EMORY HEALTHCARE

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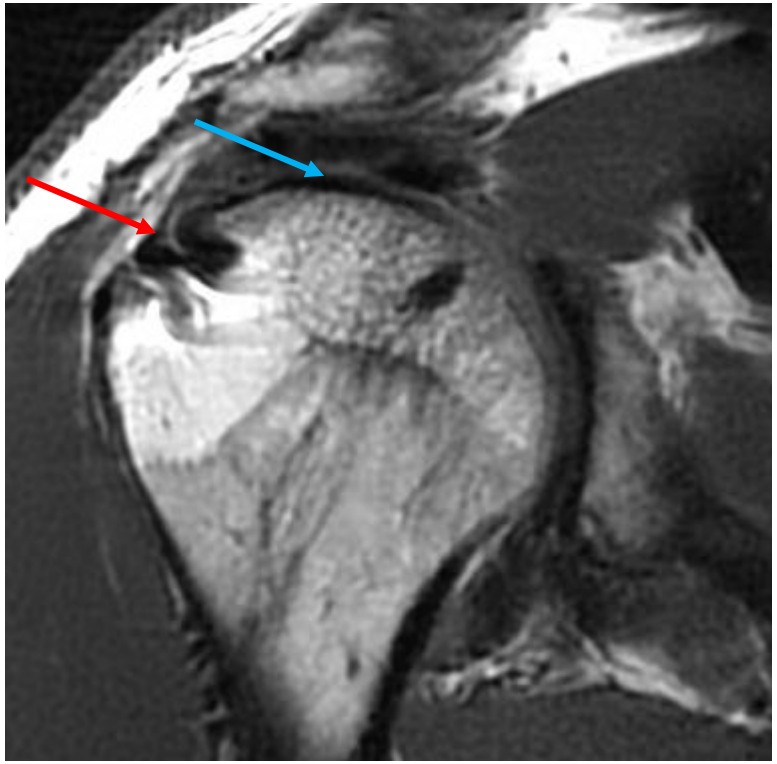
Arthroscopy / MRI Correlation Conference

Department of Radiology, Section of MSK Imaging
Department of Orthopedic Surgery

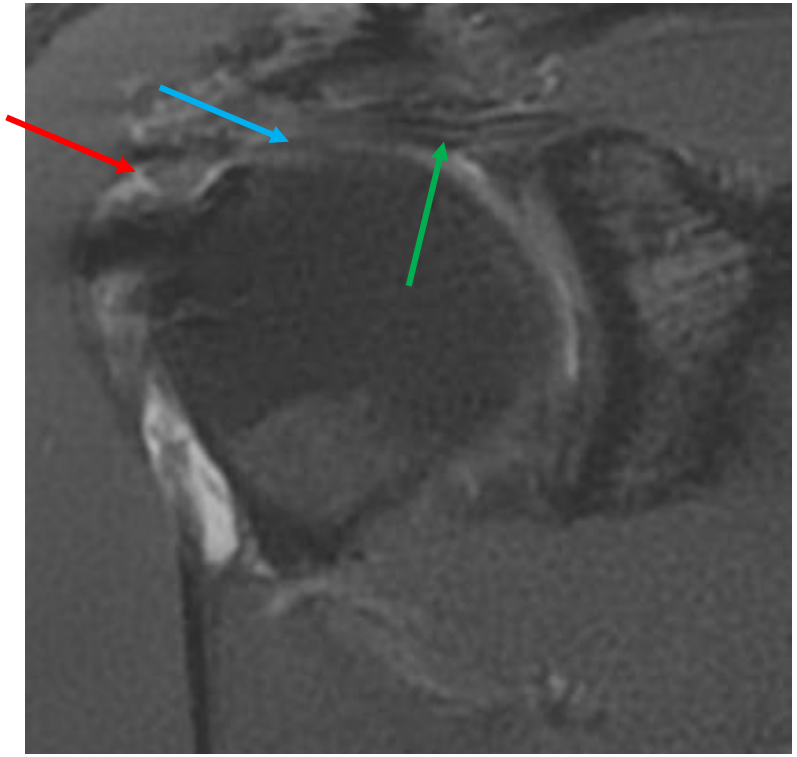
Conference #3

Case 1: Shoulder

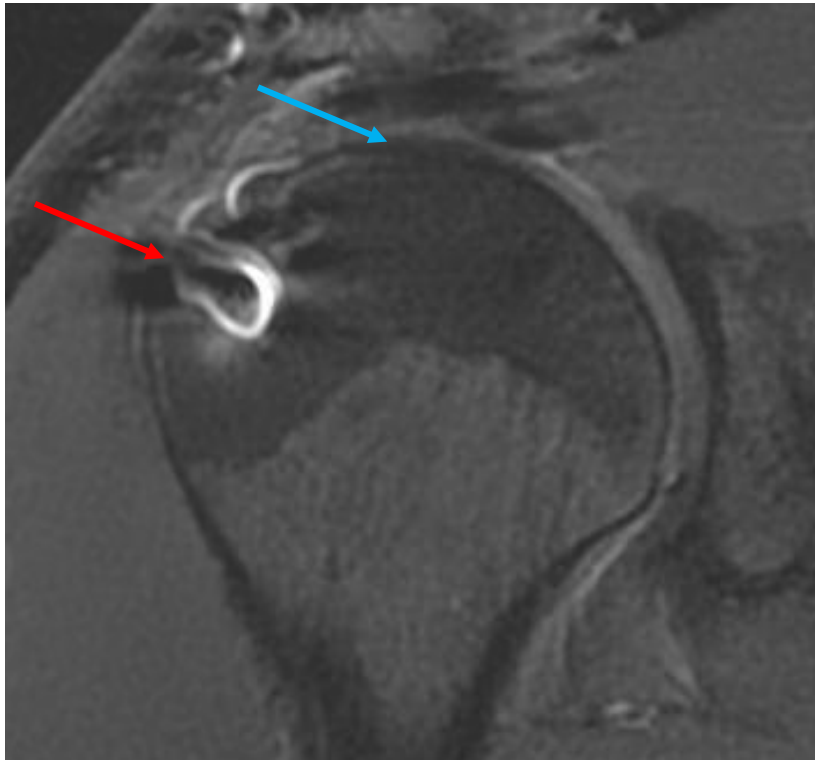
- 51 YOM who presents to clinic with acute on chronic left shoulder pain.
- Status post open left rotator cuff repair in 2002.
- No issues following repair until January 2016. During this time the patient injured his left shoulder during exercise which included circuit work outs that consisted of rapid alternations between bench press and push-ups. Patient progressed well with his shoulder rehab and a PRP injection was performed in December 2016.
- Since his last clinic visit in May, had US evaluation and PRP injection of the supraspinatus tendon. The MRI which we will look at is before the PRP injection.
- In August, raised his left arm during football practice and felt a small pop in his shoulder. He had immediate aching pain that exceeded 8/10. Today, he rates his pain as 0/10 at rest and 4/10 with motion but notes motion has been severely limited for several days. He has been taking Aleve and applying peppermint with some relief since the event.
- He has been modifying his lifting routine and notes little to no change over the last 6 weeks since the PRP. Today, he returns with an acute injury that has further exacerbated his previous symptoms. He also reports anterior shoulder pain with biceps curls.



Cor PD



COR PDFS



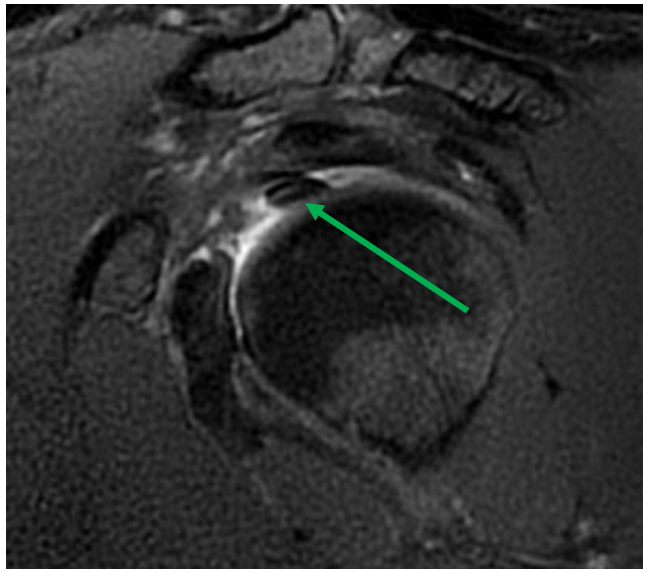
COR PDFS

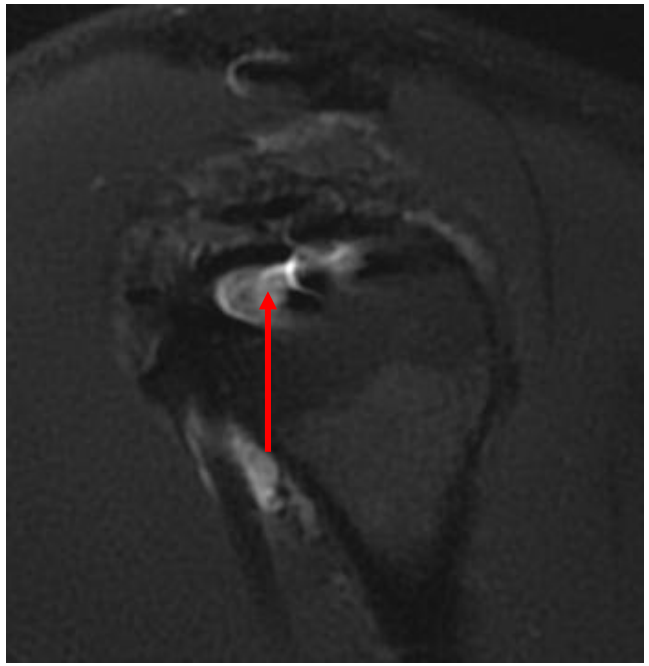
Suture anchors at supraspinatus footprint cause susceptibility artifact which limit evaluation in the region (red arrows).

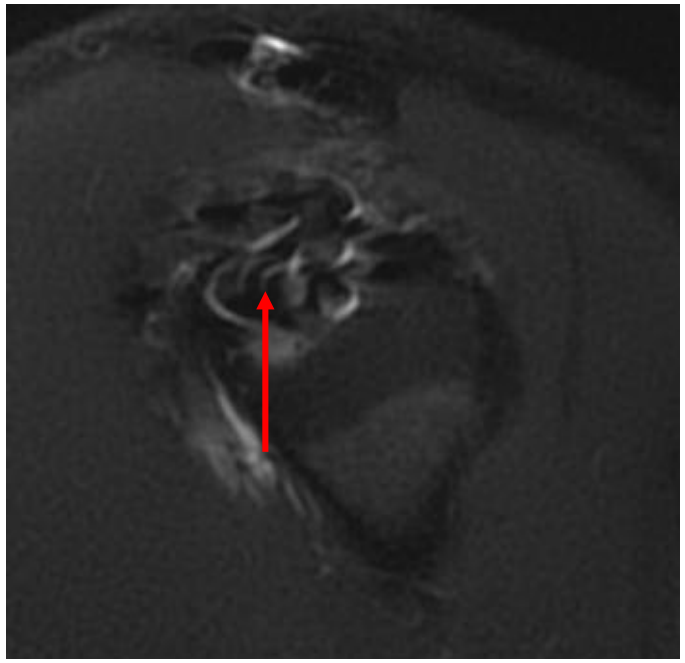
Thinning of the cartilage along superior humeral head (blue arrows).

