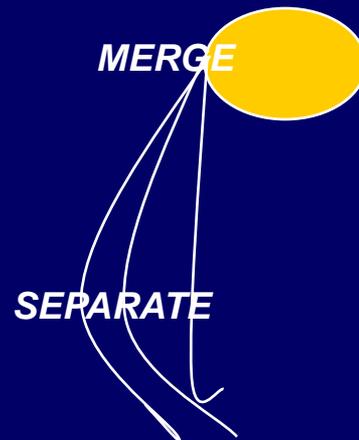
□ Superior

□ 2 – Intermediate

□ Mid

□ 3 - Deep

□ Inferior



4 DISTINCT ANATOMIC STRUCTURES

*MEDIAL PATELLOFEMORAL LIGAMENT
MEDIAL PARAPATELLAR RETINACULUM
MEDIAL PATELLOTIBIAL LIGAMENT
MEDIAL PATELLOMENISCAL LIGAMENT*



R:2600 TE:31.14
C:1 ET:7
5thk/ 3sp
FOV:140

lex

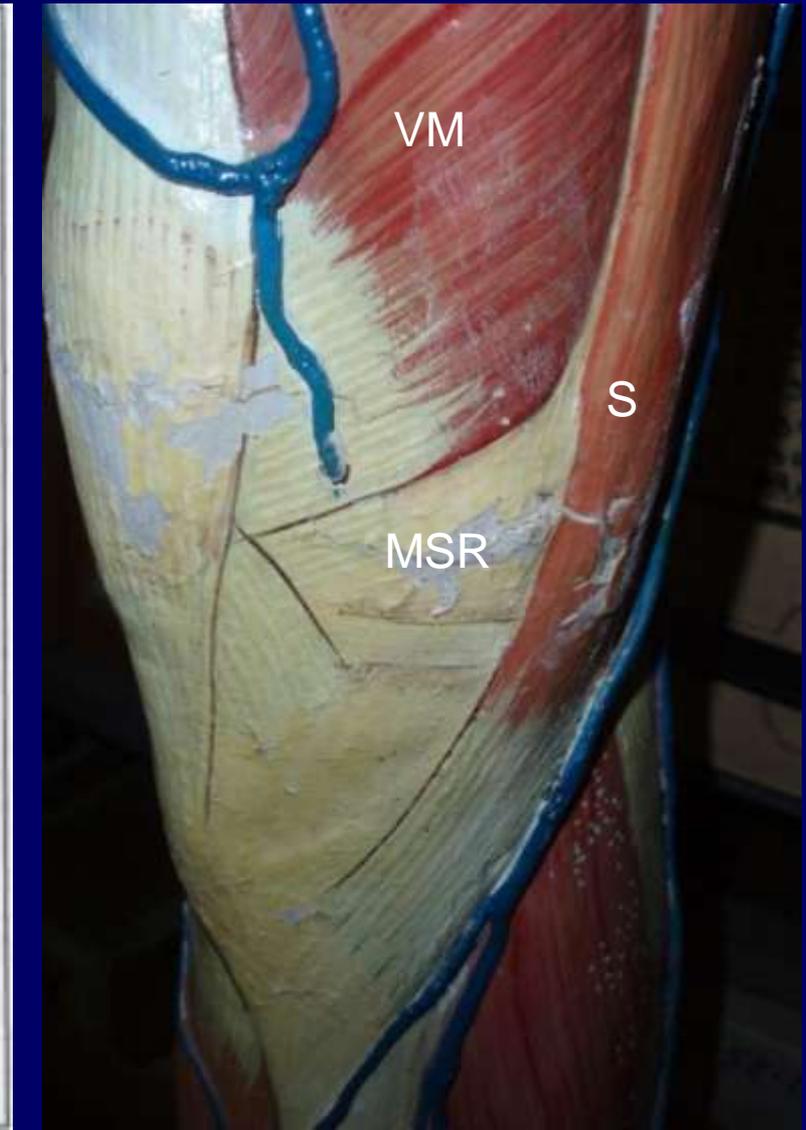
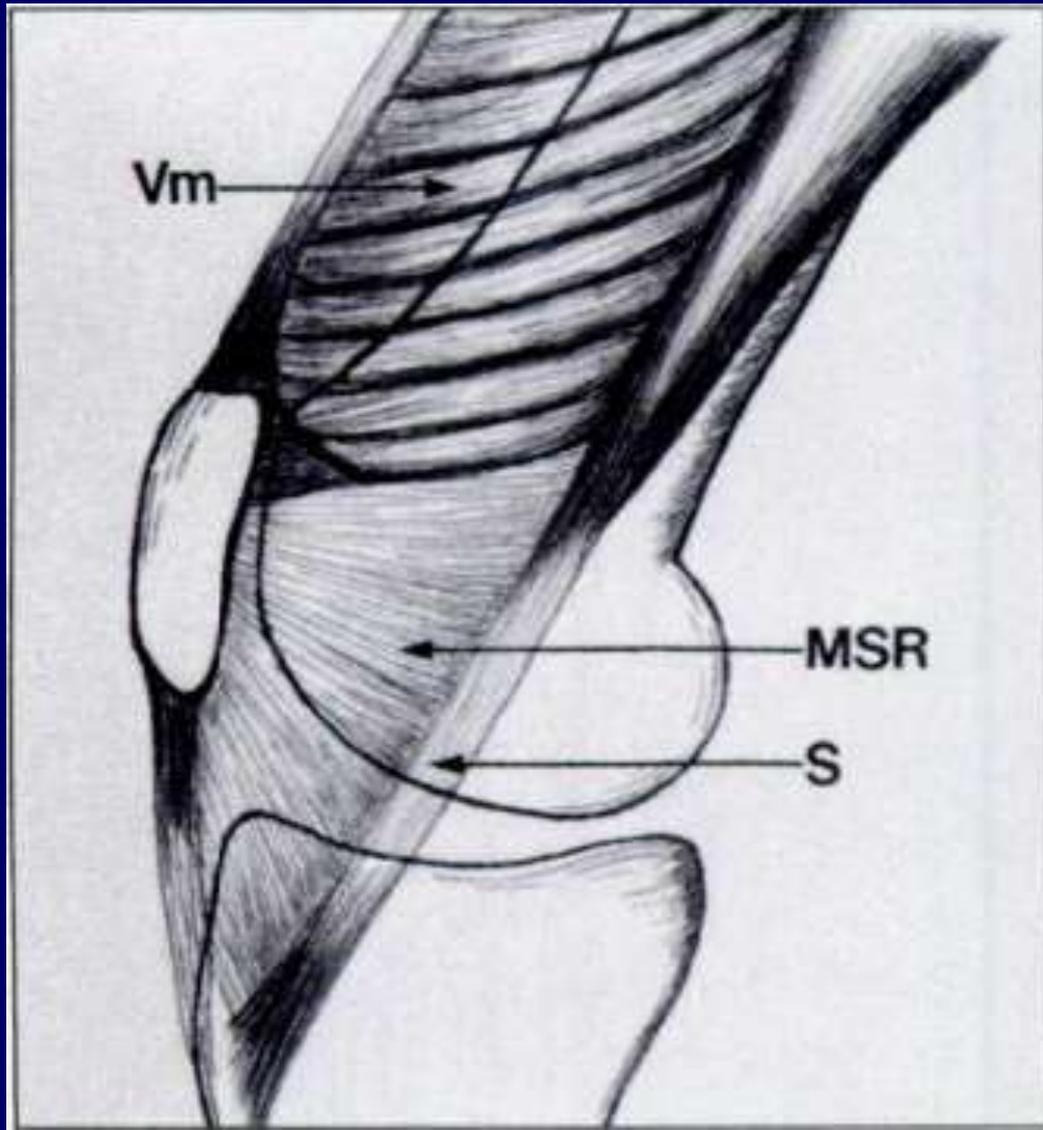
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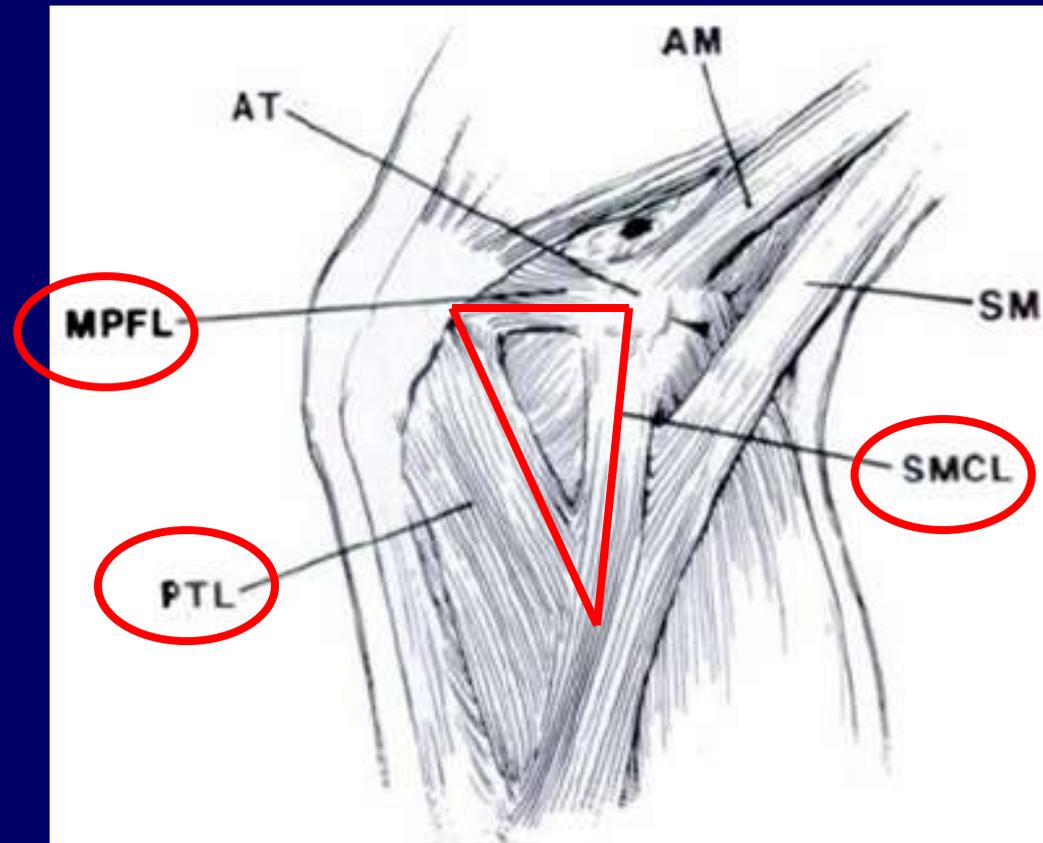
g the

LAYER 1



Layer 2 :

- Fibers form inverted triangle
- Central split in triangle defines 3 separate ligaments

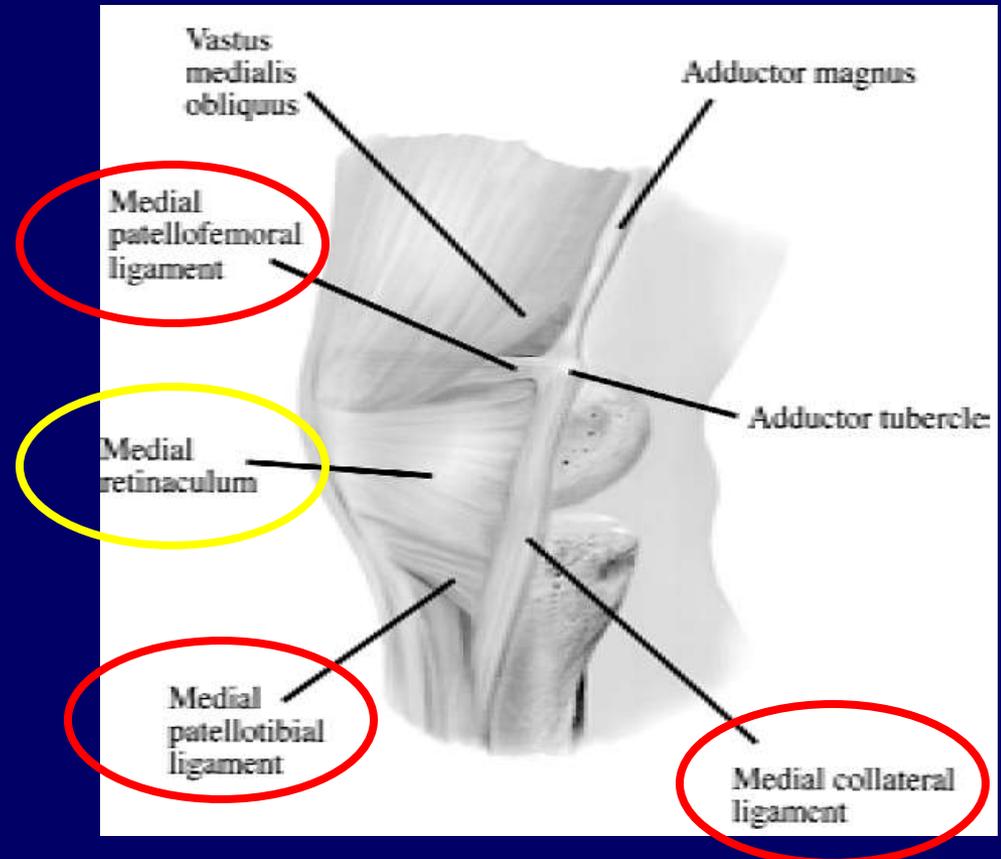


Layer 2 :

