Injury to the Knee Extensor Mechanism

Romulo Baltazar

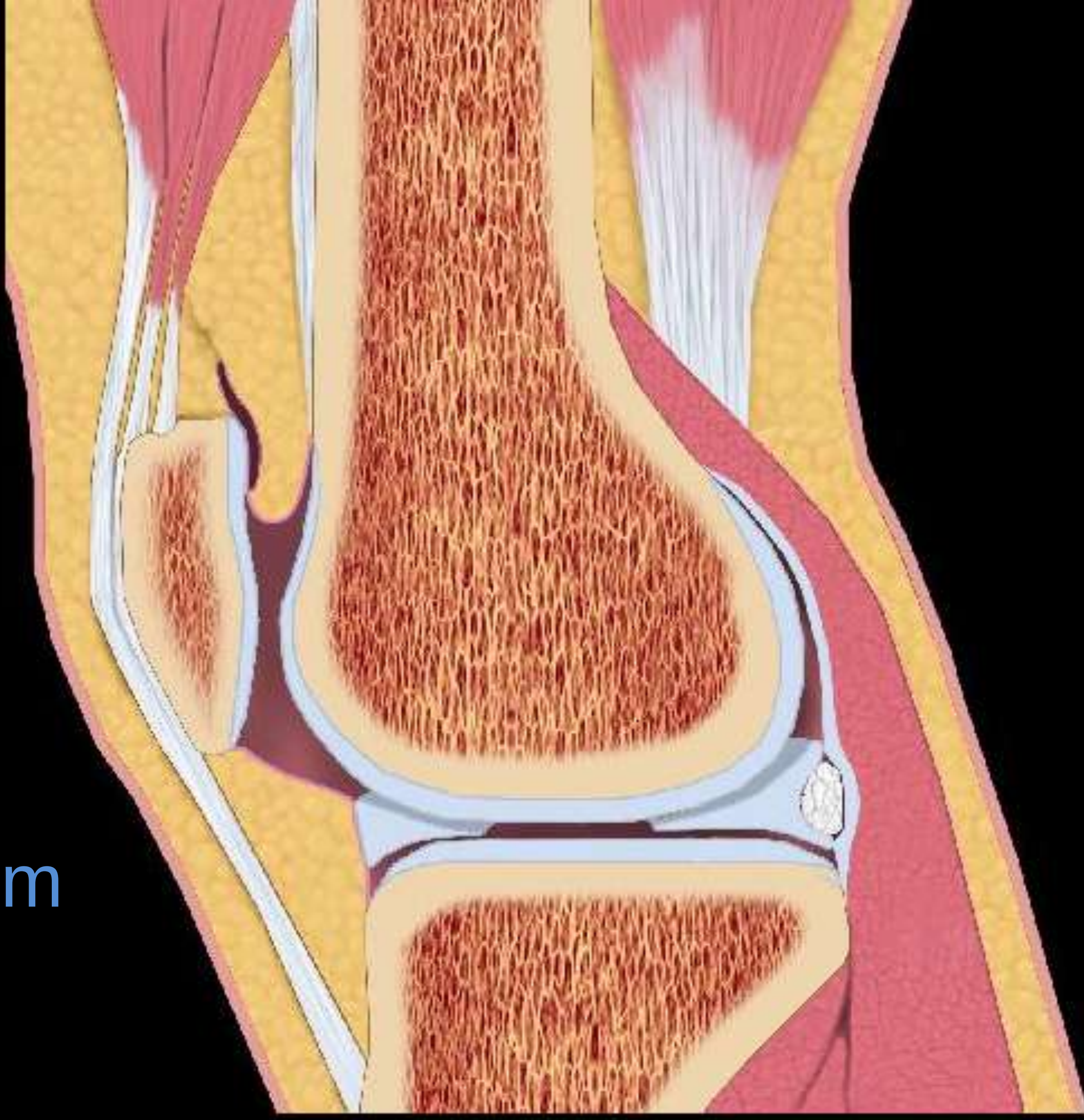
May 27, 2009

Objectives

- Review of Patellofemoral Joint Biomechanics
- MRI of Injury to the Extensor Mechanism
    - Quadriceps Tendon
    - Patella
    - Patellar Tendon
- MRI of Patellar Dislocation

- Case Series: Spectrum of Injury to the Quadriceps Continuation

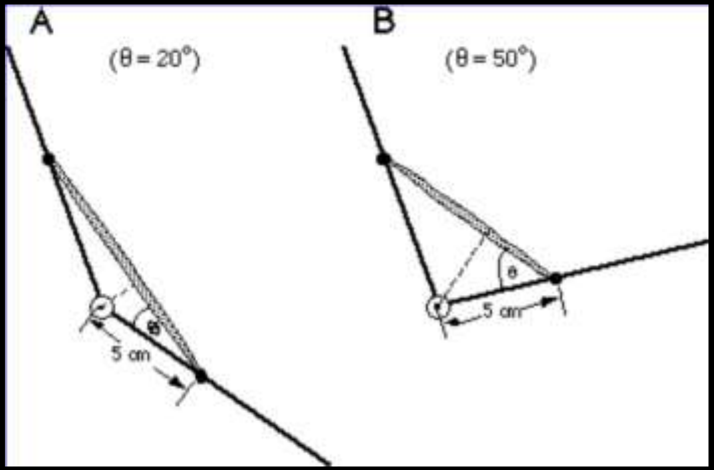
Gross Anatomy of the Extensor Mechanism



Patellofemoral Biomechanics

- Patella is the largest sesamoid bone
- Nearly the entire non-articular surface is ensheathed by the tendinous attachments of the quadriceps and patellar tendons
- Synovial articulation with femoral trochlea posteriorly

- Anteriorly displaces the extensor tendons, thereby increasing the mechanical advantage of the quadriceps about the center of rotation

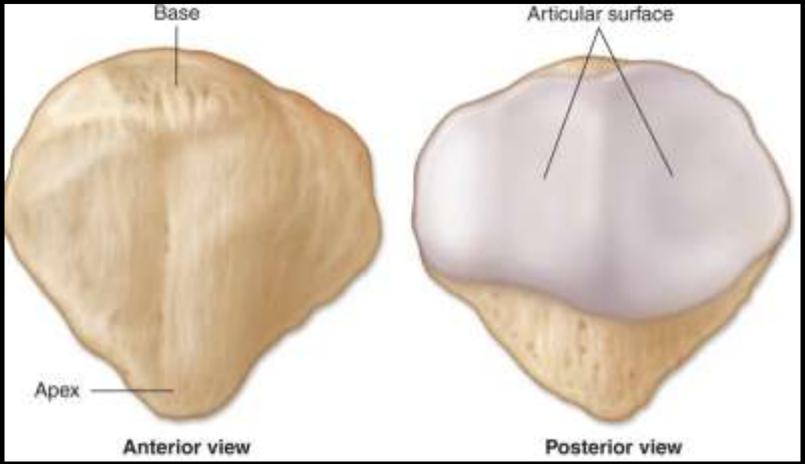


http://muscle.ucsd.edu/musintro/ma.shtml

Patellar Morphology

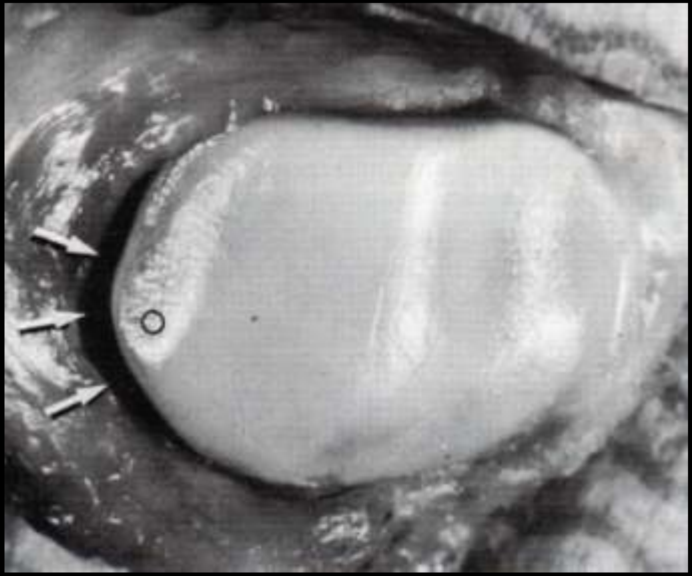
- Anterior surface of the patella forms a vague triangle, slightly wider than high
  - proximal base, onto which the quadriceps attaches
  - distally pointing apex, onto which the patellar tendon attaches

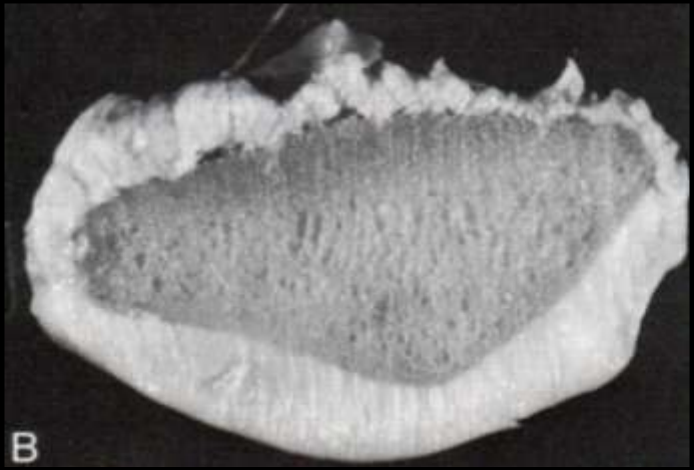
- Posterior surface of the patella
  - superior ¾ - articular
  - inferior ¼ - non-articular (variable!)



Anatomy – Patellar Articular Surface

- Divided by a vertically-oriented 'median ridge'
  - Lateral facet
  - Medial Facet
- Further divided by a 'secondary vertical ridge', which may be only cartilaginous
  - Medial facet proper
  - Odd facet
- Some authors describe two additional transverse ridges that further subdivide the medial facet proper and the lateral facet
- Trochlea = Femoral sulcus = Patellar groove = Patellar facets

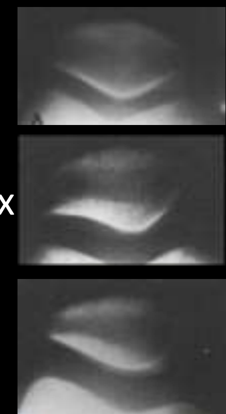




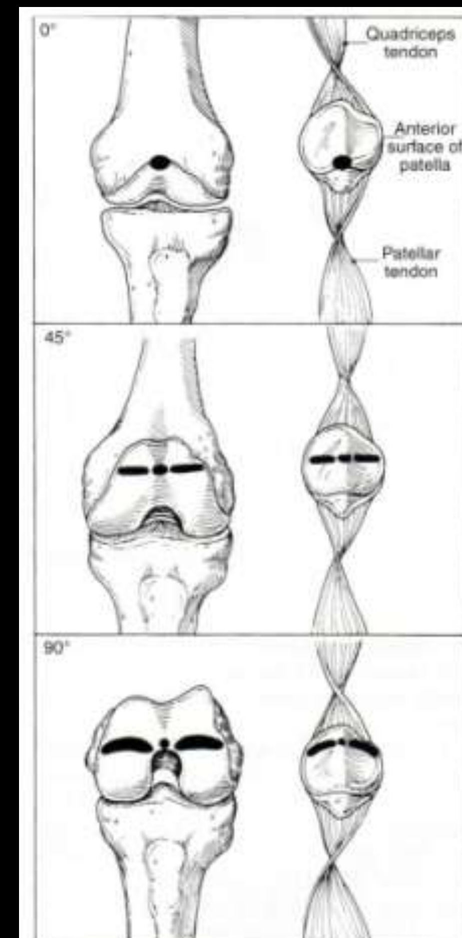
Fulkerson JP. Disorders of the Patellofemoral Joint, 4th ed. p 4-5.

Anatomy – Patellofemoral Articulation

- Wiberg's Patellar configurations
  - Type I (10%) – equal medial and lateral facets both concave
  - Type II (65%) – small medial facet, flat or convex concave lateral facet
  - Type III (25%) – very small medial facet



- Trochlear shape, not patellar shape, is the most important single stabilizing factor
- Contact between patella and trochlea increases with flexion from 30 to 90 deg
- Patella alta deformity reduces PF contact at various degrees of flexion and may result in instability



Scuderi GR. The Patella. p 20.

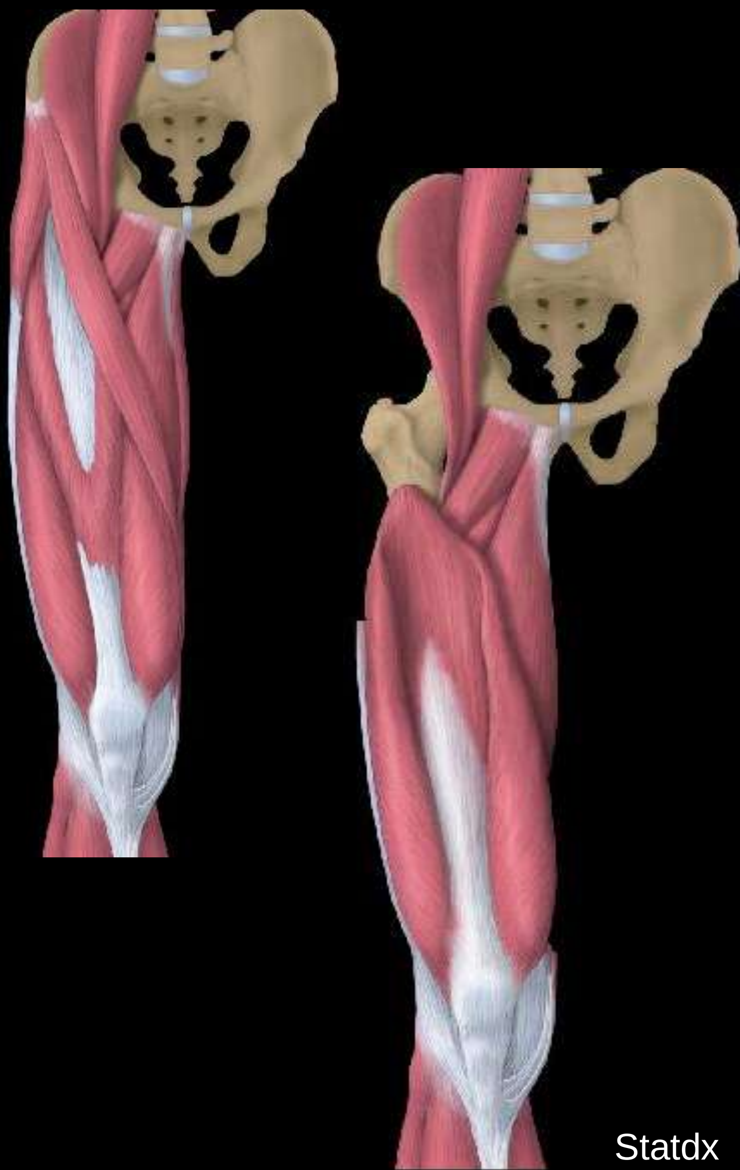
Anatomy – Passive Soft Tissue Stabilizers

- Patellar is anchored via a cruciform soft tissue system comprised of *passive* and *active* elements
- Passive Stabilizers
  - Patellar Tendon (from patellar apex)
  - Lateral Retinaculum (from lateral patellar margin)
    - Superficial layer – confluent with ITB
    - Deep layer - Epicondylopatellar band (to femur) / Transverse ligament / Patellotibial band (to tibia)
  - Medial Retinaculum (from medial patellar margin)
    - Medial Patellofemoral Ligament (MPFL) – superior 2/3
      - » 50% to 60% of lateral restraint from 0° to 30° of knee flexion
    - Medial Patellomeniscal Ligament (MPML) – inferior 1/3
    - Medial Patellotibial Ligament (MPTL)

Anatomy – Active Soft Tissue Stabilizers

- Rectus femoris – most superficial
    - Insert on patellar base anteriorly
    - Most superficial fibers continue distally
        - Broad att onto anterior patellar surface
        - Superficial fibers of the patellar tendon

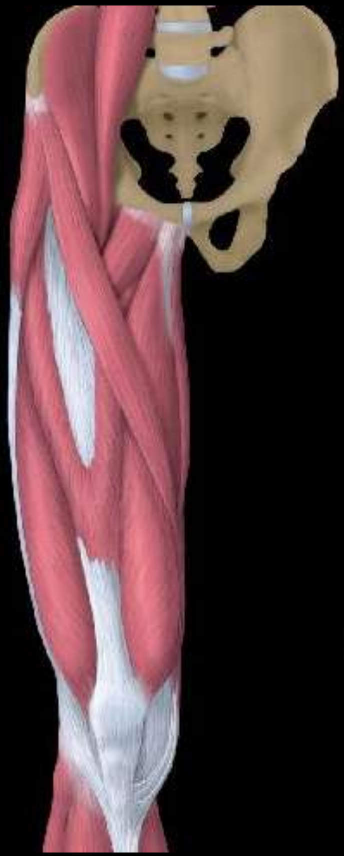
- Vastus Lateralis – intermediate
    - Vastus lateralis longus
        - Inserts onto patellar base superolaterally
        - Forms lateral retinaculum
        - Aponeurosis forms layer anterior to patella
    - Vastus lateralis obliquus
        - Inserts onto lateral margin of patella



Statdx

Anatomy – Active Soft Tissue Stabilizers

- Vastus Medialis – intermediate
  - Vastus medialis longus
    - Inserts onto patellar base superomedially
    - Forms medial retinaculum
    - Aponeurosis forms layer anterior to patella
  - Vastus medialis obliquus
    - Inserts superior / superomedial patella
    - Tightly adherent to MPFL
    - 47 deg medial orientation in relation to the femoral axis
      - First muscle to weaken in the face of PF pain
      - last to regain its strength (Beidert)

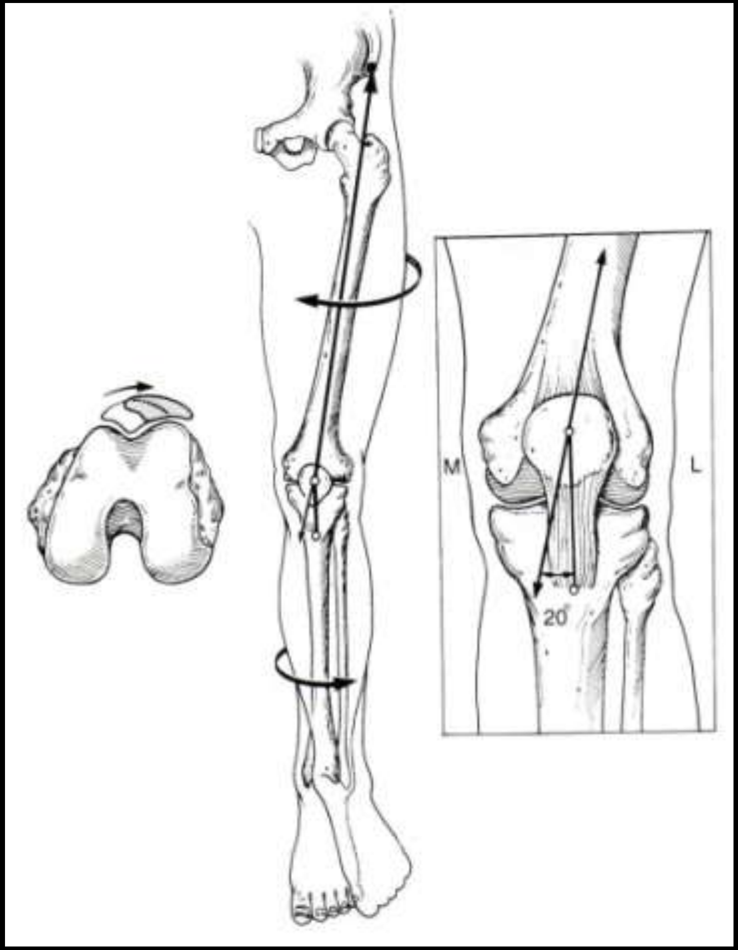


- Vastus Intermedius – deep
    - Inserts onto patellar base posteriorly

Statdx

Anatomy – Patellar Soft Tissue Stabilizers

- Q-Angle
    - Line from AIIS of the pelvis to center of patella
    - Line from center of patella to tibial tubercle
    - Normal angle: 17 for females, 14 for males
- Gross representation of the cumulative lateral moment exerted on the patella by the contracting quadriceps
- Increased angle would appear to predispose to lateral patellar subluxation or dislocation
    - Increased by the femoral neck anteversion and tibial torsion
    - However, no established direct correlation
    - Only one of several variables



Scuderi GR. The Patella. p 18.

Anatomy – Patellar Soft Tissue Stabilizers

Patellofemoral stability strengthens with increasing flexion

1) Larger posterior vector and smaller lateral vector of forces is applied by quadriceps tendon and patellar tendon onto patella

2) Knee flexion is accompanied by tibial internal rotation, with consequent medial movement of the tibial tuberosity → the Q-angle is reduced

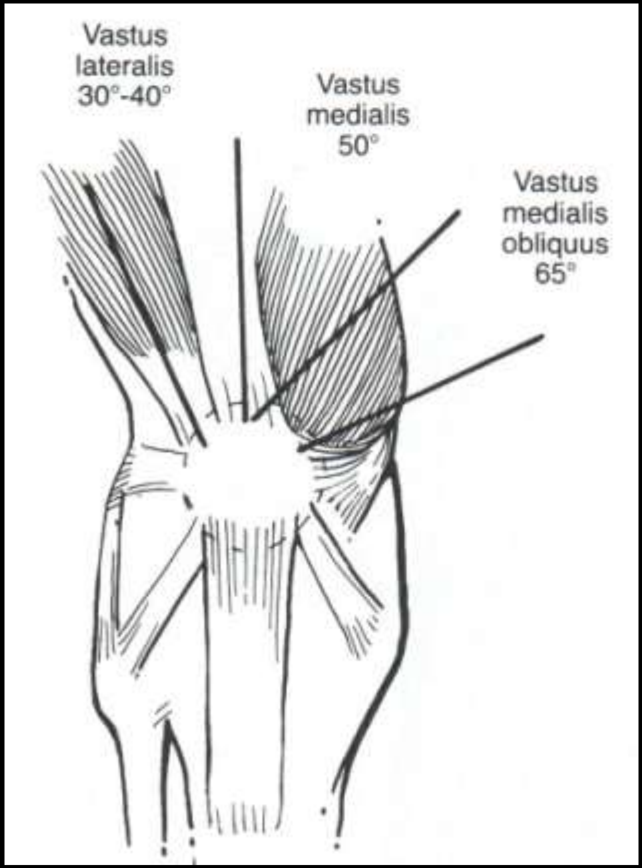
3) Patellar and trochlear geometries confer increased contact in flexion

Schmid MR et al. Am J Sports Med 2002 30: 388

Anatomy – Patellofemoral Stability

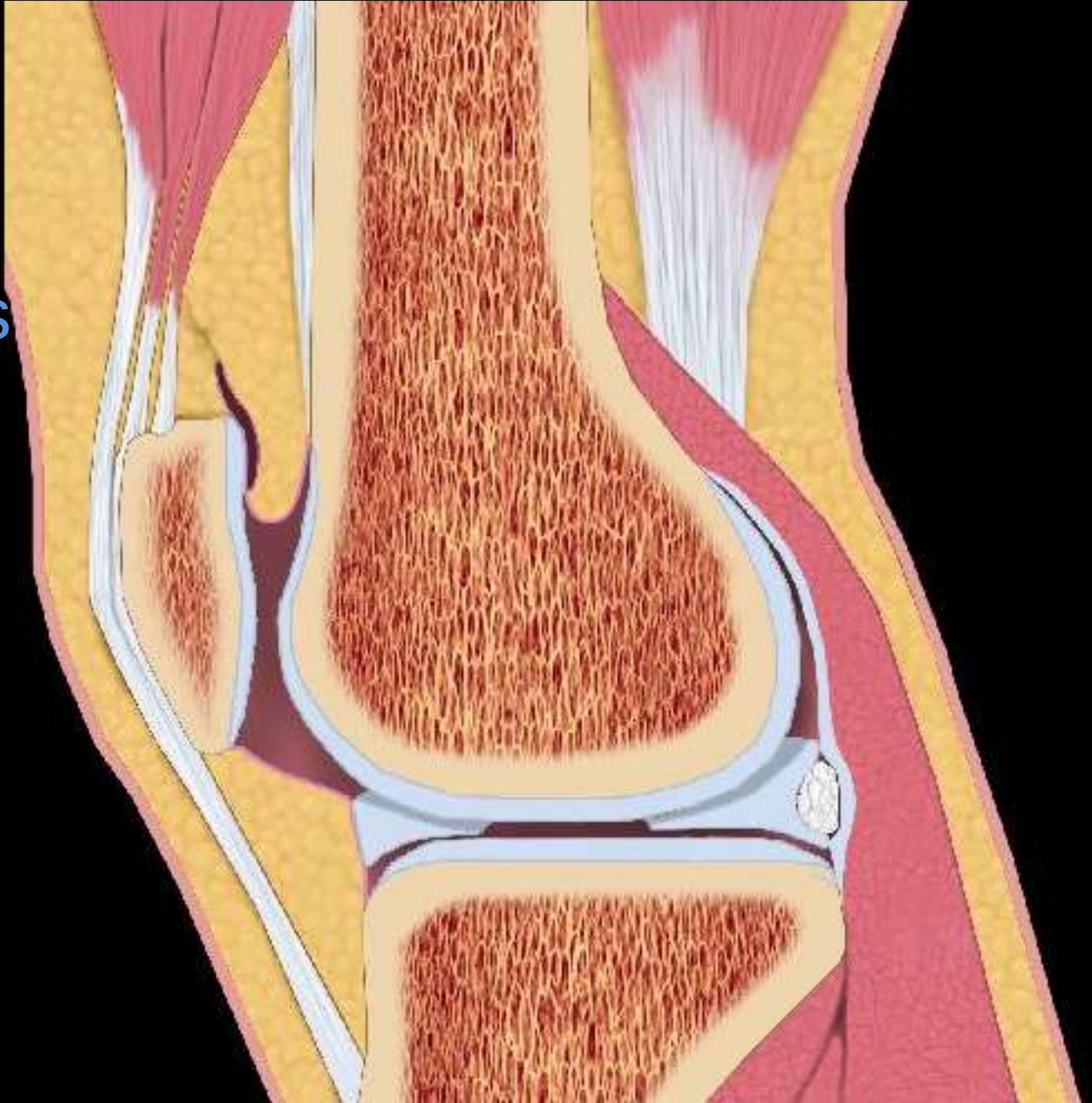
Key Points

- Femoral trochlear geometry is the #1 most important factor in patellofemoral stability
- MPFL is the #1 most important soft tissue restrain in patellofemoral stability
- Vastus medialis obliquus function is also vital for stability given its orientation
- Patellofemoral stability strengthens with increasing flexion and is weakest at 20 degrees flexion

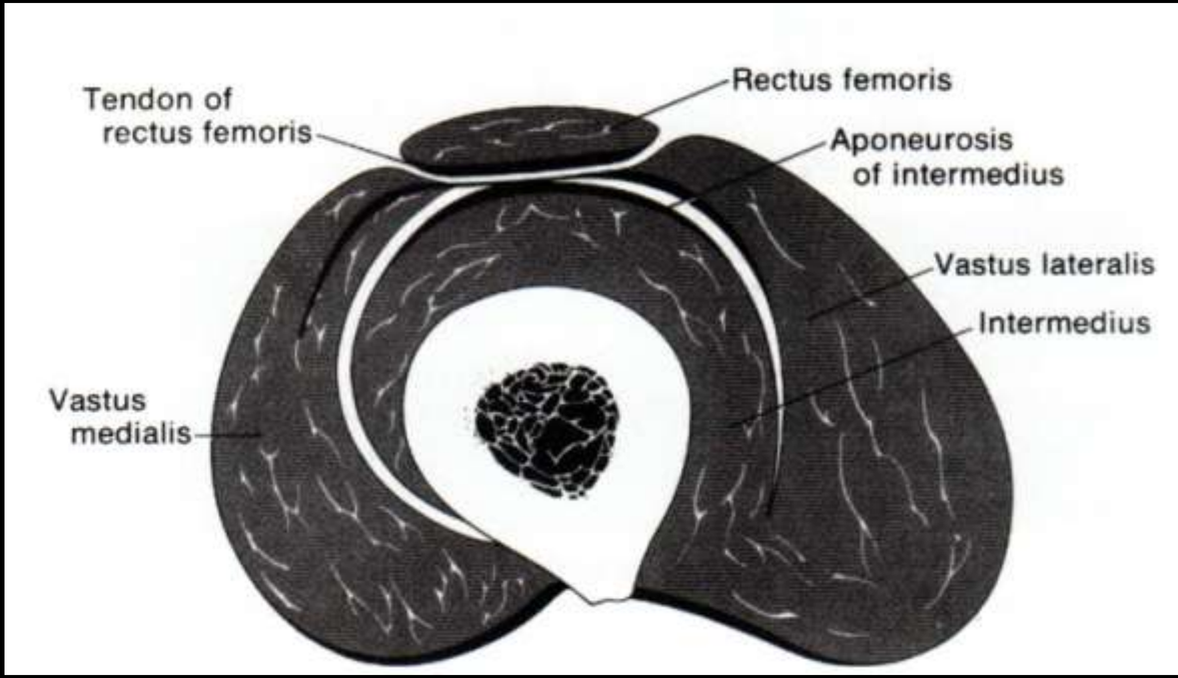


Resnick D. IDJ p1887.