Linear intermediate PDFS signal in the intraarticular portion of the long head of the biceps tendon (green arrow).

Supraspinatus tendon irregular and mildly attenuated medial to footprint, but difficult to evaluate due to hardware. No fluid cutting through tendon.







COR PDFS

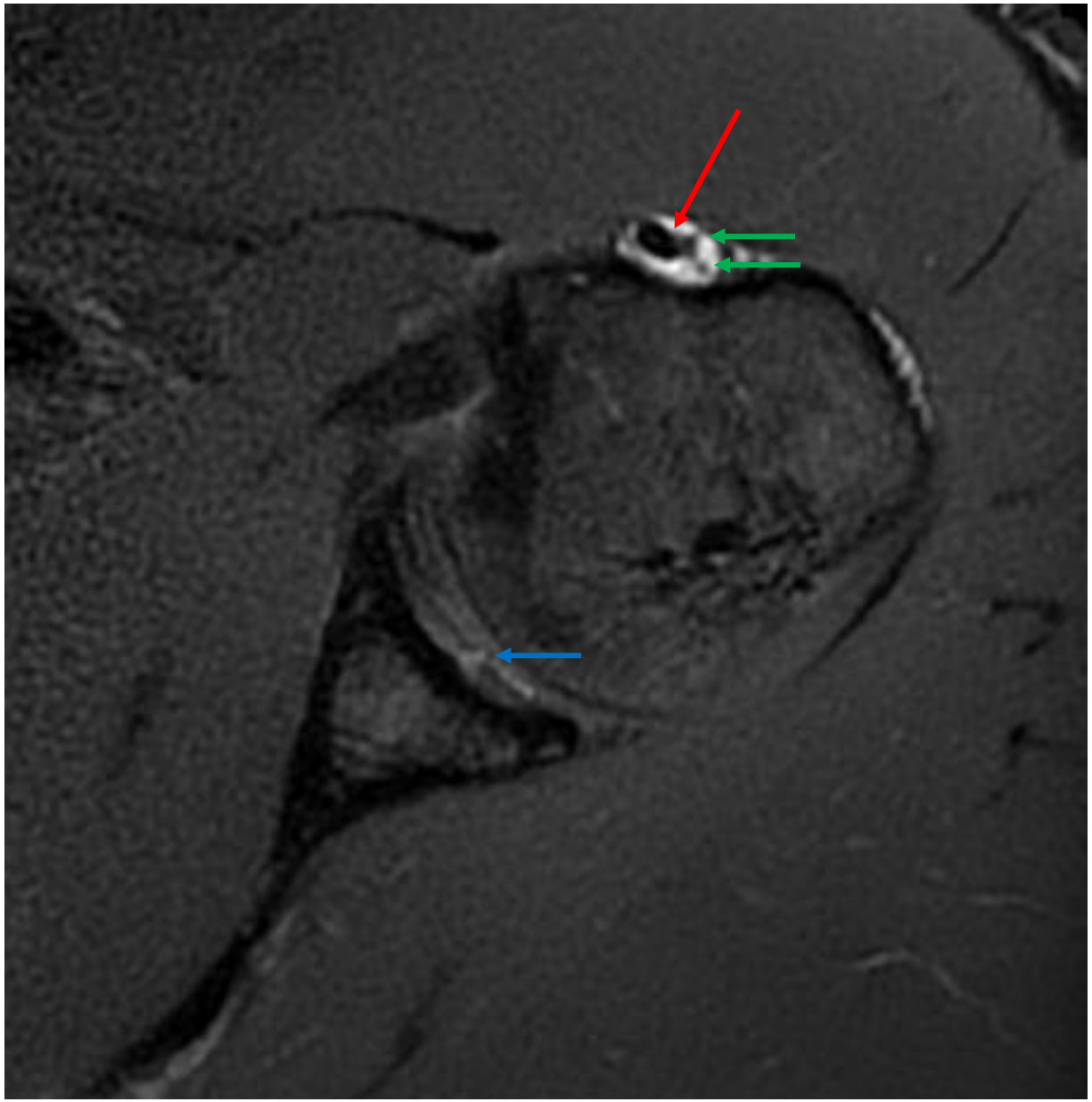
from medial to lateral (top left to bottom right)

Suture anchors at supraspinatus footprint cause susceptibility artifact which limit evaluation in the region (red arrows).

Linear intermediate PDFS signal in the intraarticular portion of the long head of the biceps tendon (green arrow).

Subscapularis partial thickness tear (articular side, yellow arrow).

AX PDFS



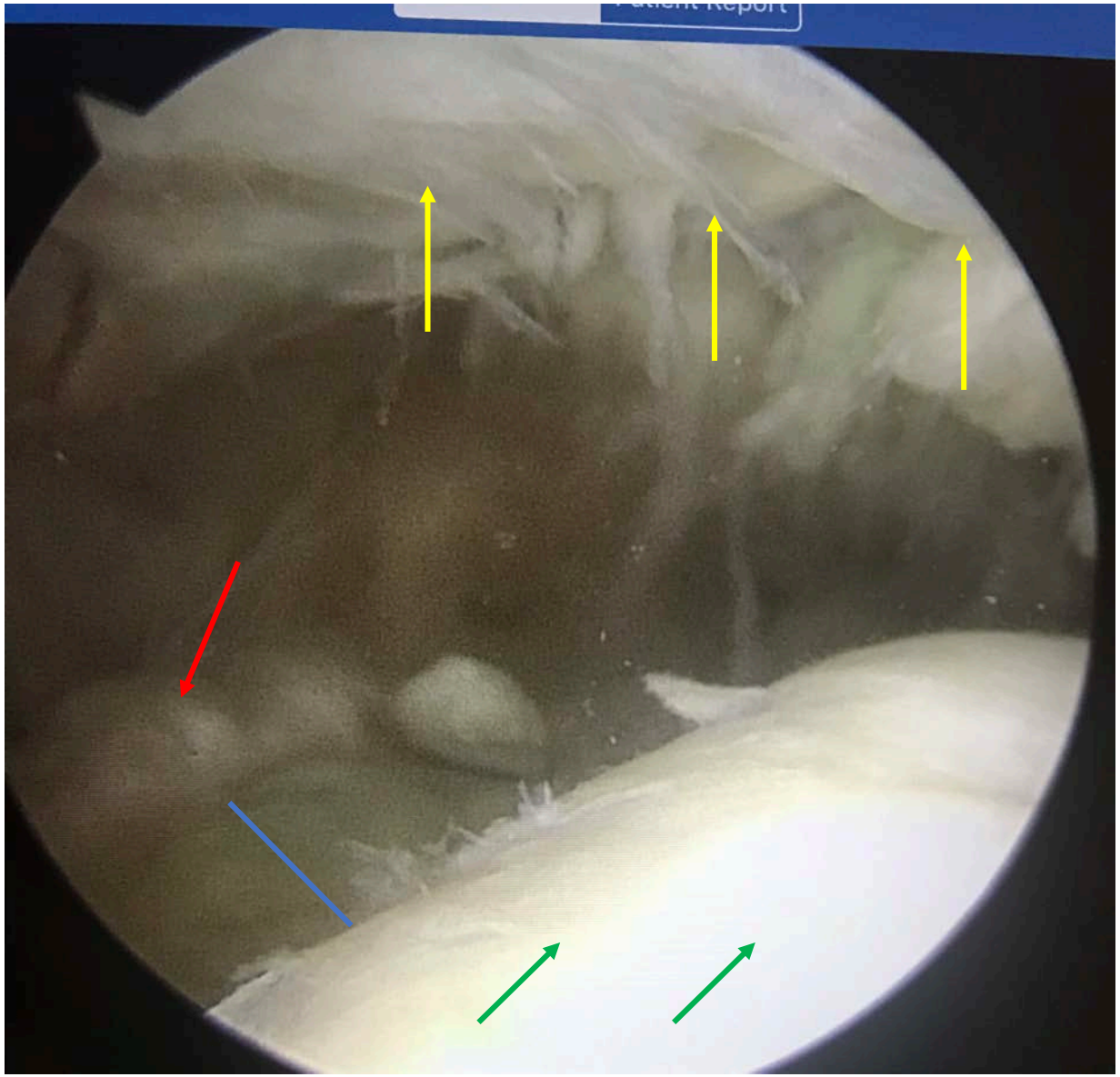
Fluid in LHB tendon sheath (red arrow).

Mesotenon (green arrow).

Cartilage irregularity posterocentral glenoid (blue arrow).

Articular view

lateral is on left of image, medial on right



Severally frayed and irregular articular surface fibers of the supraspinatus tendon hangs down (yellow arrows).

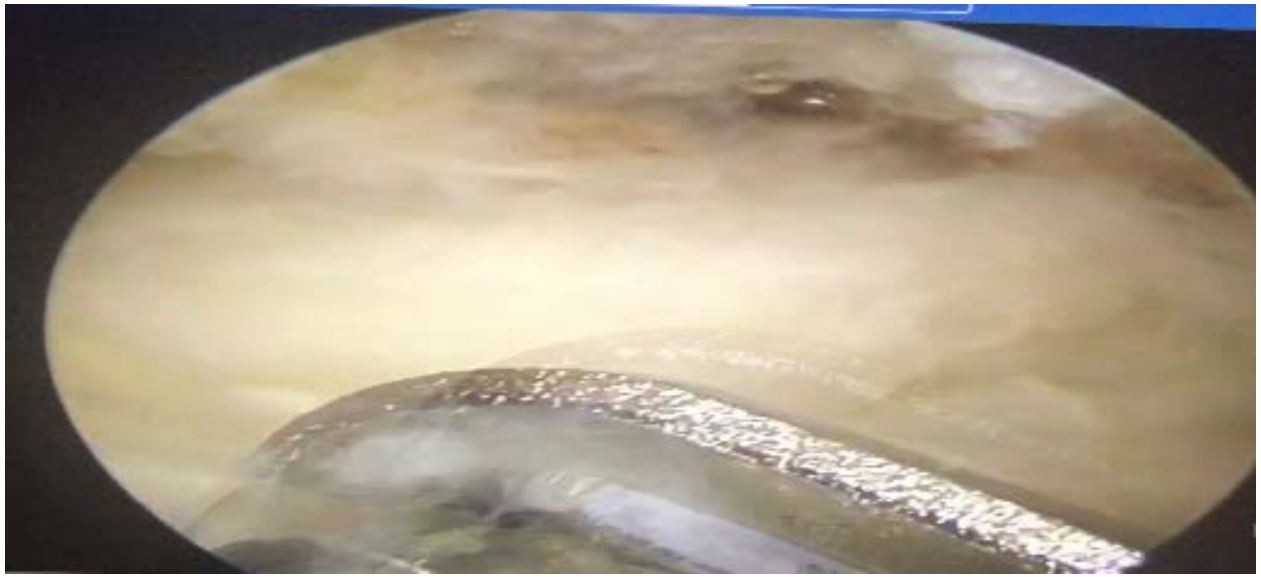
Minimal tissue seen at the footprint (red arrow). Medial to this, there is an area of bear footprint (blue line).

Medial to the bare footprint is the articular surface of the humeral head (green arrows).

More lateral, thin tendon fibers or scar attach to the footprint (high grade partial thickness articular sided tear).