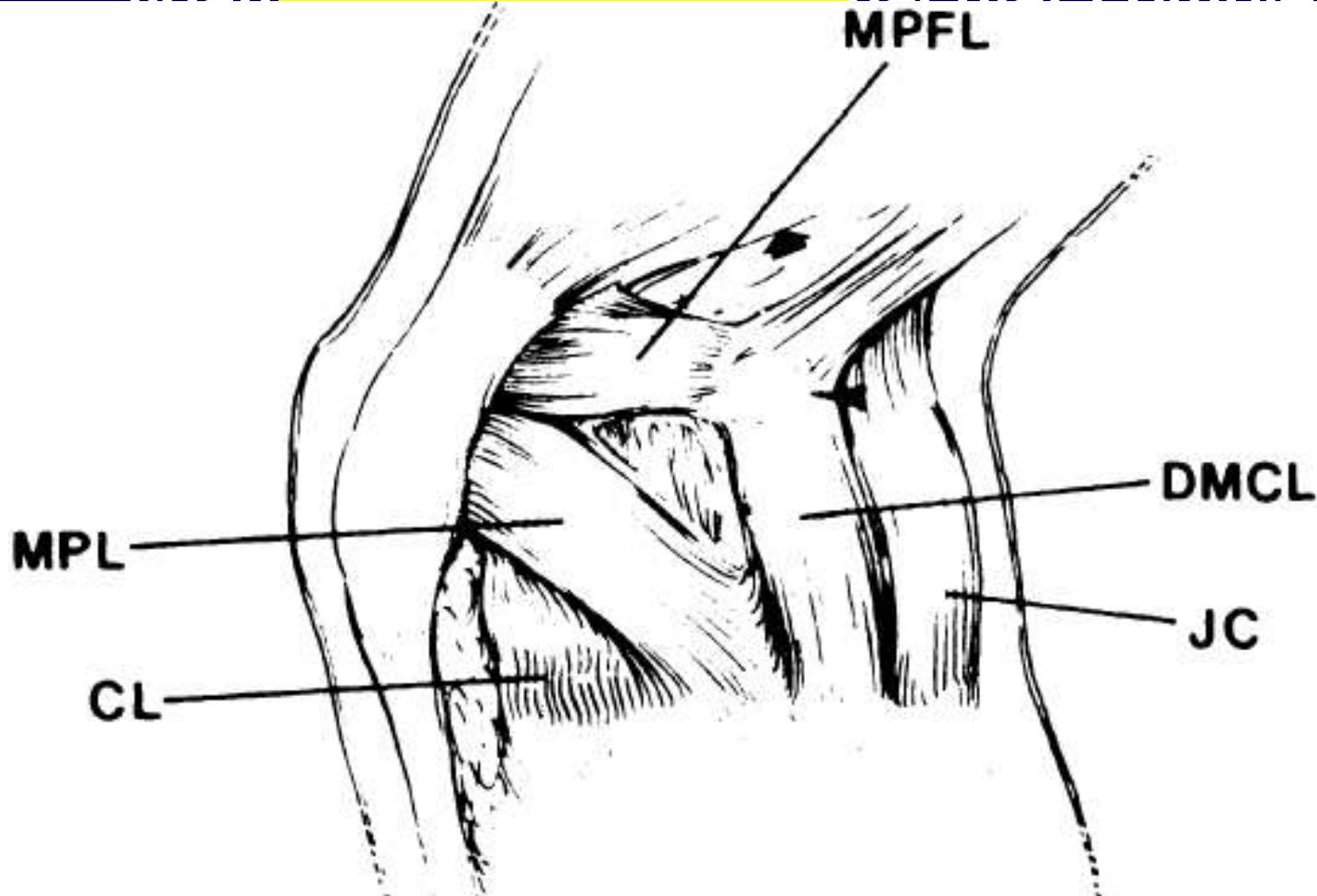
Main component ligaments of medial retinacular complex

- *Medial patellofemoral ligament*
- *Medial patellotibial ligament*
- *Superficial MCL*

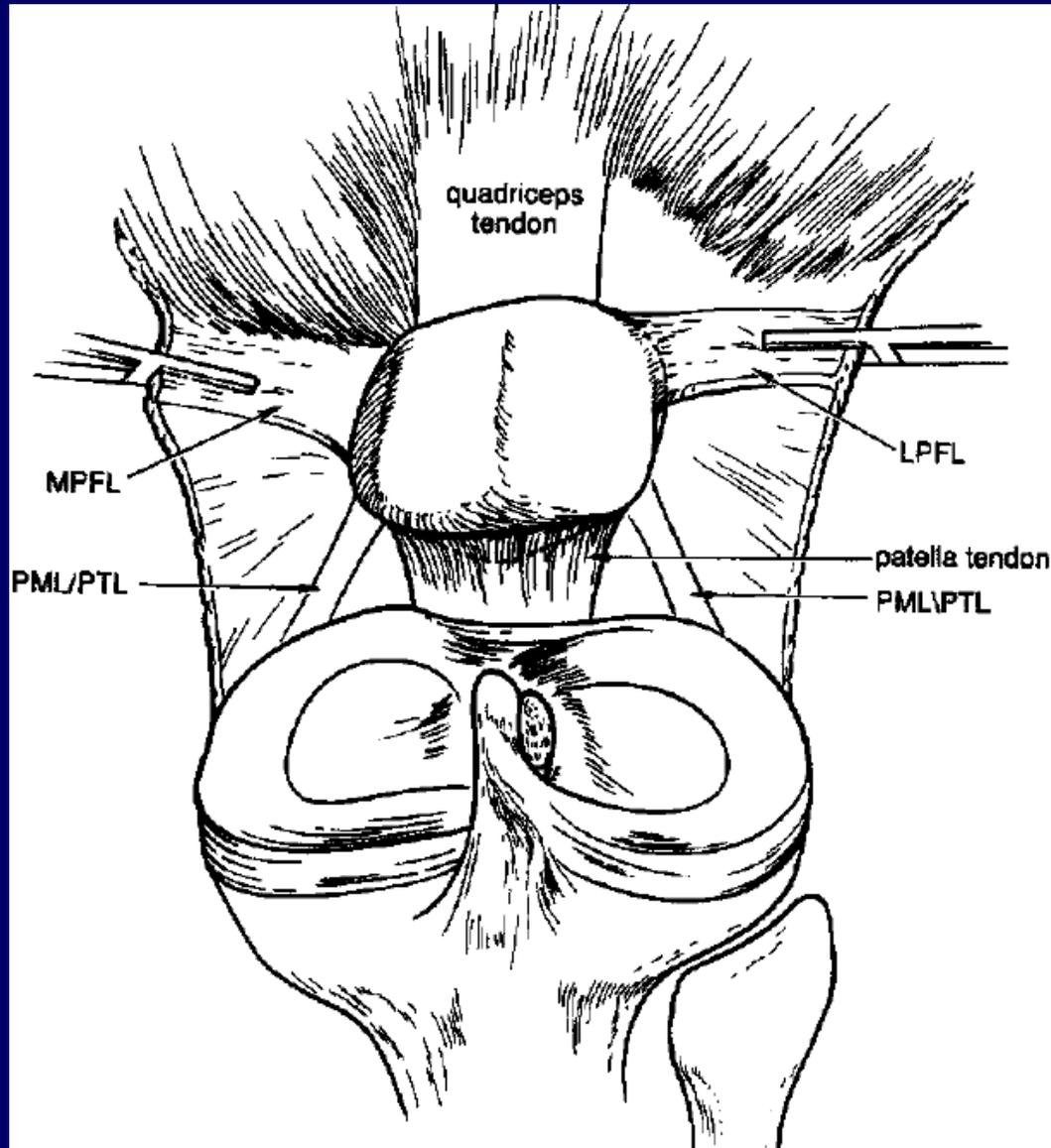
- *Medial Retinaculum –*
 - *Parapatellar retinaculum*
 - *Anterior to Superficial MCL*
 - *Layer 2 (longitudinal fibers) + Layer 1*



Layer 3 :
Main component
ligaments of medial retinacular complex



Apply Layers to Levels



- Knowledge of the expected anatomic location of these four ligaments as well as their relationships to one another is crucial if one is to differentiate between them on MRI and thereby predict with accuracy which structures have been injured.

SUPERIOR

VMO
MPFL

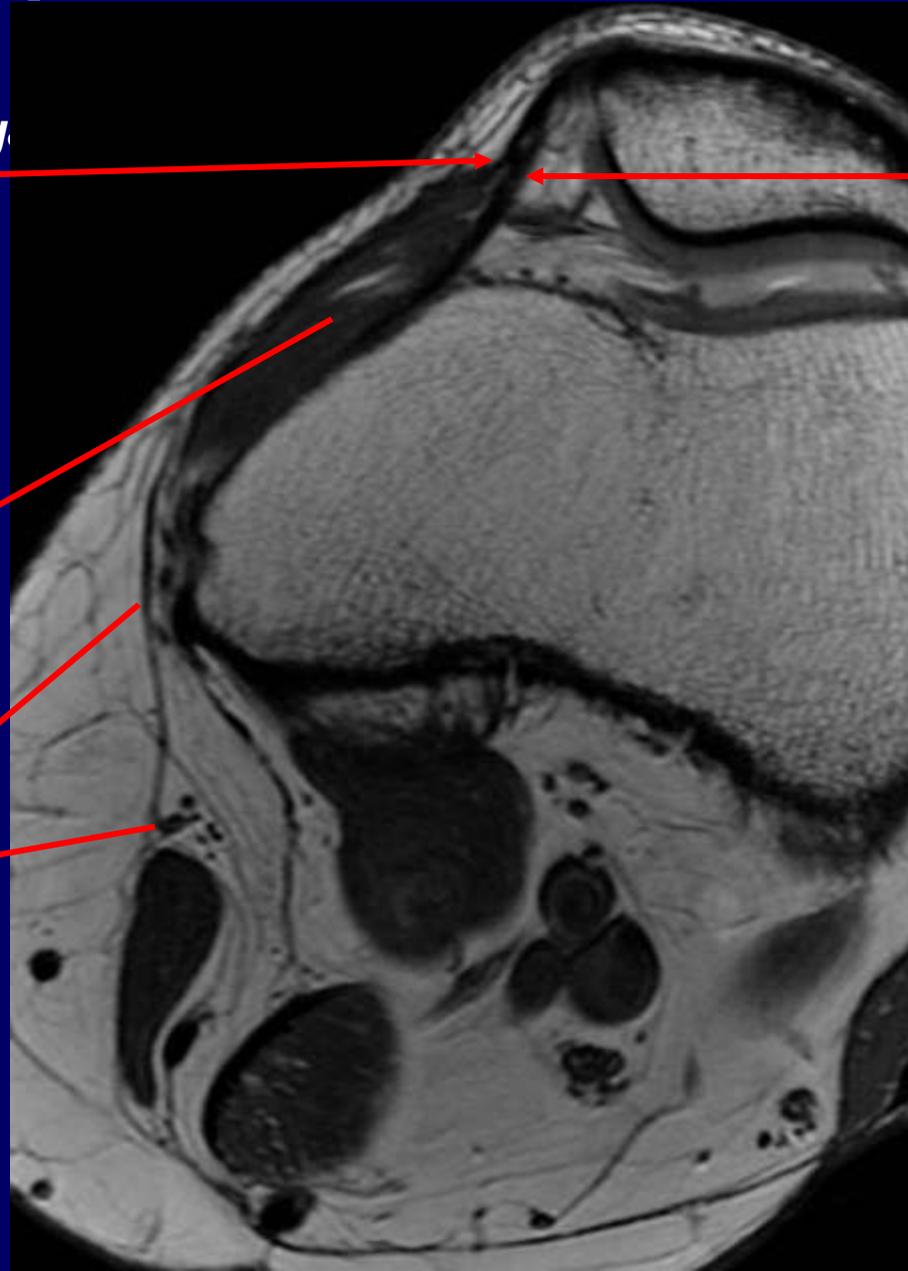
lig

LAYER 1 MERGES WITH
VMO FASCIA

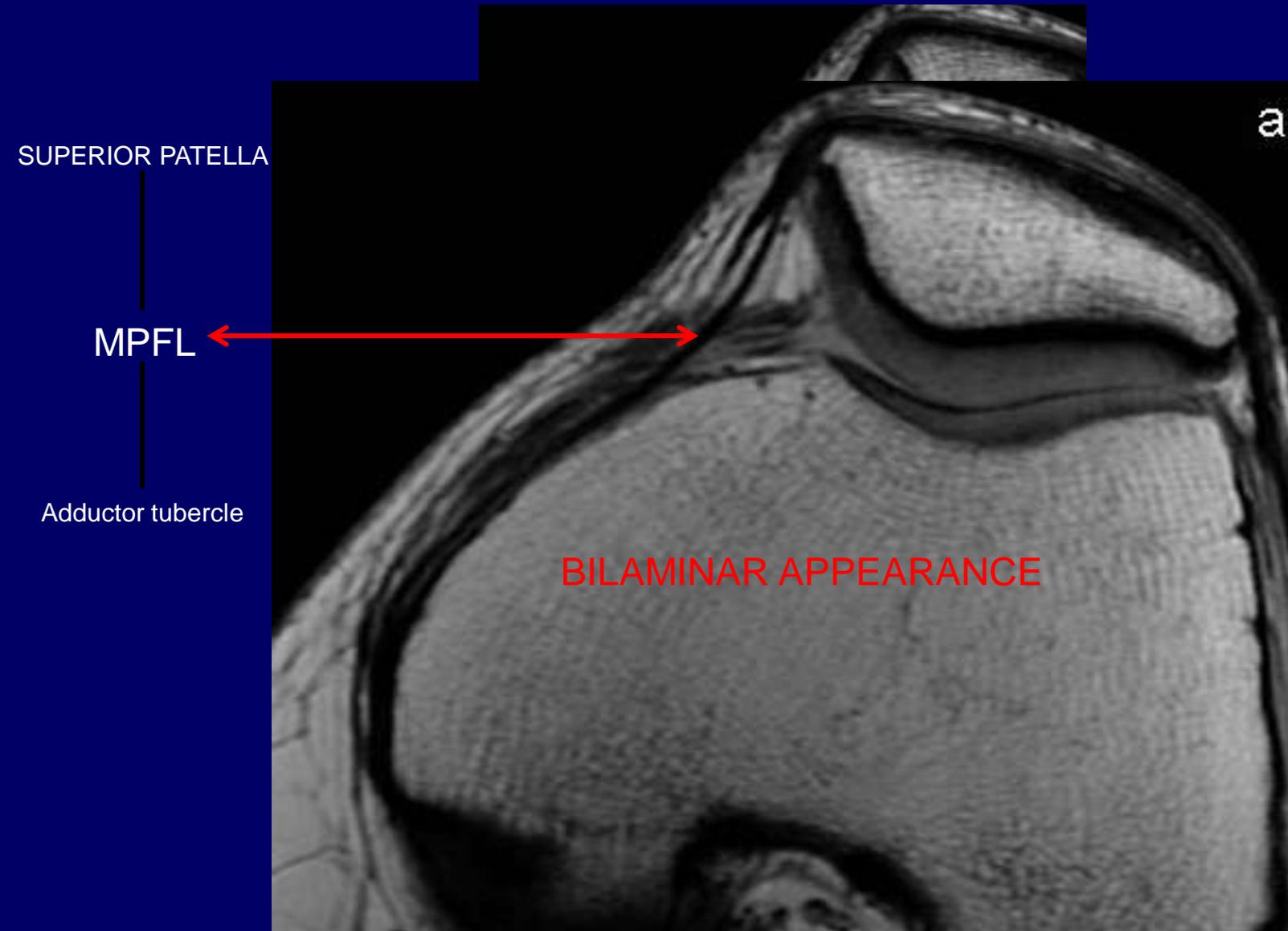
LAYER 2
MPFL

VMO

LAYER 1



SUPERIOR



MID

*Main component
ligaments of medial retinacular complex*

- ***Medial Retinaculum –***
 - ***Parapatellar retinaculum***
Superficial MCL fibers (Layer 2)
+
Crural fascia (Layer 1) merge
 - Merges with VMO fascia anteriorly