The Quadriceps Tendon



The Quadriceps Tendon - Gross Anatomy in Detail



Fulkerson JP. Disorders of the Patellofemoral Joint, 4th ed. p 18.

Courtesy Gisele Portes

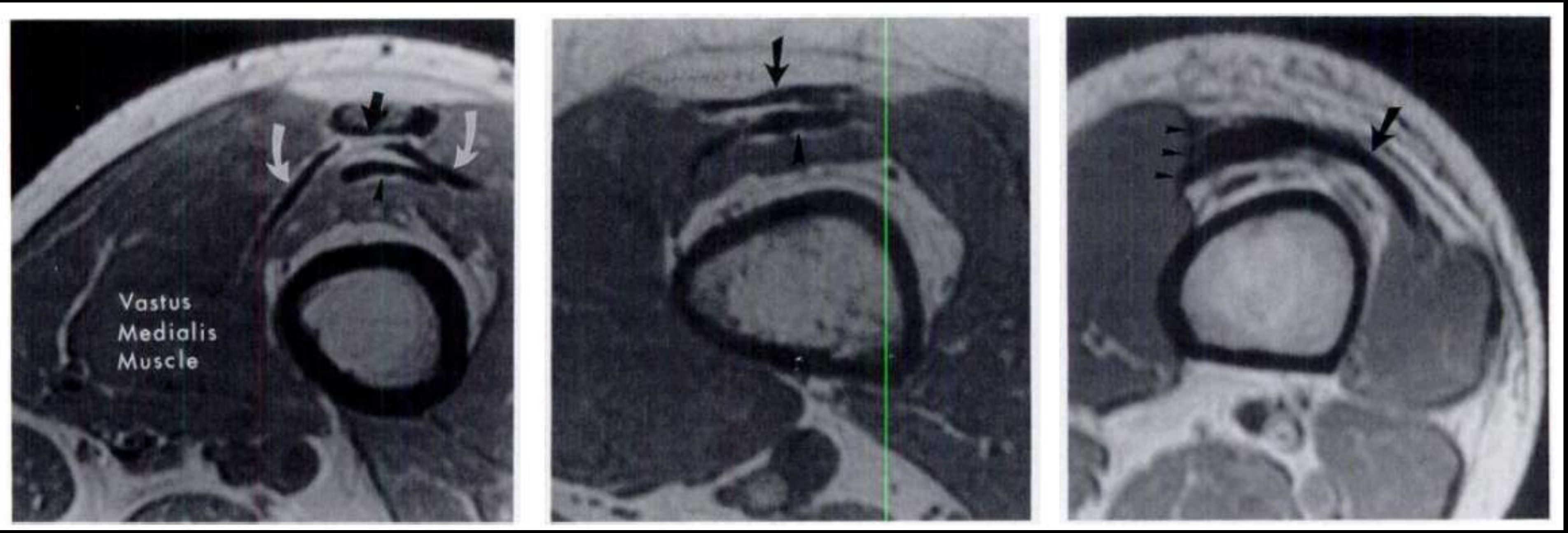
The Quadriceps Tendon - MRI Anatomy

- Laminated structure in almost all cases with tendon fibers interspersed by planes of fat (not to be confused w tear)
- Average thickness : 6 – 10 mm
- Fibers originating from the deep fascia of each of the four constituents of the quadriceps merge variably to create a laminated distal tendon

- superficial layer = rectus femoris muscle
- two middle layers = vastus medialis and vastus lateralis
- deep layer = vastus intermedius

Dwek JR, Chung CB. Pediatr Radiol. 2008 Sep;38(9):925-35.

The Quadriceps Tendon - MRI Anatomy

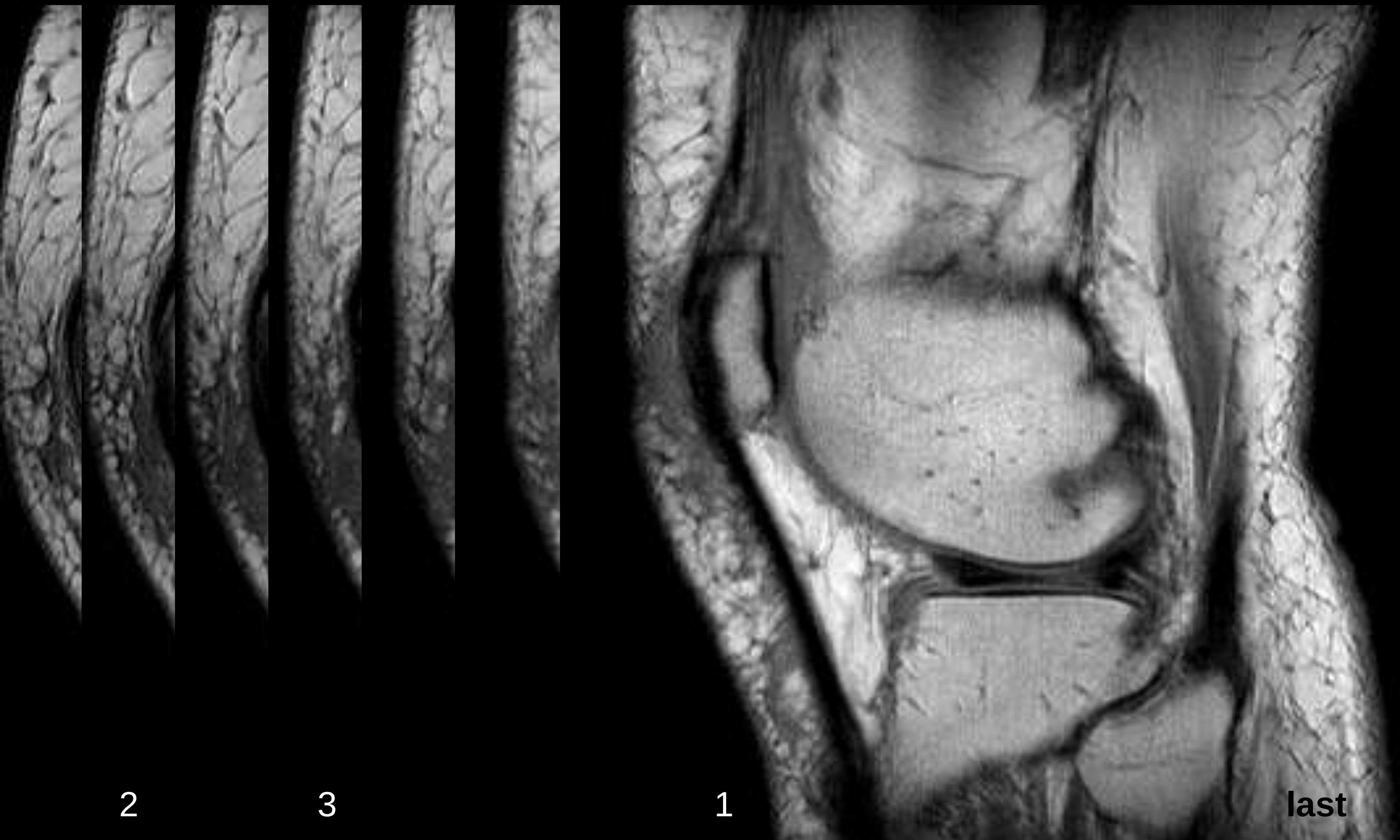


* the manner in which the middle 2 layers merge determines the number of layers
  - if no merge - 4 layers
  - if merge with each other - 3 layers (most common)
  - if merge with rectus femoris or vastus intermedius - 2 or 3 (most common)

* usually more merging laterally than medially
  - mid-sagittal - 3 layers (2 or 4 not unusual)
  - laterally - 1 layer
  - medially - 2-3 layers

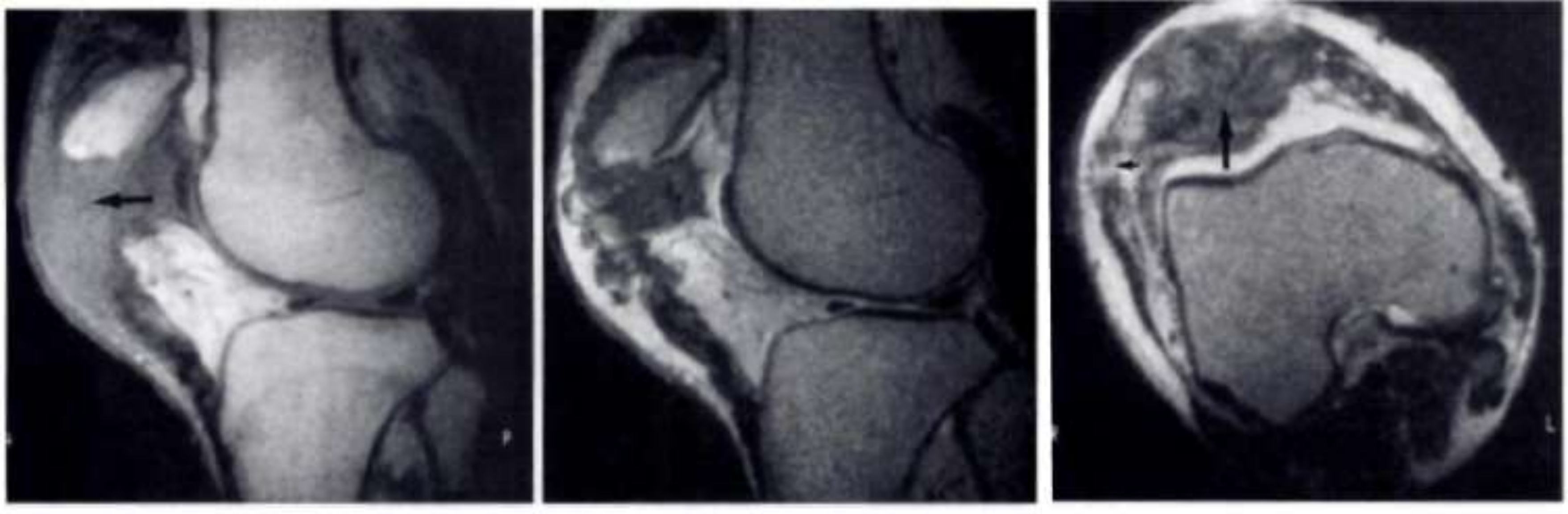
Zeiss J et al. AJR. 1992 Nov;159(5):1031-4.

The Quadriceps Tendon - MRI Anatomy



Quadriceps Tendon Injury

- Quadriceps Tendon Disruption
- Quadriceps Tendon Partial Tear



RIGHT

LEFT

30-year-old diabetic male.

Right – disruption of patellar tendon and lateral patellar retinaculum.

Left – disruption of quadriceps and medial patellar retinaculum.

Sonin AH et al. Radiographics. 1995 Mar;15(2):367-82.

Traumatic Injury to the Quadriceps Tendon

- Patella > **quadriceps** > patellar tendon
- Occur relatively infrequently
- Usually in patients older than 40 years.
- Unilateral >> bilateral (think systemic disease)
- Indirect forces - acute violent contraction of quadriceps with flexed knee and planted foot
  - violent deceleration from running with a planted lead foot (in young athletes)
  - fall onto fixed flexed knee (in elderly persons decsending stairs)
- Occurs in setting of chronic deterioration
  - Repetitive microtrauma (sports)
  - Weakening due to underlying systemic processes
    - obesity / steroid use / DM / gout
    - renal failure / hyper PTH /
    - RA / SLE

Case from Scripps

Quadriceps Tendon Disruption

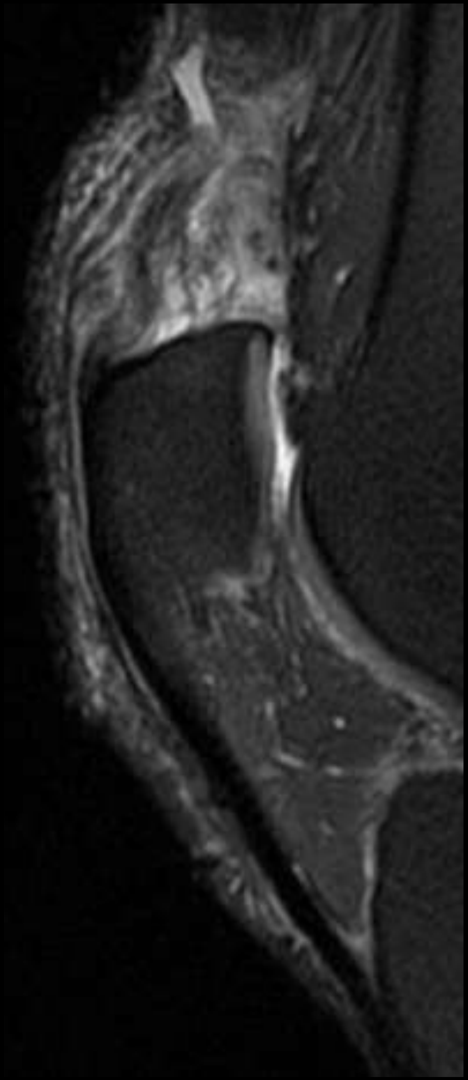
Radiography

- In most cases of disruption, there is distraction of the ends of the tendon due to muscle contraction.
- Patella may be displaced inferiorly (patella baja)
- Patellar tendon may demonstrate a wrinkled appearance
  ddx = hyperextended knee,
  ACL tear with anterior tibial translation
- Prepatellar bursa may be distended as joint fluid passes through the ruptured tendon

Quadriceps Tendon Disruption

MR Imaging

- Most tears occur within 2 cm of the osteotendinous junction of the distal quadriceps
- Treatment: Immediate surgery

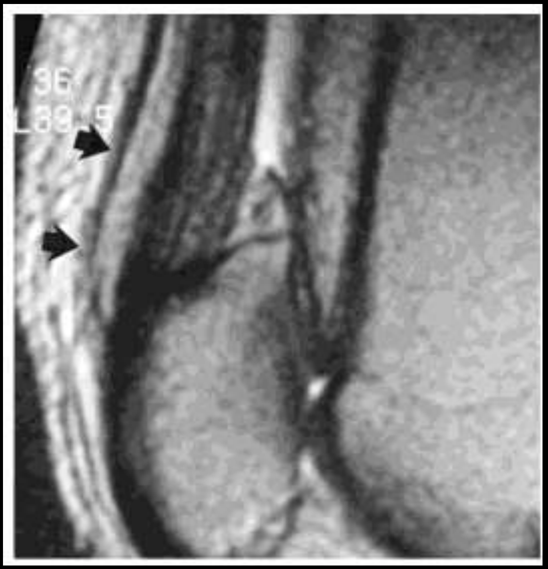


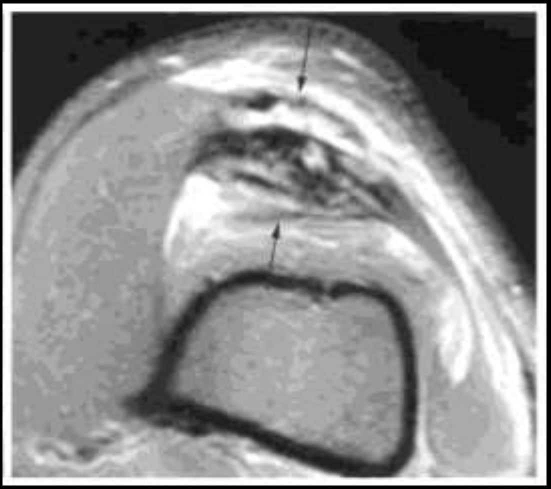
Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

Quadriceps Tendon Partial Tear

MR Imaging

- Discontinuity of any one of the tendon layers is consistent with a partial tear
- Most often involves the rectus femoris
  - Under the greatest tensile force
  - superficial location
  - predominance of type II fibers
  - eccentric muscle action
  - extension across two joints
- Patient may retain almost normal function
- Treated conservatively



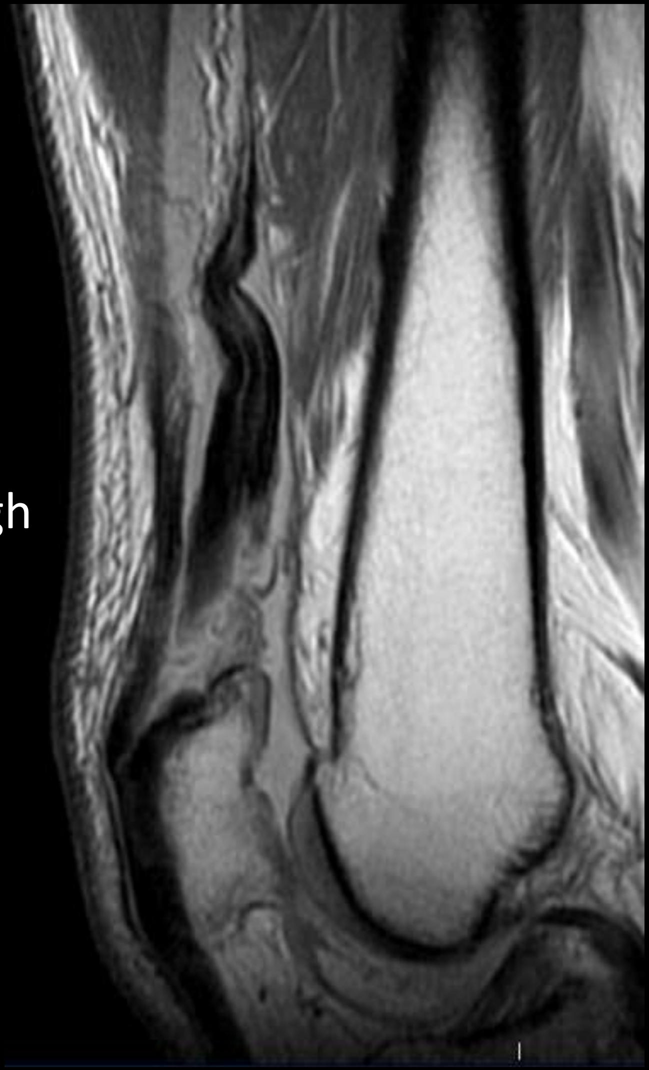


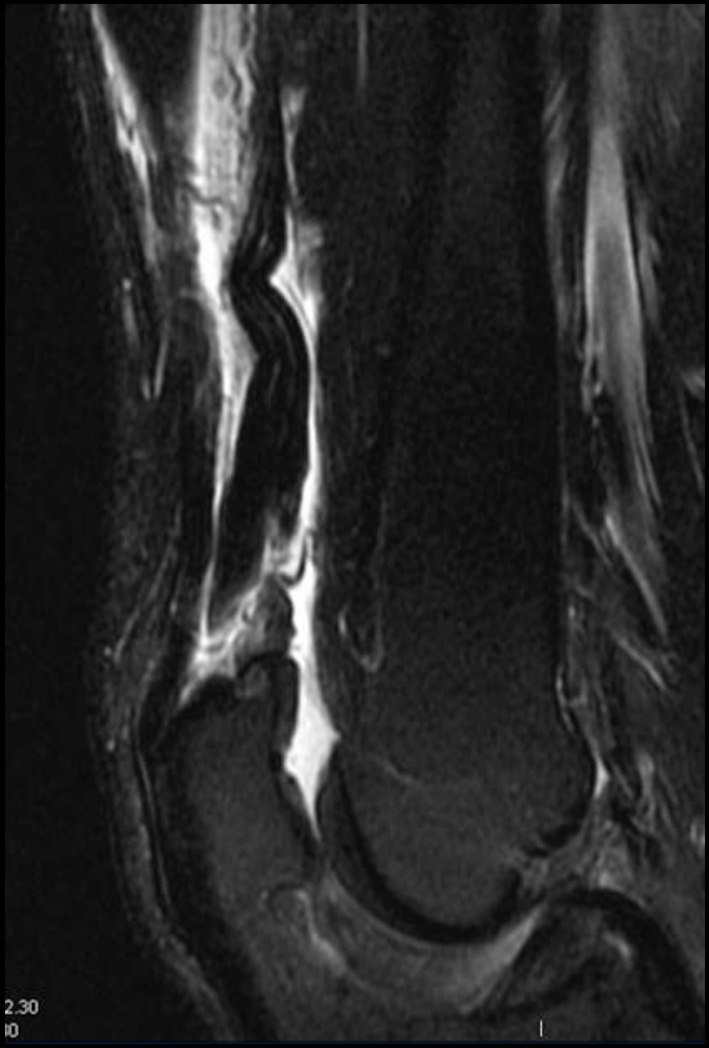
Bencardino JT et al. Radiographics. 2000 Oct;20 Spec No:S103-20.