No full thickness tear. Cannot see up through the cuff into the subacromial space.

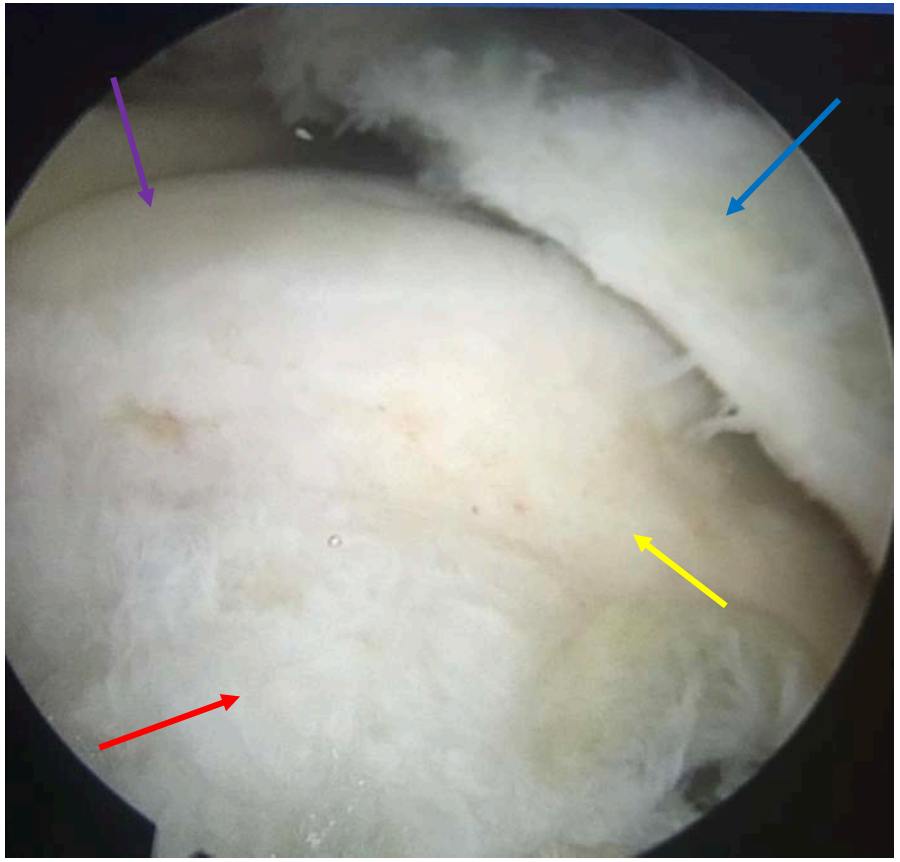
Bursal view



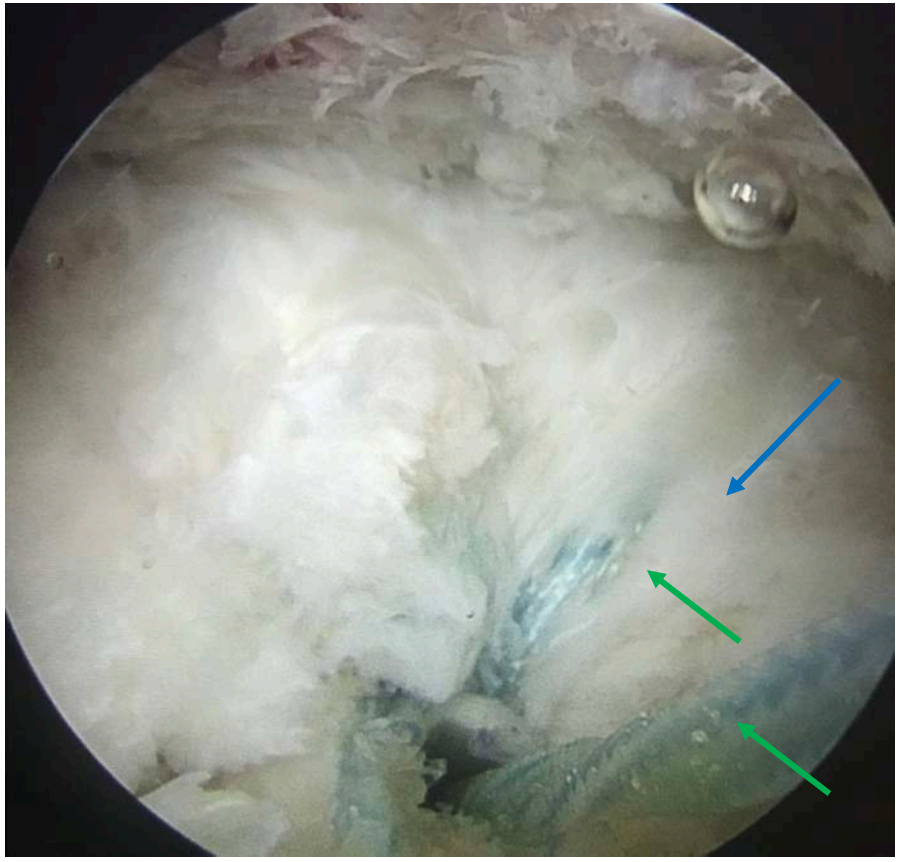
Selected stills from video clip (next slide) showing the shaver passing on top and debriding the bursal surface. More laterally (not shown) very thin tendon remained and debriding converted the partial thickness tear into a full thickness tear.

Subacromial/subdeltoid bursa synovial tissue seen along superior edge of the images.

Pre-repair, bursal side. Lateral to left, medial to right.



Post-repair, bursal side. Lateral to left, medial to right.



U shaped 2 X 2 cm tear with foot print fibers laterally (red arrow) and retracted tendon stump medially (blue arrow).

The humeral head can be seen below the tendon gap. There is intermediate to high grade chondral loss along the superior humeral head (yellow arrow) with more normal appearing cartilage posterior (purple arrow).

After the repair, the gap is closed and the stump has been lateralized and secured with suture anchors (green arrows).

Case 1: Shoulder

Diagnosis: High grade partial thickness articular sided tear.

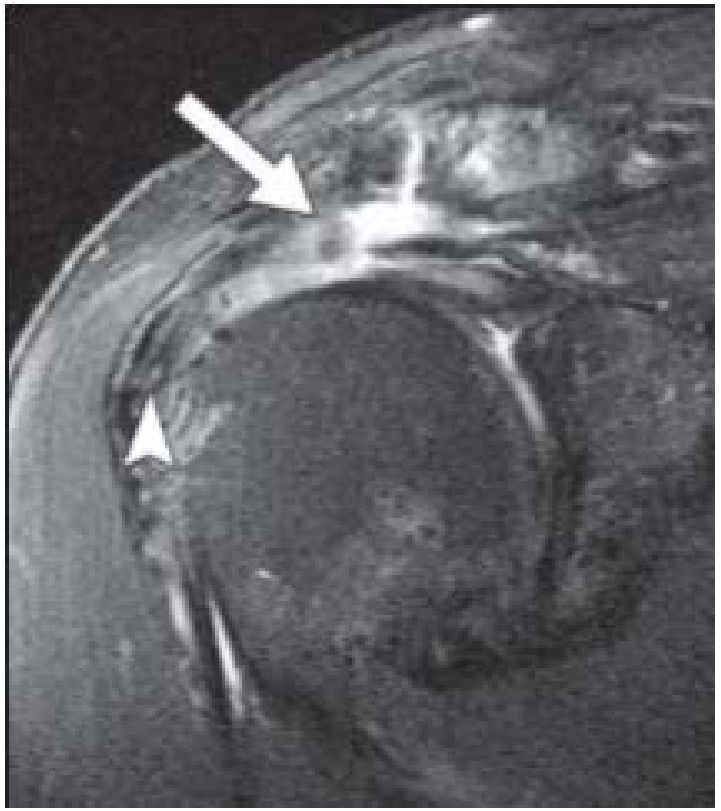
- Other findings:
  - Normal (pristine per the report) long head of the biceps tendon.
  - Fraying of articular surface subscapularis, but no tear.
  - Grade 3+ cartilage loss superior humeral head.
  - Minimal posterior superior glenoid cartilage wear.
  - Anterior acromial spur.

- Surgery performed:
  - Supraspinatus tendon repair.
  - Subacromial / subdeltoid bursectomy.
  - Subacromial decompression with spur removal.
  - Humeral head chondroplasty.

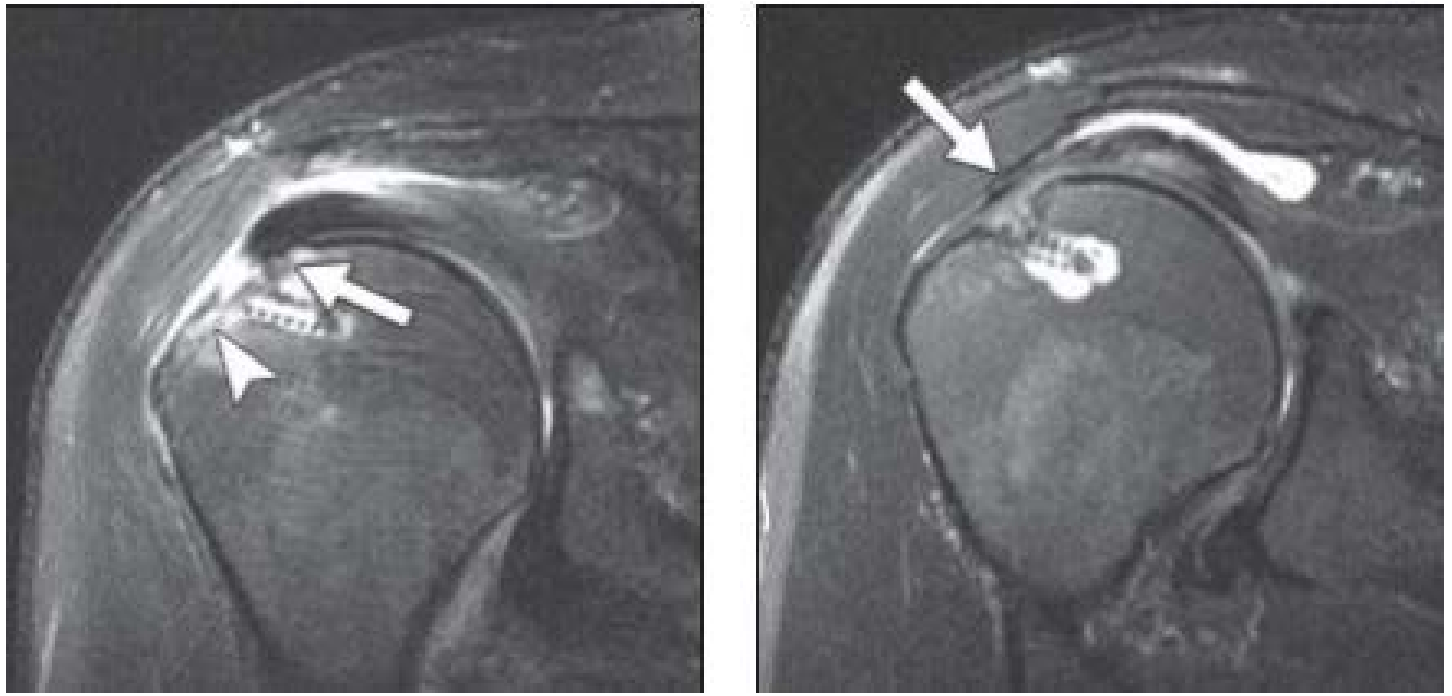
Case 1: High grade partial thickness tear in setting of prior cuff repair.