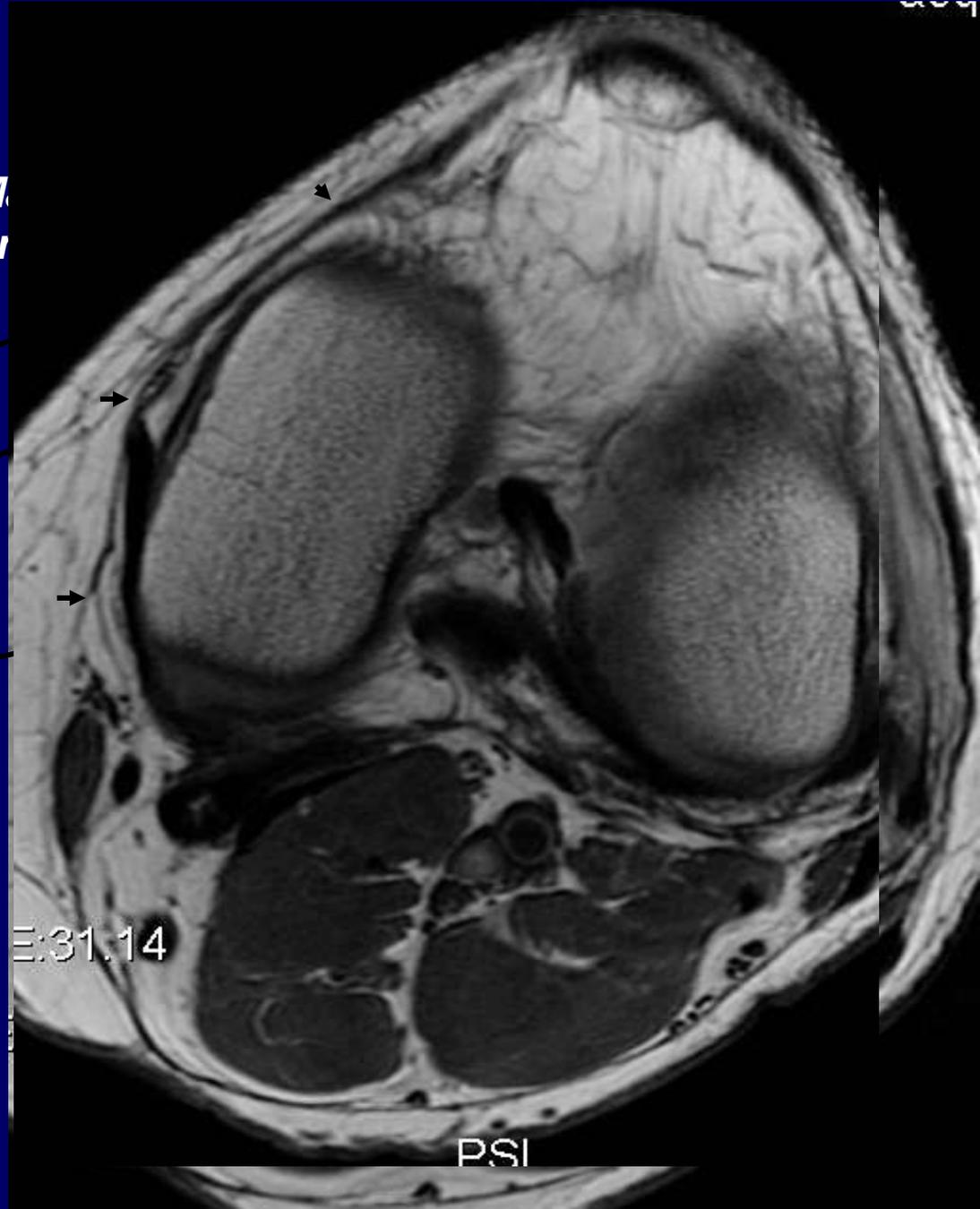
- ***Medial Patellomeniscal Ligament (Layer 3)***



MID

M
ligaments of r

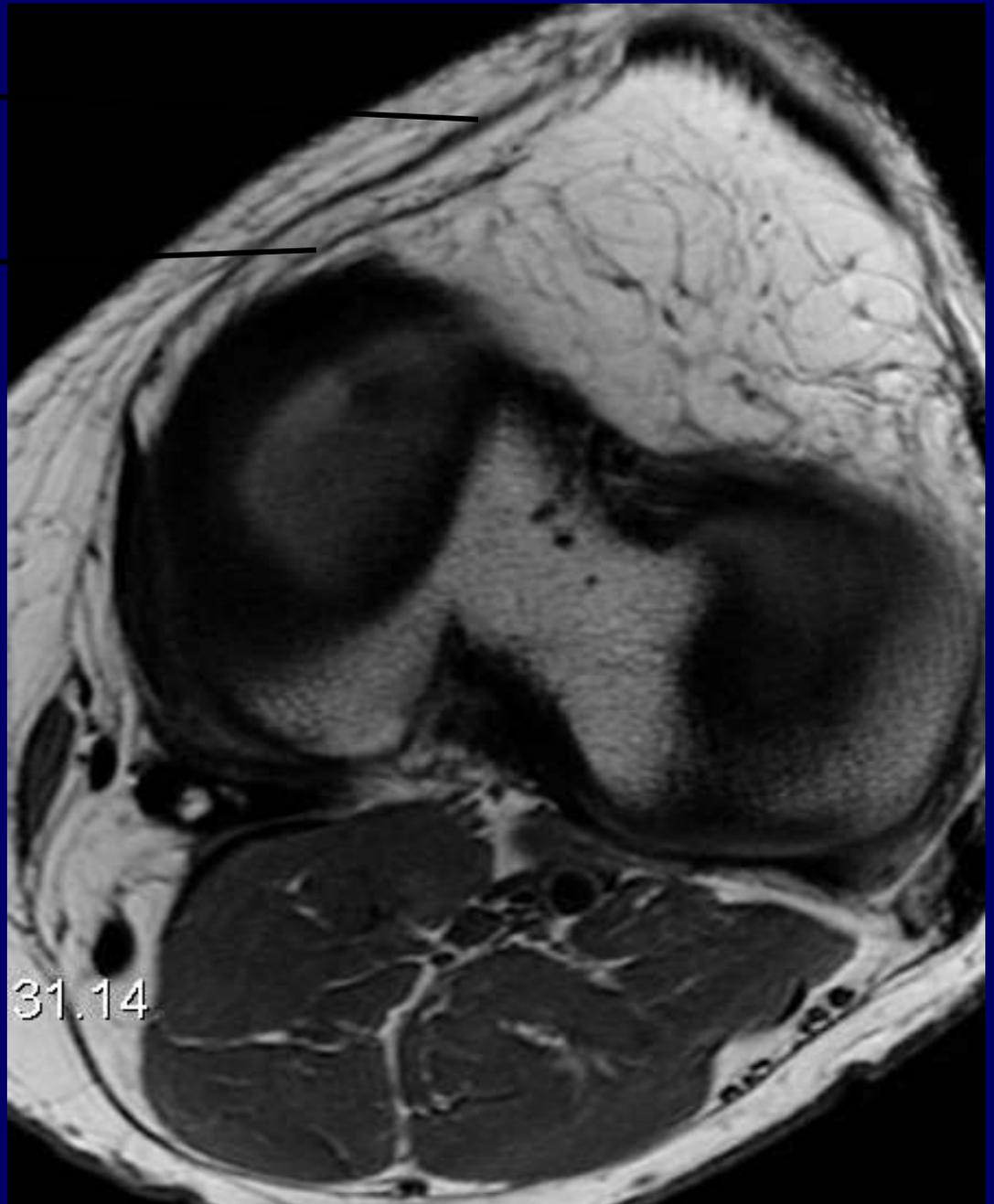
- **Medial Retinaculum –**
 - **Parapatellar retinaculum**
 - **Superficial MCL fibers (Layer 2)**
+
Crural fascia (Layer 1) merge
 - **Merges with VMO fascia anteriorly**



*Medial Retinaculum –
Parapatellar retinaculum*

MID

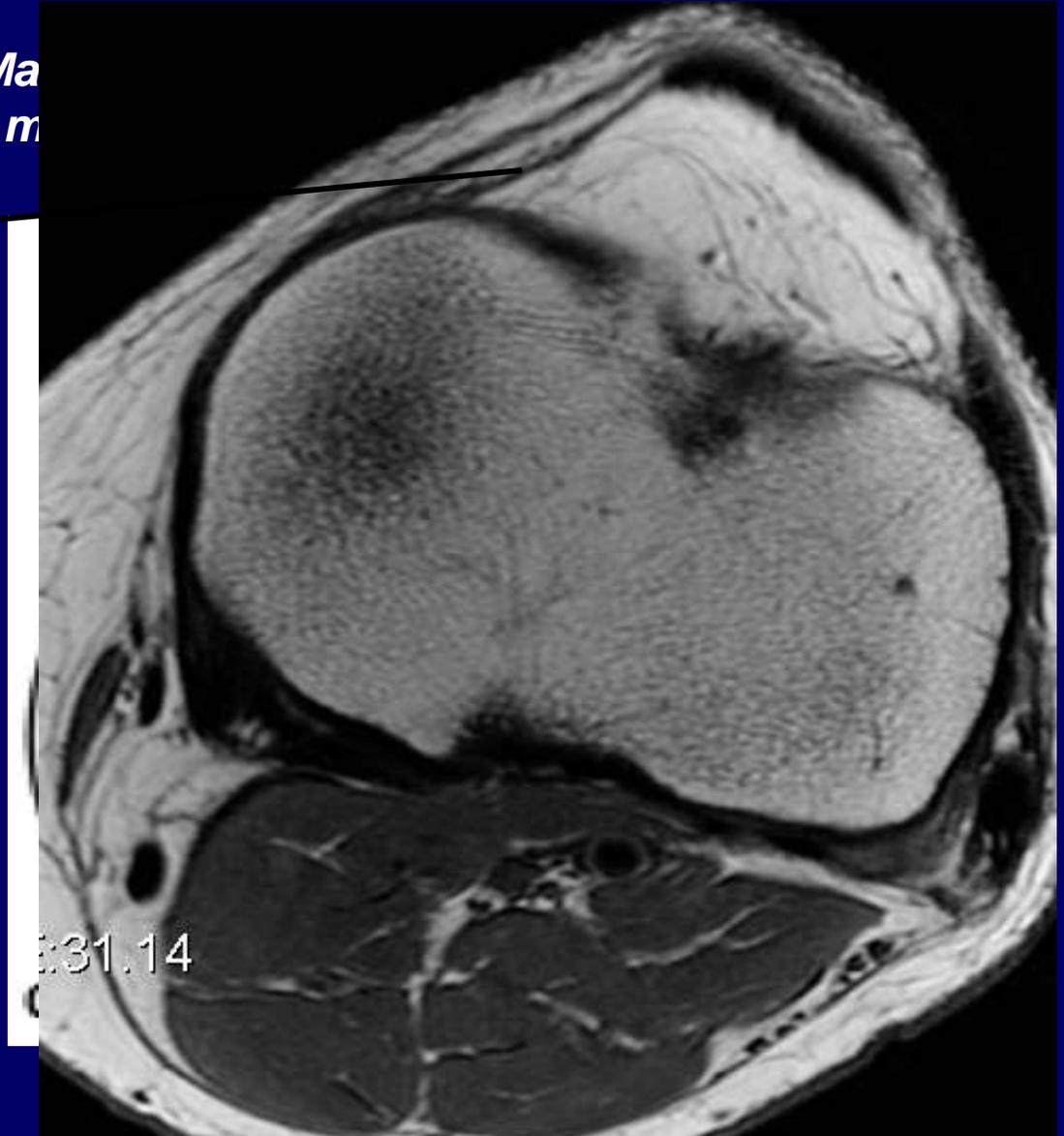
□ *Medial Patellomeniscal
Ligament (Layer 3)*