Quadriceps Tendon Partial Tear

MR Imaging

- 51 year-old male with high grade partial tear sparing the rectus femoris



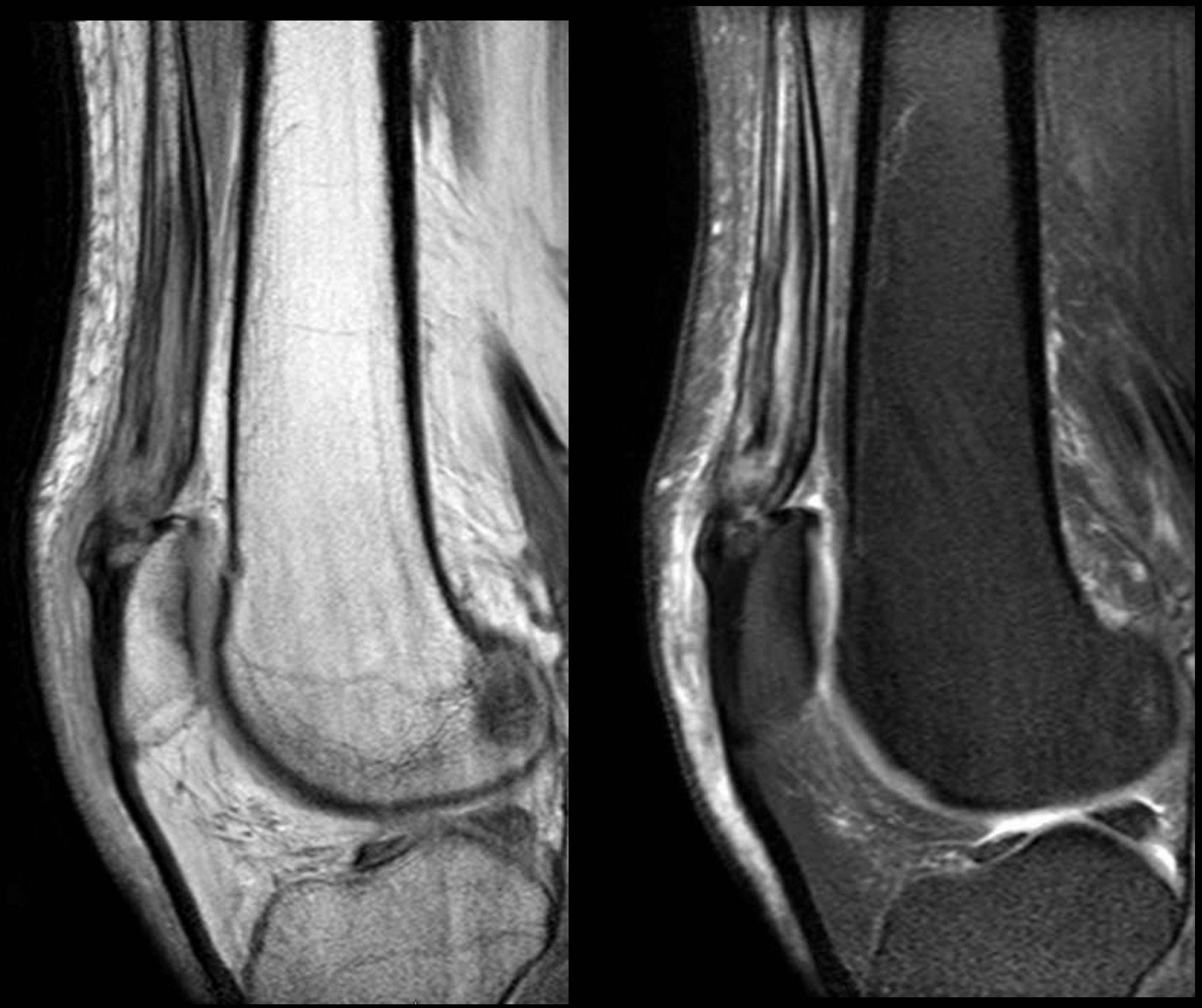


Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

Quadriceps Tendon Partial Tear

MR Imaging

- 65 year-old male with high grade partial tear sparing the vastus intermedius

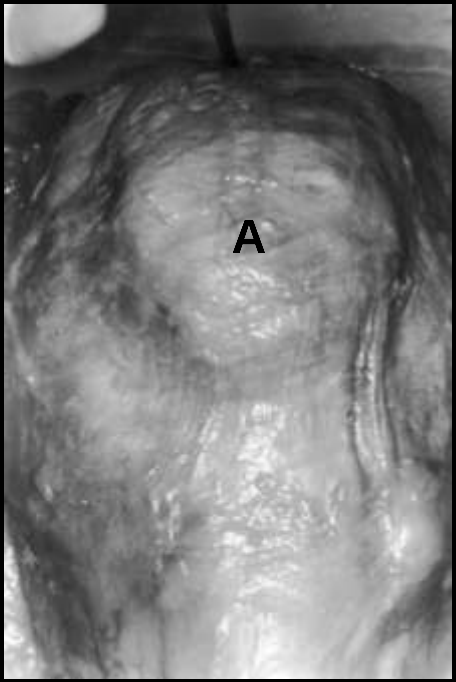


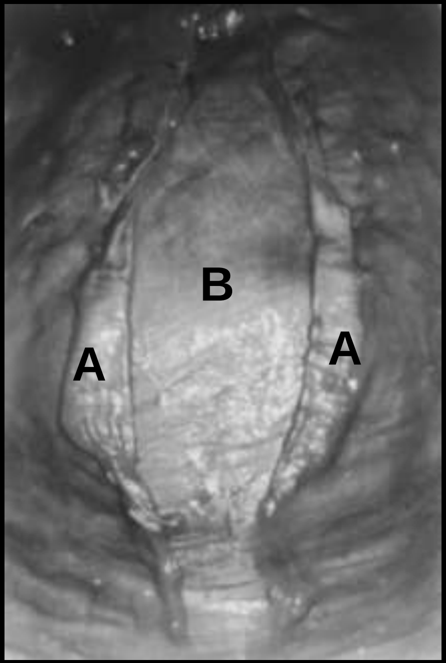
Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

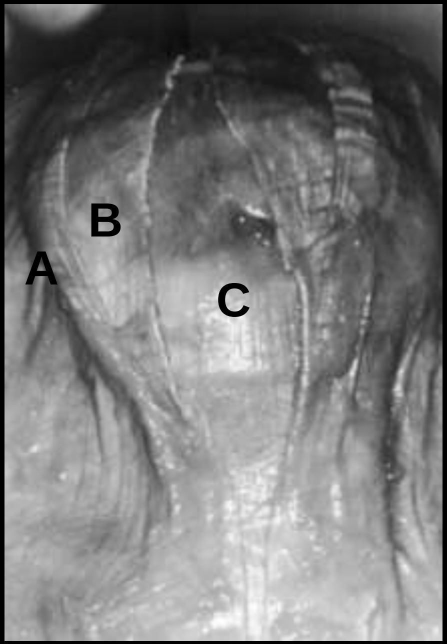
The Quadriceps Continuation

Trilaminar Soft Tissue Anatomy Anterior to the Patella

Dye et al JBJS 2003







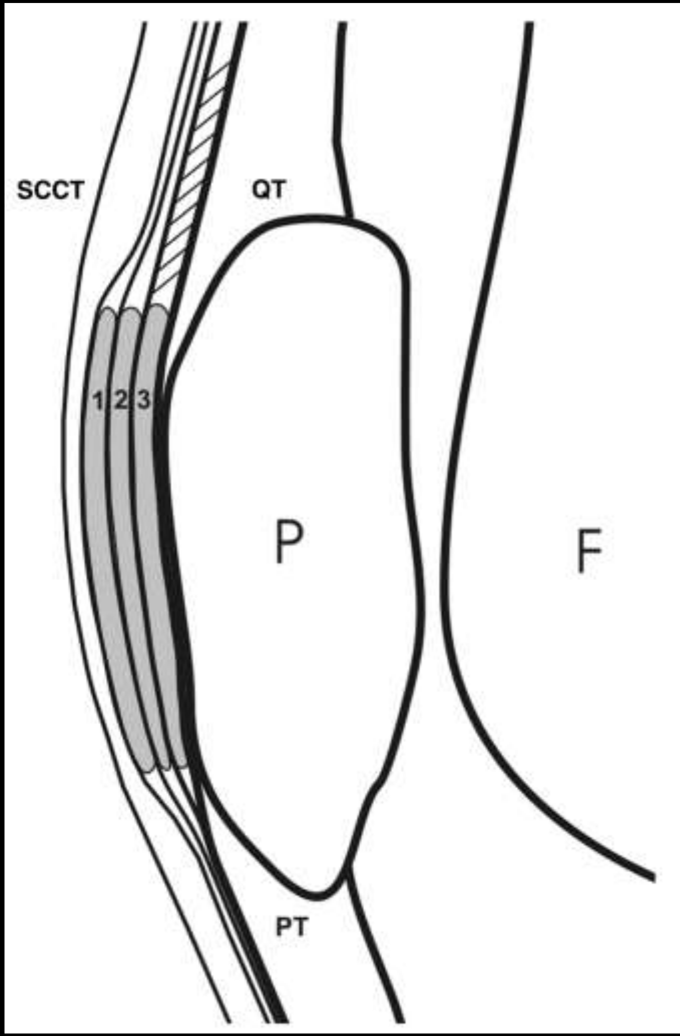
A – SUPERFICIAL – transversely-oriented extension of fascia lata

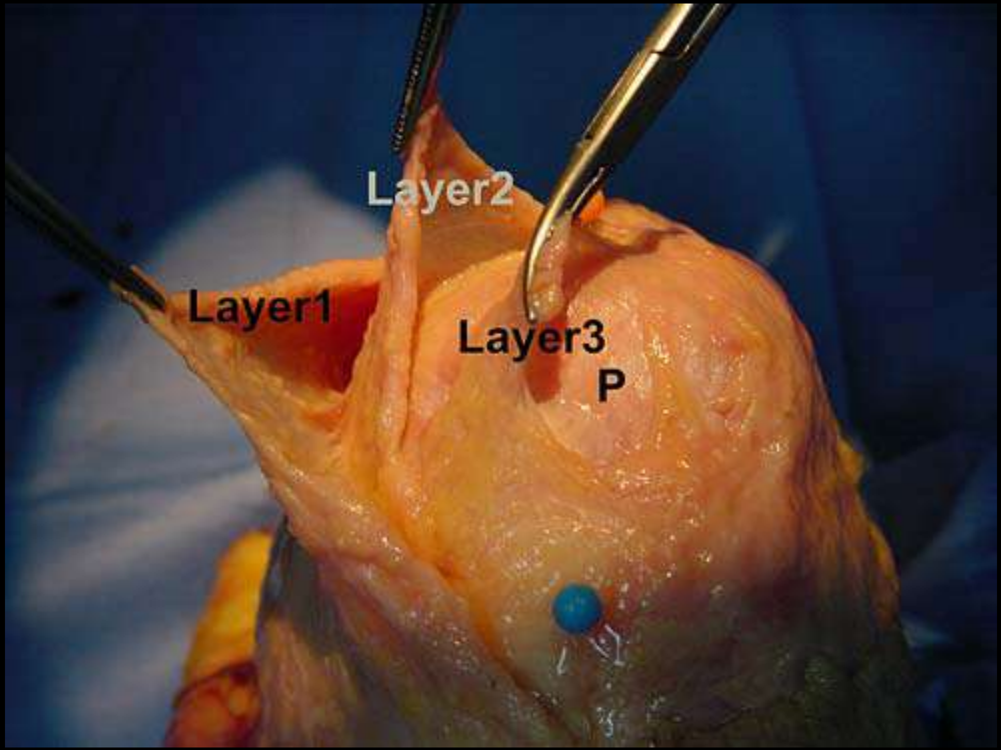
B – INTERMEDIATE – obliquely-oriented layer of aponeurosis
extension of v. medialis and lateralis with some contribution from rectus fem.
easily dissected from C until superior, medial, and lateral margins of the patella

C – DEEP - longitudinally oriented extension of rectus femoris tendon

Dye SF et al. J Bone Joint Surg Am. 2003 Jun;85-A(6):1012-7.

Trilaminar Pre-Patellar Bursa

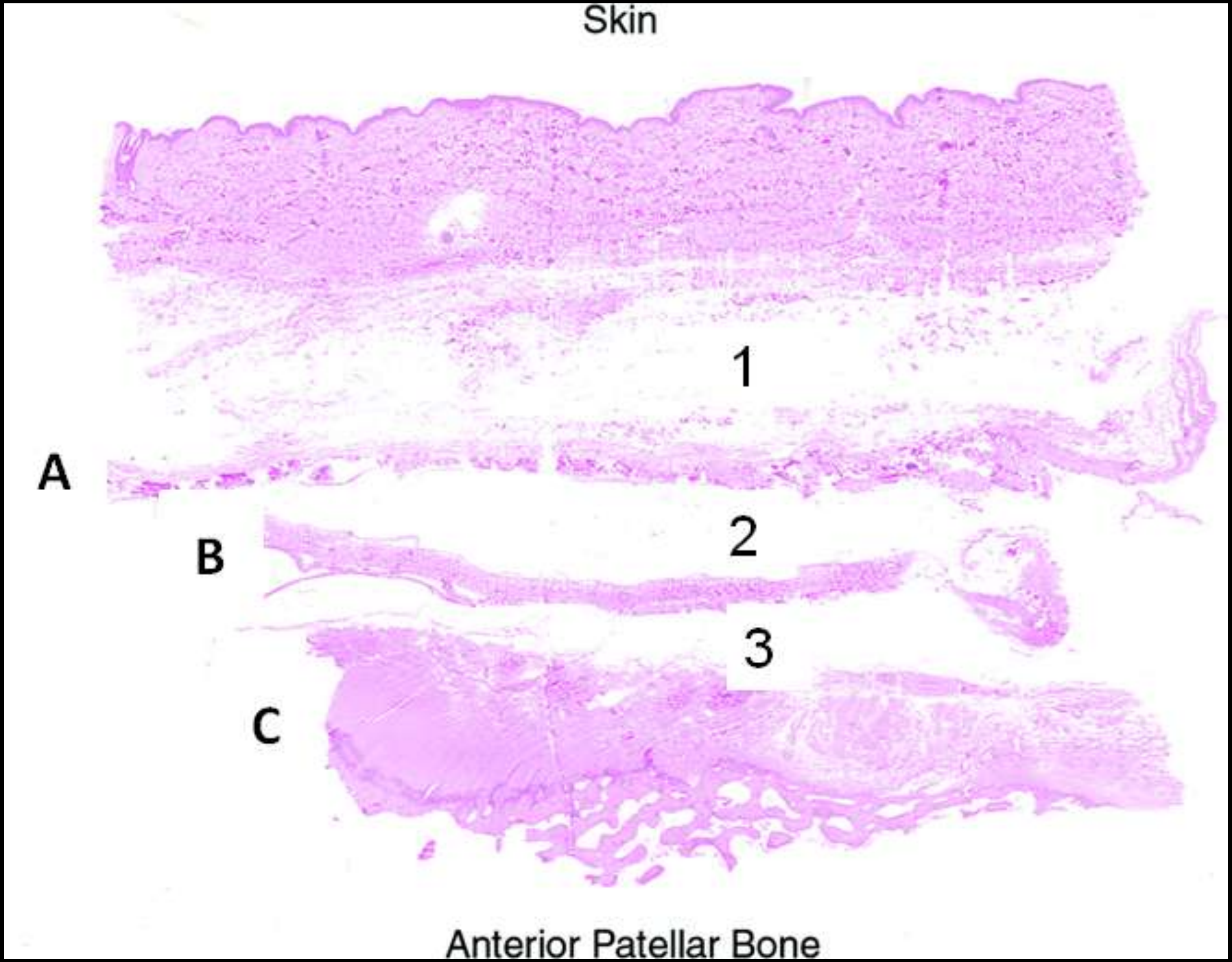




Aguiar RO et al. AJR; 188(4):W355-8.

Andrikoula S et al. Knee Surg Sports Traumatol Arthrosc;14(3):214-20. Epub

Trilaminar Pre-Patellar Bursa



1 – prepatellar subcutaneous bursal space

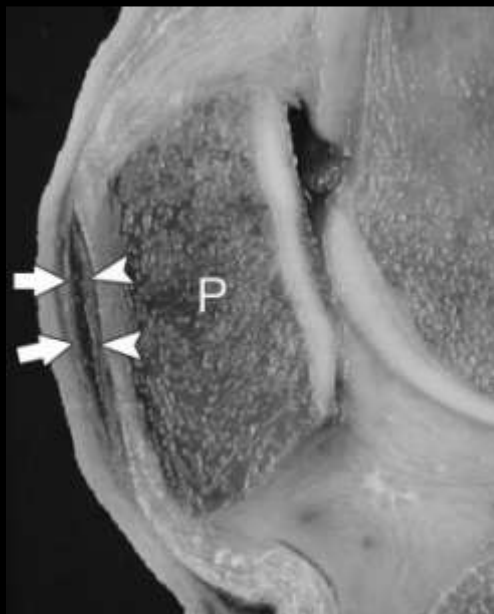
2 – prepatellar subfascial bursal space

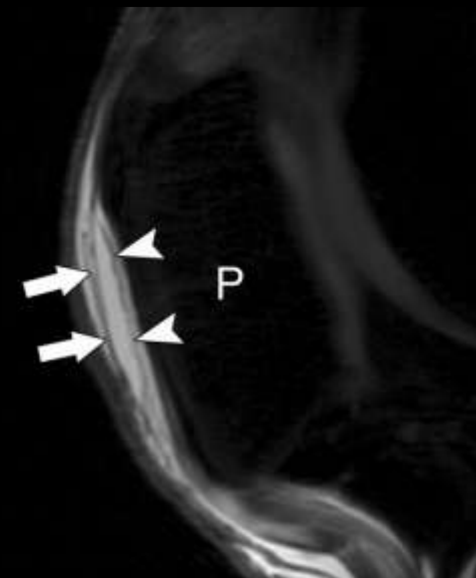
3 – prepatellar subaponeurotic bursal space

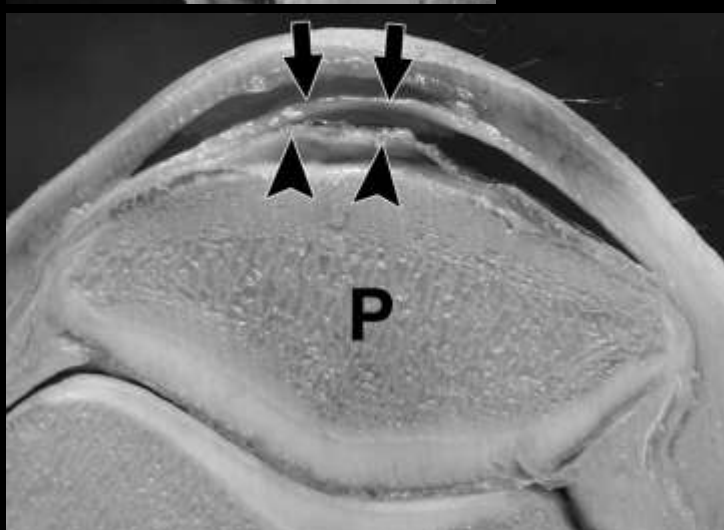
Dye SF et al. J Bone Joint Surg Am. 2003 Jun;85-A(6):1012-7.

Trilaminar Pre-Patellar Bursa

Anatomic photographs and MR images following US guided bursography







Aguiar RO et al. AJR; 188(4):W355-8.

Prepatellar Quadriceps Continuation

Gross anatomy, Histology, and MR Imaging

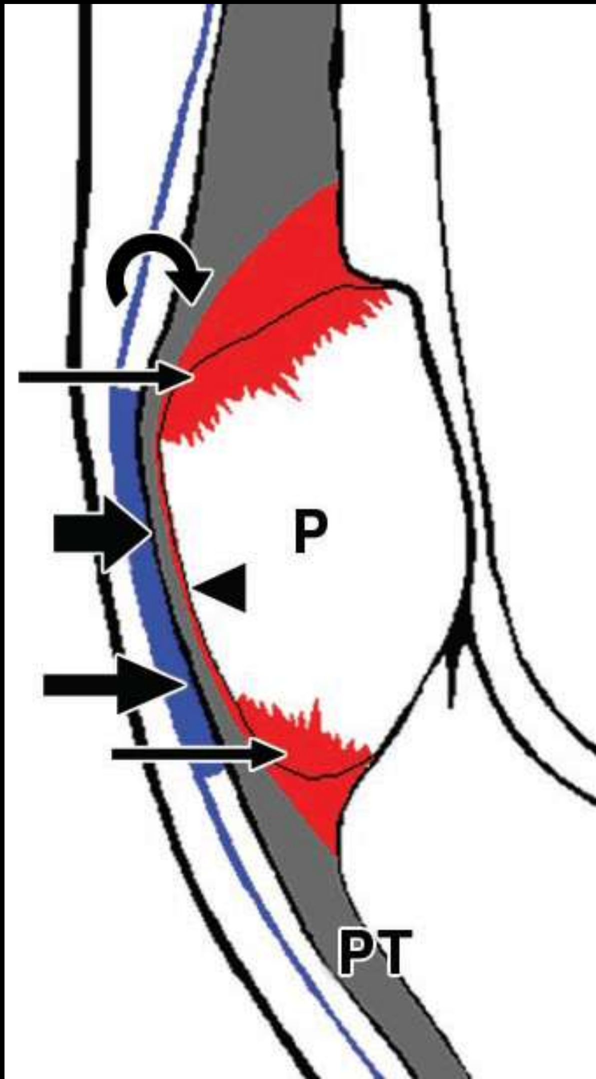
GREY = tendon,
RED = fibrocartilage,
BLUE = bursa

- Wangwinyuvirat et al. AJR 2009 Mar;192(3):W111-6.
- Pre-patellar continuation of the quadriceps aponeurosis
  - Fibers arise from the aponeurosis of the rectus femoris
  - Low T1 signal, indistinguishable from anterior patellar cortex
- Chondroapophyseal attachement (enthesis) to anterior surface of the patella via a very <u>thin</u> seam of fibrocartilage
  - Prone to shearing?
  - Different anatomic function?

THICK

THIN

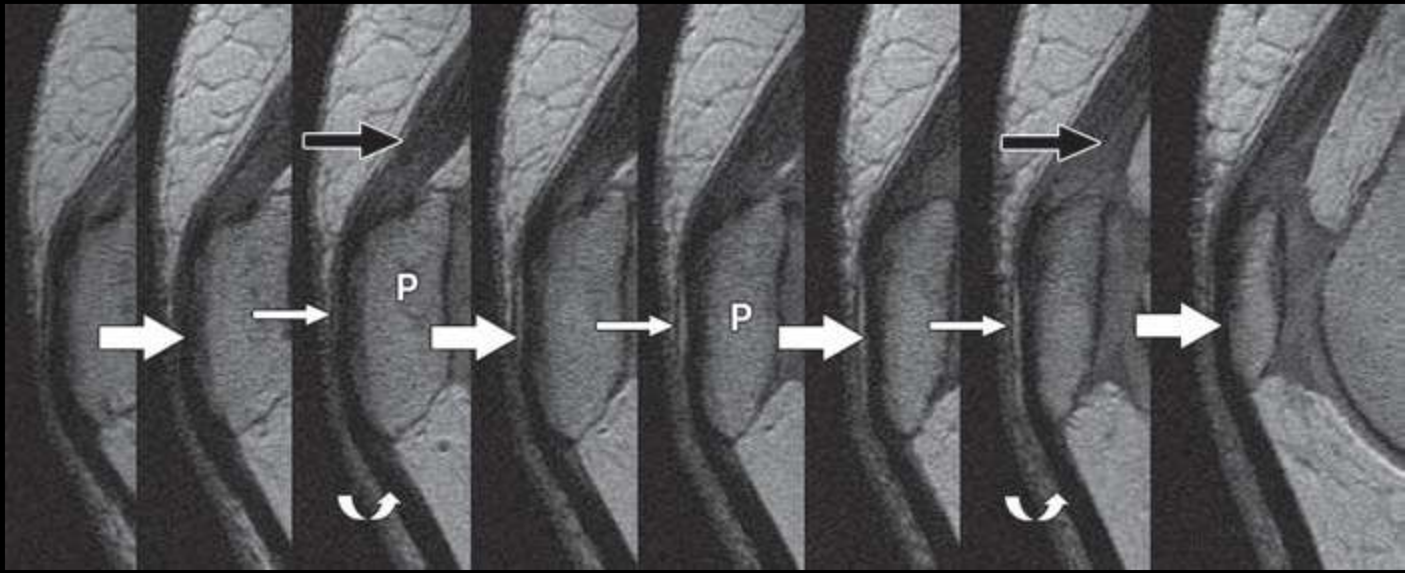
THICK



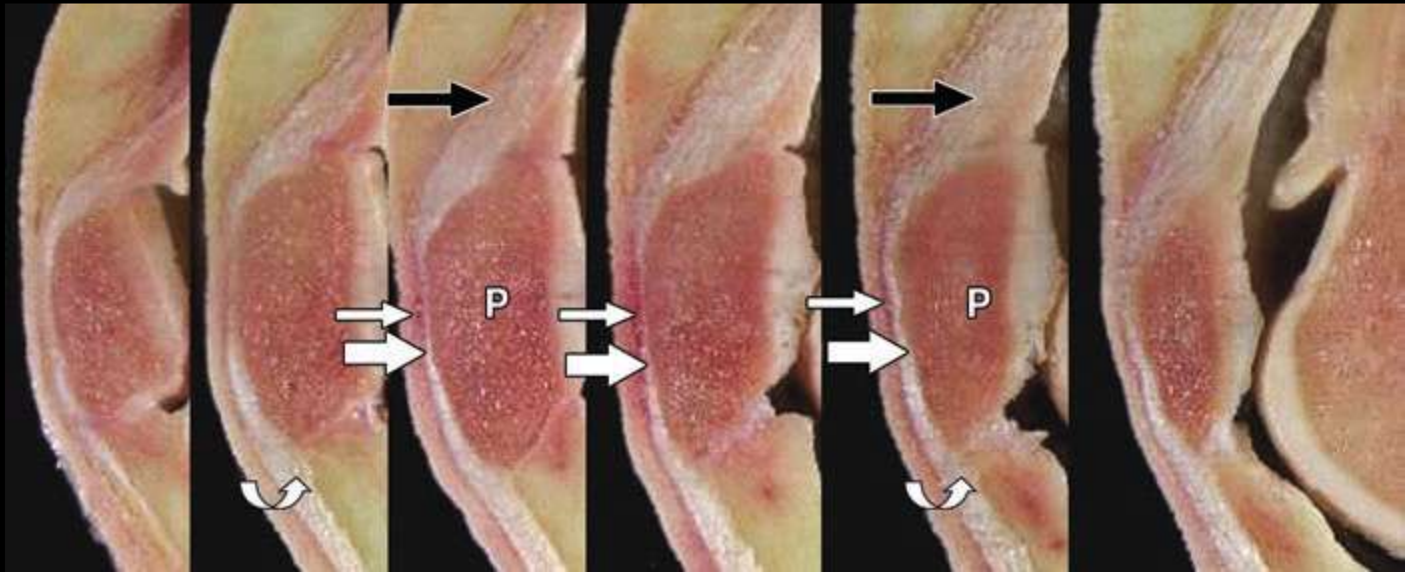
Prepatellar Quadriceps Continuation

Gross anatomy, Histology, and MR Imaging

Series of sagittal T1WI



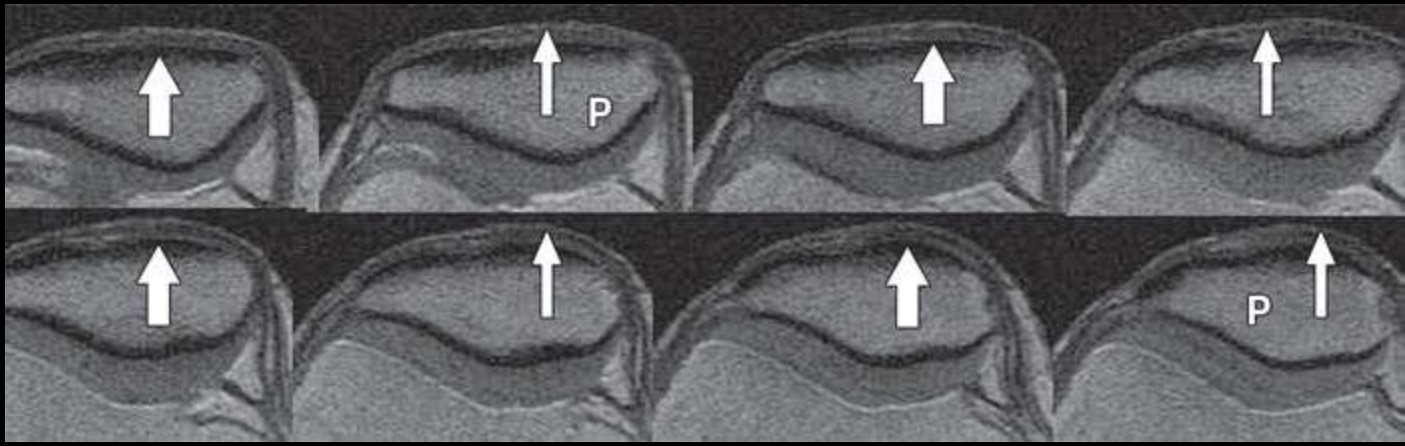
Photographs of anatomic specimen



Prepatellar Quadriceps Continuation

Gross anatomy, Histology, and MR Imaging

Series of axial T1WI



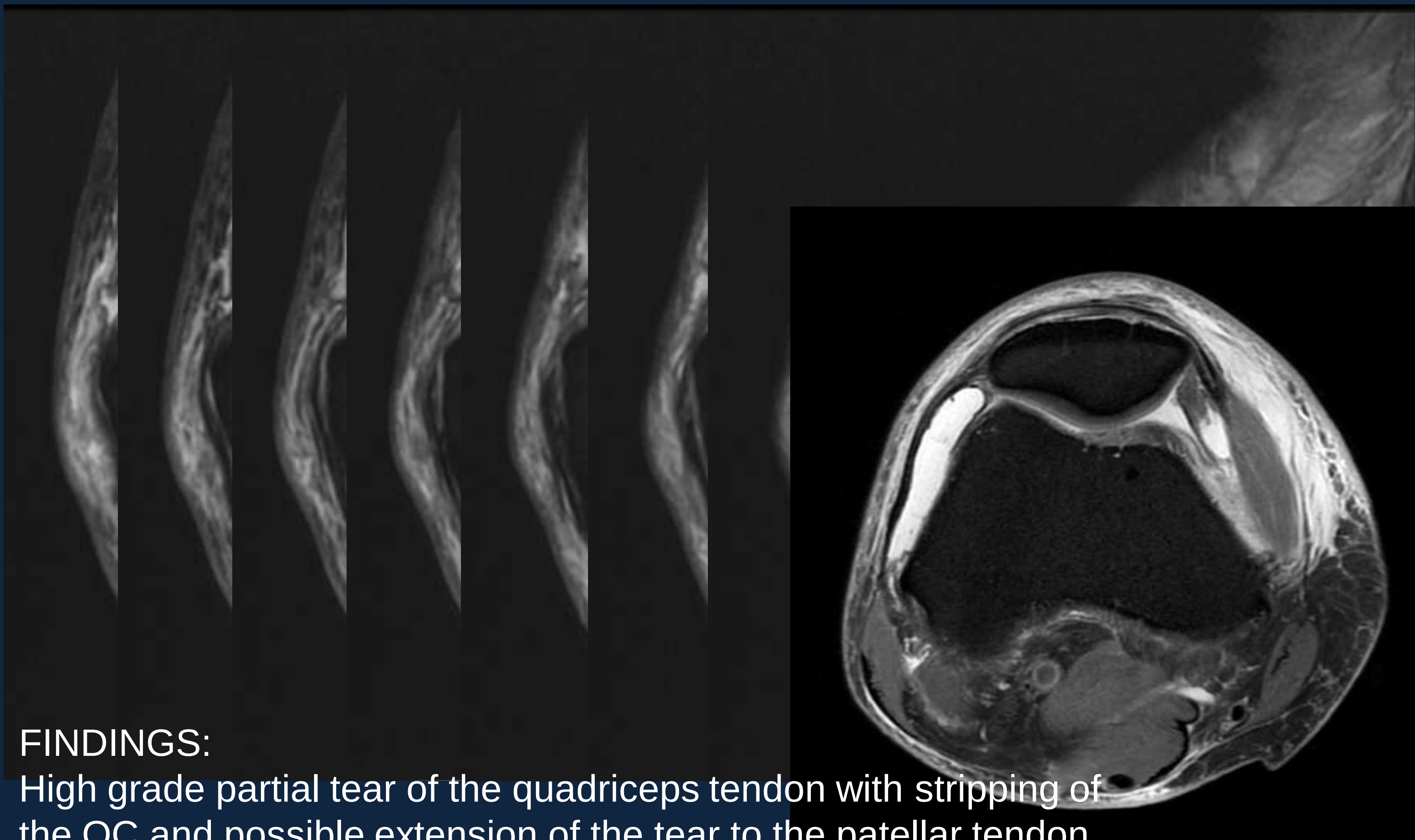
Photographs of anatomic specimen

Injury to the Quadriceps Continuation

Case Series

Romulo Baltazar, Diego Lemos, Donald Resnick, and Evelyn Fliszar

CASE 1 – Extension from Quadriceps Tendon (1 of 4)
54 Year-old male who injured his knee after running and falling.