- Information and pearls:
  - MRI has a high sensitivity and specificity for detection of RCT prior to surgery.
  - MRI has a high sensitivity and specificity for detection of recurrent full thickness tears by two primary signs:
    - Fluid T2 signal passing through tendon substance.
    - Tendon non-visualization.
    - 90% accuracy --- Radiology. 1993 Feb;186(2):443-7. (1.5 T magnet, not MRA)
    - 100% sensitivity reported by Crim *et al*. AJR. 2010;195: 1361-1366, with one false positive
  - Large studies specifically looking at accuracy of MRI to detect recurrent partial thickness tears lacking, but probably low accuracy based on available data.
    - 0/5 detected --- Radiology. 1993 Feb;186(2):443-7.
  - There is a reported MRI temporal evolution of the repaired cuff tendon.
    - Crim reports the repaired tendon may look thinned, frayed or irregular, may have increased T2 signal (less then fluid) and the footprint may look undercovered. This may be seen for at least up to a year in intact tendons.

Case 1: High grade partial thickness tear in setting of prior cuff repair.



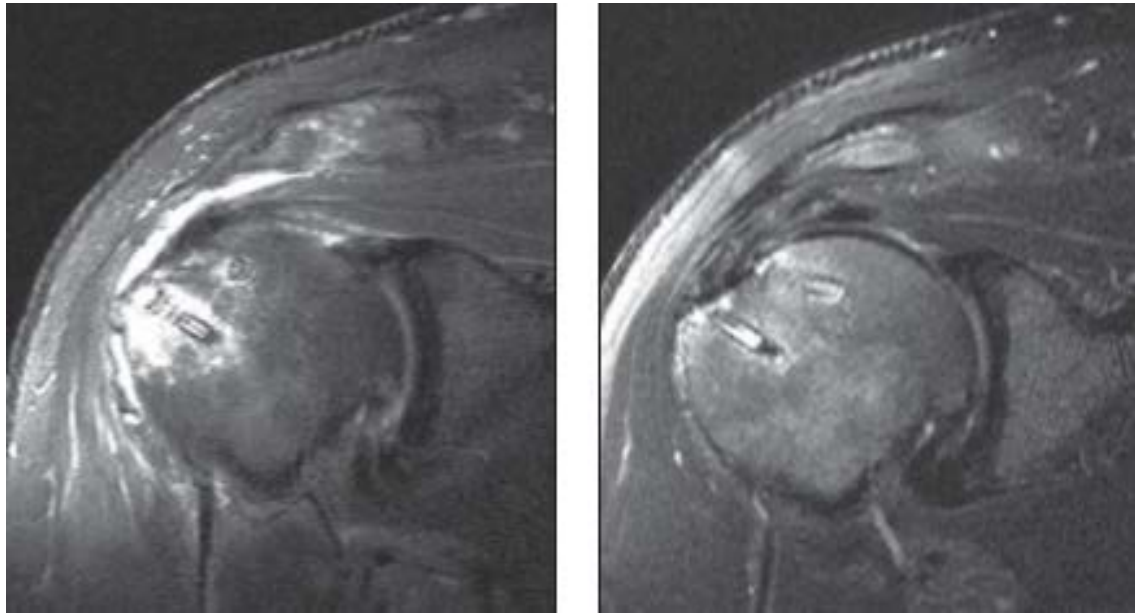
Recurrent full thickness cuff tear



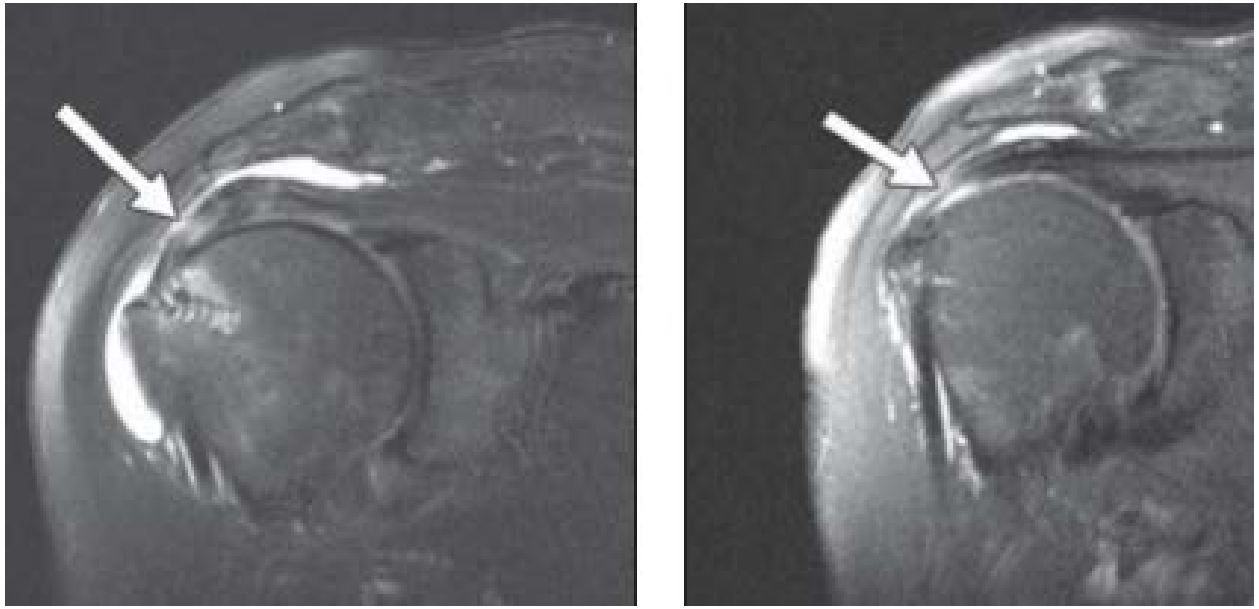
False positive for recurrent full thickness tear. On left images at 6 weeks, on right at 1 year follow up with conservative management.

AJR. 2010;195: 1361-1366.

Case 1: High grade partial thickness tear in setting of prior cuff repair.



On left images at 6 weeks, on right at 1 year. Progressive coverage of the footprint with persisting tendon heterogeneity.



On left images at 3 months, on right at 1 year. Progressive apparent thinning of the tendon despite increased clinical functional score at 1 year (though it should be noted that there was a functional score improvement in the patient with full thickness cuff re-tear).

AJR. 2010;195: 1361-1366.

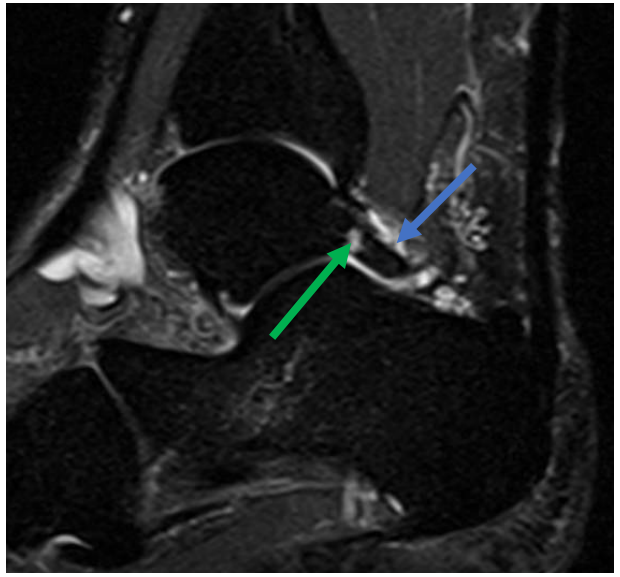
Case 2: Ankle

- 39 YOF presenting with several months of nontraumatic posterolateral ankle pain.

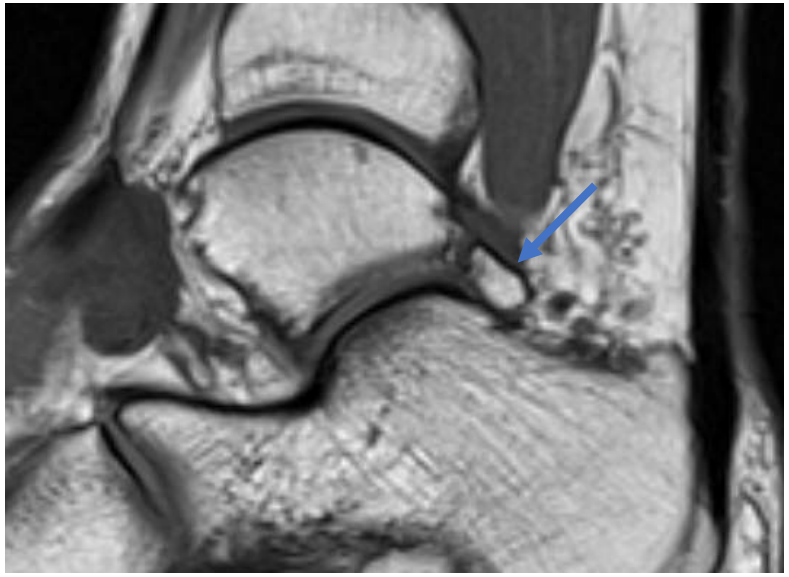
- Symptoms began with a new jogging regimen but were exacerbated by a dance class. Subsequently, any physical activity made it worse and she experienced pain at night.

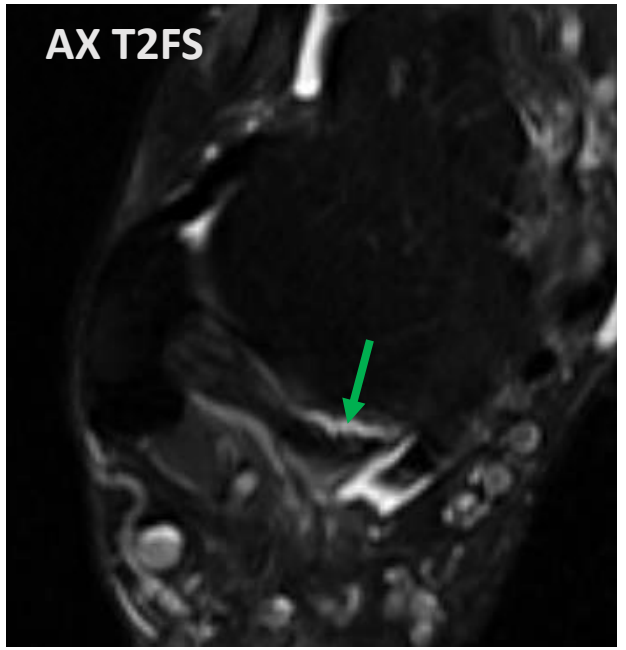
- Two joint injections were provided, the first (anterior) of which provided no relief. The second (posterior) provided some relief, but symptoms quickly recurred.