INFERIOR

Ma
ligaments of m

- Patellotibial Ligament



SE:6

SLA

VMO

MPFL

Medial Retinaculum

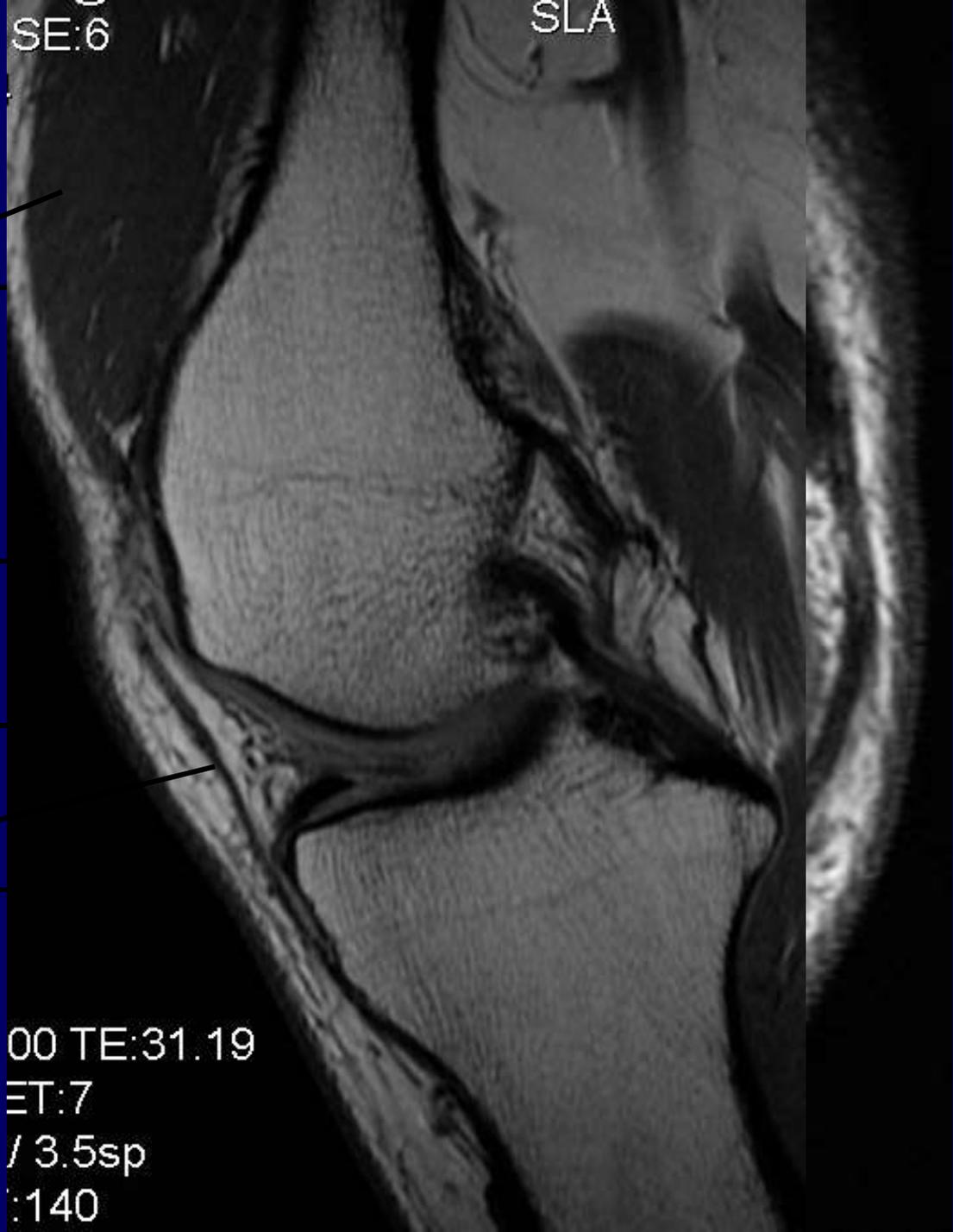
MPTL

00 TE:31.19

ET:7

/ 3.5sp

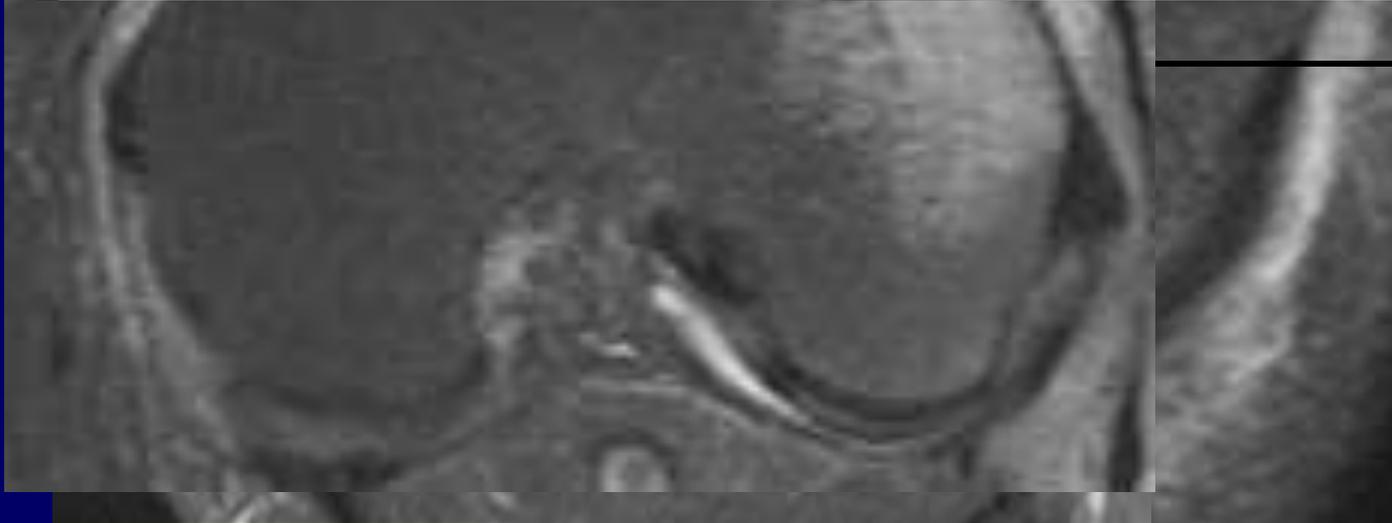
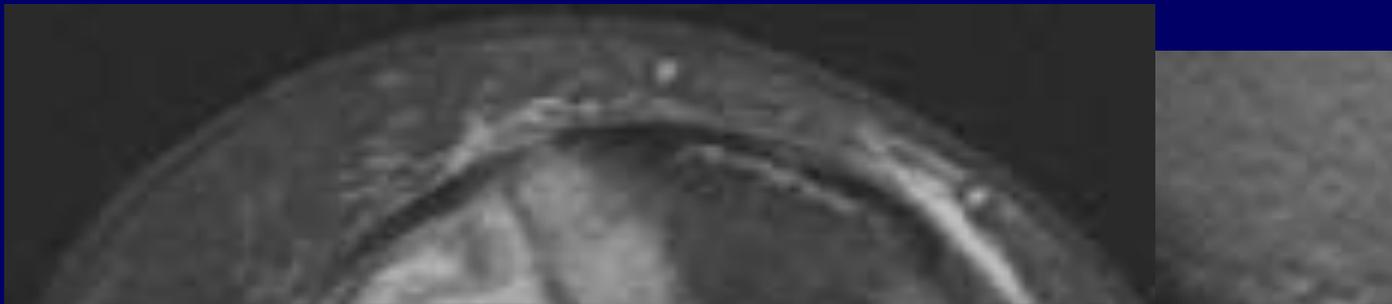
:140



MR Imaging of acute dislocation of the patella

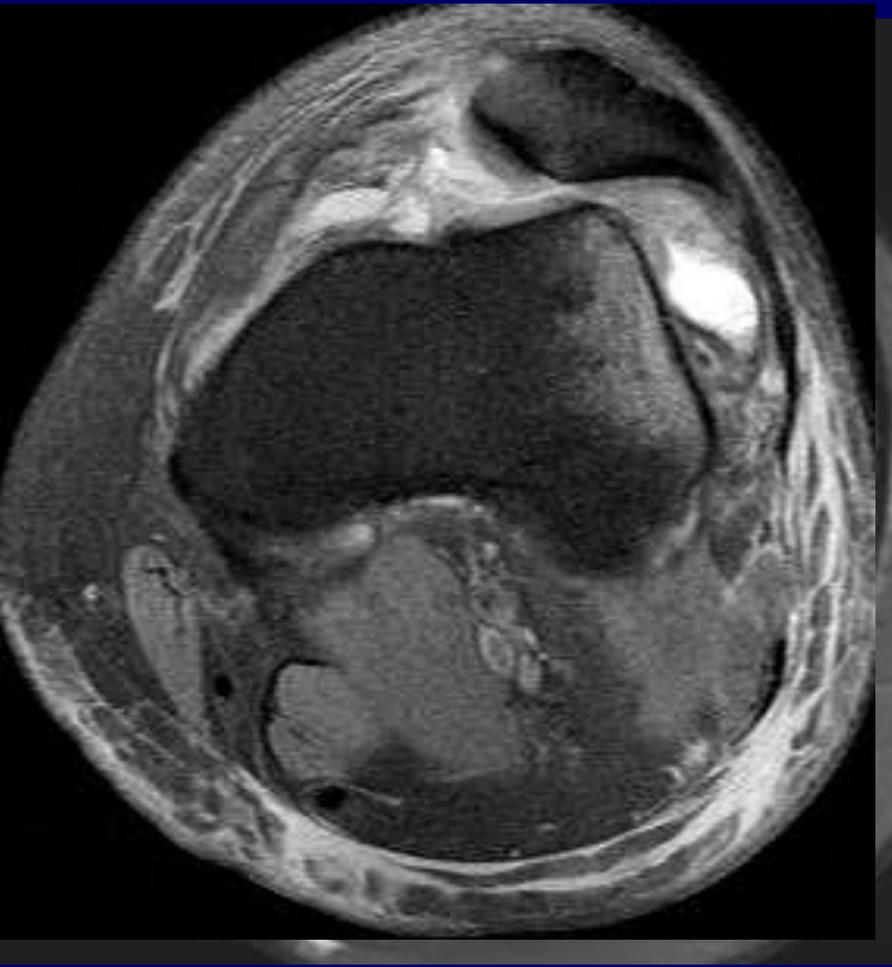
- Classic bone contusion pattern
- Joint effusion/hemarthrosis
- Injury to the medial soft tissue restraints
- MPFL injury
- Edema/Elevation of the VMO
- Osteochondral injury
- Patella (avulsion) fracture