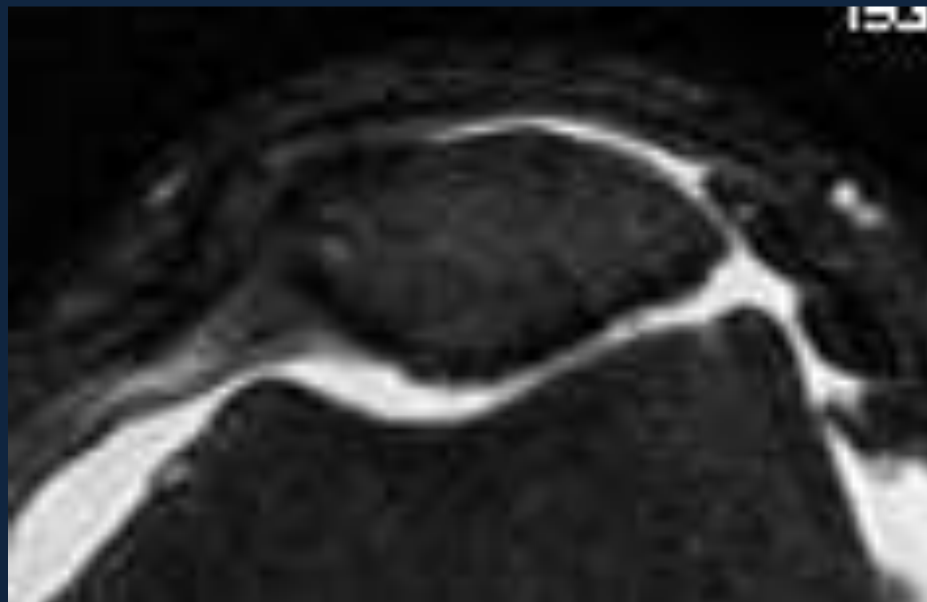


FINDINGS:
High grade partial tear of the quadriceps tendon with stripping of the QC and possible extension of the tear to the patellar tendon.

Extensive edema superficial to the VMO.

Courtesy Michelle Nguyen

CASE 2 – Extension from Quadriceps Tendon (2 of 4)

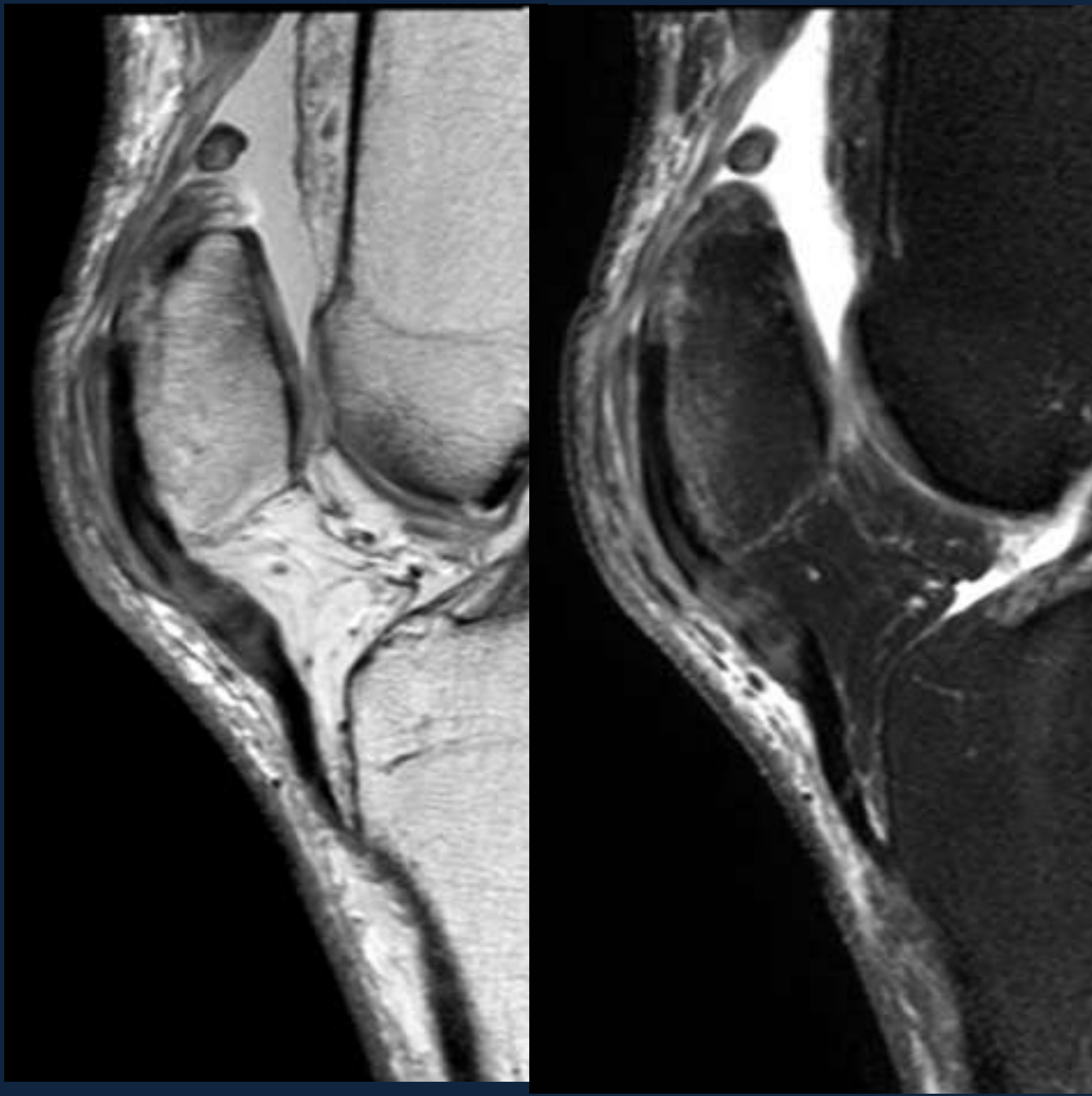


FINDINGS:
Near complete or complete disruption of the distal quadriceps tendon just proximal to the osteotendinous junction with stripping and uplifting of the QC from the proximal patellar pole.

Chronic tendinosis of the quadriceps and patellar tendon.

Courtesy Don Resnick

CASE 3 – Extension from Quadriceps Tendon (3 of 4)
79 year-old male.

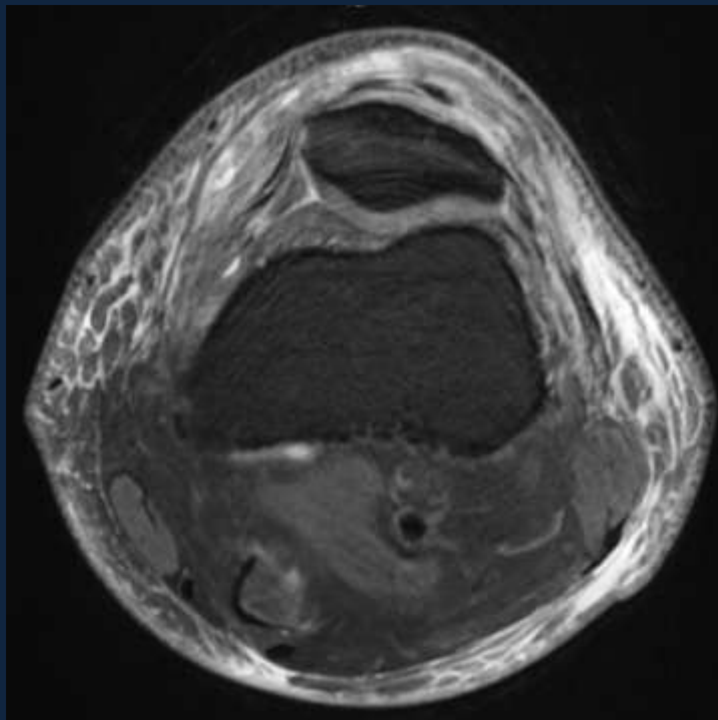


FINDINGS:
Near complete or complete disruption of the quadriceps tendon at the osteotendinous junction with stripping of the QC from the proximal patellar pole.

Chronic tendinosis of the patellar tendon.

Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

CASE 4 – Extension from Quadriceps Tendon (4 of 4)
49 year-old with direct blow to the knee during fall down hill.



FINDINGS:
Isolated tear of the rectus femoris with stripping of the QC.

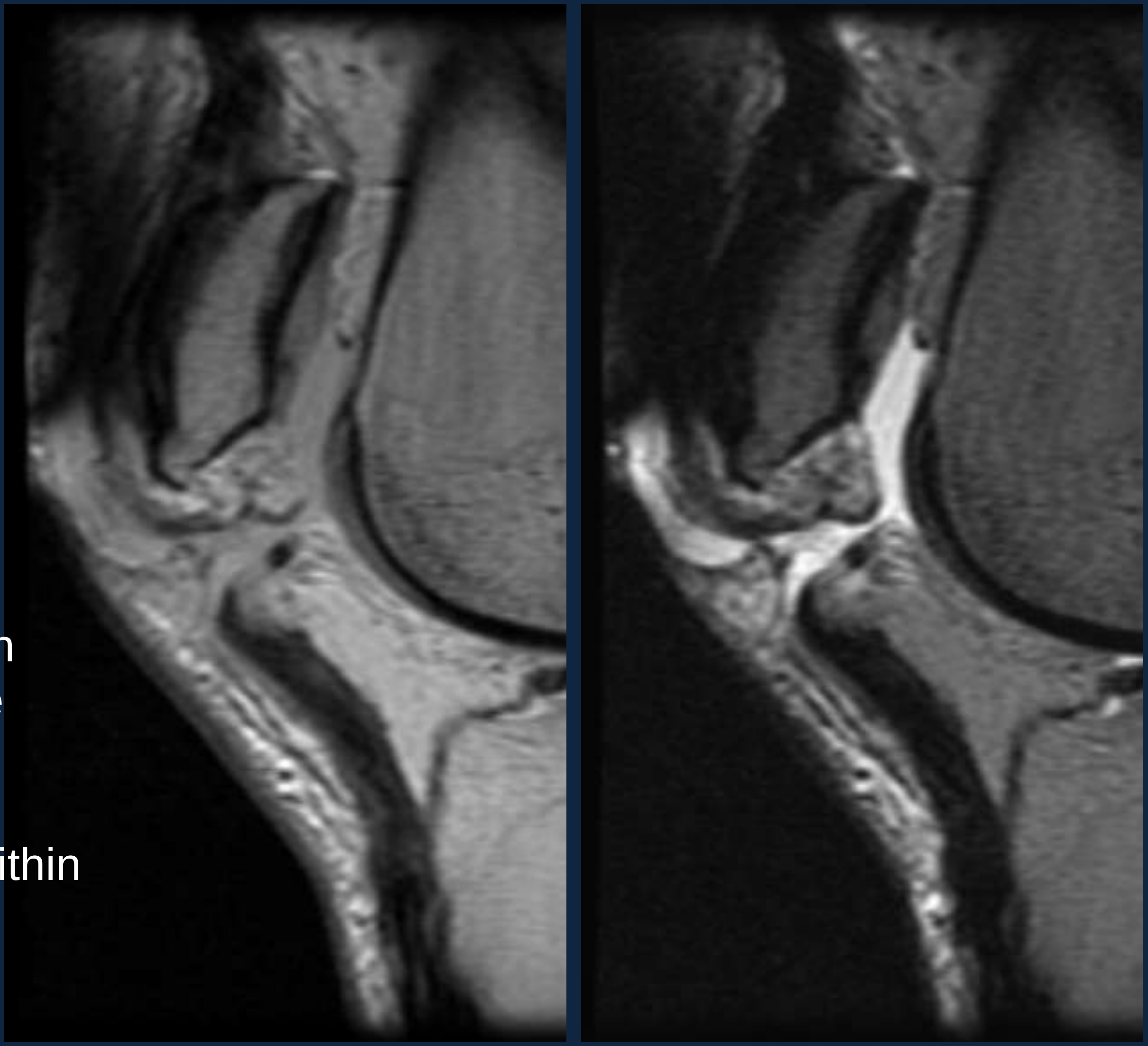
The intermediate layer prepatellar subaponeurotic bursa is also torn.

Courtesy Luke Hiller

CASE 5 – Extension from Patellar Tendon (1 of 3)

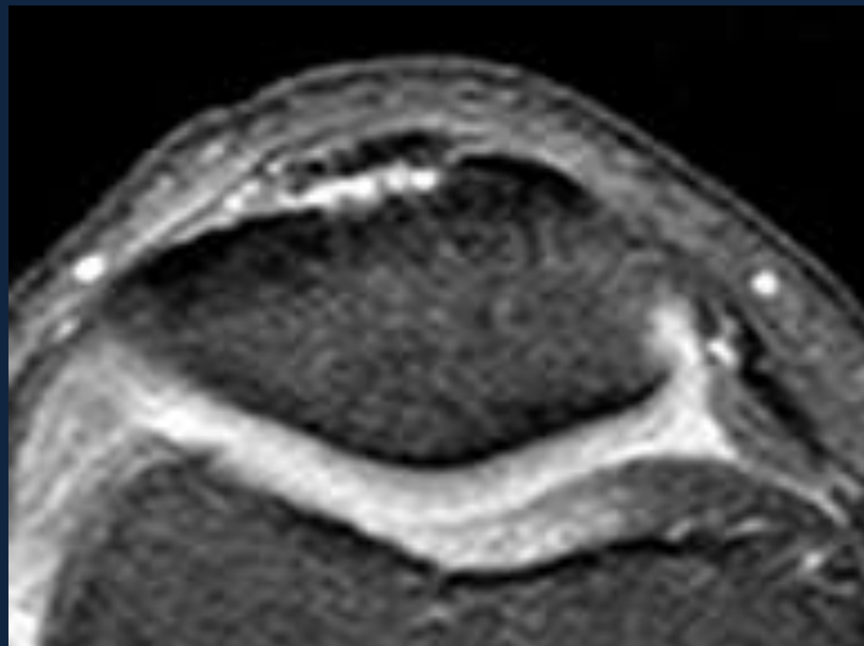
FINDINGS:
Disruption of the QC and patellar tendon at the osteotendinous junction with stripping of the QC from the distal patellar pole.

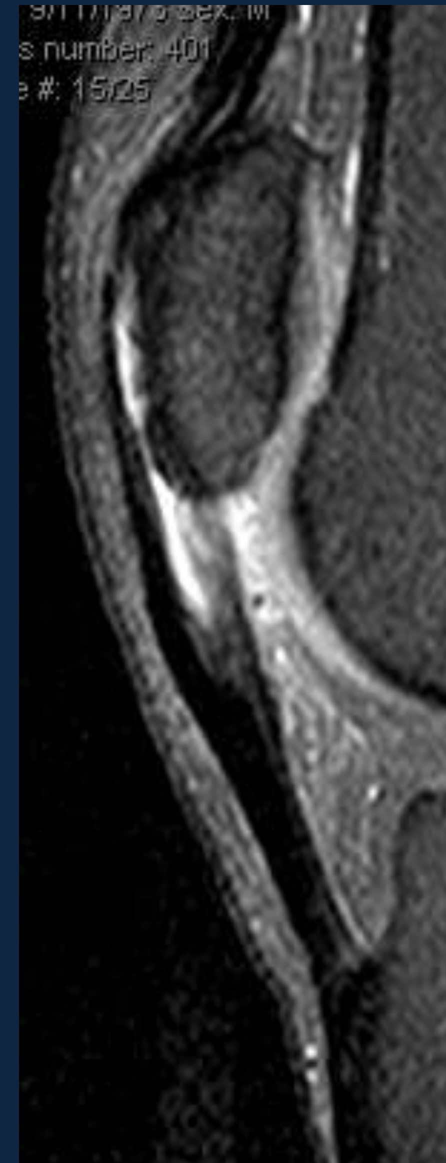
Torn fibers are entrapped within the patellofemoral joint.



Courtesy Mini Pathria

CASE 6 – Extension from Patellar Tendon (2 of 3)



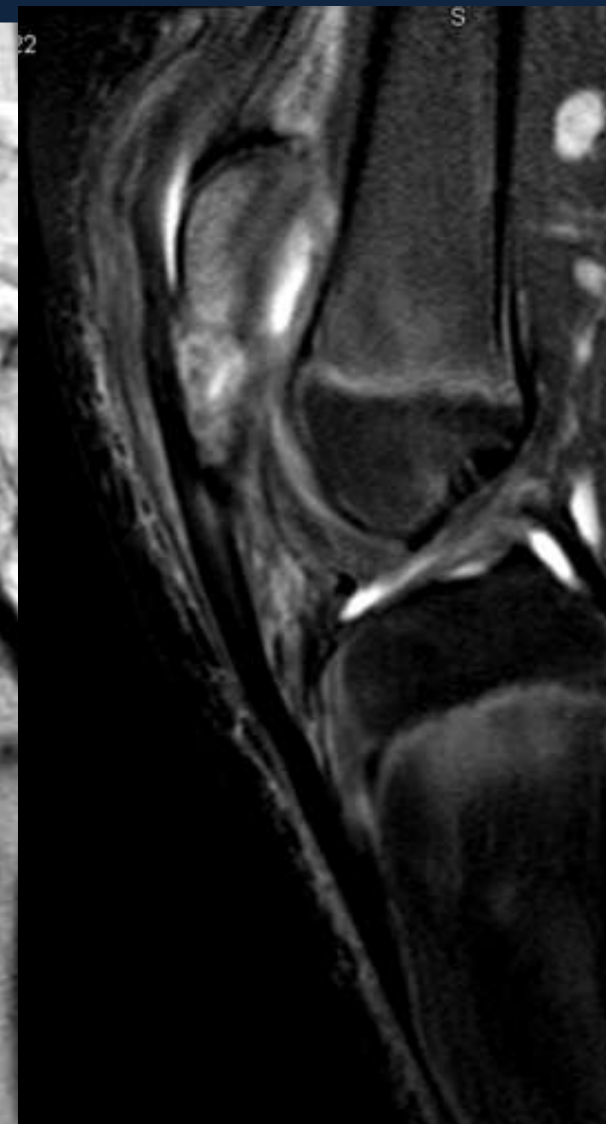


FINDINGS:
Disruption of the patellar tendon at the osteotendinous junction with stripping of the QC from the distal patellar pole.

Torn fibers are entrapped within the patellofemoral joint.

Courtesy Don Resnick

CASE 7 – Extension from Patellar Tendon (3 of 3)



FINDINGS:
Patellar sleeve avulsion with stripping of the QC from the proximal and distal patellar poles and extension of the tear into the distal quadriceps tendon.

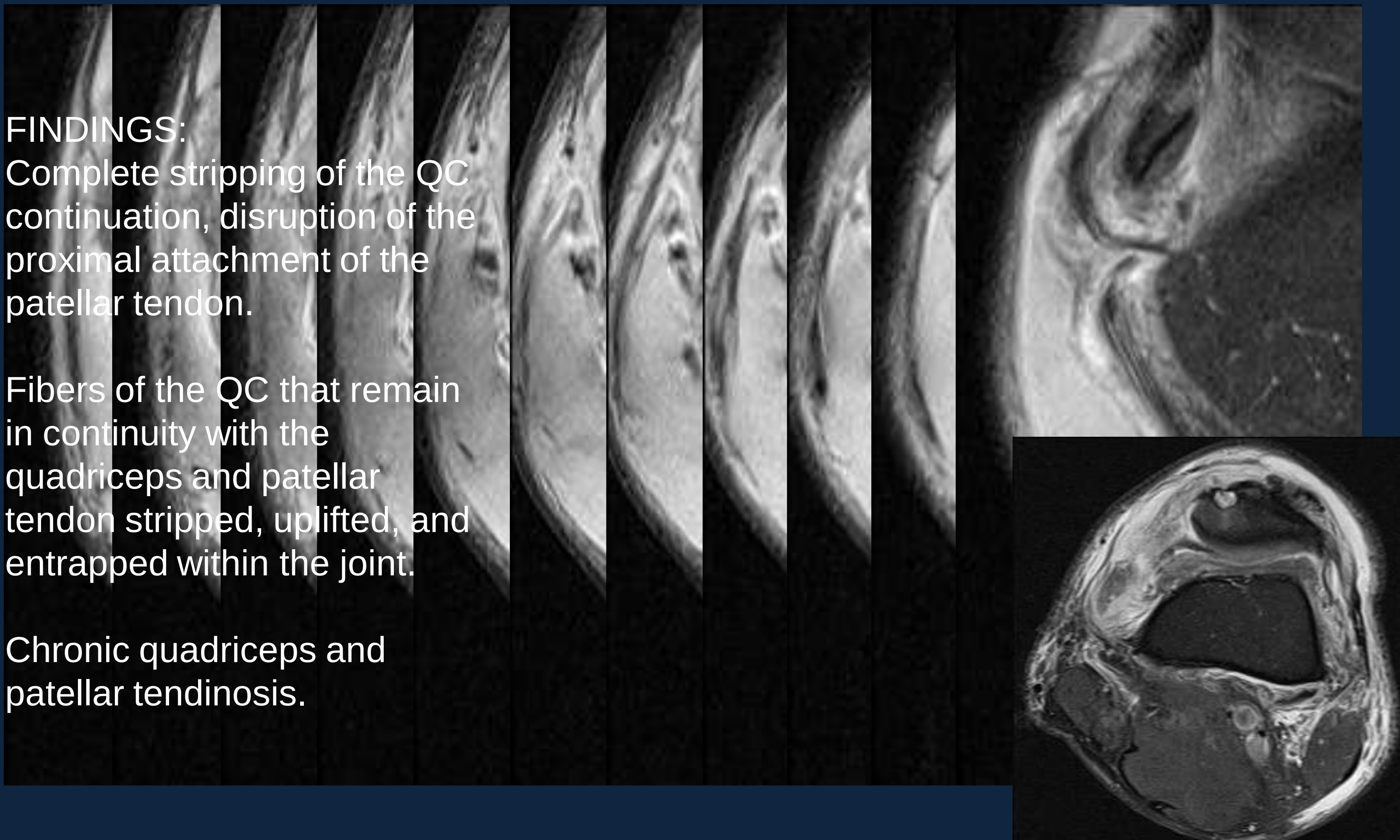
Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

CASE 8 – Massive tear of Extensor Mechanism Involving All Components
44 year-old male with chronic knee pain now with recent helmet to knee football injury.

1 month prior to injury

Immediately after injury

CASE 8 (cont'd) – Massive tear of Extensor Mechanism Involving All Components
44 year-old male with chronic knee pain now with recent helmet to knee football injury.



FINDINGS:
Complete stripping of the QC continuation, disruption of the proximal attachment of the patellar tendon.

Fibers of the QC that remain in continuity with the quadriceps and patellar tendon stripped, uplifted, and entrapped within the joint.