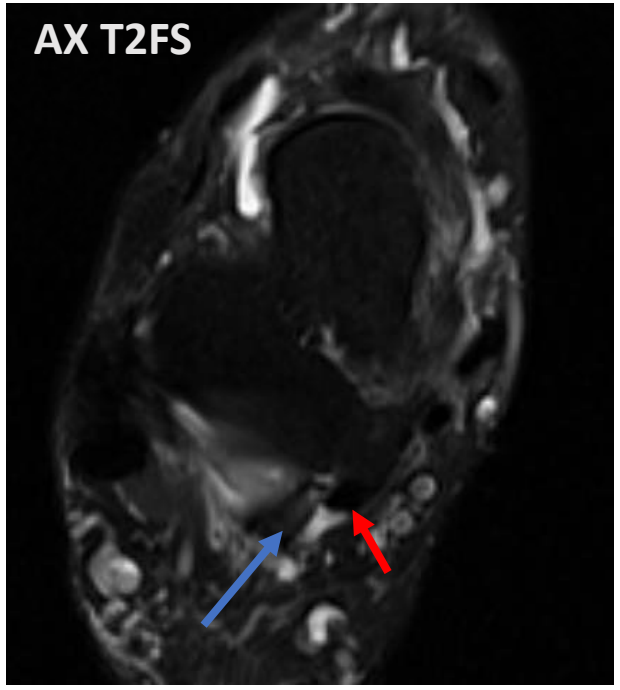
SAG STIR

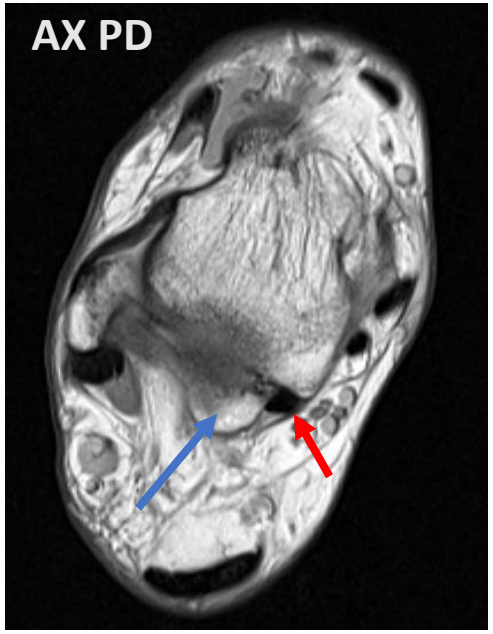


SAG T1









Multiple views of an os trigonum (blue arrows) in this patient with symptomatic posterior ankle pain. The os is surrounded by fluid and/or synovial tissue. The flexor hallucis longus (FHL, red arrow) is located just medial to the os. Fluid cuts across the synchondrosis (green arrows) which may allow for motion of the os and irritation of the bones and surrounding soft tissues.

Posterior Ankle Arthroscopy

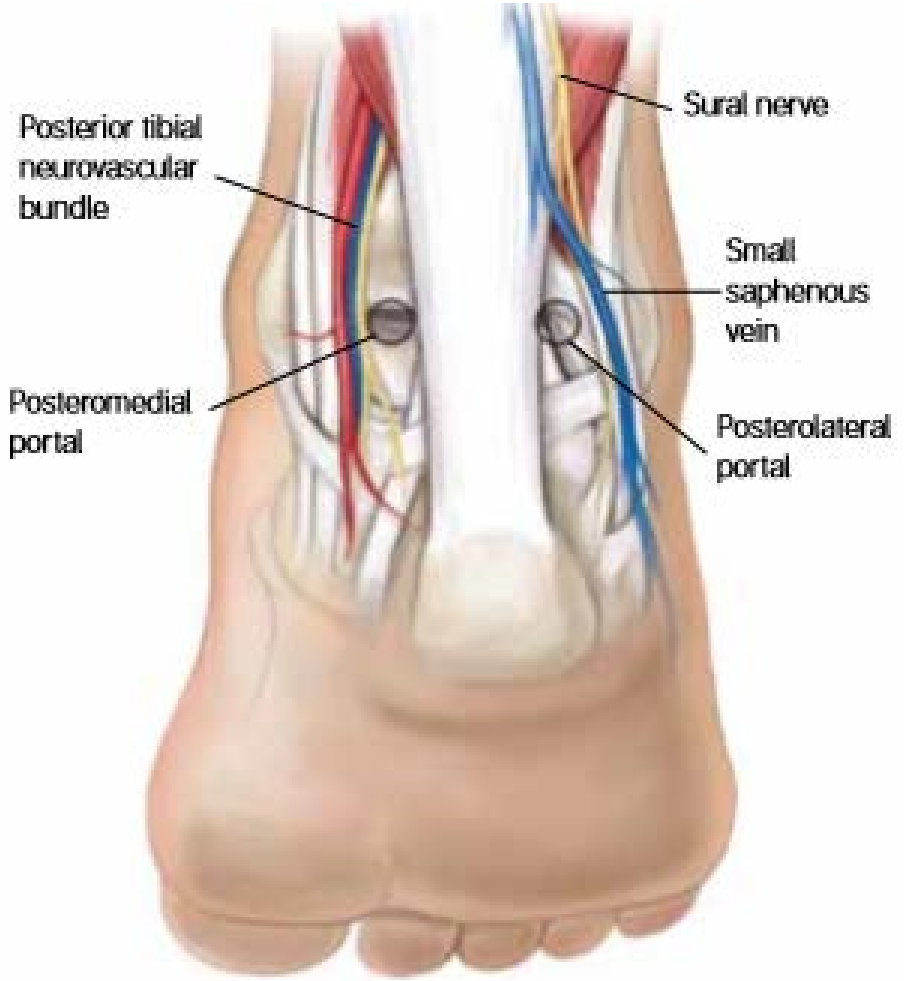
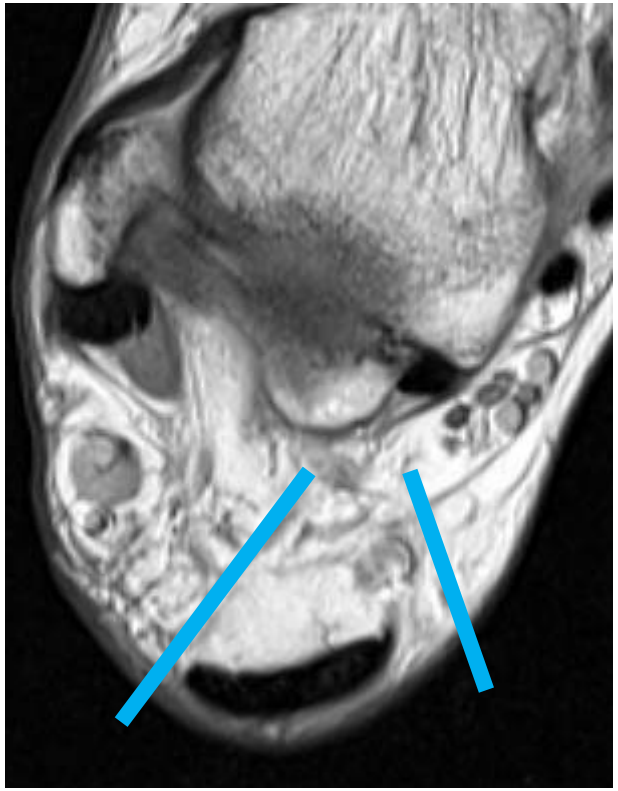


Figure 7. Recommended posterior portals

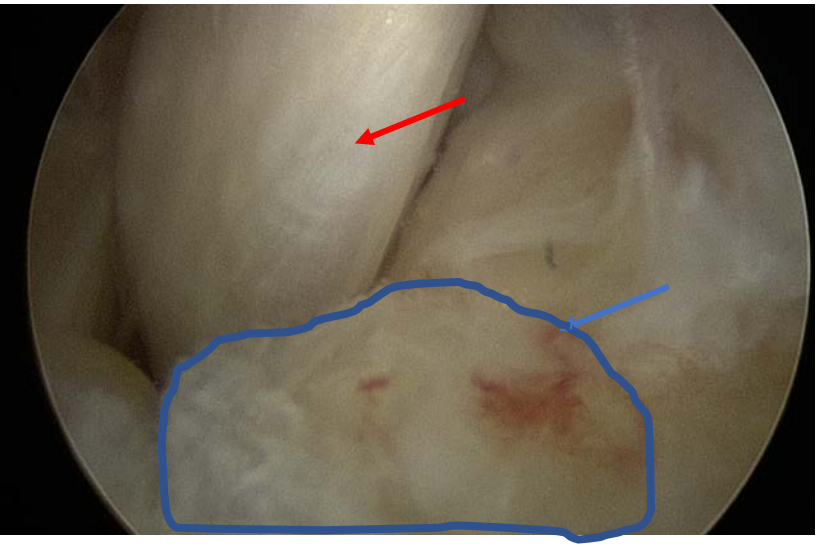


https://www.smith-nephew.com/global/surgicaltechniques/sports%20med/ankle_foot_arthroscopy_10600384b_us.pdf

A posterior incision is made to access the subtalar and tibiotalar joints.

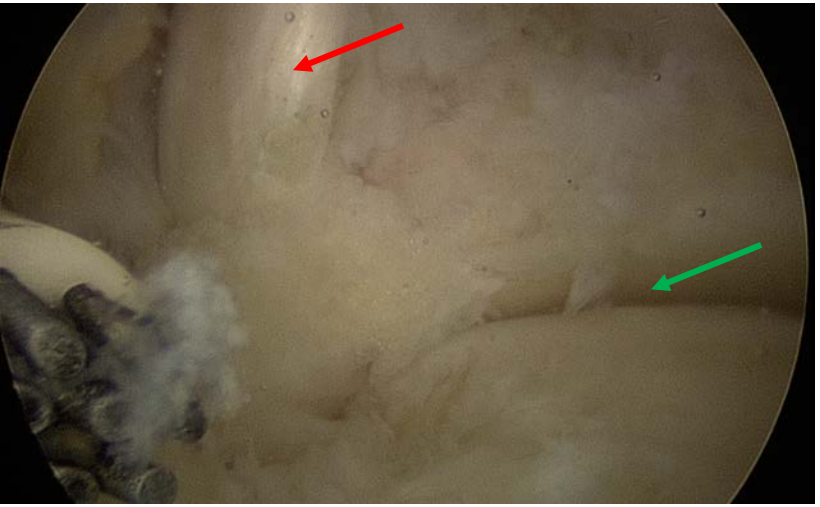
Posterior subtalar joint cartilage

Talar dome



Top left: Os trigonum (blue arrow) covered with capsular tissue and synovial material is seen directly adjacent to the flexor hallucis longus, FHL tendon (red arrow).

Top right: Close up of the os trigonum after some of the overlying capsular tissue has been debrided showing the bony nature of the os (blue arrow).



Bottom left: The os trigonum has been removed. The FHL tendon (red arrow) is again seen and the tissue around the tendon has been debrided. With the os trigonum removed, the subtal joint is now visible (green arrow).

Bottom right: The os trigonum after removal.

Case 2: Ankle

Diagnosis: Os trigonum syndrome.

- Other findings:
  - Posterior tibiotalar recess synovitis.
  - Small cartilaginous loose bodies from tibiotalar joint.

- Surgery performed:
  - Os trigonum removal.
  - Partial synovectomy.

Case 2: Os trigonum syndrome.