BONE MARROW CONTUSIONS

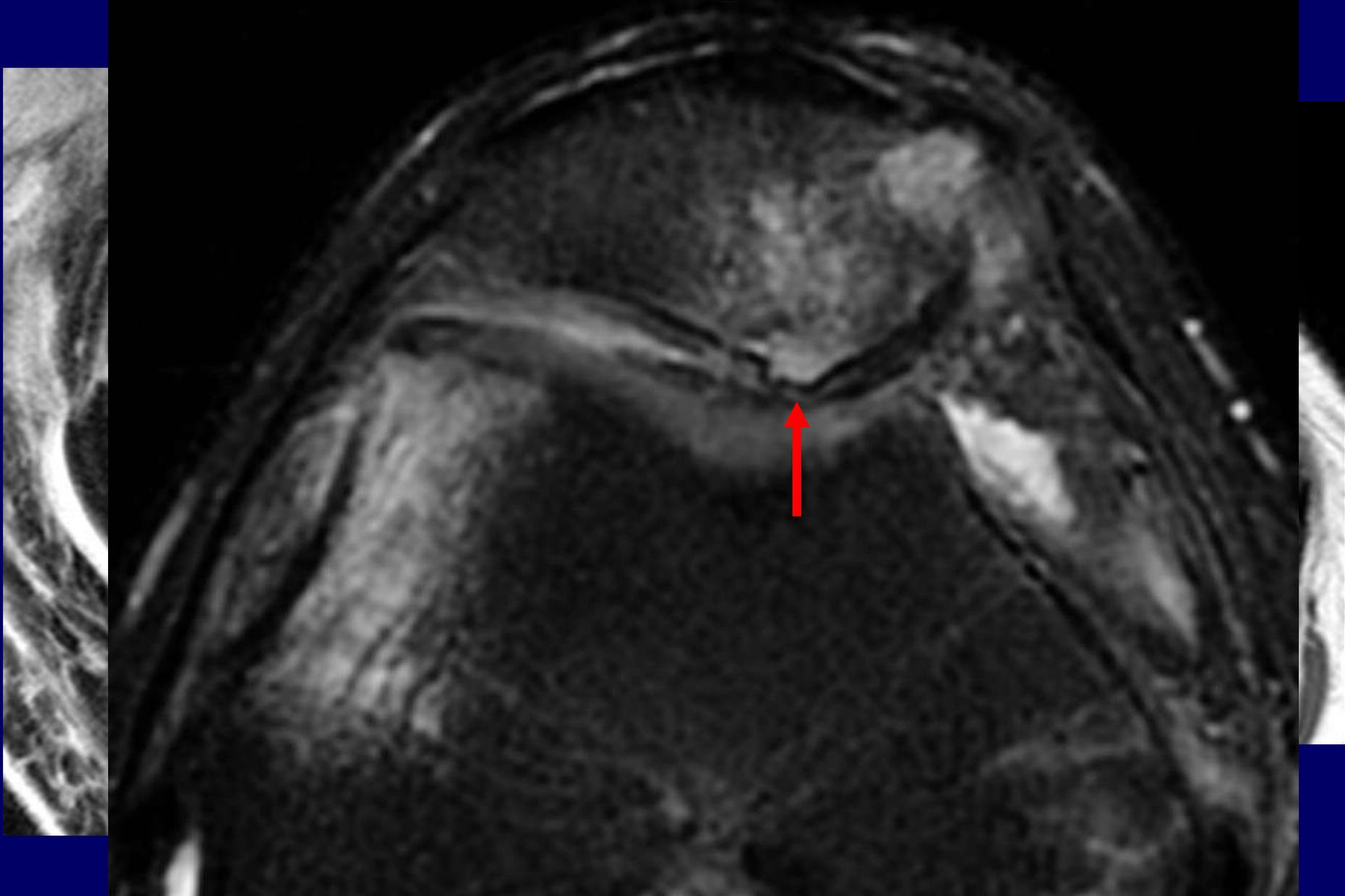


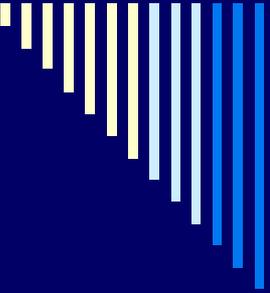
ANTEROLATERAL
LATERAL FEMORAL CONDYLE

JOINT EFFUSION OR HEMARTHROSIS



Osteochondral Injury





MPFL INJURY

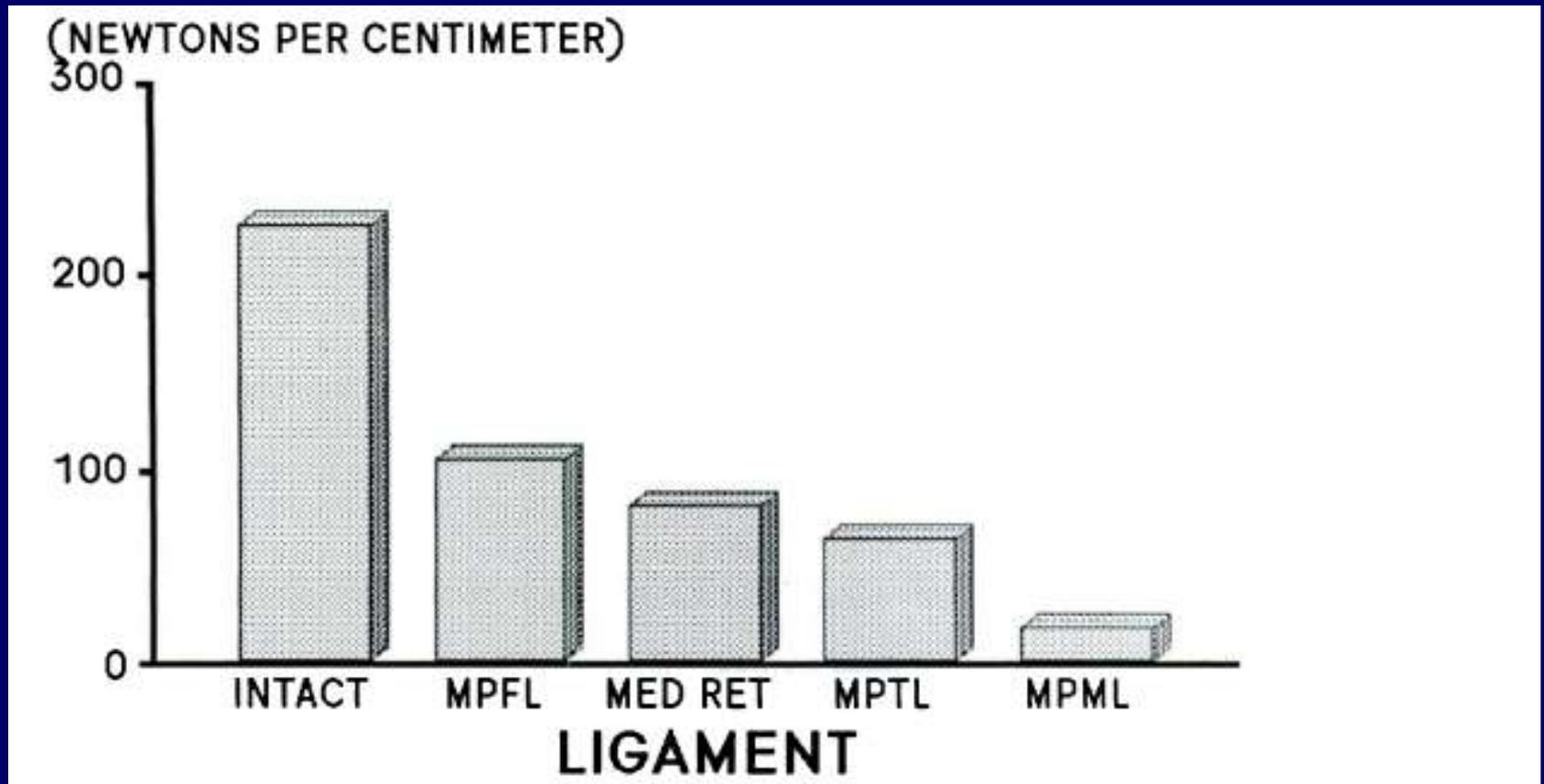
- Most commonly in the proximal fibers
 - All agree

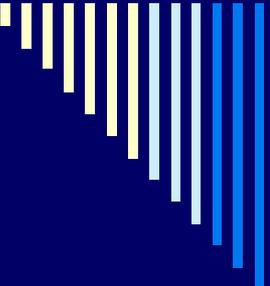
 - Majority near or at the femoral attachment site to the adductor tubercle
 - More recent studies

 - Majority at the patellar attachment
 - Earlier studies
-

MEDIAL RETINACULAR INJURY

BIOMECHANICAL TESTING





MPFL INJURY

- Use standard system for grading ligamentous injuries:

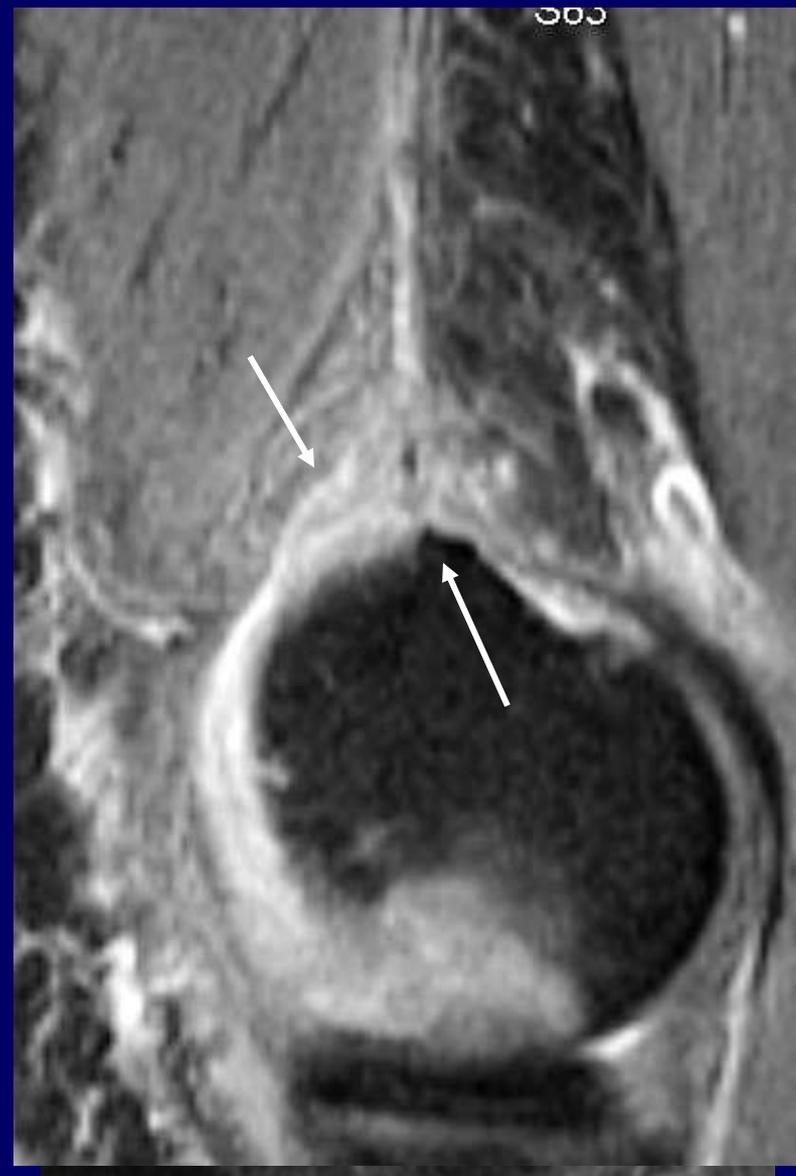
The MPFL fibers are graded as:

- Normal (intact fibers with no adjacent edema)
 - Stretched (wavy continuous fibers with adjacent edema)
 - Disrupted (no intact fibers)
-

VMO ELEVATION with MPFL AVULSION

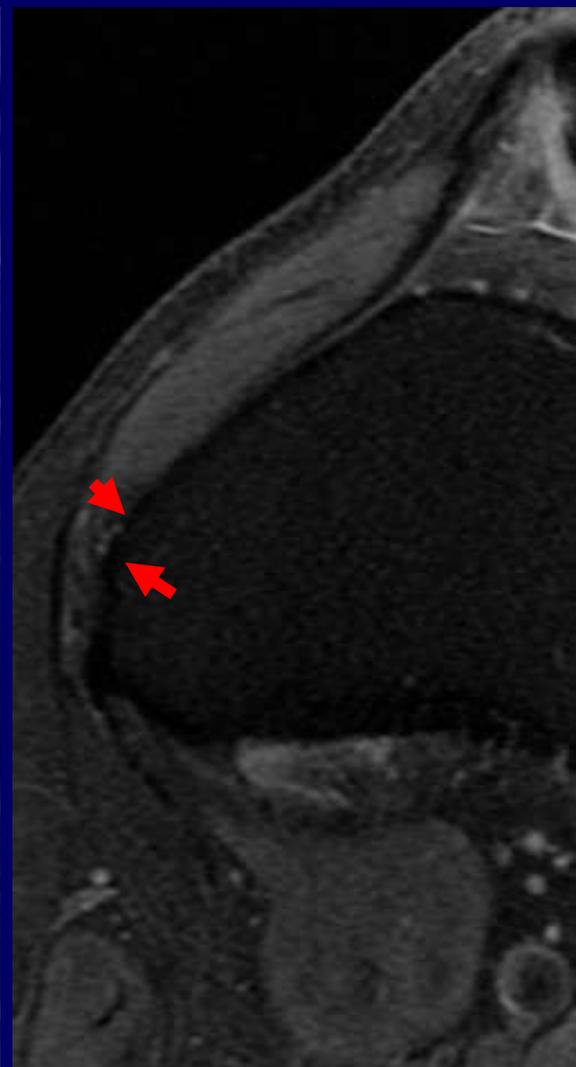
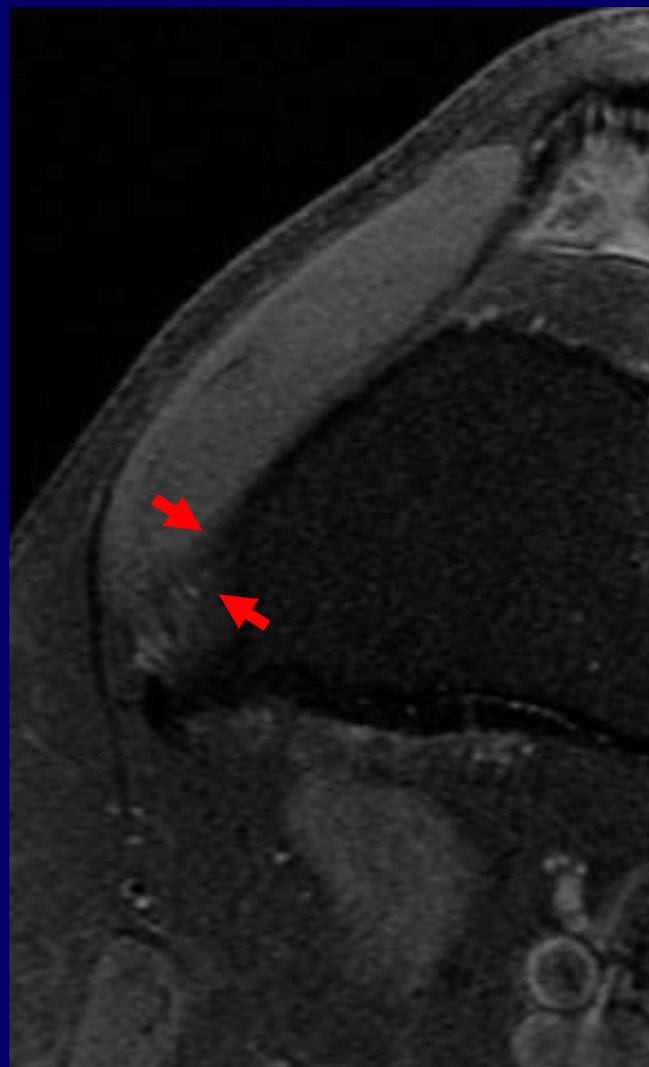
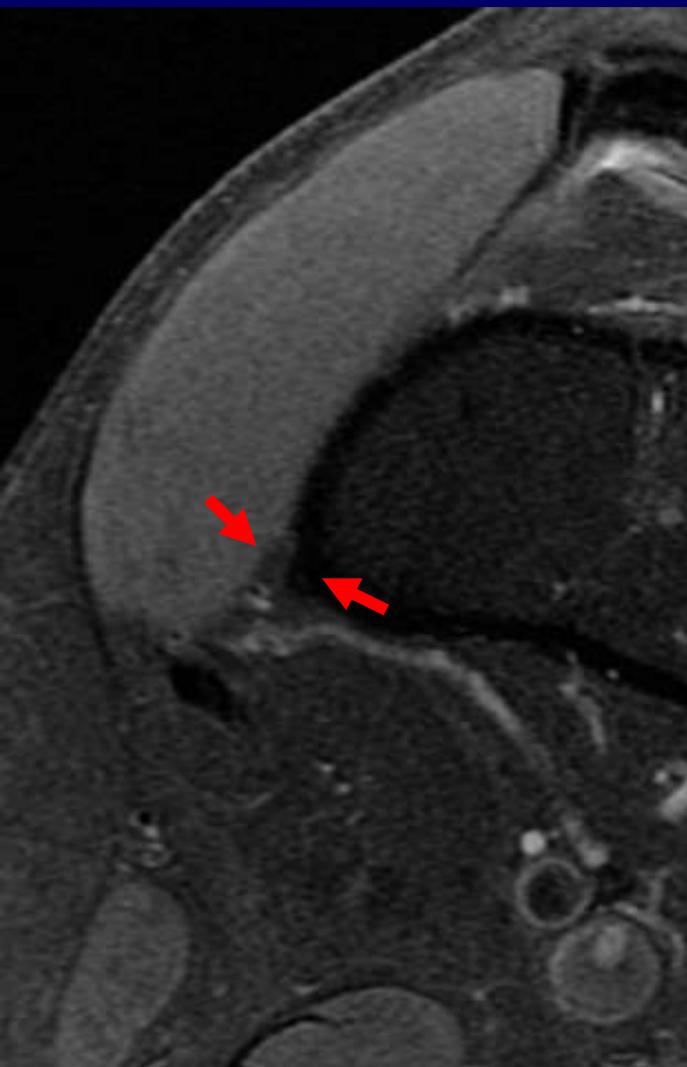