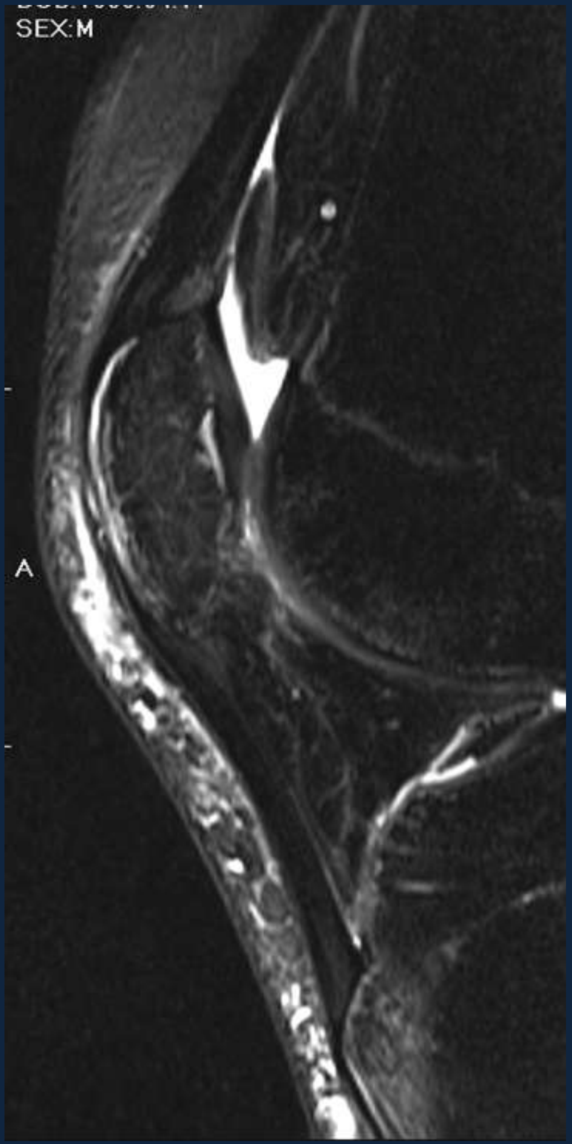
Chronic quadriceps and patellar tendinosis.

Case from Scripps

CASE 9 – Isolated involvement of the QC (1 of 4)

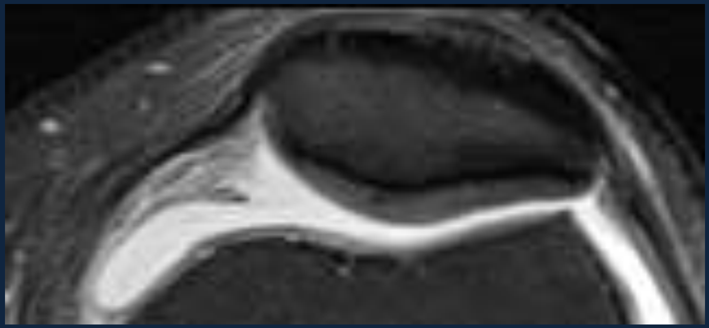
FINDINGS:
Stripping of the QC with intact quadriceps and patellar tendons.

Fluid within the prepatellar bursa.



Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

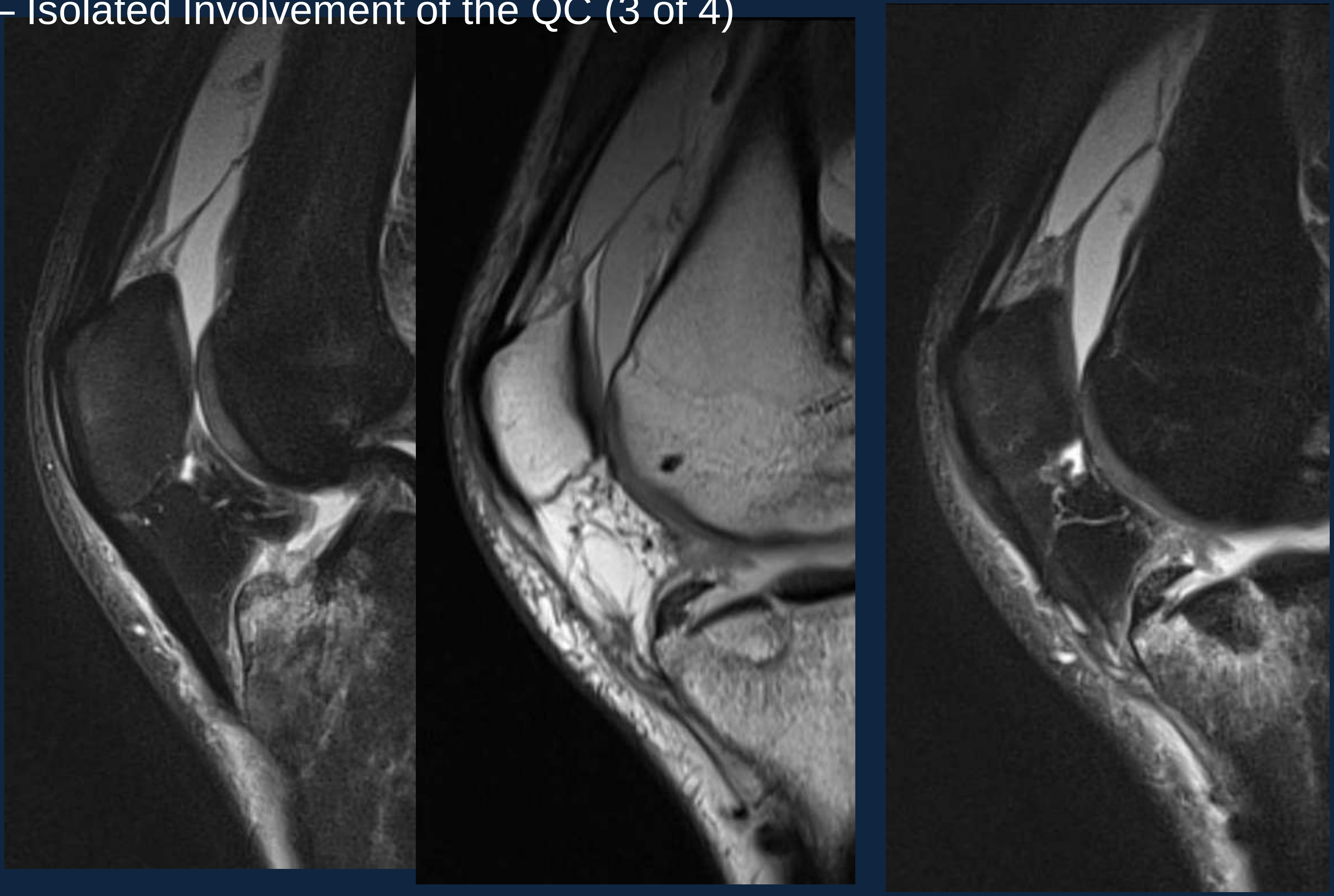
CASE 10 – Isolated involvement of the QC (2 of 4)
55-year-old male with four months of left knee pain following dashboard injury to left knee.



FINDINGS:
Minimal fluid tracking deep to the QC.

Case from Scripps

CASE 11 – Isolated Involvement of the QC (3 of 4)



FINDINGS:
Stripping of the QC with intact quadriceps and patellar tendons.

Impaction fracture of the weight-bearing surface of the medial tibial plateau.

Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

CASE 12 – Isolated involvement of the QC (4 of 4)

FINDINGS:
Even less fluid deep to the QC with questionable delamination of the anterior fibers of the quadriceps tendon.

Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

CASE 13 – Direct impaction to medial condyle with QC involvement.
20 year-old male skateboarder hit by car.

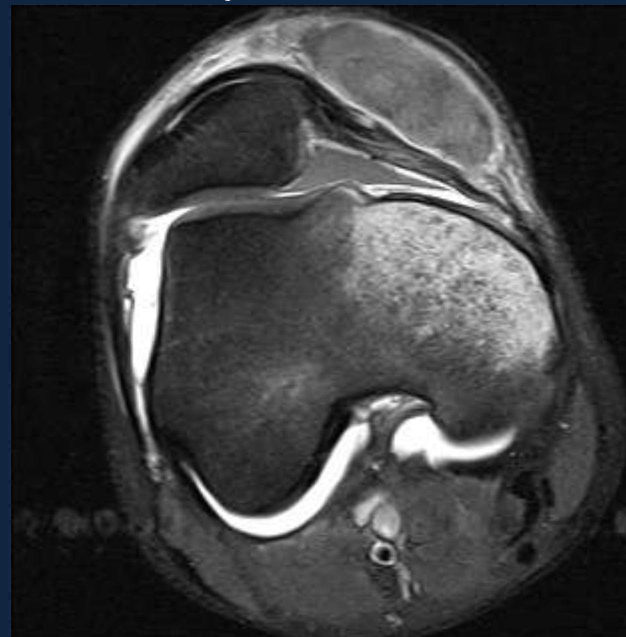
FINDINGS:
Stripping of the QC with intact quadriceps and patellar tendons.

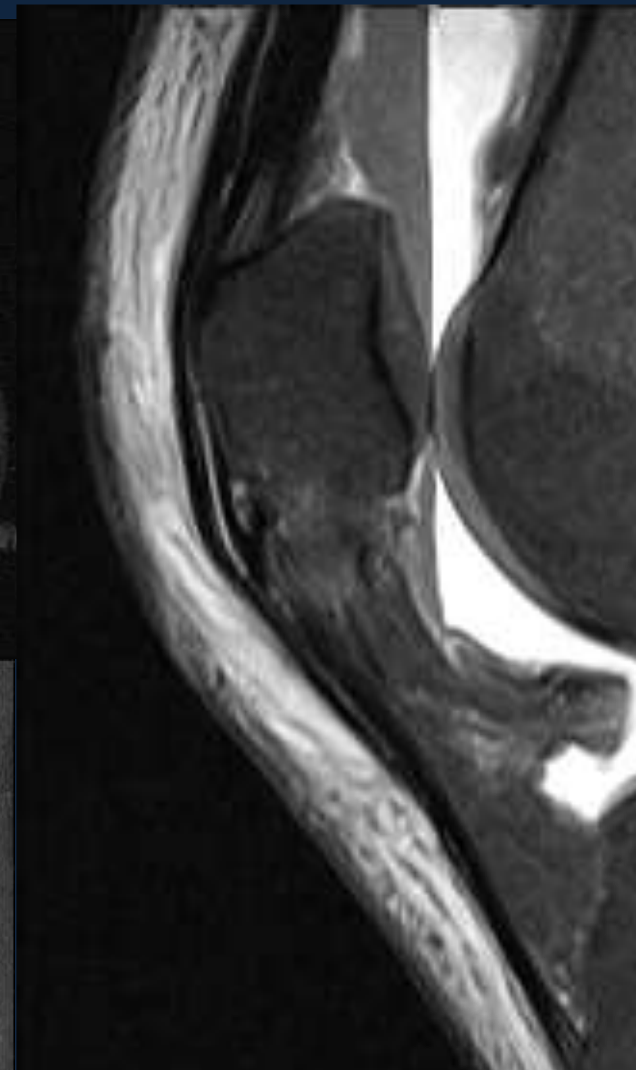
Impaction fracture of the medial femoral condyle just peripheral to the medial aspect of the trochlea.

Large lipohemarthrosis.

Large hematoma superficial to the VMO.

Extensive fluid within the prepatellar soft tissue.



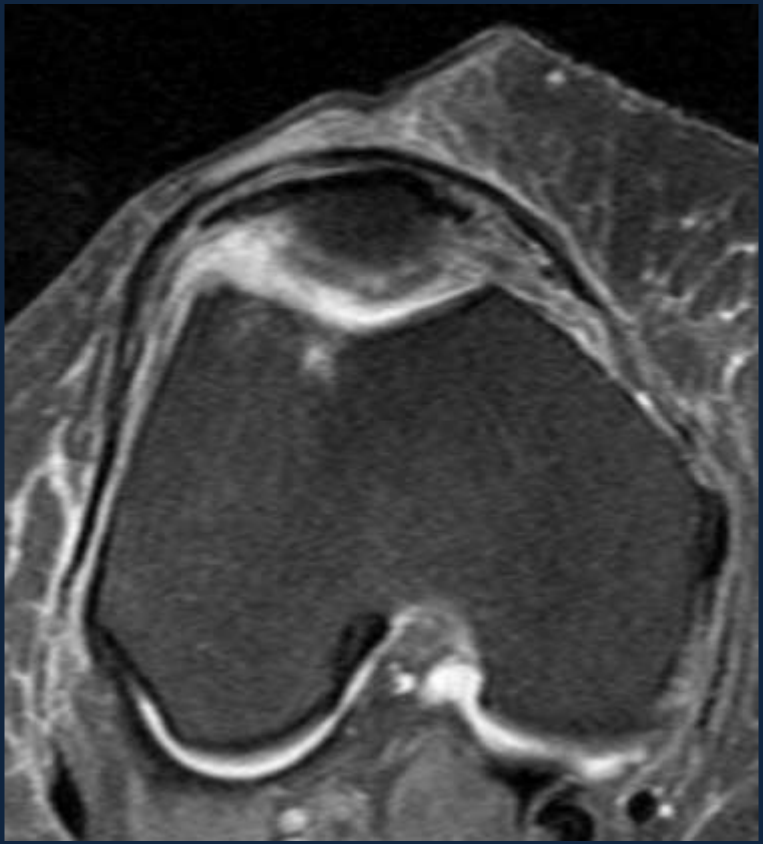


Case from Scripps

CASE 14 – Confusing Anatomy (1 of 2)

FINDINGS:
Stripping of the QC with extension into an otherwise intact patellar tendon.

* Note that the stripped QC fibers are in continuity with the medial and lateral retinacula on the axial image.

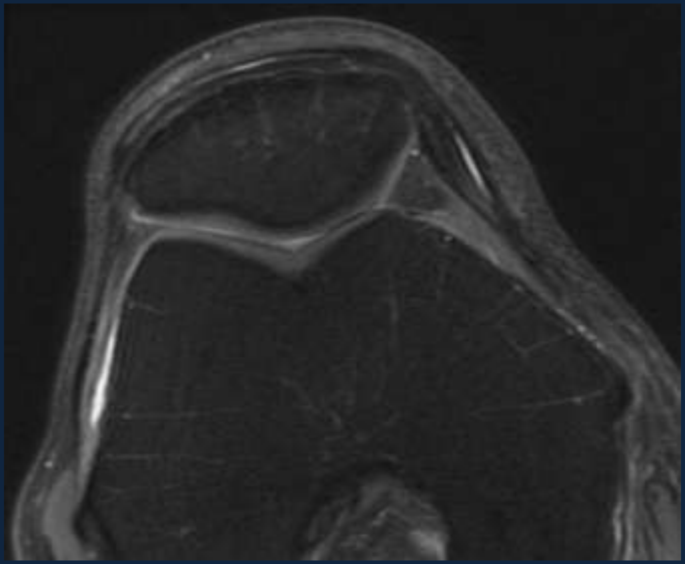


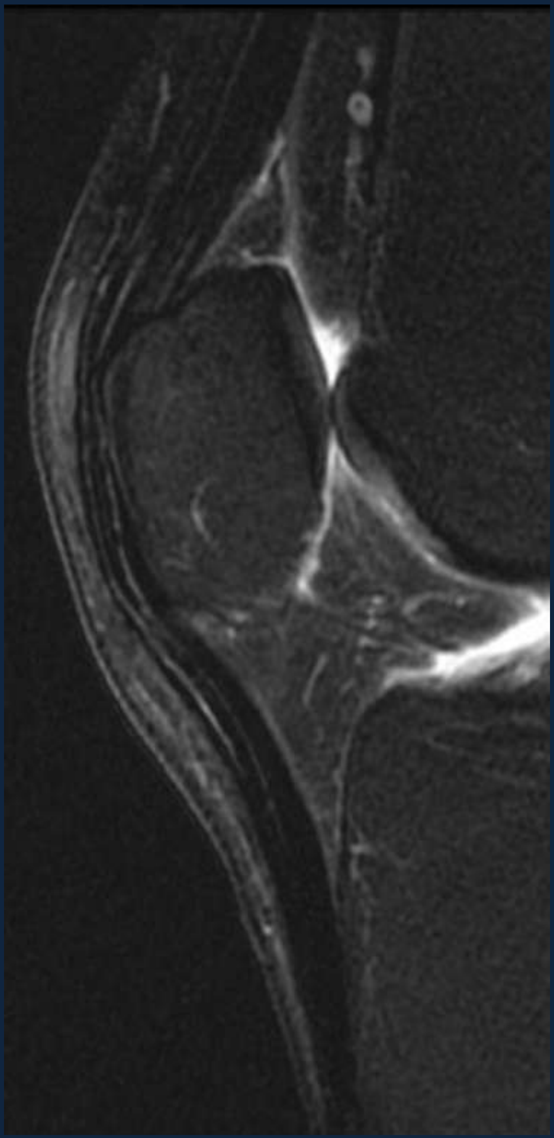
Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

CASE 15 - Confusing Anatomy (2 of 2)

FINDINGS:
Stripping of the QC with extension into an otherwise intact patellar tendon.

* Note that the stripped QC fibers are in continuity with the medial and lateral retinacula on the axial image.





Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

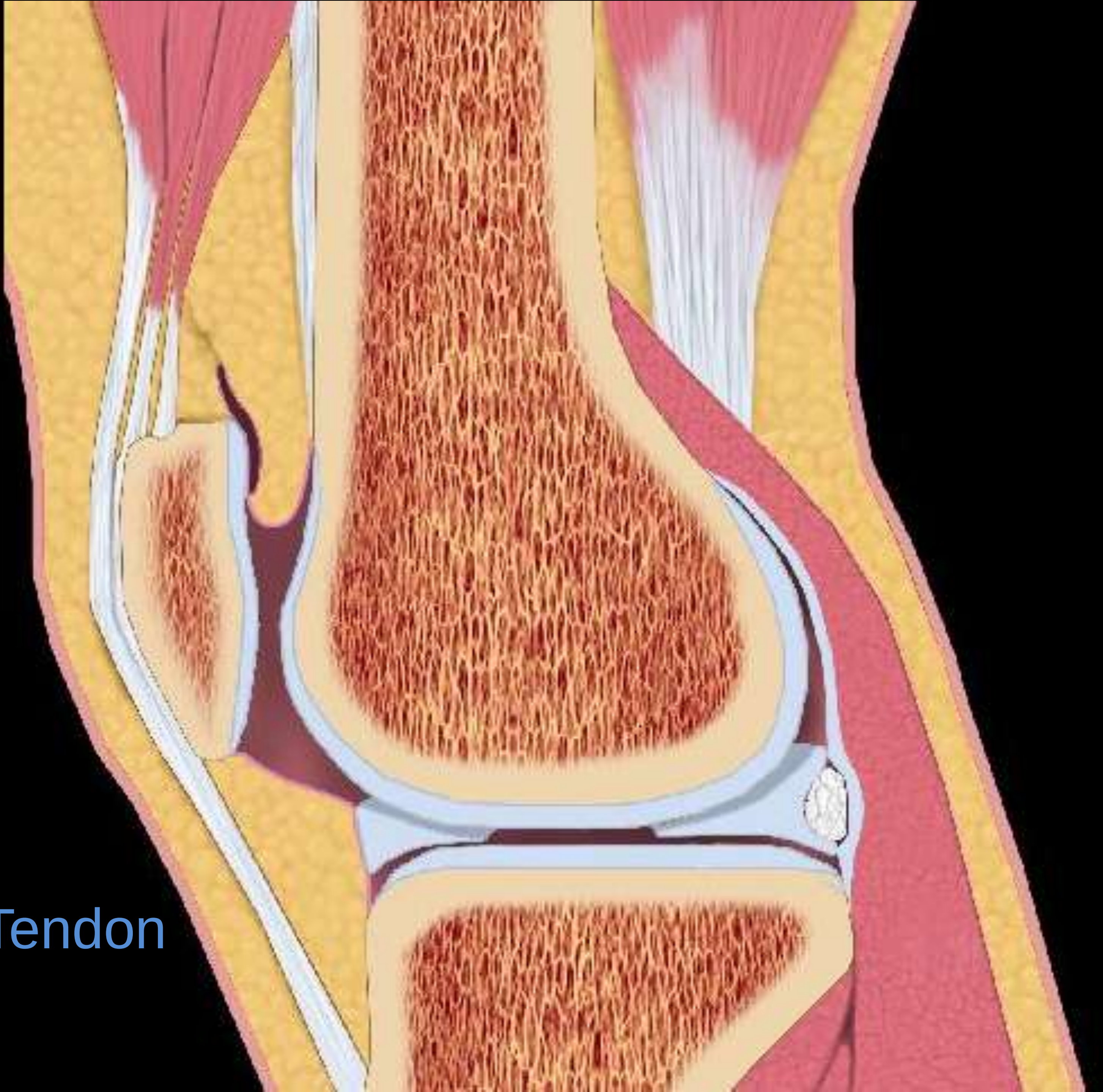
Quadriceps Continuation

Conclusions

- Nothing published on the extensor continuation in the orthopedic literature.

- Stripping of the quadriceps continuation from its patellar attachment can occur as an extension of a tear involving the distal quadriceps or proximal patellar tendons at their insertions.
  - Given the settings in which quadriceps and patellar tendon tears occur, this implies a background of degeneration, which was evident in several of the cases.
  - On a biomechanical level, this is unlikely to be of clinical significance since it does not directly contribute to the stability of the extensor mechanism.
  - Injury is not likely to alter management.
    - In the setting of complete disruption, quadriceps / patellar tendon repair alone is likely to restore function of the extensor mechanism. (?)
    - In the setting of partial tear, patients will usually respond well to conservative management

- Injury to the quadriceps continuation can also occur as an isolated event.
  - Edema deep to the QC has been seen in the context of direct anterior blow.
  - Also seen in patients with no anterior knee pain, possibly as a manifestation of degeneration.



The Patellar Tendon

Patellar Tendon Anatomy
Gross Anatomy

- Flat band band extending obliquely in the lateral direction from distal pole of the patella to the tibial tuberosity
    - 6-8 cm in length
    - 7 mm in AP thickness
- Superficial fibers are direct extensions of the rectus femoris tendon via the extensor continuation
- Flanked medially and laterally by the retinacula
- Separated from tibia by the deep infrapatellar bursa

Yu JS et al. Radiographics. 1994 May;14(3):541-51.

Courtesy Gisele Portes

Patellar Tendon Anatomy

Gross Anatomy

As you go more laterally, there is continuity with the fibers of the medial retinaculum

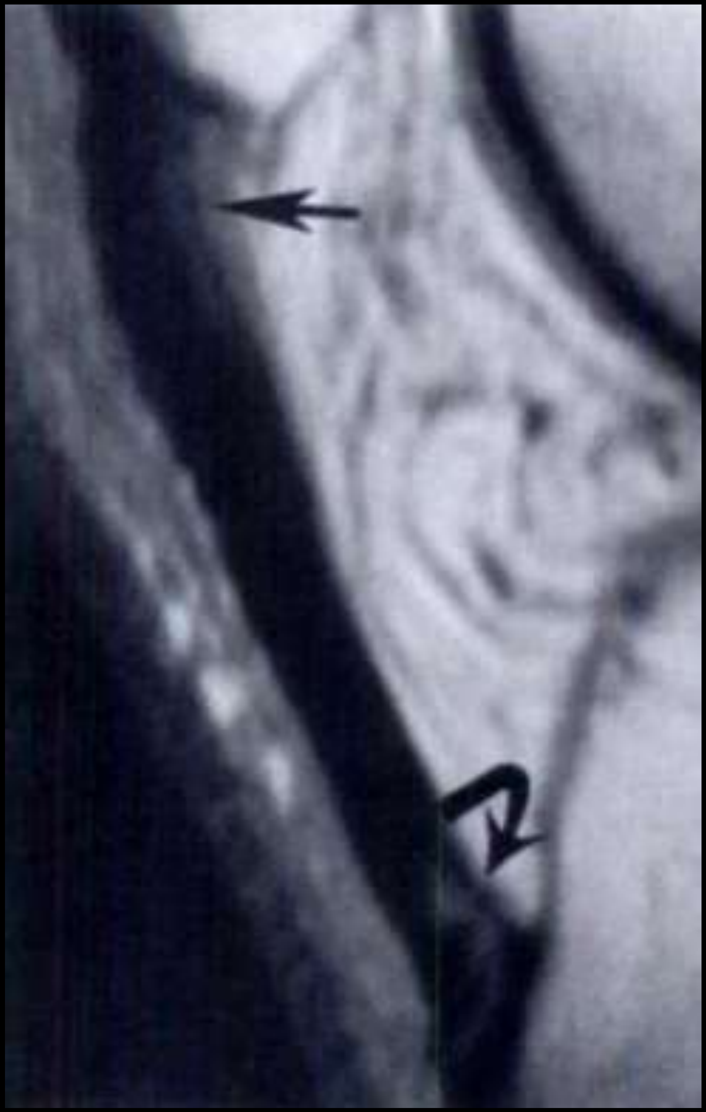
As you go more medially, there is continuity with the fibers of the medial retinaculum

Courtesy Gisele Portes

Patellar Tendon Anatomy

MR Imaging

- Homogeneous low signal intensity appearance except for small occasional triangular areas of intermediate signal intensity directly below the patella and adjacent to the tibial tuberosity.
- Both the superficial and deep margins generally appear distinct and smooth.
- The tendon generally thickens distally; however, the normal thickness proximally does not exceed 7 mm
- Magic angle artifact can be seen in the normal tendon that is buckled due to hyperextension of the knee.



Patellar Tendon Injury

- Patellar Tendon Disruption
- Patellar Tendon Partial Tear
- Jumper’s Knee

Patellar Tendon Disruption

Radiography

- Patella > quadriceps > **patellar tendon**
- Usually patients younger than 40 years-old as a result of athletic traumatic injury
- Can also be complication of
  - TKA
  - ACL repair with bone-patellar tendon autograft (0.2%)
  - local steroid injection near the inferior pole of the patella as treatment for jumper's knee (probably a result of steroid-induced breakdown of collagen)
- May occur as the final result of long-standing patellar tendon degeneration due to repetitive microtrauma or systemic disease.