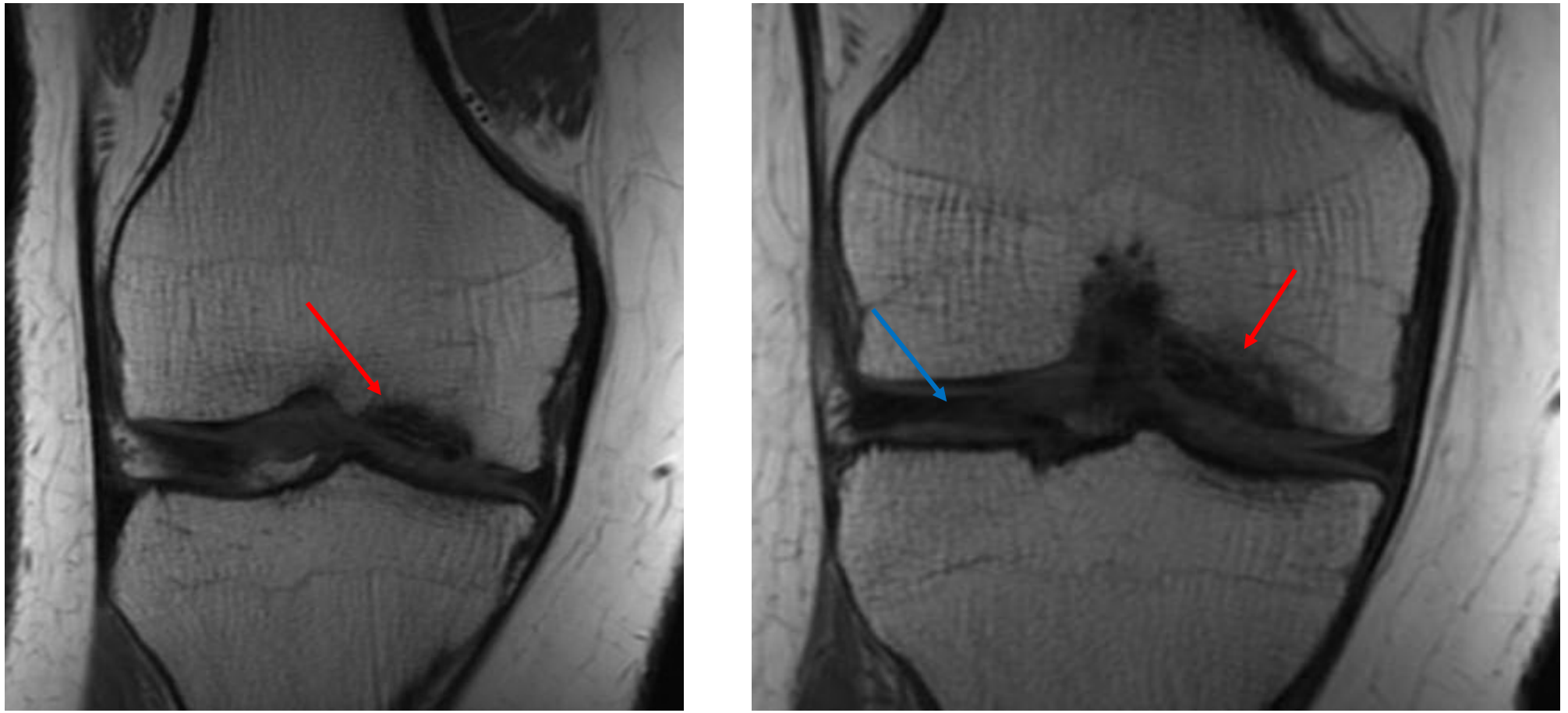
- Information and Pearls:
  - An os trigonum is an unfused posterior lateral talar process.
  - An elongated and fused posterior lateral talar tubercle is known as a Stieda process.
  - There is an estimated 10-15% os trigonum prevalence.
  - The posterior talofibular ligament attaches to the posterior lateral talar process.

Case 3: Knee

- 20 YOM with history of chronic right knee pain. Radiographically, was known to have an osteochondral lesion (OCL) and attempted conservative therapy first. Pain persisted and he elected for surgery.

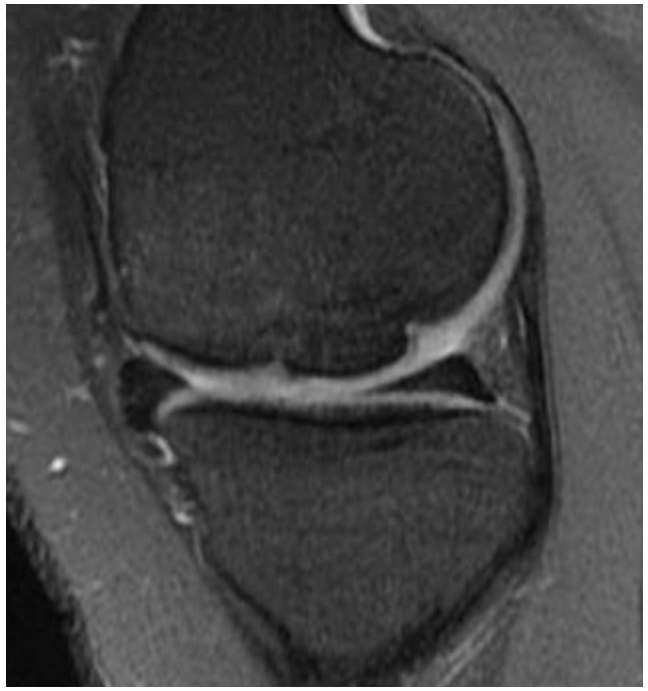
- The patient has no lateral knee pain.

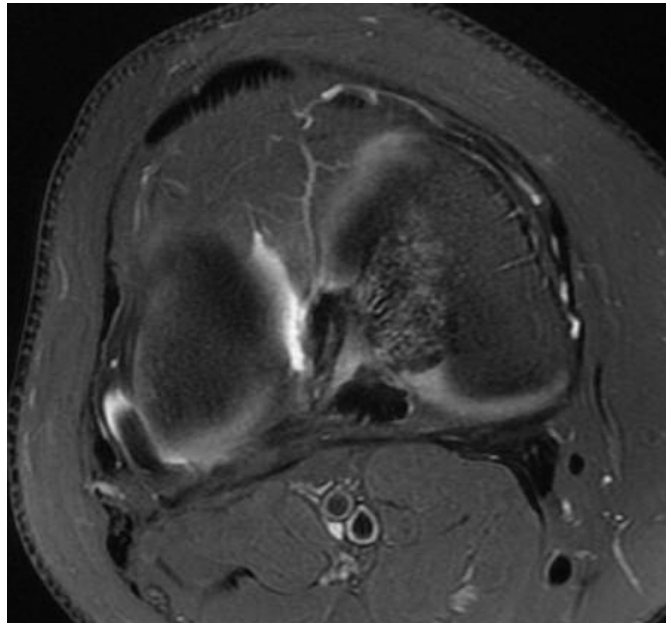
COR PD



Large osteochondral lesion inner margin of the medial femoral condyle (red arrows).

The body of the lateral meniscus (blue arrow) appears elongated and extends too medially into the notch. This is suggestive of a discoid meniscus on this single coronal view.



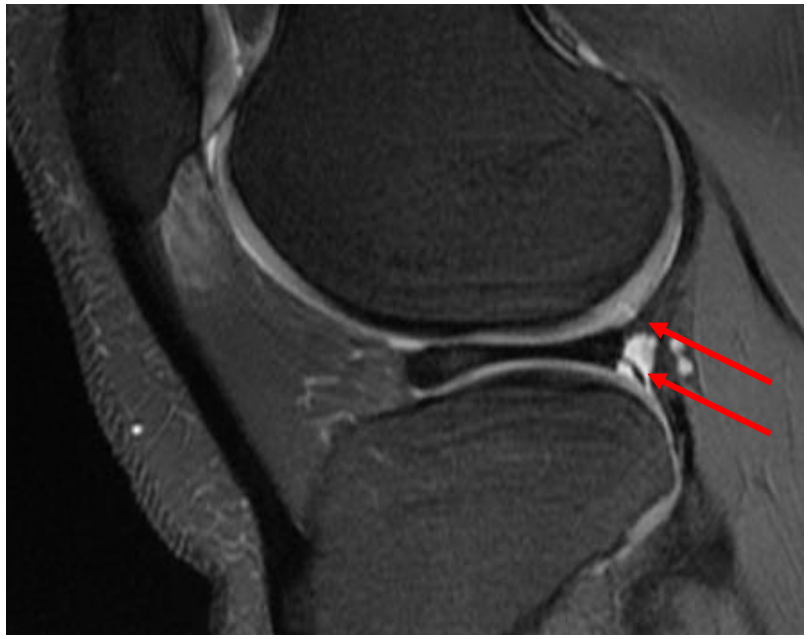


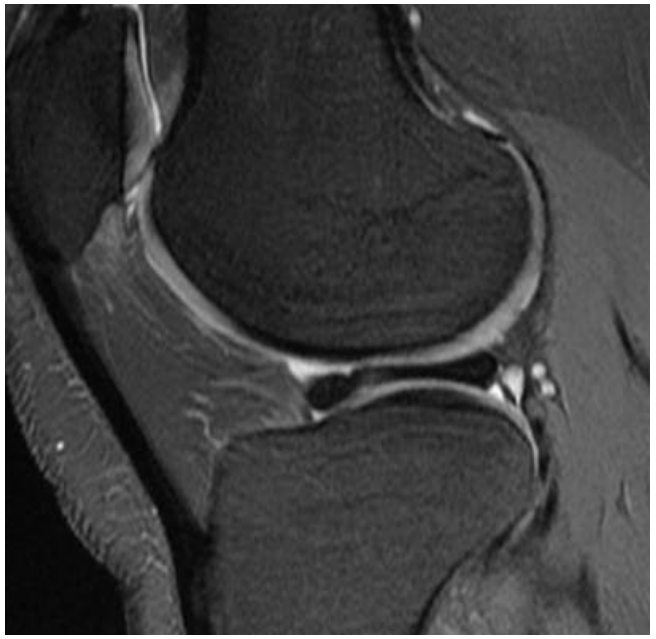
SAG and AX PDFS

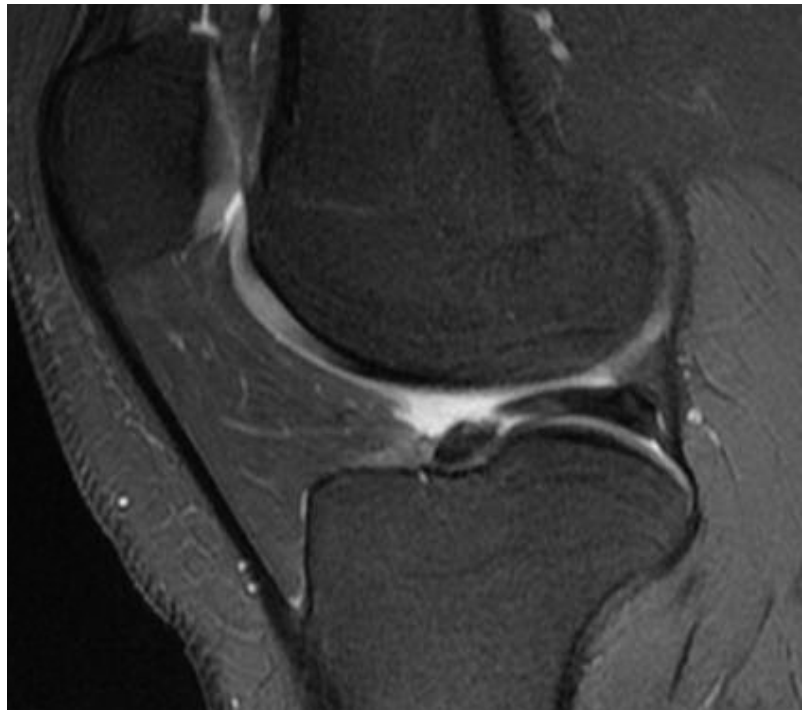
Large osteochondral lesion inner margin (posterolateral) of the medial femoral condyle.