Normal



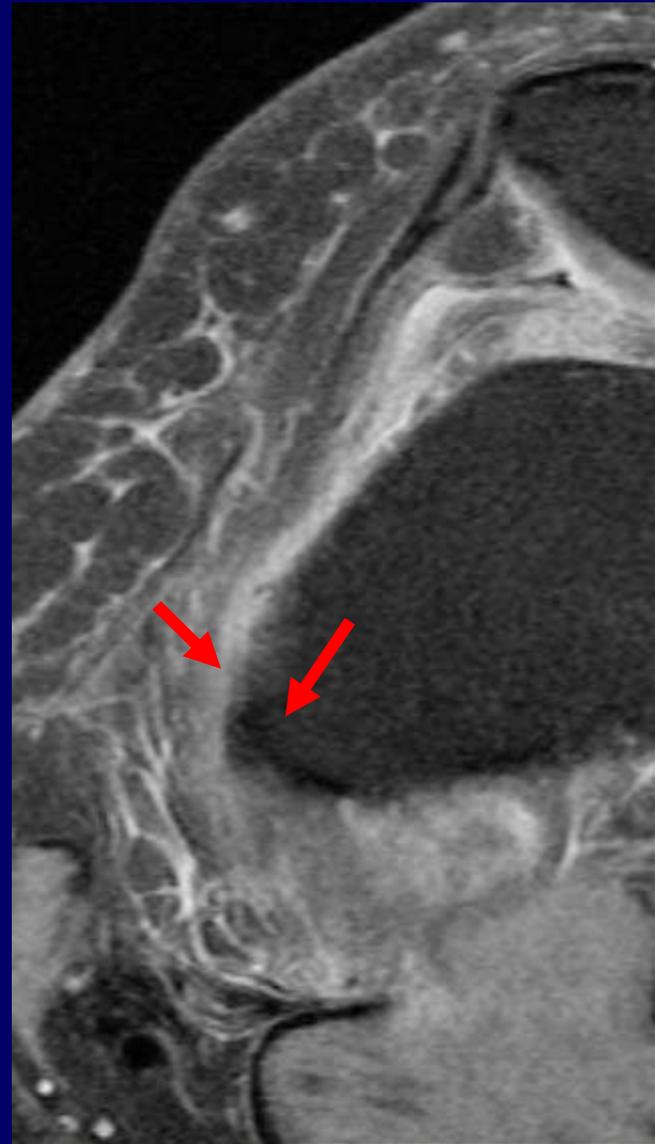
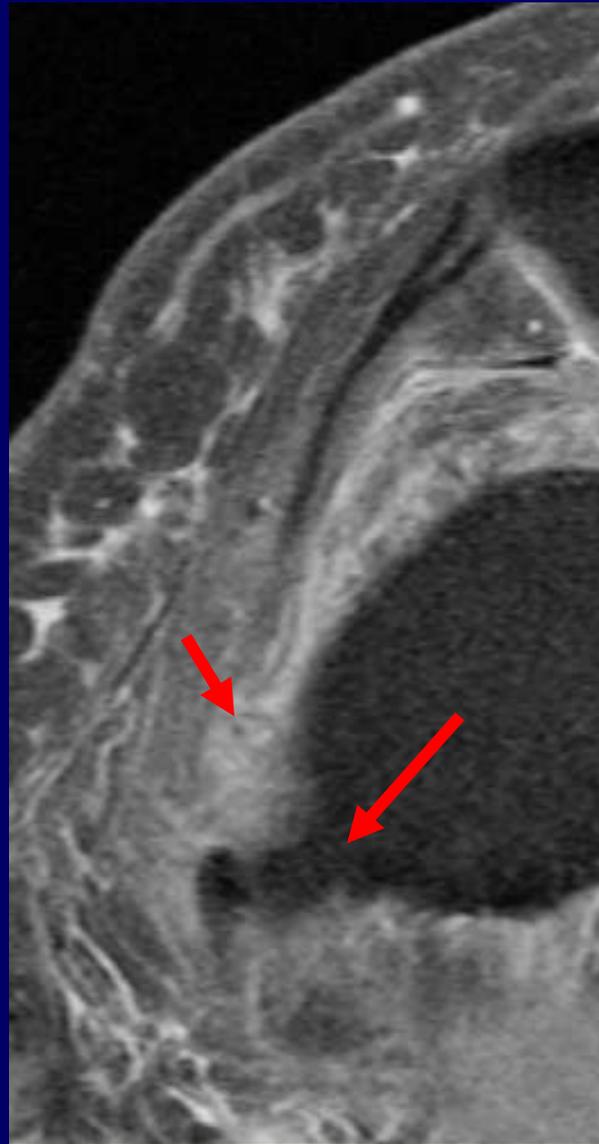
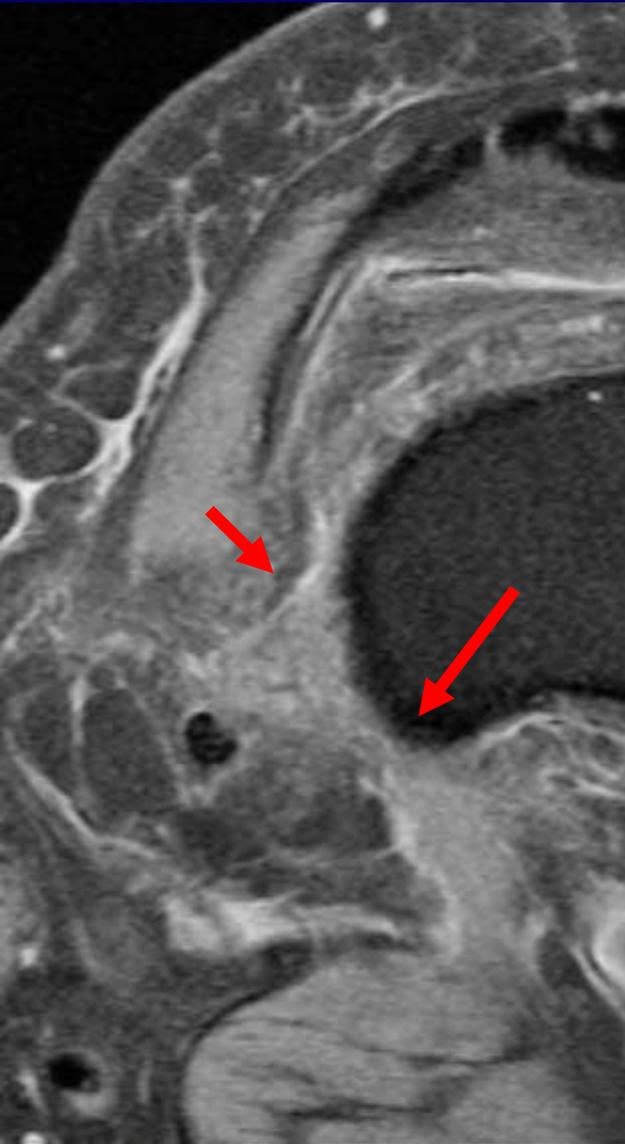
Abnormal

VMO



Normal

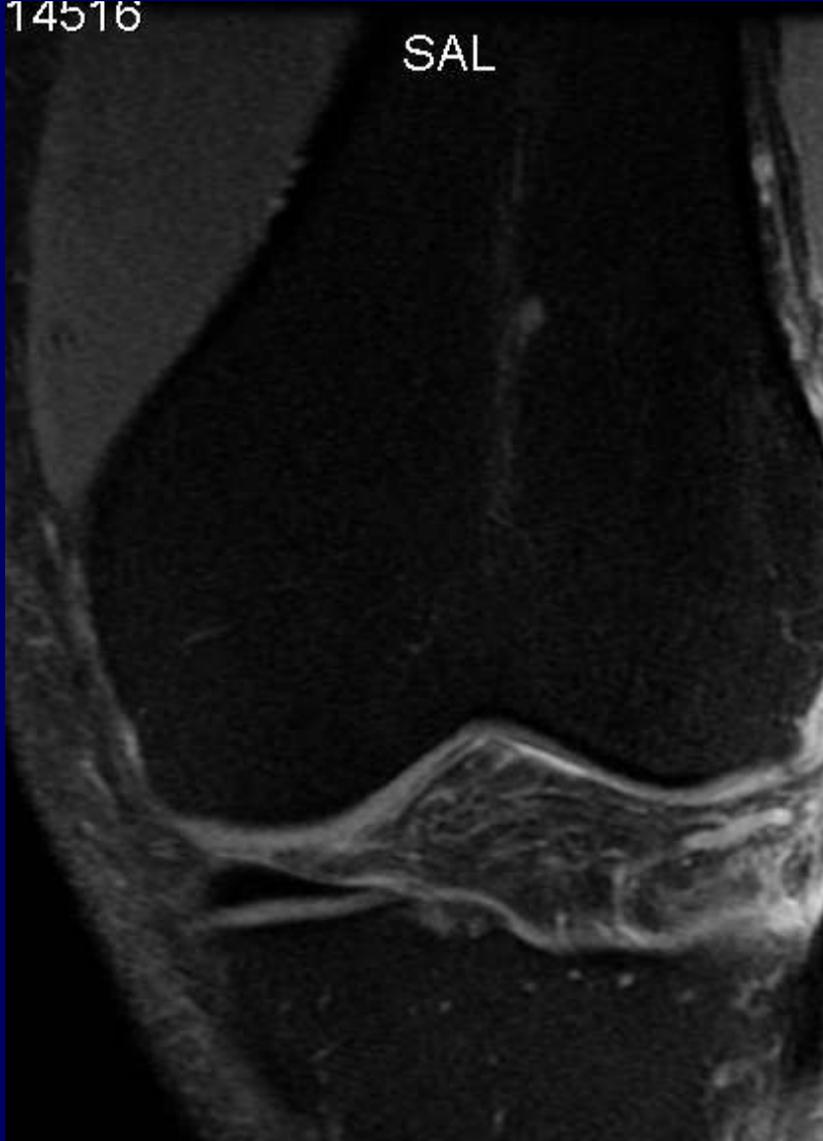
VMO ELEVATION with MPFL AVULSION



VMO Edema

14516

SAL



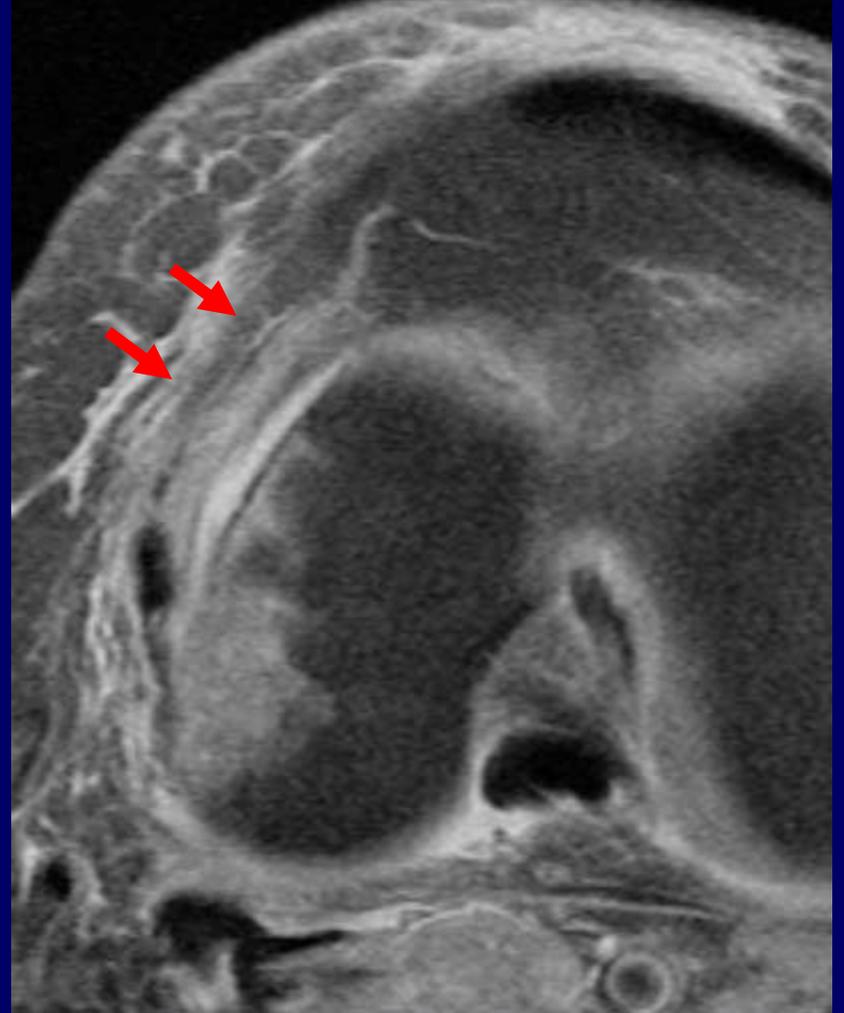
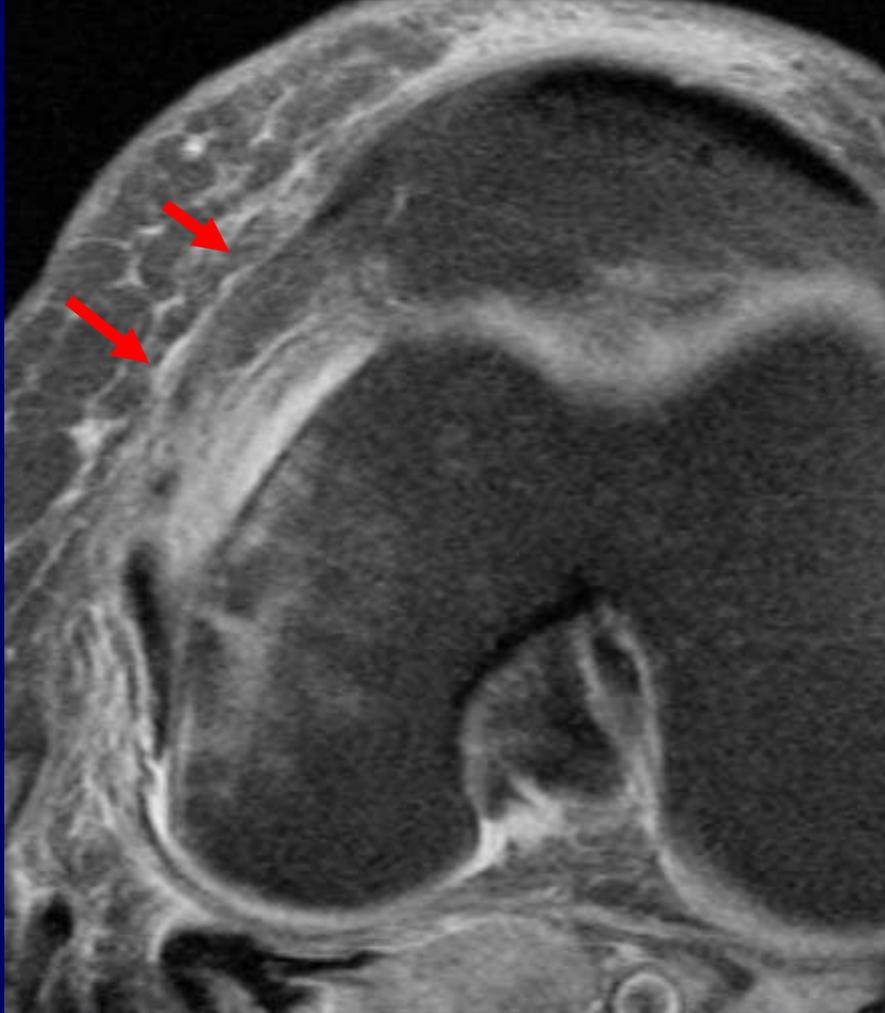
Normal