Courtesy Mini Pathria

Patellar Tendon Disruption
MR Imaging

- Mechanism: violent eccentric contraction of the quadriceps with knee flexed and foot planted (falls)

- In the flexed knee position, the patellar tendon sustains greater stress than the quadriceps tendon, with the tensile load much higher at the insertion sites than in the mid substance

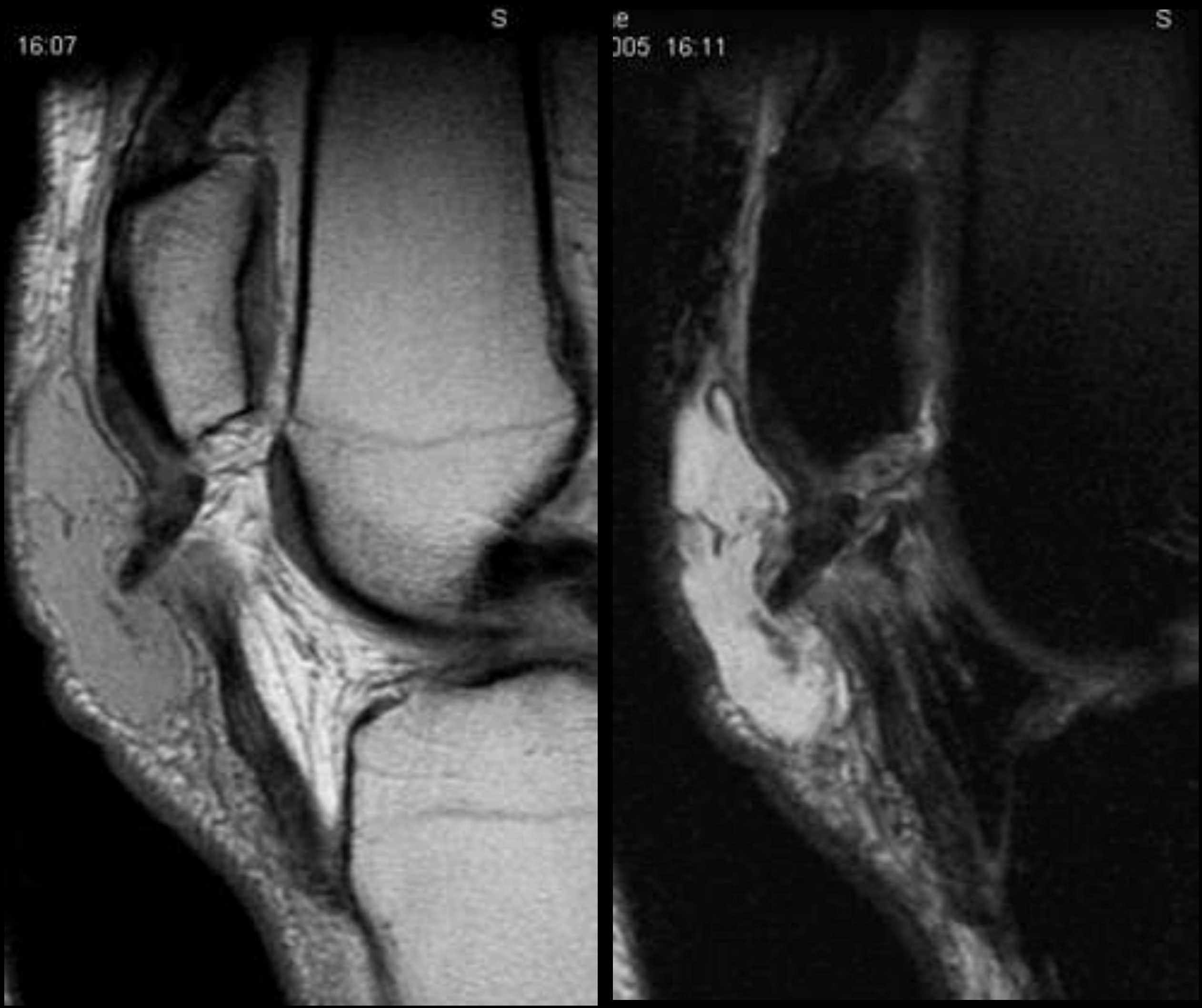
- Therefore, the patellar tendon commonly ruptures near its proximal osteotendinous junction at the inferior pole of the patella
- Less commonly occur at distal attachment – usually younger pts

Courtesy Mini Pathria

Patellar Tendon Disruption
MR Imaging

- In the setting of SLE, RA, diabetes mellitus, or chronic renal failure, bilateral ruptures can occur with lower-energy stress.

- Patellar tendon tends to tear in the mid substance in patients with systemic disease, rather than at the osteotendinous junction, as typically occurs in acute traumatic injury

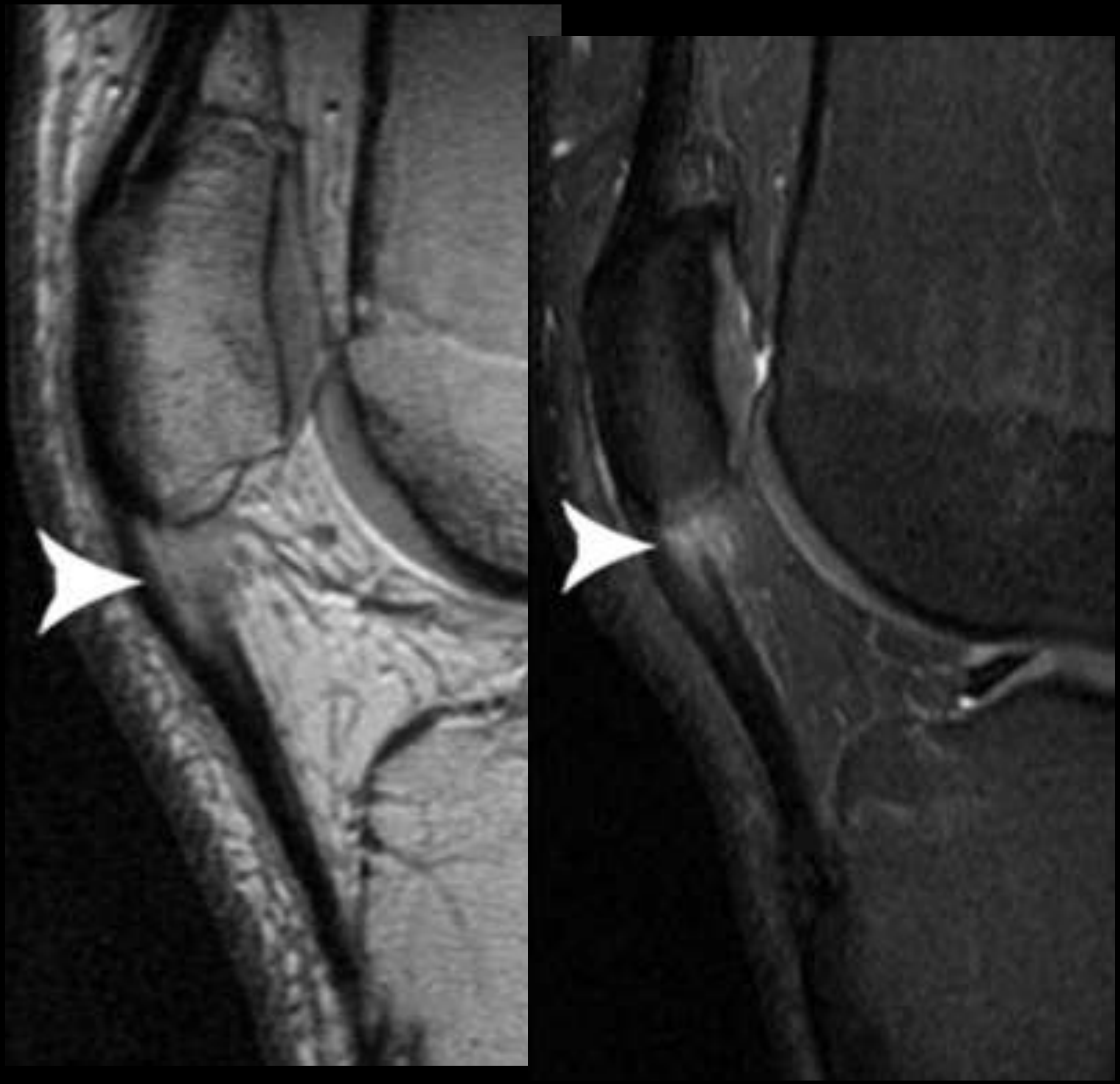


Case from FAHC, courtesy of Diego Lemos & Evelyn Fliszar

Patellar Tendon Partial Tear

MR Imaging

- Signal abnormality usually at the deep fibers of the proximal patellar tendon.
- Occasionally, the most apparent feature on MR imaging will be a region of soft tissue edema within hoffa's fat at the undersurface of the tendon
- This finding should prompt closer inspection of the posterior fibers of the patellar tendon



Dupuis CS et al. Radiographics. 2009 May-Jun;29(3):877-86.

Jumper's Knee

- Chronic microtearing, mucoid degeneration, and fibrinoid necrosis of the deep fibers of the proximal patellar tendon due to chronic overload in jumping athletes

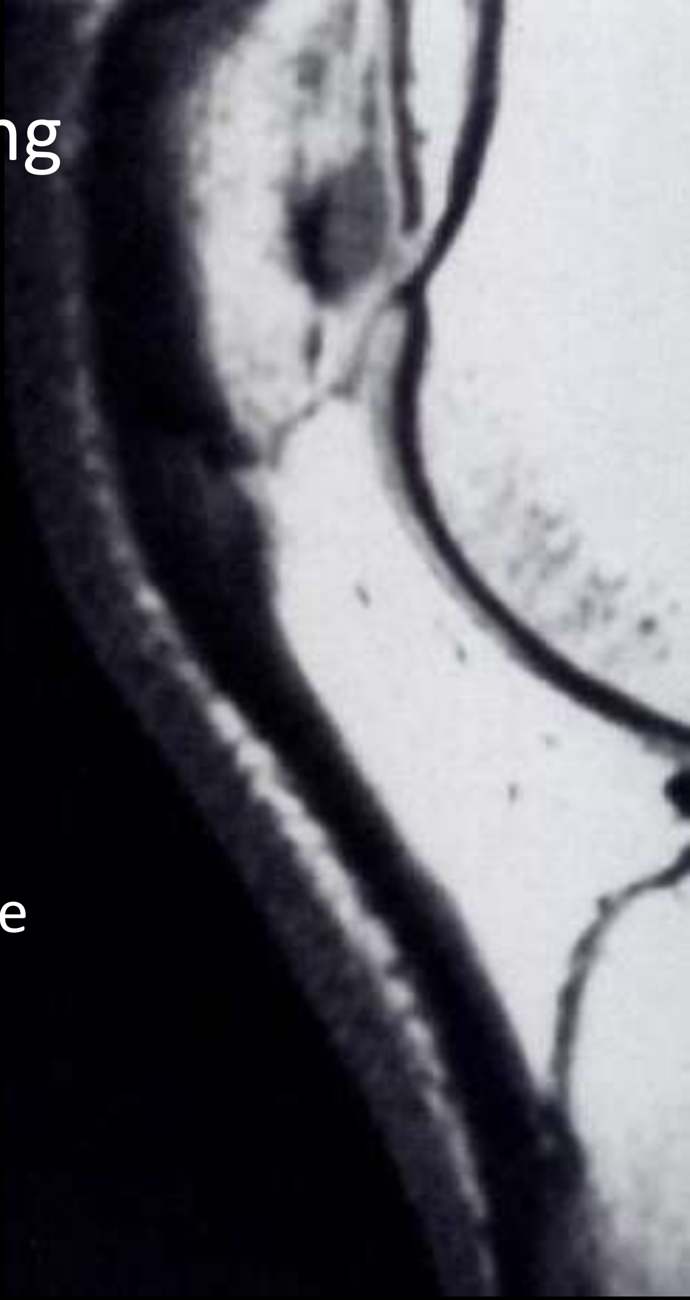
- Related to activities that require repetitive, forceful quadriceps muscle contractions such as basketball, volleyball, high jumping, and running

- Patients experience pain exacerbated by exercise

- On physical examination, localized tenderness of the patellar tendon at its origin on the inferior patellar pole

Berquist TH. MRI Clin N Am. 2007 Feb;15(1):25-38.

Jumper’s Knee - MR Imaging



- Jumper’s knee is a clinical diagnosis
- PD or T2 signal hyperintensity and undersurface irregularity
  - Proximal third
  - Medial fibers
  - Deep surface
- Sagittal width of patellar tendon as a single parameter for the diagnosis of jumper's knee may be misleading [Schmid]
  - early articles established 7 mm as the cutoff
  - subsequent studies have demonstrated an extensive overlap among symptomatic and asymptomatic

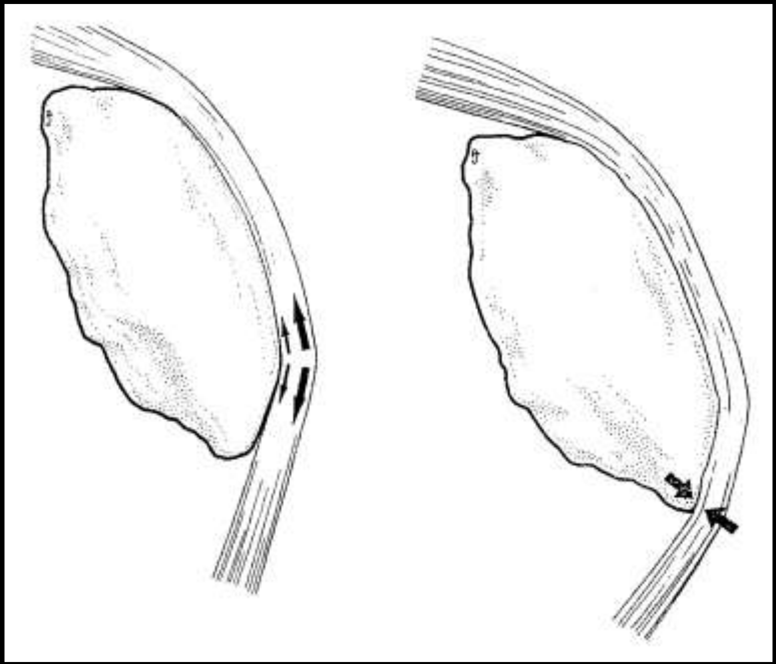
el-Khoury GY et al. Radiology. 1992 Sep;184(3):849-54.

Jumper's Knee - Treatment

- Mild forms of patellar tendinitis are treated with reduction of sporting activity, physical therapy, eccentric exercise, and anti-inflammatory drugs.
- Use of corticosteroid injections is controversial
- Surgical intervention is considered if nonoperative treatment fails
  - Excision of the degenerated part of the patellar tendon via longitudinal split, followed by suturing
  - Can be supplemented with drilling of the inferior patellar pole, which is thought to induce hypervascularity and healing
- Many surgeons resect the nonarticular portion of the patellar apex (apicotomy), which may be of benefit if patellar impingement plays a role in the pathophysiology of Jumper's knee. (Wheeless Textbook of Orthopedics)

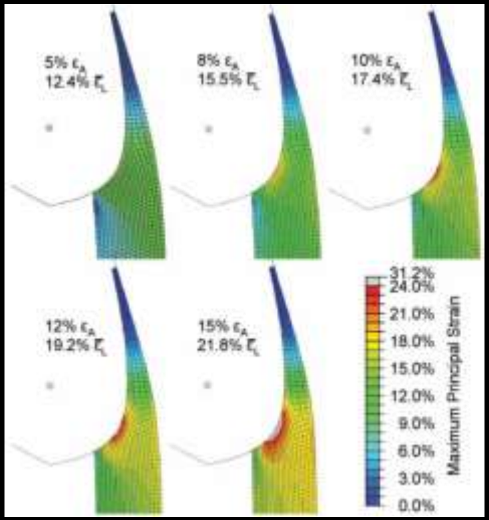
Jumper's Knee - Impingement Theory

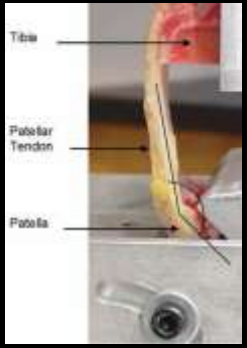
- DP Johnson et al. J Bone Joint Surg [Br] 1996;78-B:452-7.
- MRI in various degrees of flexion
- Observed impingement of the inferior patellar pole against the patellar tendon in a position of 60° of flexion on MRI
- Supported by the dorsal-proximal location of the signal abnormality associated with patellar tendonitis

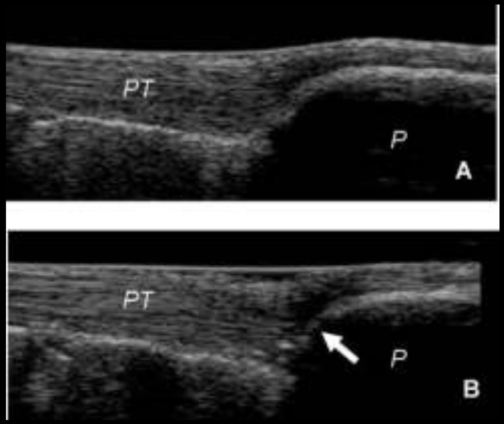


A diagrammatic representation of the stress in the superior part of the patellar tendon while the knee is in flexion. If the condition was due to a stress overload, the maximal stress and the lesion would be in the superficial aspect of the tendon (a). If it was due to impingement the classical lesion as identified on MRI would be observed (b).

Jumper's Knee - Impingement Theory







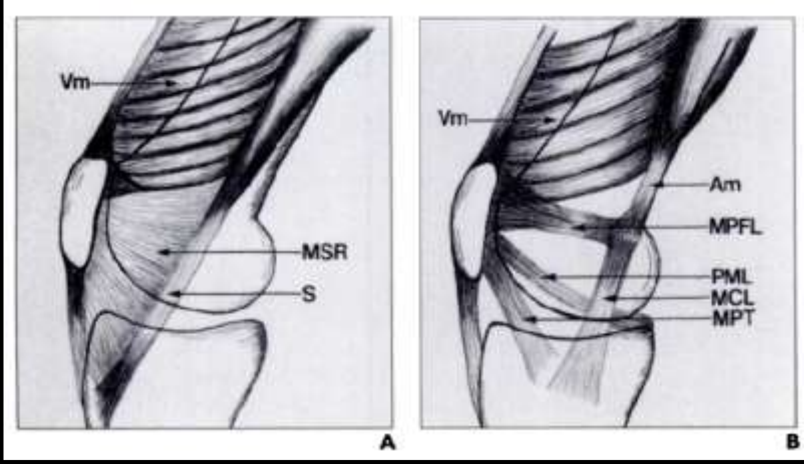
- Two recent articles have challenged this theory
- Lavagnino 2008 – computational model of patella – PT complex; human cadaveric patella-PT-tibia specimens were loaded under conditions predicted by the model to significantly increase localized tendon strain; ultrasound
- Schmid 2002 - Reassessment of difference in patella – patellar tendon angle with increasing flexion
- Impingement is most likely not a factor

Lavagnino M et al. Am J Sports Med. 2008 Nov;36(11):2110-8. Epub 2008 Sep 3.

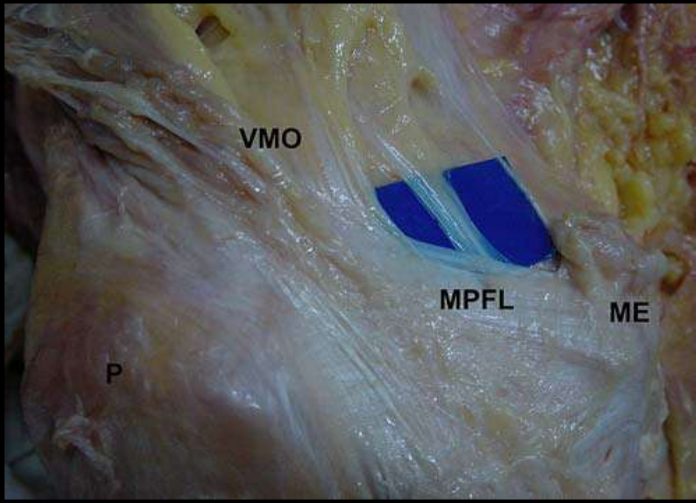
The Medial Retinaculum

Medial Retinaculum - Anatomy

- Medial Patellofemoral Lig (MPFL)
  - From superomedial margin patella
  - To adductor tubercle / TCL attachment
- Medial Patellomeniscal Lig (MPML)
  - From medial margin patella
  - to ant horn medial menisus / coronary lig
- Medial Patellotibial Lig (MPTL)
  - From inferomedial patella / patell tendon
  - To medial margin of tibia / TCL attachment



- MPFL has received considerable recent attention in the orthopedic literature
  - 40-50% of medial restraint against lateral translation
  - Many orthopedists advocate primary repair or reconstruction for acute or recurr dislocation



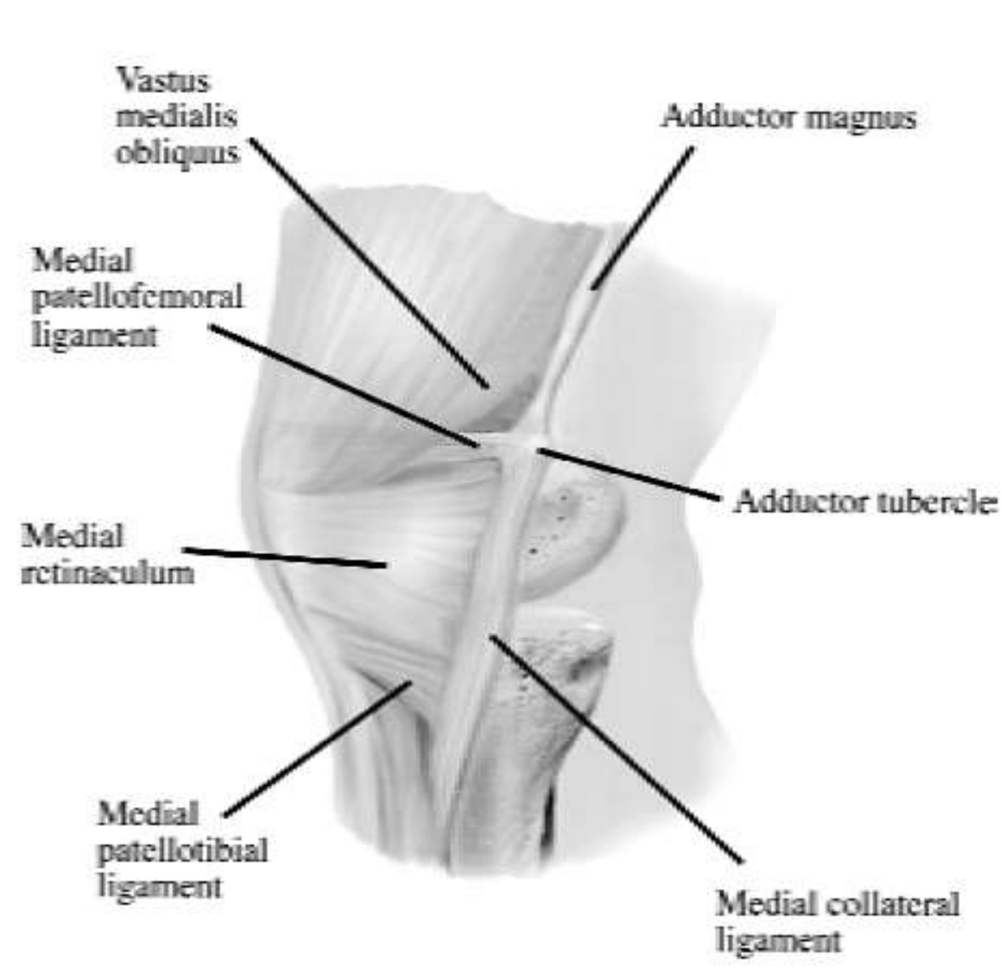
Starok M et al. AJR. 1997 Jun;168(6):1493-9.

Andrikoula S et al. Knee Surg Sports Traumatol Arthrosc. 2006 Mar;14(3):214-20.

Medial Retinaculum - Anatomy

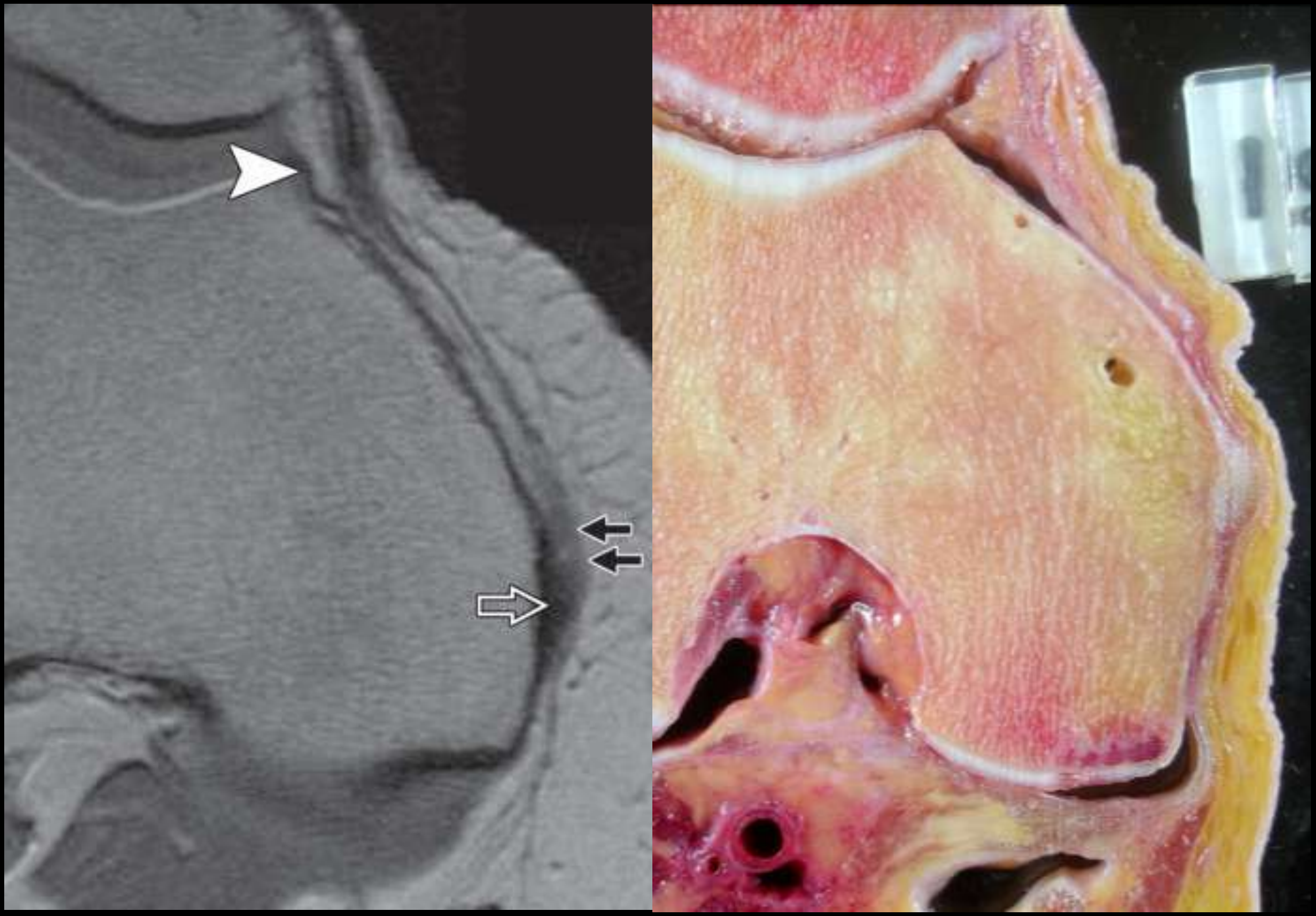
- Condensations in tissue planes derived largely from vastus medialis aponeurosis

- Not discrete structures



Sanders TG et al. JCAT. 2001 Nov-Dec;25(6):957-62.