There is subchondral bone marrow edema, but there is no undercutting by fluid and there are not underlying subchondral cysts suggesting this is a stable lesion.

The overlying cartilage appears irregular, but large full thickness defects are not seen.





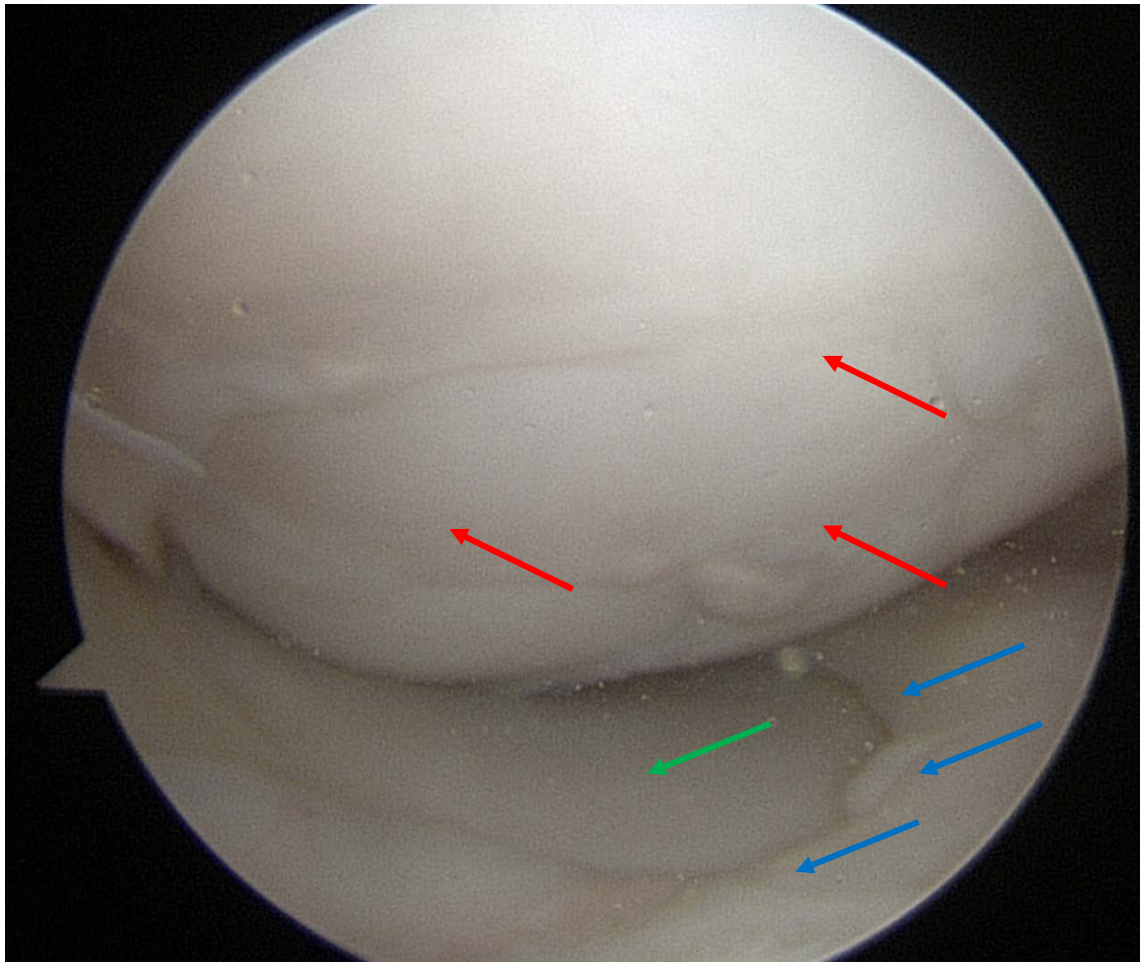


SAG PDFS

Too many bow ties with body extending too far medially confirming presence of a discoid lateral meniscus.

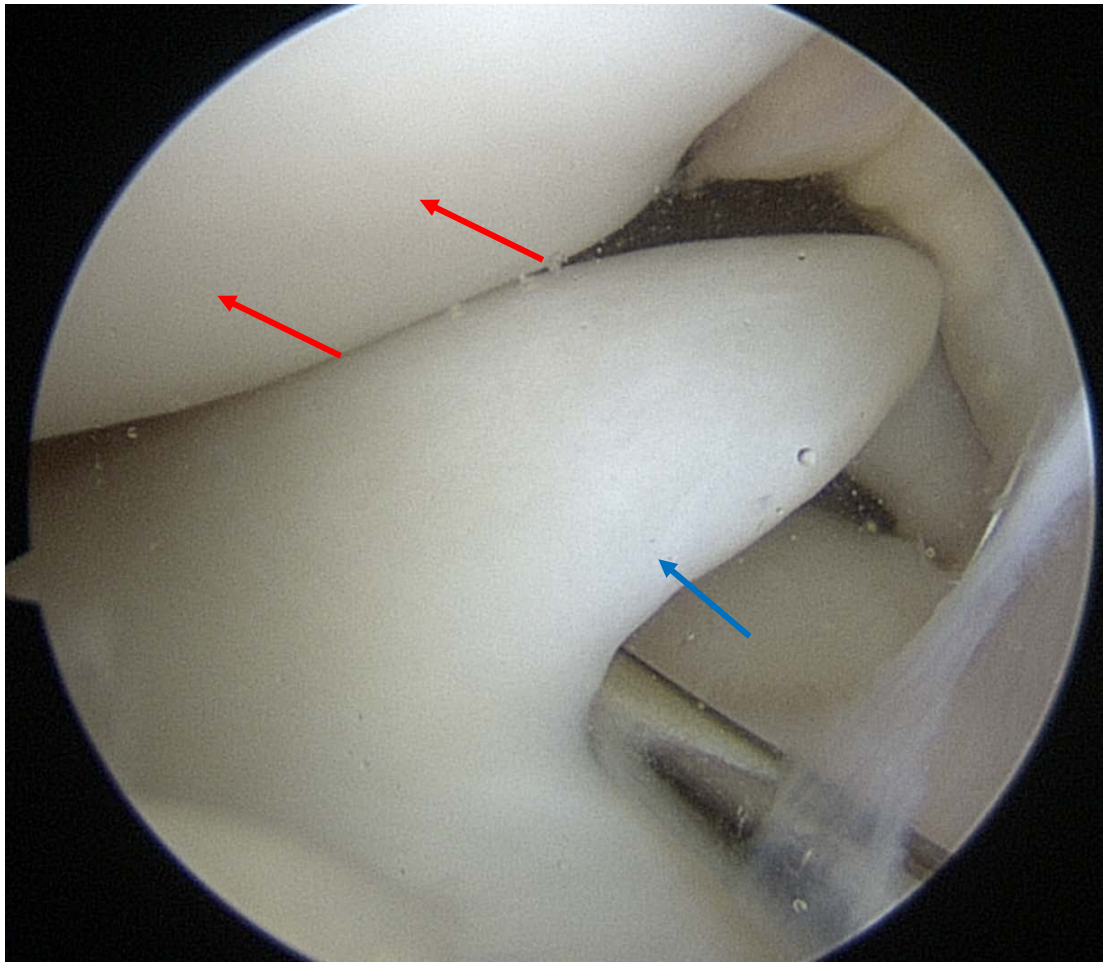
The anterior inferior and posterior superior popliteomeniscal fascicles are present excluding a Wrisberg variant (red arrows).

Degenerative signal seen in the discoid lateral meniscus, but no MR criteria for tear.



Medial compartment

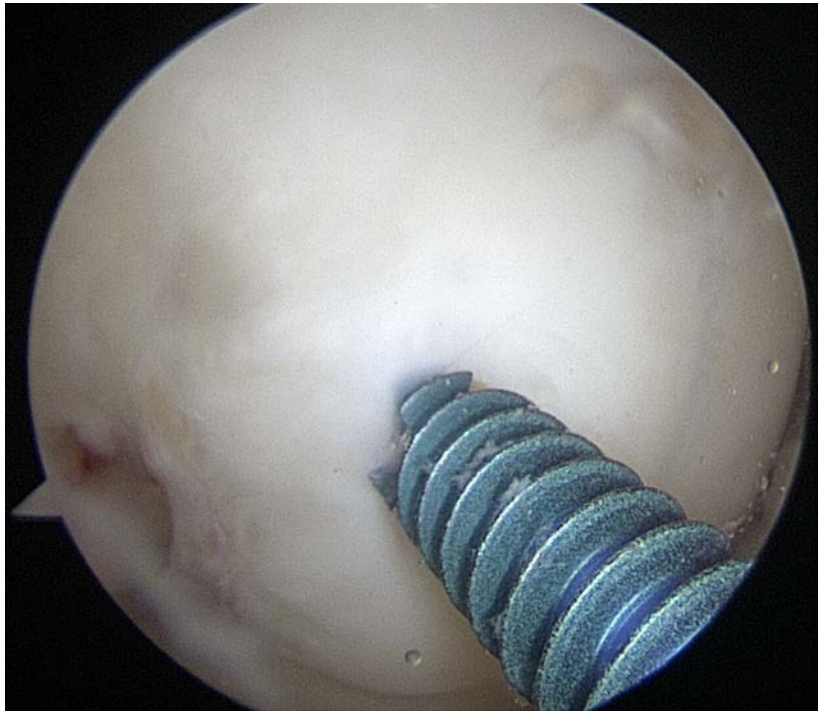
Irregularity of cartilage overlying the inner margin of the medial femoral condyle (red arrows). The free edge of the medial meniscus is seen (blue arrows) as is cartilage along the weight bearing surface of the medial tibial plateau (green arrow). The cruciates would be to the left side of the image if scope panned laterally.



Lateral compartment

Probe pushes tibial surface of discoid lateral meniscus superiorly (blue arrow). This is near the anterior horn with the body located posterior in image. Note the enlarged rounded appearance of the free edge of the discoid meniscus. The cruciates would be to the right of the image if the scope panned medially. Note the smooth appearance of the lateral femoral condyle cartilage compared to the medial condyle (red arrows).

OCL from the posterior side. Note the irregularity and step off at the articular surface compared to the normal adjacent cartilage (red arrow).



OCL was stable to probing. Therefore, decision was made to place screws across OCL into normal underlying bone to reduce risk of future destabilization.

Three screws were placed across OCL and are embedded into bone (blue arrows).

Intraop fluoro shots at end of case showing positioning of the three screws across the OCL.

Case 3: Knee

Diagnosis: Osteochondral lesion, medial femoral condyle.

- Other findings: Discoid lateral meniscus.

- Surgery performed:
  - Stabilization of OCL with three screws.

Case 3: Osteochondral lesion and discoid meniscus.