S51

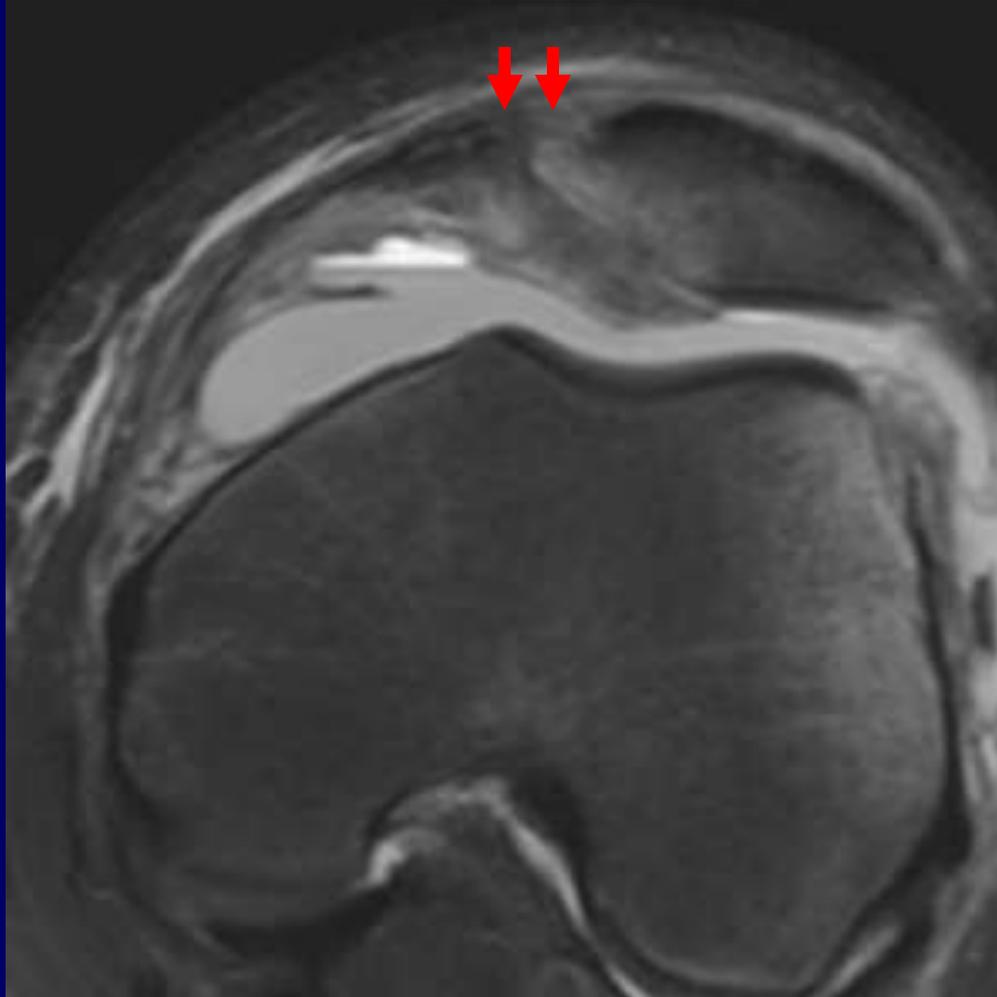


Abnormal

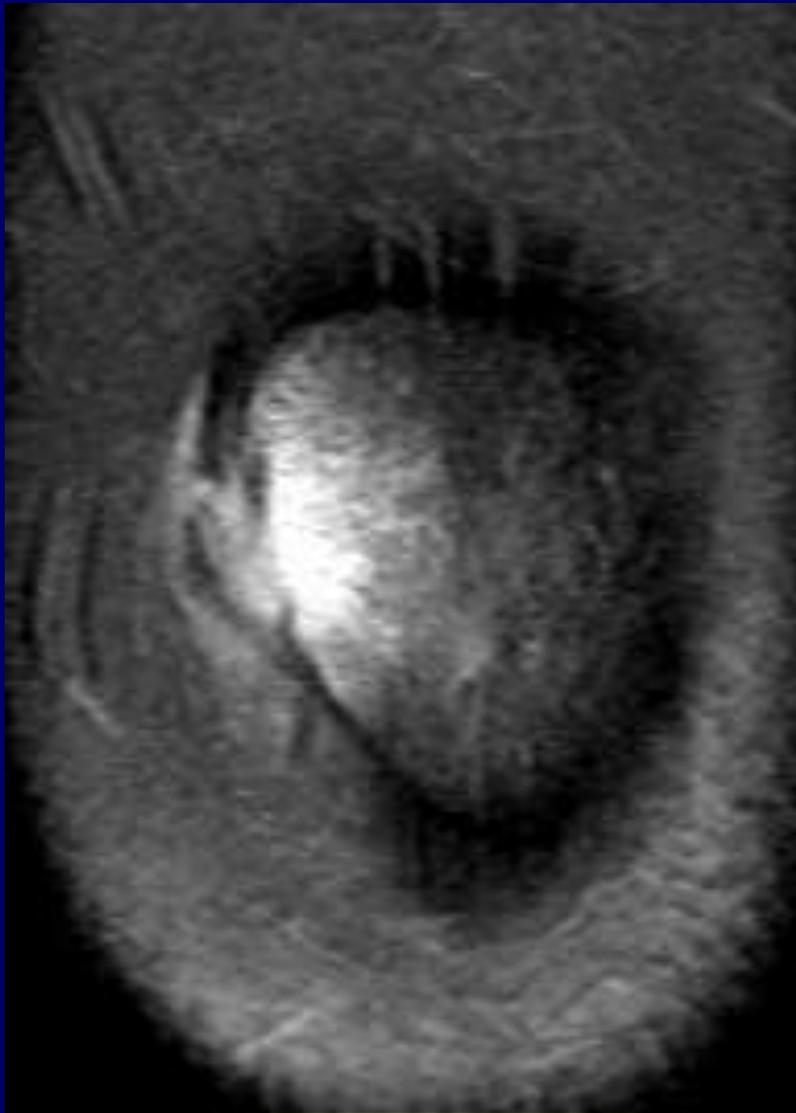
Patellar Retinaculum Midsubstance Tear



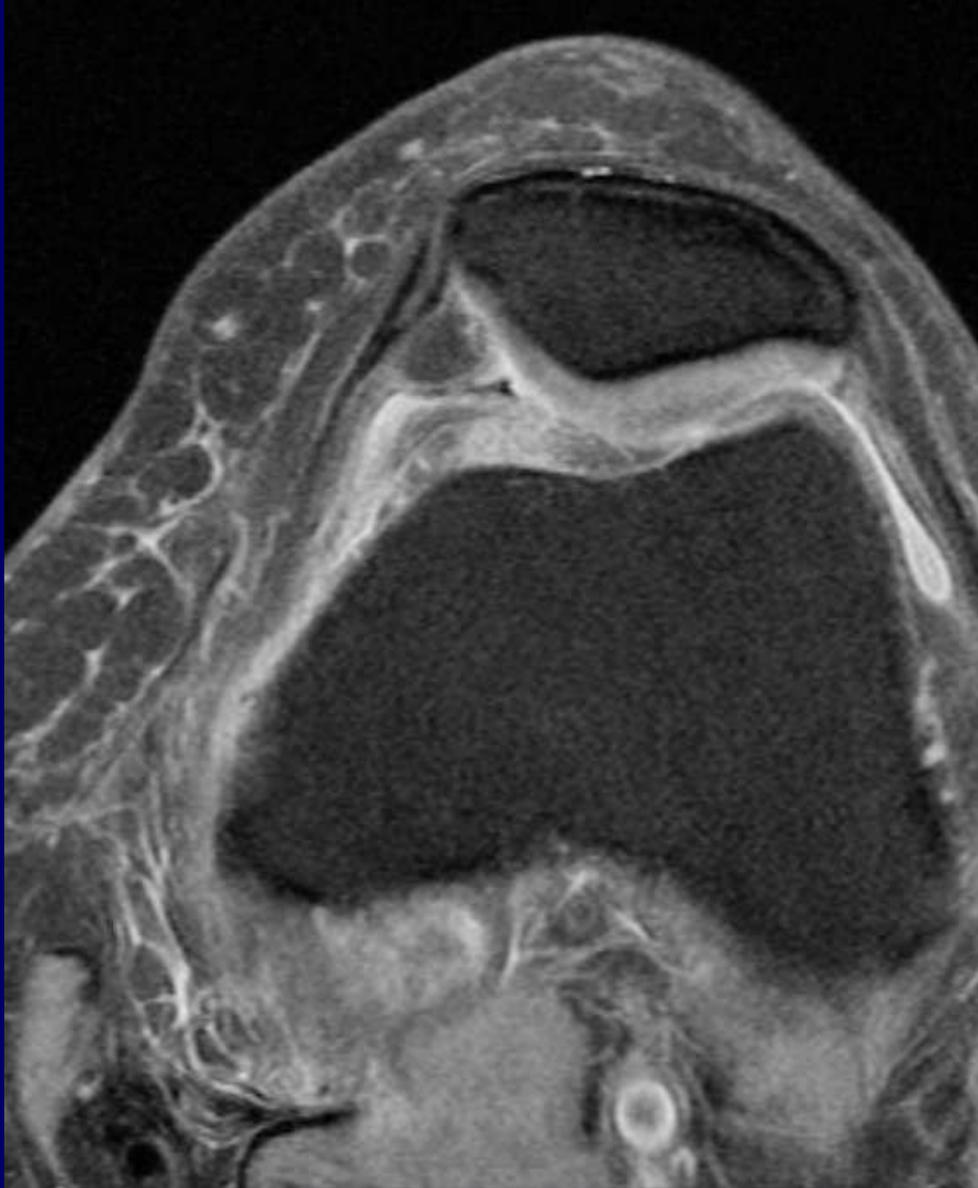
Retinaculum Tear at Patellar Insertion



Patella Avulsion Fracture



Associated Internal Derangements



Partial MCL injuries 11-25%

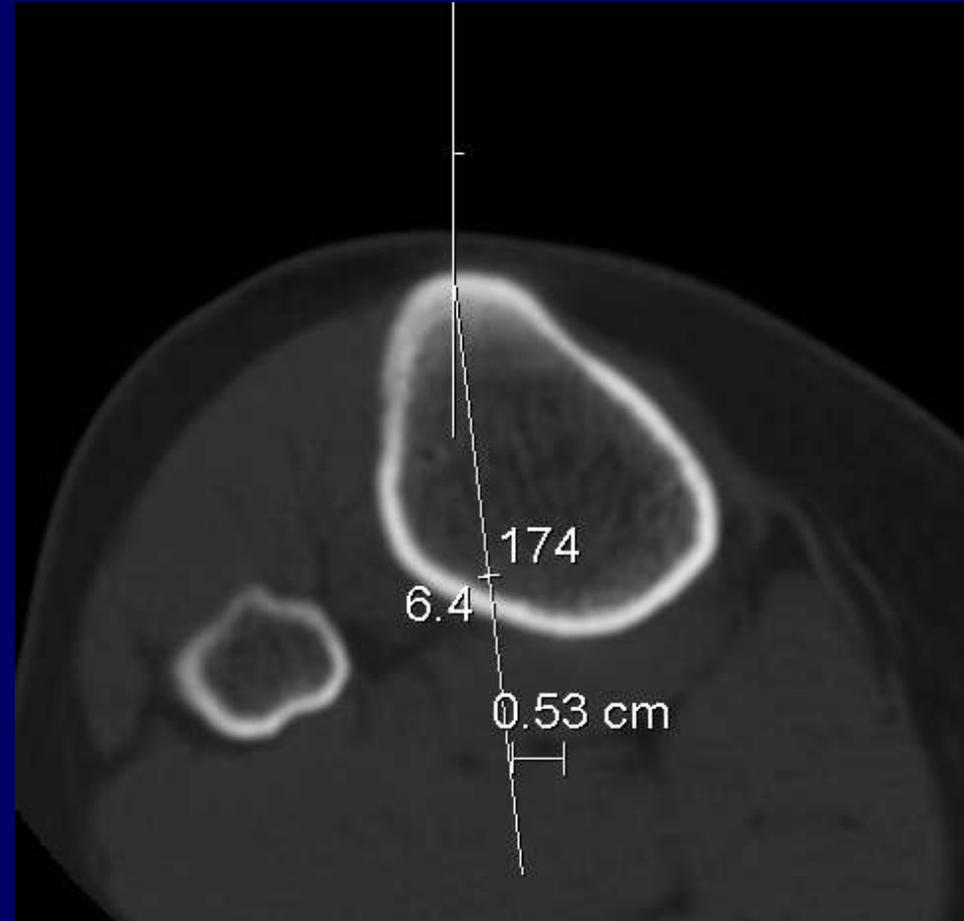
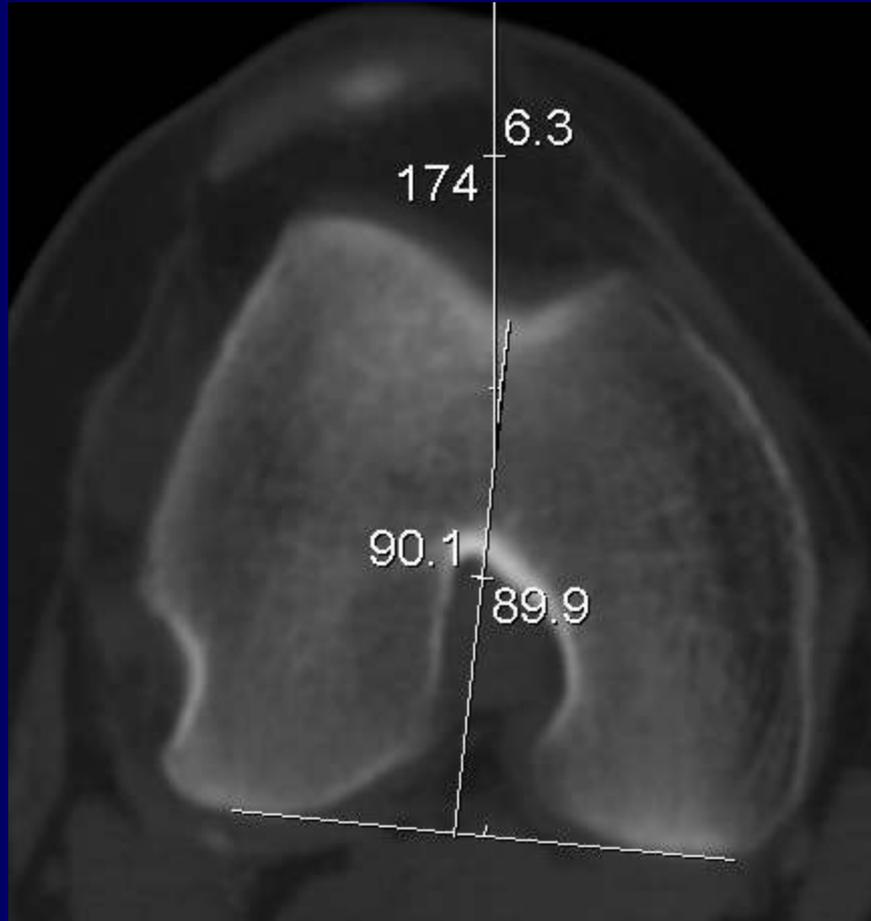


100% Extensive edema around VMO



89% MPFL Injury

CT and Patellofemoral Maltracking



Tibial tubercle to trochlear groove displacement is 6 mm lateral

Surgical Reconstruction of Patellofemoral Maltracking



Proximal Realignment

Distal Realignment

Tibial tubercle transfer



Medial – correct abnormal Q angle
Anterior – PF OA
Distal – correct patella alta

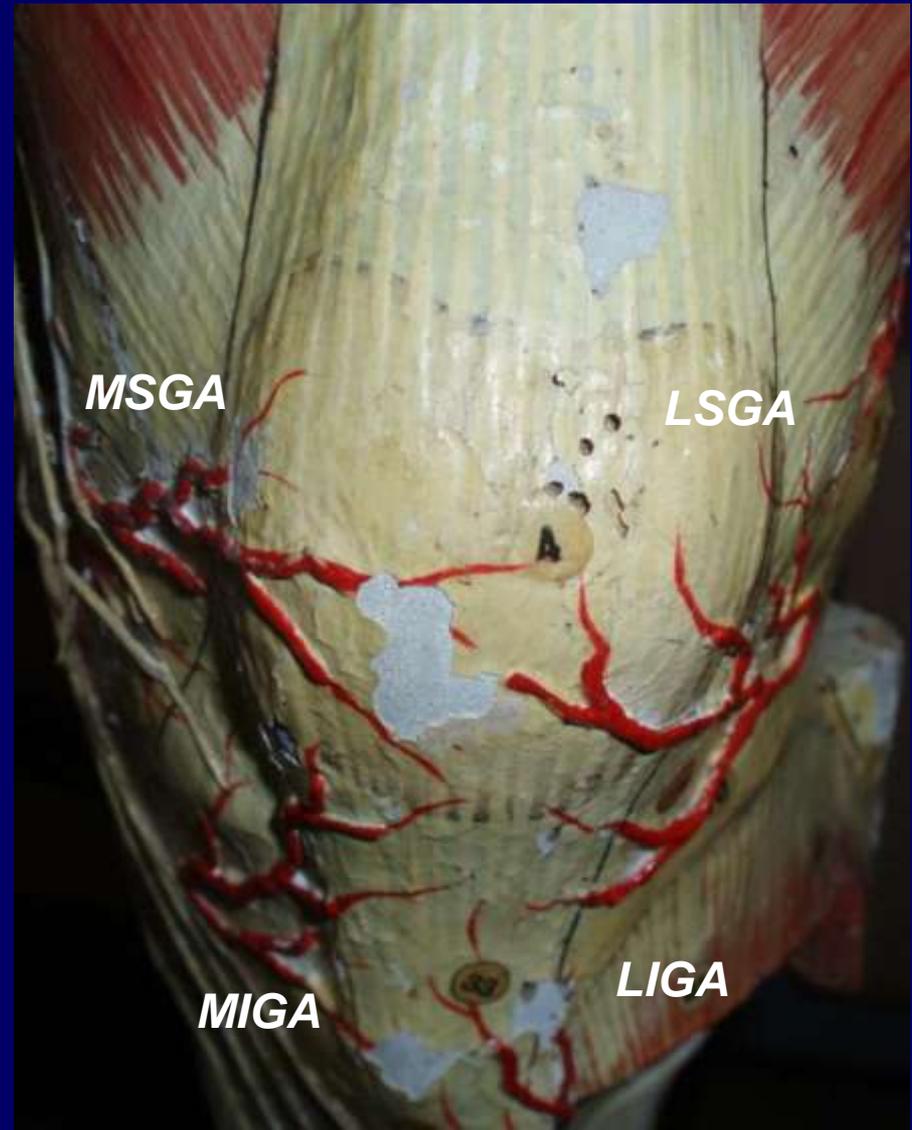
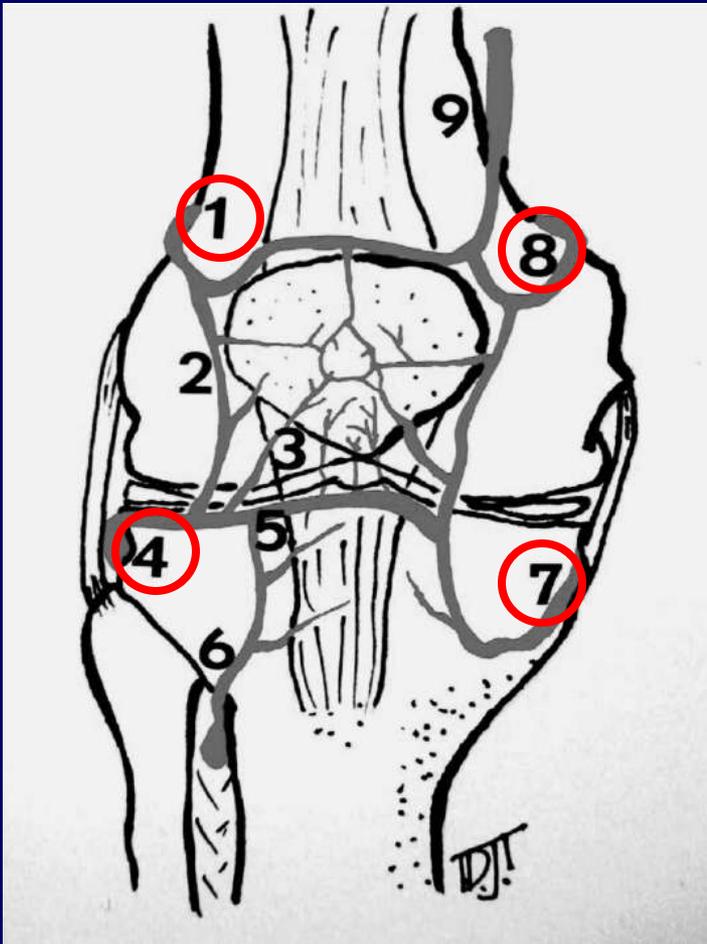
Lateral Retinacular Release



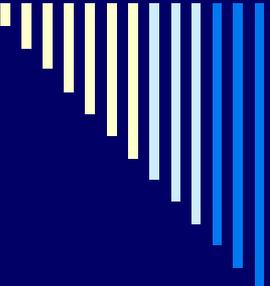
The lateral retinaculum is sectioned longitudinally 2 cm from the patellar edge.

Results have often been unpredictable, with a reported rate of satisfactory results between 20% and 92% of patients.

BLOOD SUPPLY OF THE PATELLA



Osteonecrosis of the patella



Lagniappe

- Radiographic Anatomic Pathologic Correlation from the San Diego Museum Of Man
 - All Anatomic Images courtesy of the Museum of Man