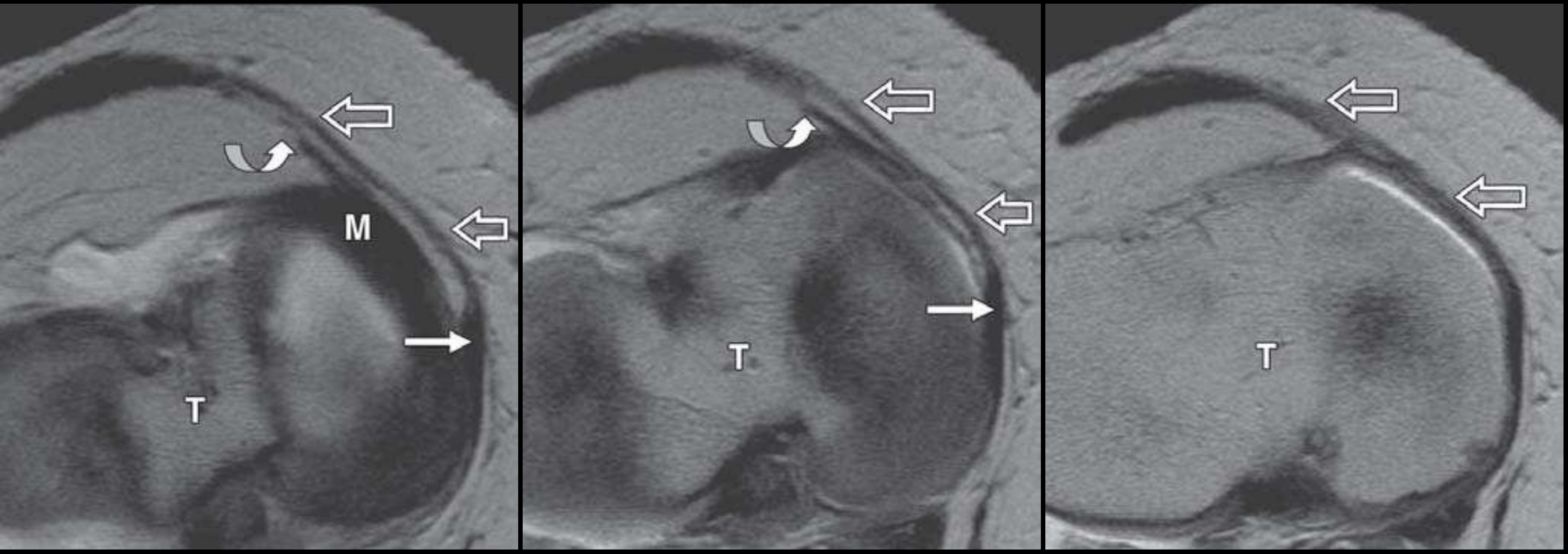
Medial Retinaculum - MR Imaging



- Region of the adductor tubercle is a common site of attachment of the MPFL, TCL, and adductor magnus tendon.

Courtesy Gisele Portes

Medial Retinaculum - MR Imaging



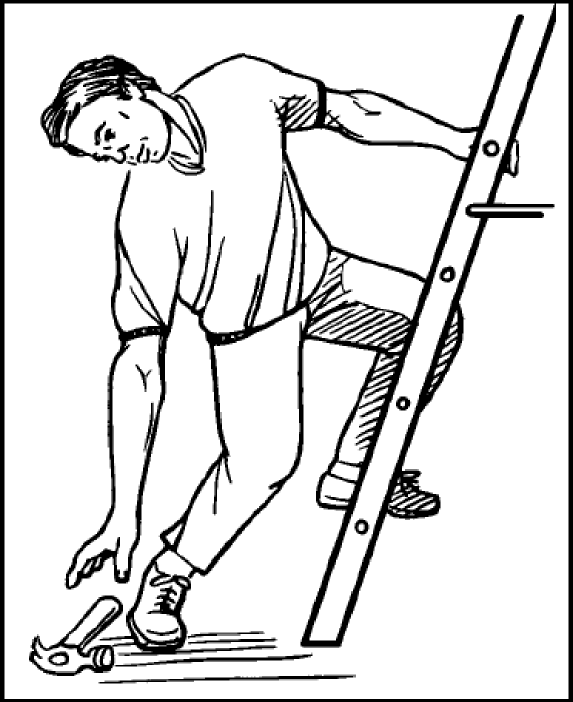
Medial patellomeniscal ligament (curved arrows, A and B)
Medial patellotibial ligament (open arrows)
Tibial collateral ligament (solid arrows, A and B).

Dirim B et al. AJR. 2008 Aug;191(2):490-8.

Transient Lateral Patellar Dislocation

- Young adult athletes

- Classic mechanism of injury:
  - internally rotated femur on a fixed tibia with the knee slightly flexed
  - As the individual attempts to straighten knee, contraction of the quadriceps places lateral force on the patella, which leads to lateral dislocation of the patella
  - The patient usually falls to the ground in pain, at which time the patella reduces spontaneously



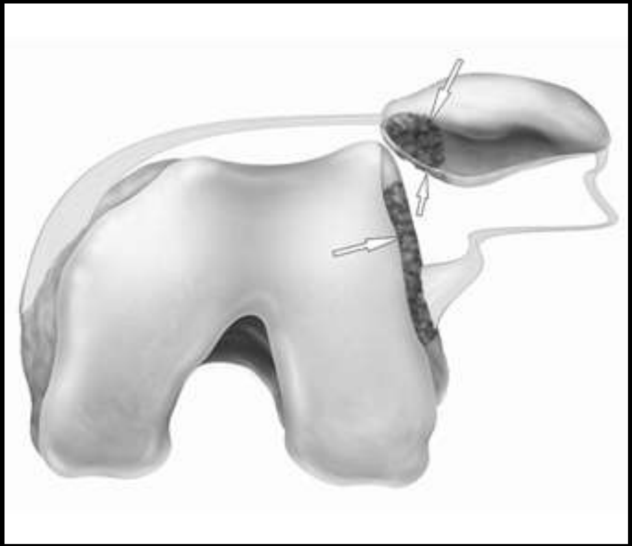
- Recurrent instability can result from
  - soft-tissue abnormalities – torn MPFL / weak VMO
  - osseous abnormalities – patella alta / trochlear dysplasia

Sanders TG et al. Radiographics. 2000 Oct;20 Spec No:S135-51.

Transient Lateral Patellar Dislocation

- Sanders TG et al. AJR. 2006 Nov;187(5):1332-7.
- Two separate stages

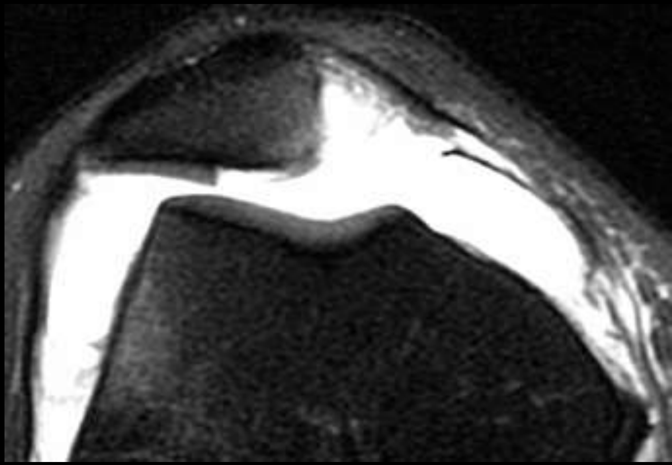
- FIRST phase - the patella translates laterally to lie along the lateral aspect of the lateral femoral condyle.
- SECOND phase - patella reduces to its normal position within the trochlear groove.
  - medial aspect of the distal pole of the patella strikes against the nonarticular surface of the anterior aspect of the lateral femoral condyle as it attempts to reduce



Transient Lateral Patellar Dislocation

MR Imaging

- Bone bruise pattern
  - nonarticular anterolateral aspect of the lateral femoral condyle
  - osteochondral injury to the inferomedial pole or median eminence
- Injury to the medial soft tissues of the knee
  - medial patellofemoral ligament
  - identification of the site of tear is useful for surgical planning since MPFL repair is advocated by many surgeons
  - elevation of the edematous VMO muscle



Courtesy Tudor Hughes

Transient Lateral Patellar Dislocation

Variations in the Lateral Femoral Condylar Osteochondral Fracture

Teleradiology case

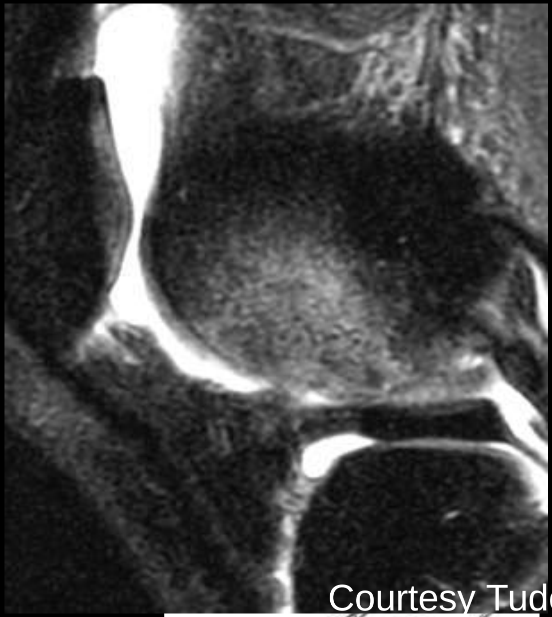
Transient Lateral Patellar Dislocation

Variations in the Lateral Femoral Condylar Osteochondral Fracture

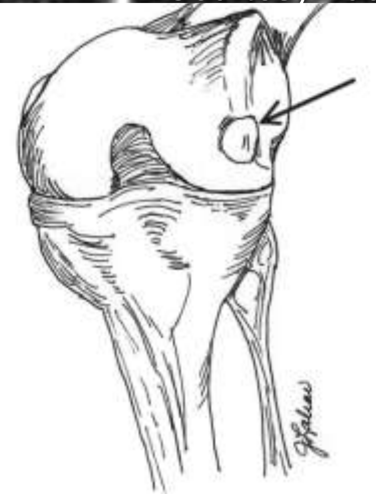
- Additional sites of osteochondral injury
  1) lateral aspect of femoral trochlea
  2) weight-bearing surface of the
     lateral femoral condyle

- Mafoosh: These injuries may occurs with the knee more flexed than the typical patella dislocation

- Shear forces across the mid-lateral femoral condyle from tibiofemoral contact in valgus rotation, either during dislocation or reduction, may alternately be responsible for this lesion.

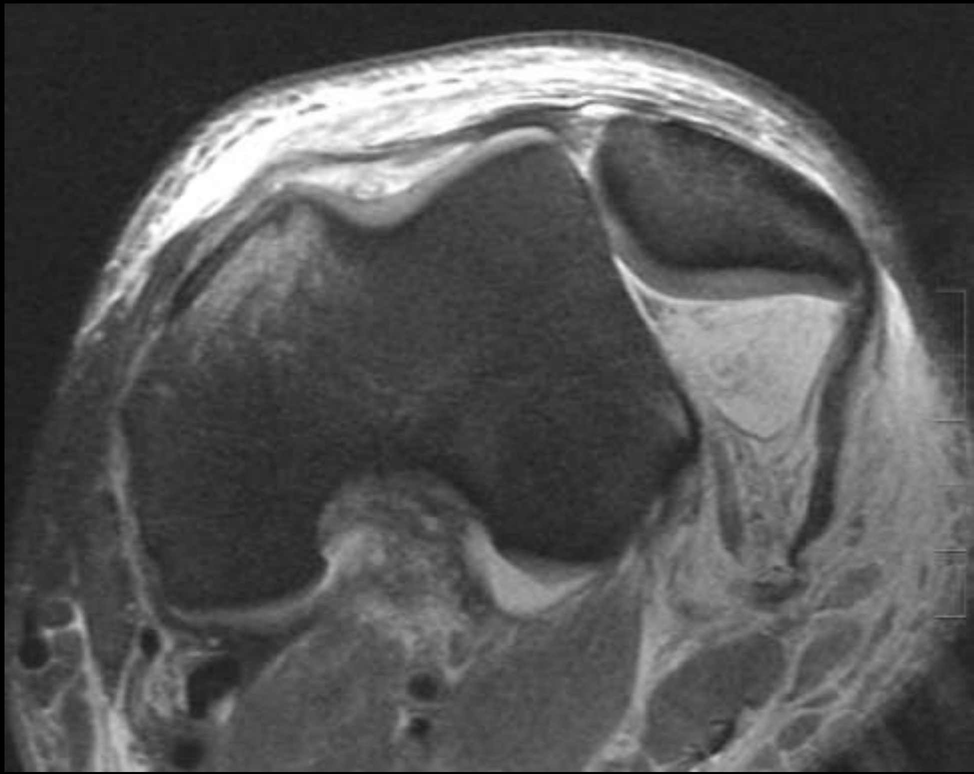


Courtesy Tudor Hugh



Mashoof AA et al. Arthroscopy. 2005 Feb;21(2):228-32.

Non-Transient Lateral Patellar Dislocation

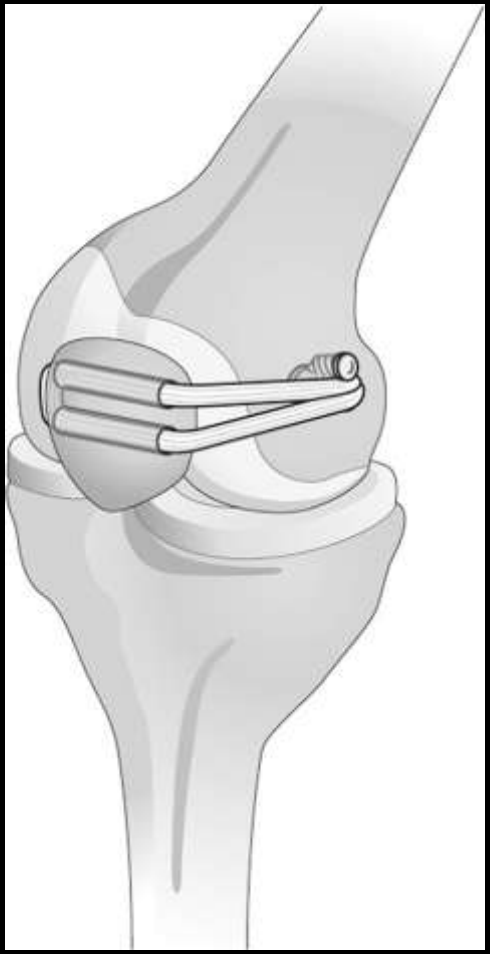


Courtesy Mini Pathria

Transient Lateral Patellar Dislocation

Treatment

- 20-44% re-dislocate if only conservatively treated
- MPFL reconstruction (if disrupted) to restore the medial tether of the patella
  - primary repair of the injured MPFL in acute patellar dislocation
  - semitendinosus, gracilis, partial quadriceps, partial patella tendon, partial semimembranosus, vastus medialis retinaculum, and allografts or artificial tendons
  - rates of redislocation of only 0% to 10%
- MPFL reconstruction in recurrent patellar dislocation
  - usage of additional procedures combined with MPFL reconstruction is controversial



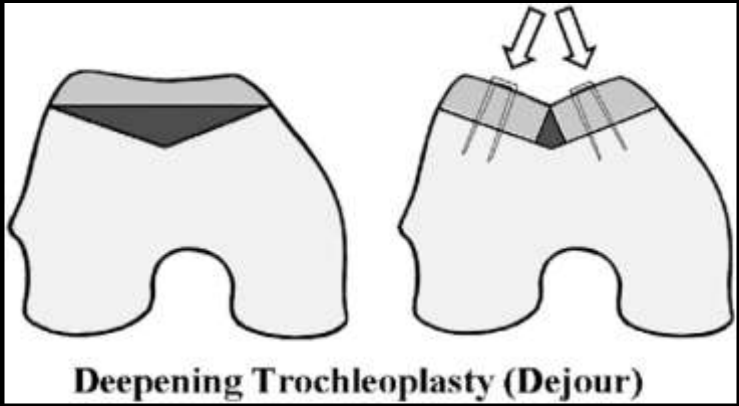
MPFL reconstruction performed with the gracilis tendon looped through two 4.5-mm patellar drill holes, passed under the fascia, and fixed in a 7-mm drill hole in the medial femoral condyle with an absorbable interference screw.

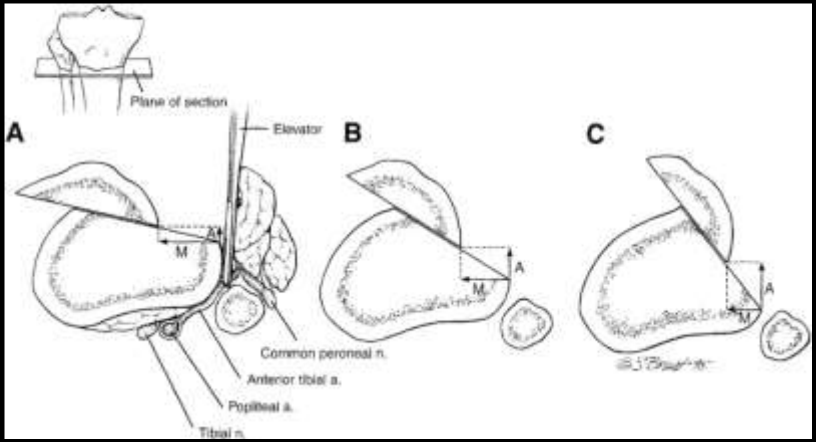
Christiansen SE et al. Arthroscopy. 2008 Aug;24(8):881-7.

Transient Lateral Patellar Dislocation

Treatment

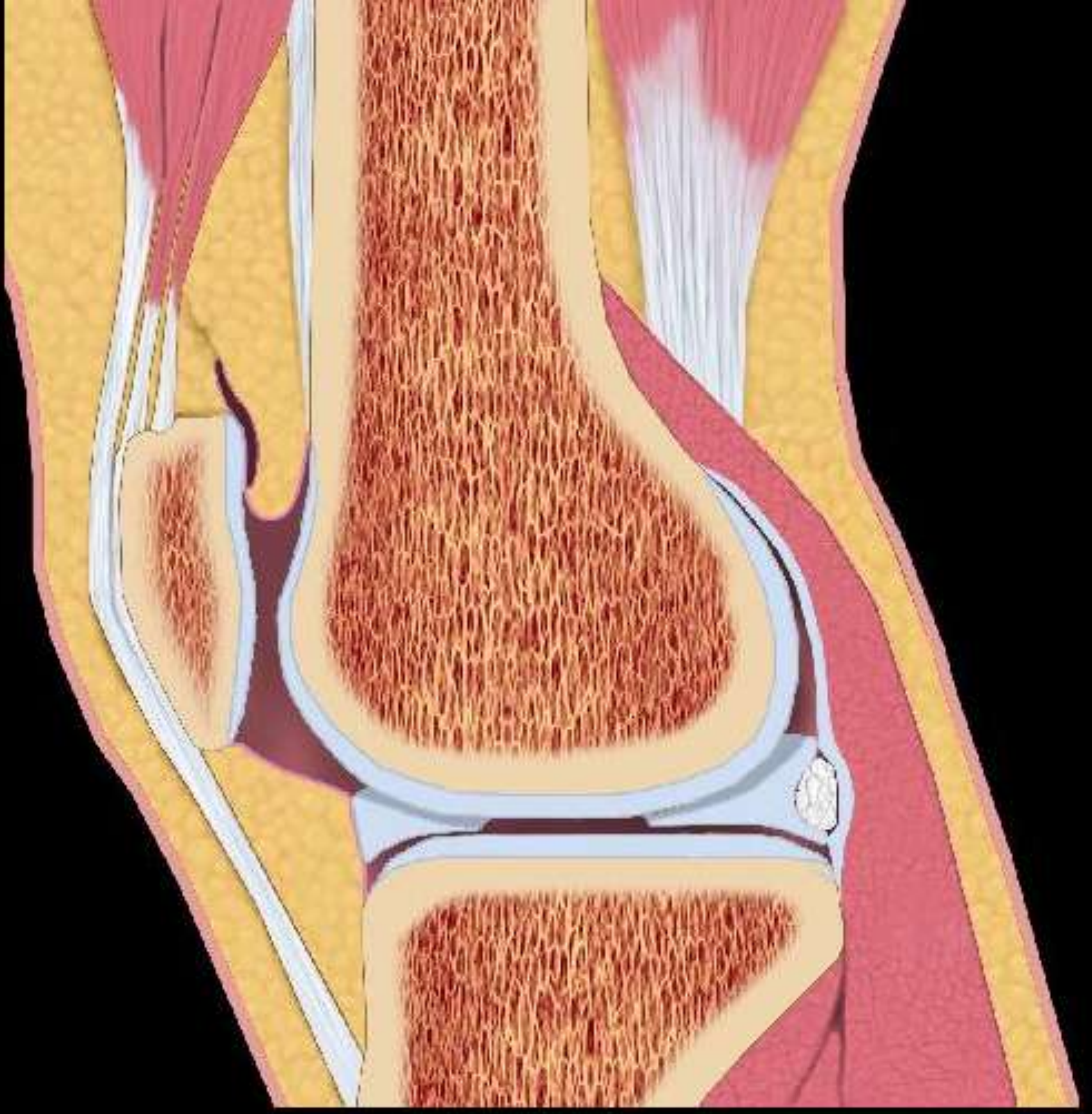
- Optimal surgical treatment for chronic patellar instability is still being debated
- Proximal realignment procedures
    - medial retinacular plication
    - lateral capsule release
- Trochleoplasty
- Distal realignment
    - tibial tubercle repositioning





Colvin AC, West RV. J Bone Joint Surg Am. 2008 Dec;90(12):2751-62.

The Patella

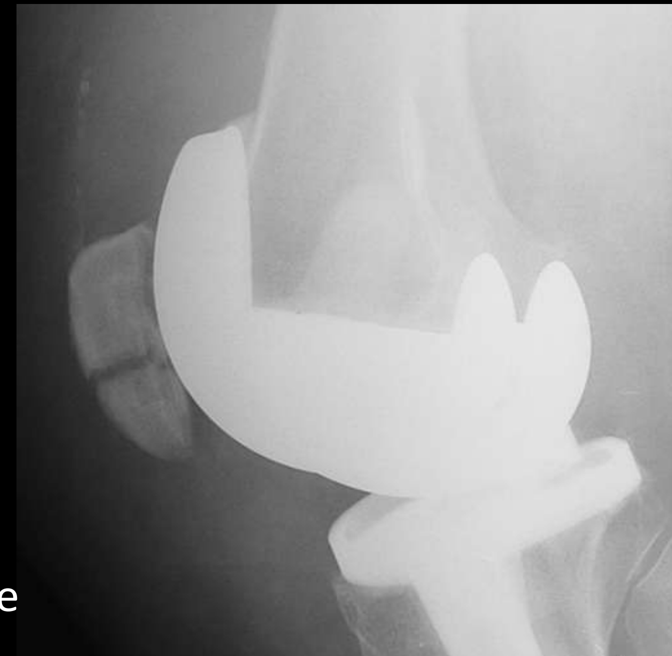


Patellar Pathology

- Patellar Fracture
- Bipartite Patella
- Dorsal Defect of the Patella

Patellar Facture

- **Patella** > quadriceps > patellar tendon
- <u>Indirect trauma</u>
  - usually occurs in the setting of a fall, which elicits violent quadriceps contraction
  - fracture is usually transverse in orientation [Sonin]
  - degree of distraction depends on whether or not the retinacula is disrupted
- <u>Direct trauma</u>
  - fracture is more likely to be comminuted or stellate, depending on the force of impact
- <u>Other settings</u>:
  - TKA (0.5% to 3.8%; first few years post-op)
  - ACL reconstruction with autologous middle third patellar bone block (first 8-10 weeks rehab)(higher risk is accelerated rehab program)



Chun KA et al. AJR. 2005 Sep;185(3):655-60.

Miller MD et al. Arthroscopy. 1999 Sep;15(6):640-3.

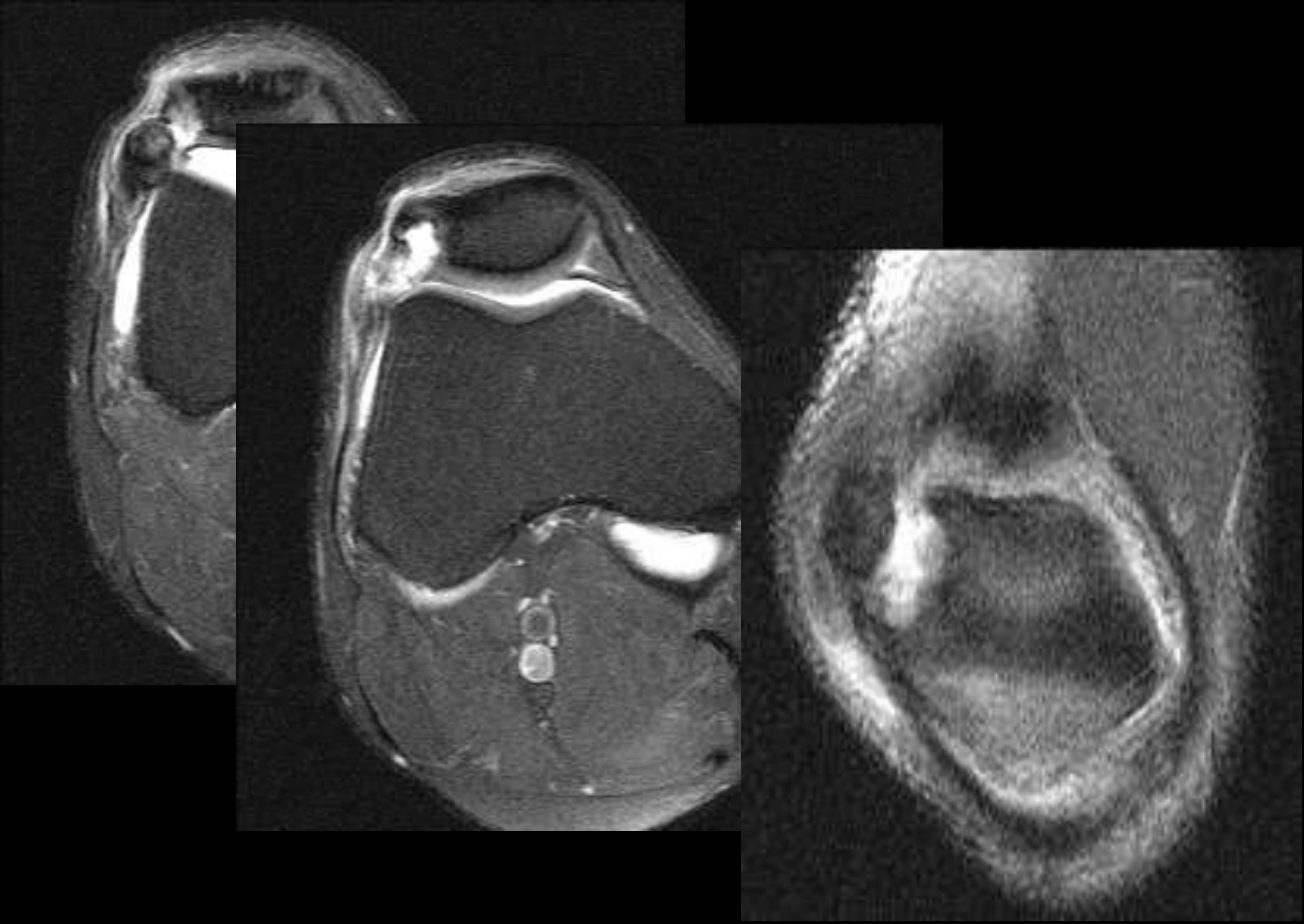
Patellar Facture

The superior pole is displaced upward by the deep fibers of the distal quadriceps tendon.