-



MYOSITIS OSSIFICANS



MULTIPLE MYELOMA



MULTIPLE MYELOMA

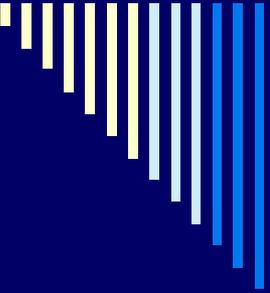


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DIAGNOSIS: ANKYLOSING SPONDYLITIS

A classic example of ankylosing spondylitis with involvement of the lumbar spine is seen. Findings include syndesmophyte formation, discal calcification, osteoporosis, and apophyseal and costovertebral joint ankylosis.

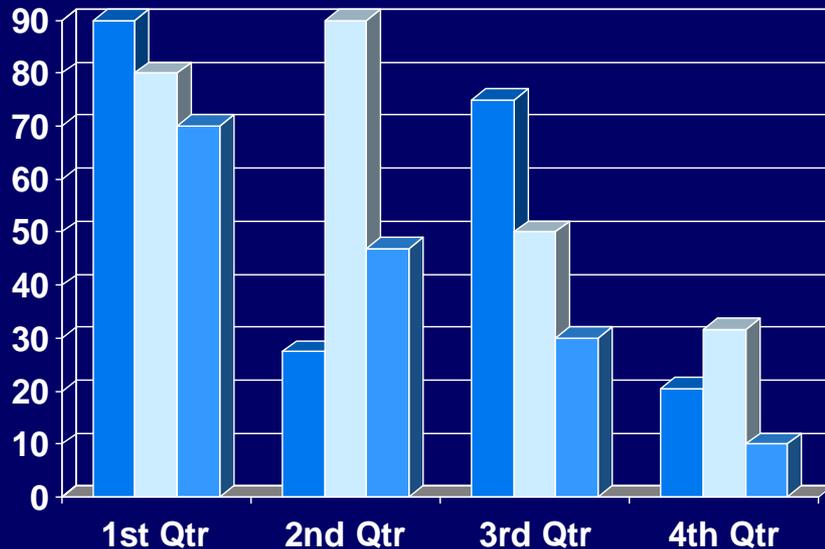




And Now A Few Final Words

A dedication to Tudor Hughes

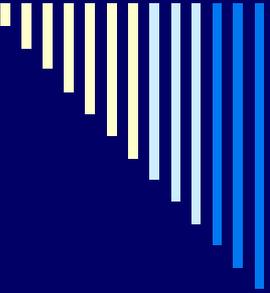
Casey's Word-Slide Statistics July 2006 – June 2007



□ Maximum # of words per/slide in this presentation = 50

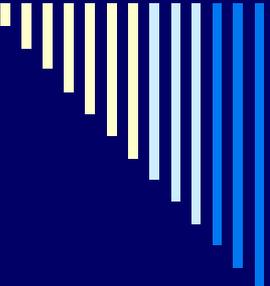
□ All time record = 1000





Credits

- All MRI Images except the one referenced in this presentation are courtesy of the University of California San Diego Healthcare System
-



The end

- Goodbye and good luck to all next year
 - I will be in the Big Easy
 - Stay in touch
 - I will always be available as your personal Mardi Gras tour guide
-

Referances

- Theodouor SJ et al, J Comput Assist Tomogr 2005;29:87–93
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- **Starok et al AJR** 1997;168:1493-1499
- *Elias et al Clinical Radiology (2004) 59, 543–557*