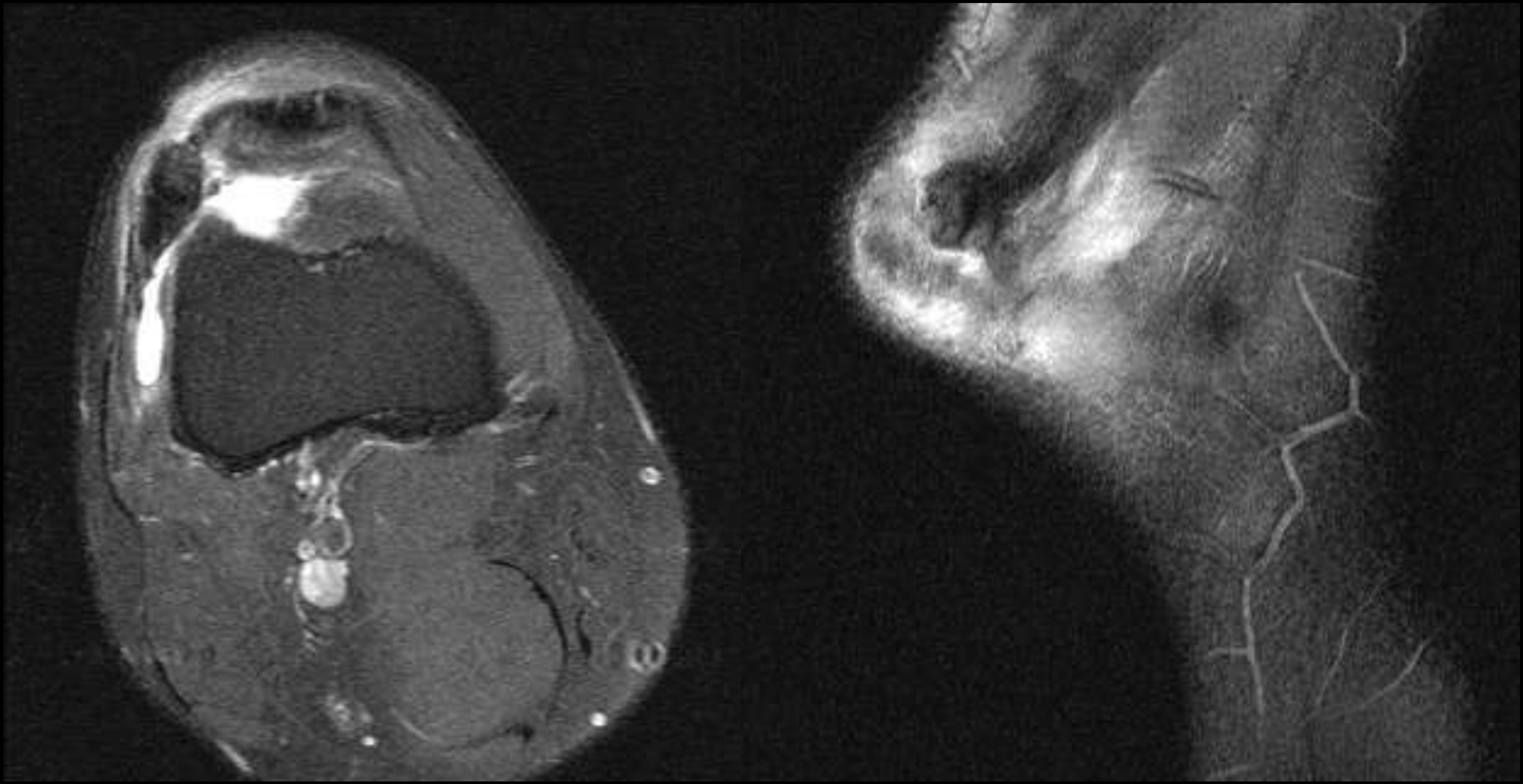
The more superficial fibers remain attached to the distal patellar fragment.

Dwek JR, Chung CB. Pediatr Radiol. 2008 Sep;38(9):925-35.

32-year old woman with knee pain following trauma



Case from Scripps



Case from Scripps

Bipartite Patella and Dorsal Defect

- The bipartite patella and the dorsal defect are usually thought of as normal variants of ossification, which is supported by the high incidence of bilateral lesions
  - Bipartite bilateral in about 50% [Scuderi]
  - Dorsal defect bilateral in 25-33% [Scuderi]
- Some have questioned whether these are actually the result of [van Hootsbeerk]
  - chronic traction by the vastus lateralis
  - deficient vascular supply within superolateral patella
- Histological support for this theory is found in reported cases of bone necrosis at the site of the dorsal defect suggesting a pathological process.
- Despite this controversy, there are definite instances when both can be the cause of pain.

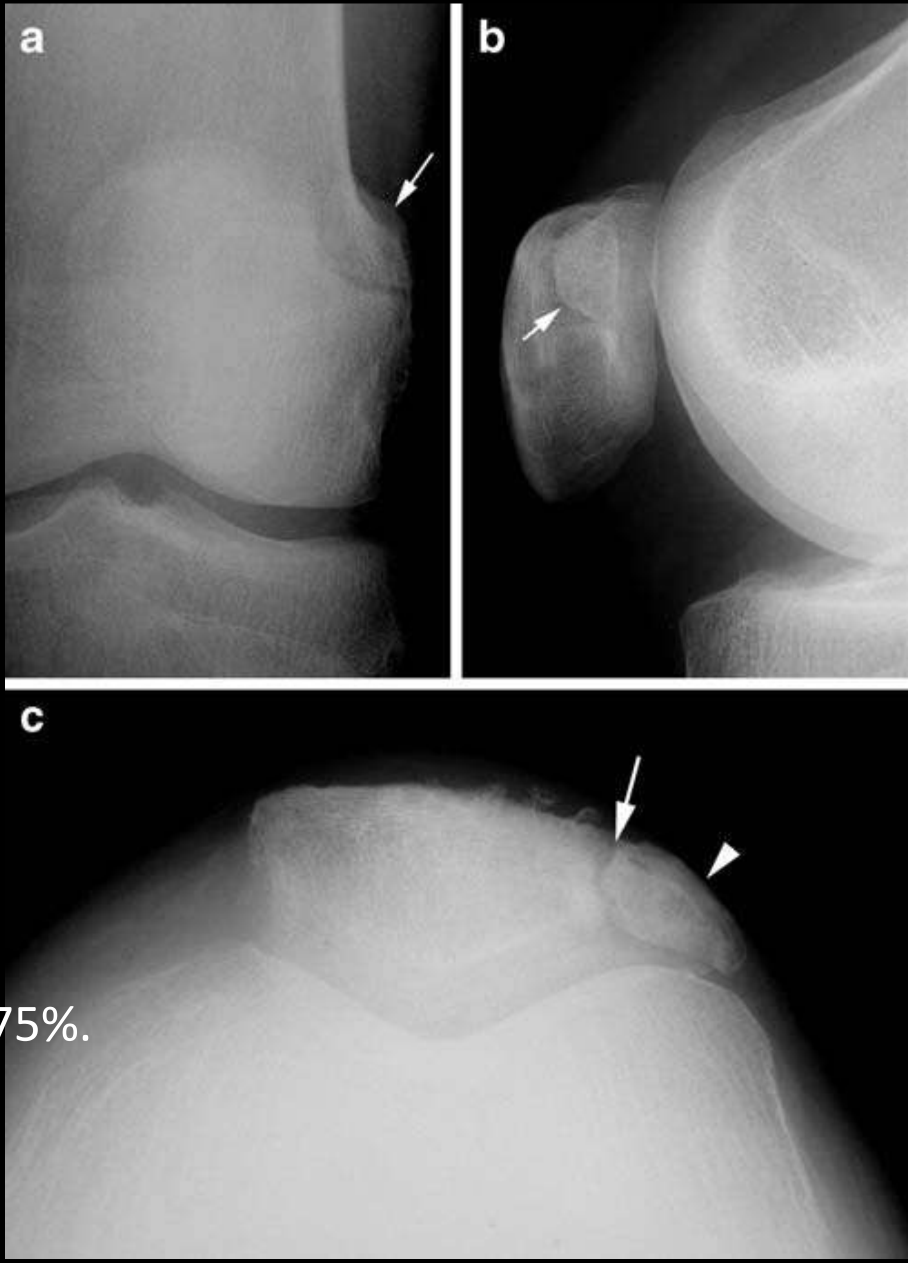
Dwek JR, Chung CB. Pediatr Radiol. 2008 Sep;38(9):925-35.

Bipartite Patella

Radiography

- < 2% of population
- 50% bilateral
- Nearly always superolateral at attachment of vastus lateralis

- Saupe classification
  - Type I, at the lower pole in 5%
  - Type II, at the lateral margin in 20%
  - Type III, at the superolateral pole in 75%.



Bipartite Patella

Radiography – Saupe Type I Bipartite Patella

(A)
Lateral radiograph shows a fracture-like line at the lower pole of the patella.

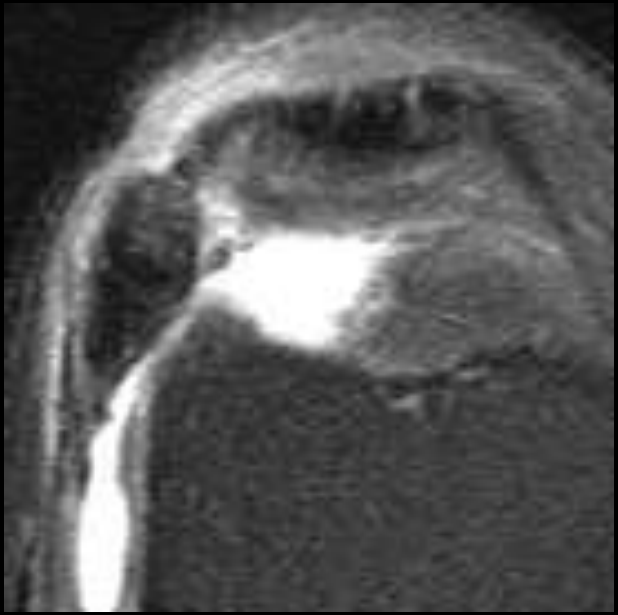
(B)
Oblique radiograph reveals the abnormality to represent a corticated ossicle that has become displaced.

Okuno H et al. Clin Orthop Relat Res. 2004 Mar;(420):257-60.

Bipartite Patella

Development

- Superolateral ossification center fails to fuse
- Remains separated by fibrocartilaginous tissue
- Posterior surface is covered by a layer of articular cartilage in continuity with the articular cartilage of the main body of the patella
- The accessory center takes at least some of the insertion of the vastus lateralis



Bipartite Patella

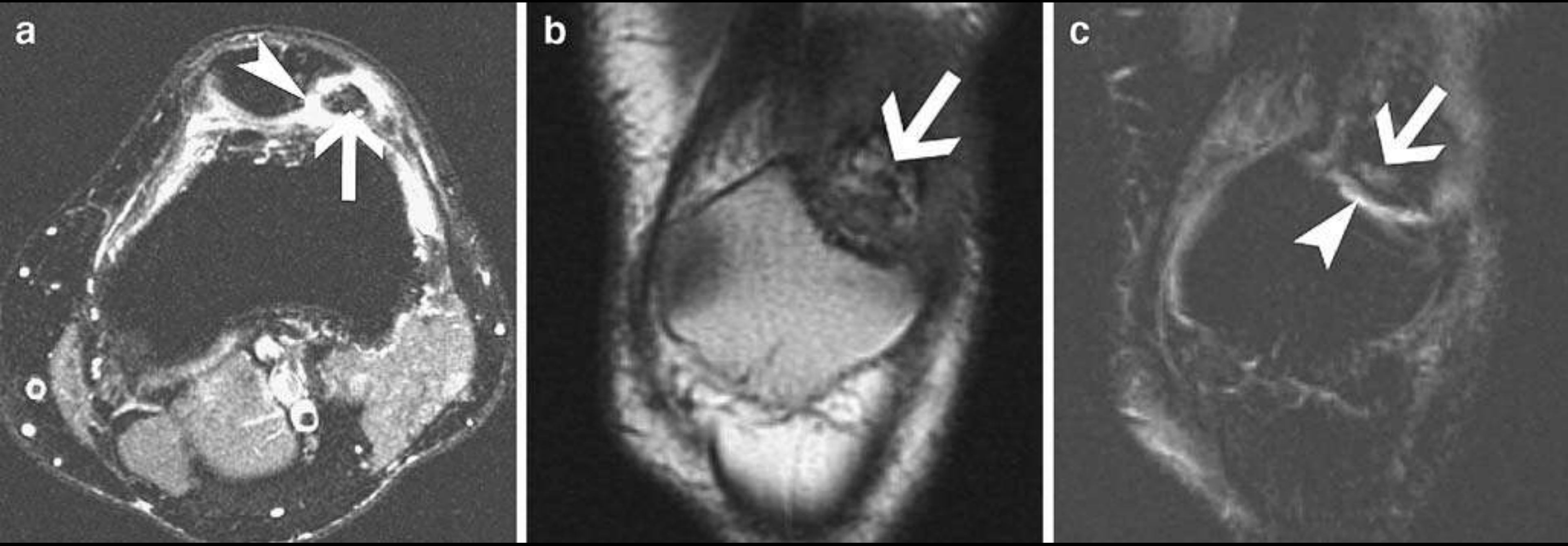
MR Imaging

- In patients with anterior knee pain, edema may be present at the interace between the two bony surfaces, indicating dysfunctional motion
- Superolateral fragment can become displaced spontaneously or while squatting.
- Most patients are managed conservatively; less frequently surgery is undertaken

Kavanagh EC et al. Skeletal Radiol. 2007 Mar;36(3):209-14.

Bipartite Patella

MR Imaging

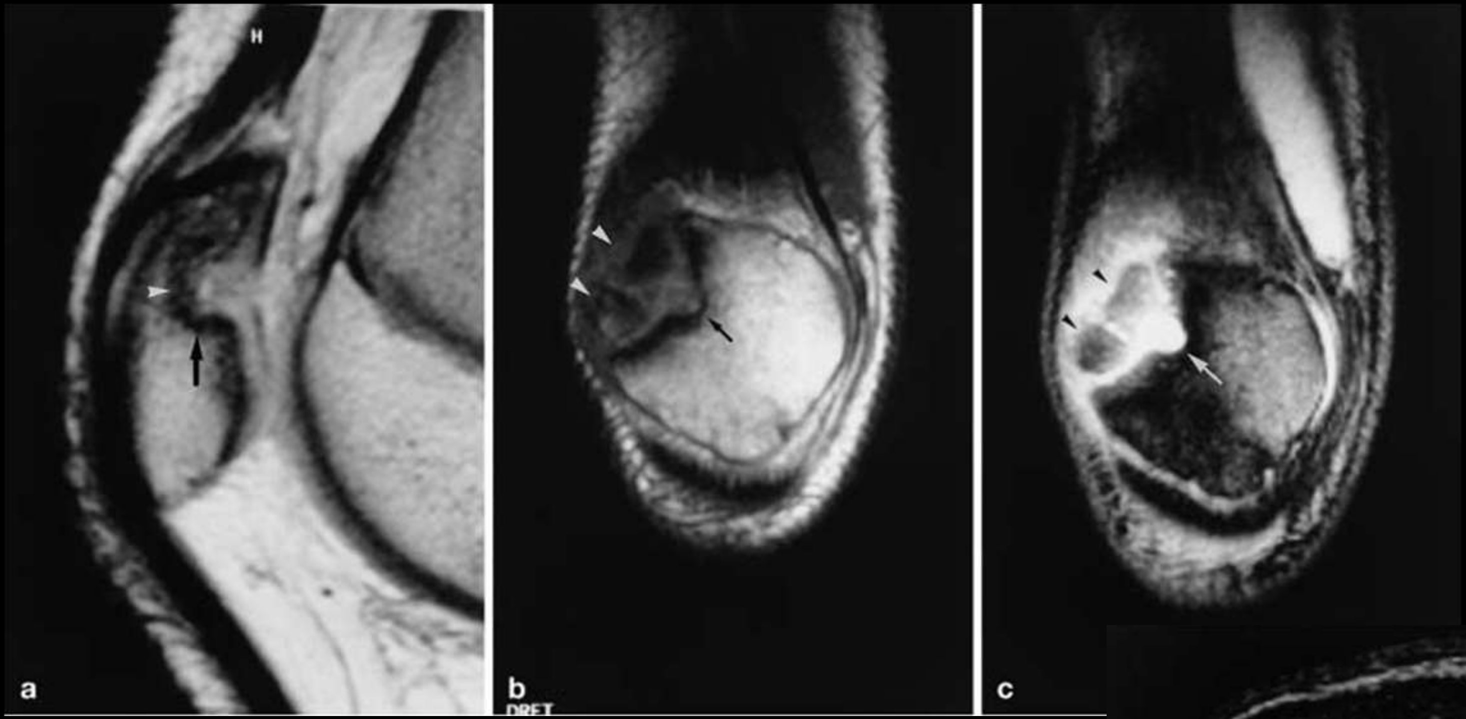


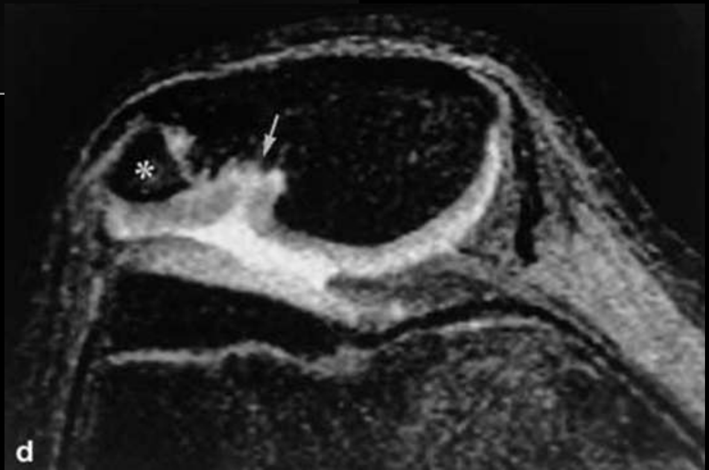
Bipartite patella (arrow) with fluid bright signal at the interface between it and the patella (arrowhead), typical for a pseudarthrosis.

Kavanagh EC et al. Skeletal Radiol. 2007 Mar;36(3):209-14.

Bipartite Patella + Dorsal Defect

MR Imaging





Mellado JM et al. Eur Radiol. 2001;11(7):1136-9.

Dorsal Defect of the Patella

Radiography

- First reported by Caffey in 1972
- Benign subchondral lesion of unknown etiology
- 0.3% - 1% of the population
- Bilateral in 25-33%
- 75% of patients diagnosed at 10-20 years of age with no cases before age 10
- Most likely developmental, with gradual partial or complete resolution spontaneously

Sueyoshi Y et al. Arthroscopy. 1993;9(2):164-9.

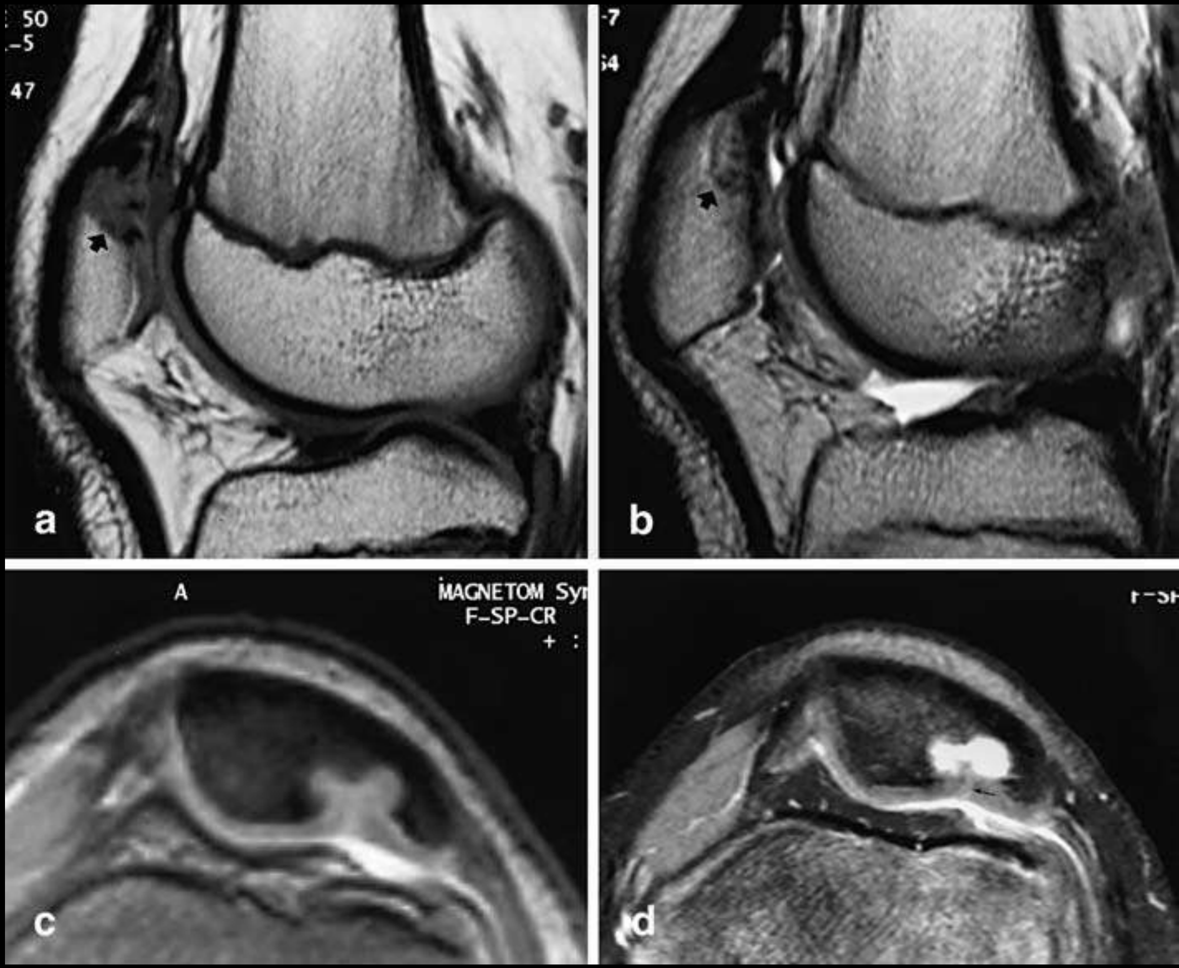
Dorsal Defect of the Patella

MR Imaging

MR signal intensity of the defect usually mirrors that of the overlying cartilage.

Areas of necrosis and fibrosis have been identified within the defect, which can cause some inhomogeneity of the signal intensity.

The overlying cartilage should be closely inspected, as it might fissure and thin and be the cause of symptoms

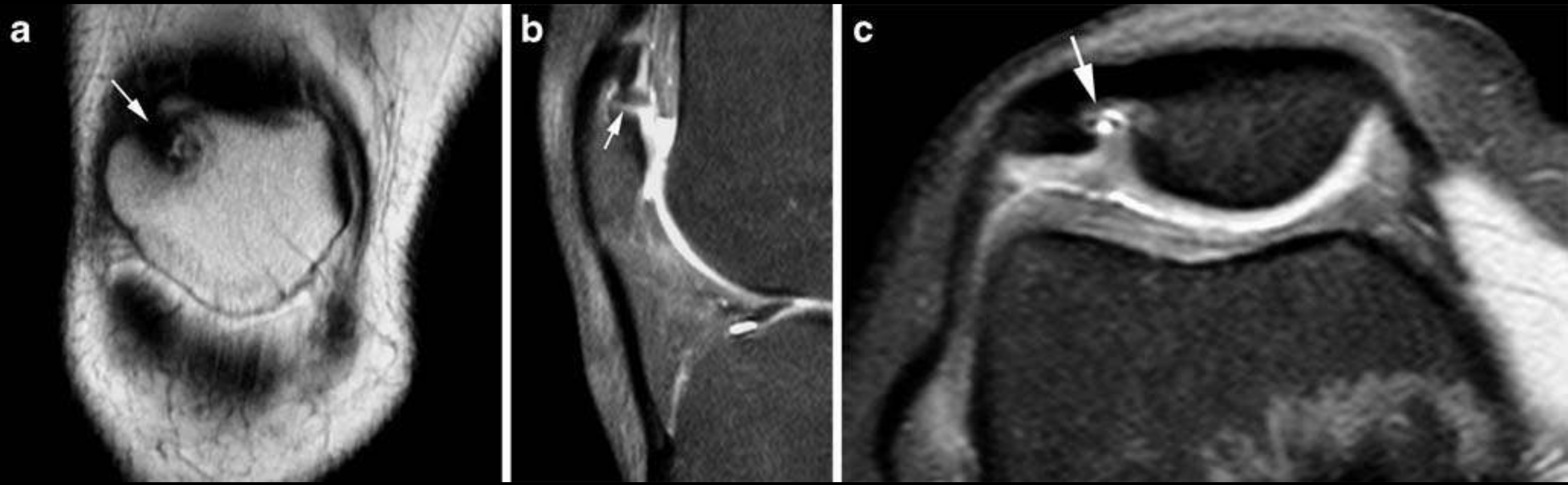


Contrast fills the dorsal defect

Locher S et al. Arch Orthop Trauma Surg. 2002 Nov;122(8):466-8.

Dorsal Defect of the Patella

MR Imaging



Hedayati B, Saifuddin A. Skeletal Radiol. 2009 May 1. [Epub ahead of print]

Subchondral bony defect (arrows) in the superolateral aspect of the patella into which the articular cartilage extends

Friday Conference case

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