- Information and Pearls:

- **<u>Osteochondral lesions</u>**
  - OCL of the knee often also called osteochondritis dissecans (especially in the younger population).
  - Classical location is posterior lateral medial femoral condyle.
  - Prognosis better when younger.
  - Prognosis worse when occurs on the lateral femoral condyle.
  - In younger patients, may have irregular subchondral plate in the medial femoral condyle, but is more posterior to the usual more central posterior location of the OCL and may be a normal variant due to rapid mineralization during growth.
  - Fluid undercutting the OCL or underlying large cysts are concerning for instability.

Case 3: Osteochondral lesion and discoid meniscus.

- Information and Pearls:

- **Discoid meniscus**
  - More common in the lateral meniscus.
  - The body extends more medially than it should and is usually thicker.
  - The large meniscus results in excessive shear forces on the meniscus predisposing to tears.
  - An unstable discoid meniscus (Wrisberg variant) is one that lacks the posterior stabilization by the popliteomeniscal fascicles and may allow for clicking, locking or more rapid degeneration of the meniscus. The only posterior stabilizing structure in the Wrisberg variant is the meniscofemoral ligament.

Case 4: Hip

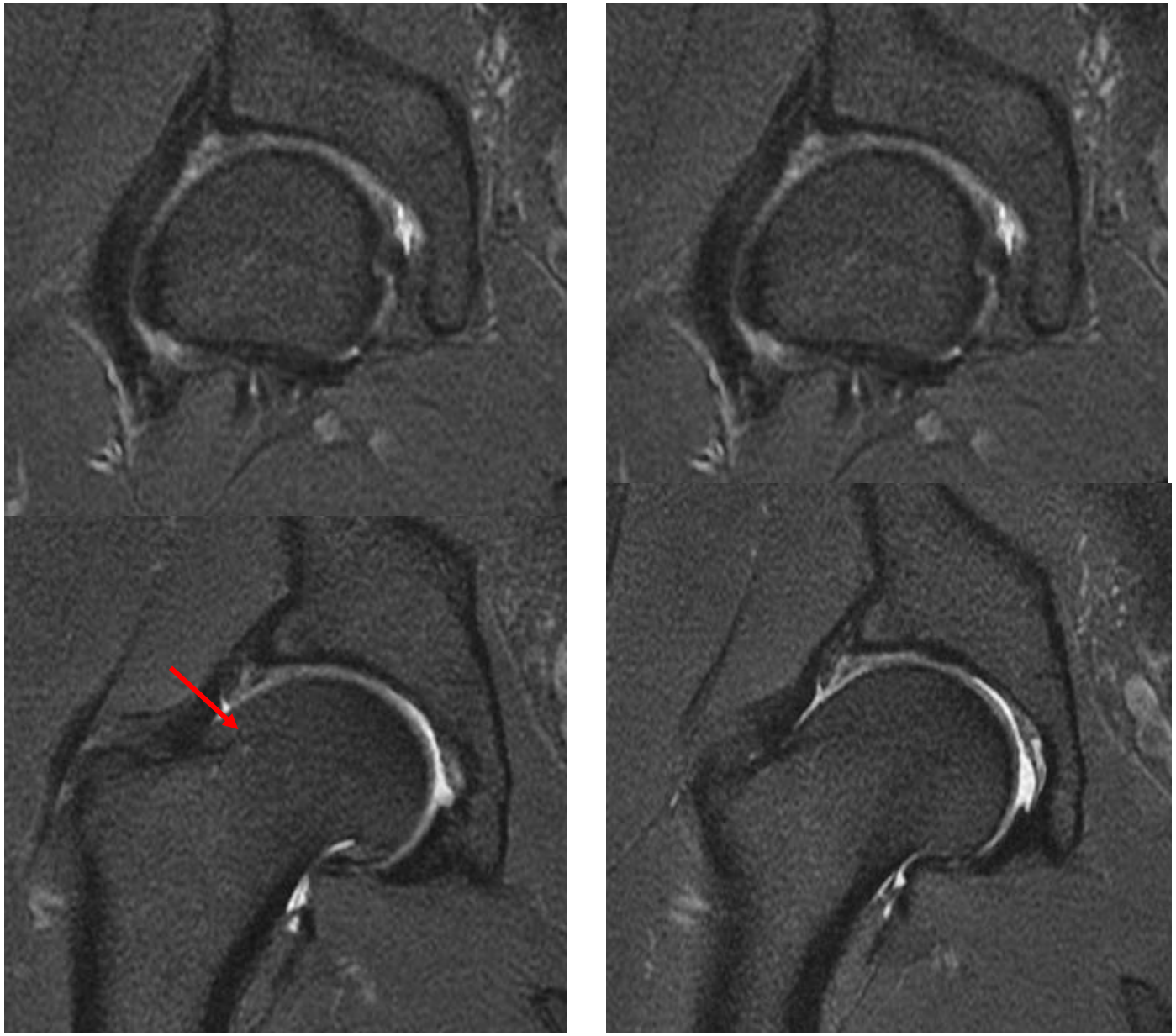
- 36 YO fit male with atraumatic right hip pain for 6 months.

- He describes the pain as constant/nagging 5/10 pain that worsens to an 8/10 with prolonged sitting, exercise, squatting.

- He also reports occasional numbness of his right foot, but that has been baseline since his L4-S1 fusion in May 2016. Patient describes his hip pain as deep in his groin into his hip.

Small bilateral cam lesions. No obvious pincer deformity or synovial herniation pits.

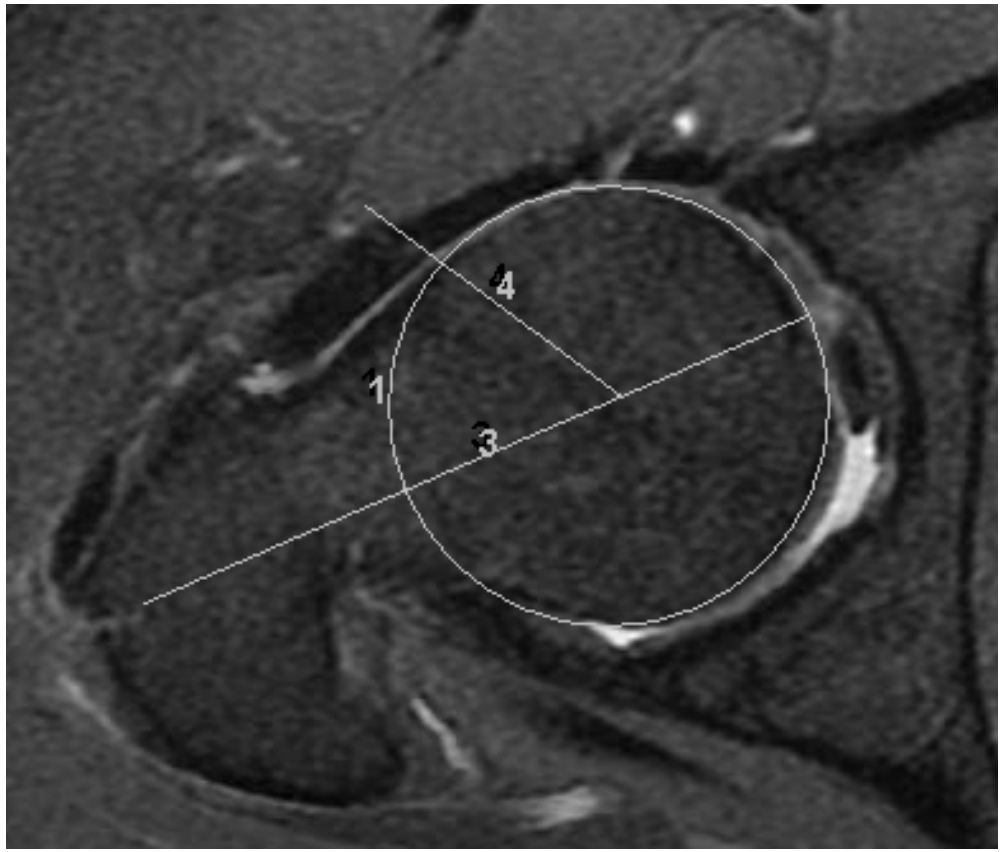
COR PDFS



Anterior and anterior superior labral tear.

Superior femoral head cartilage thinning.

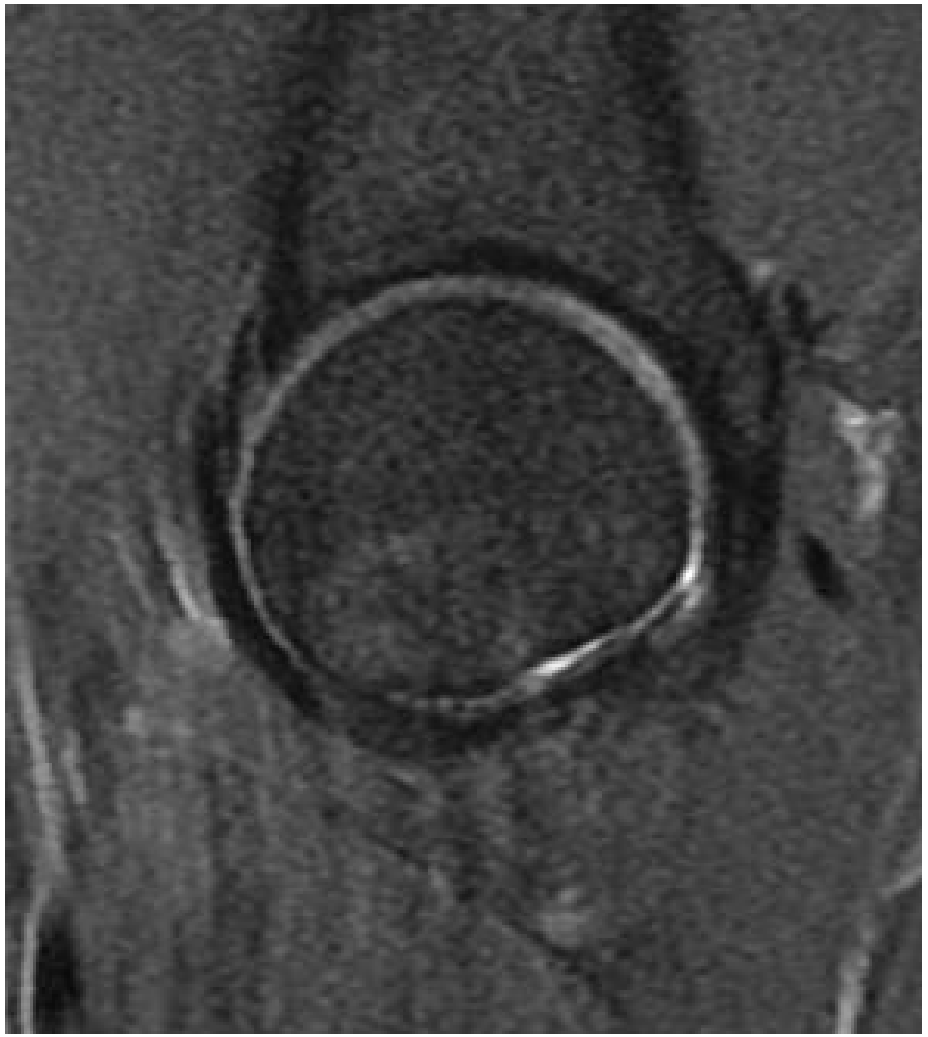
Cam deformity (red arrow).



Alpha angle

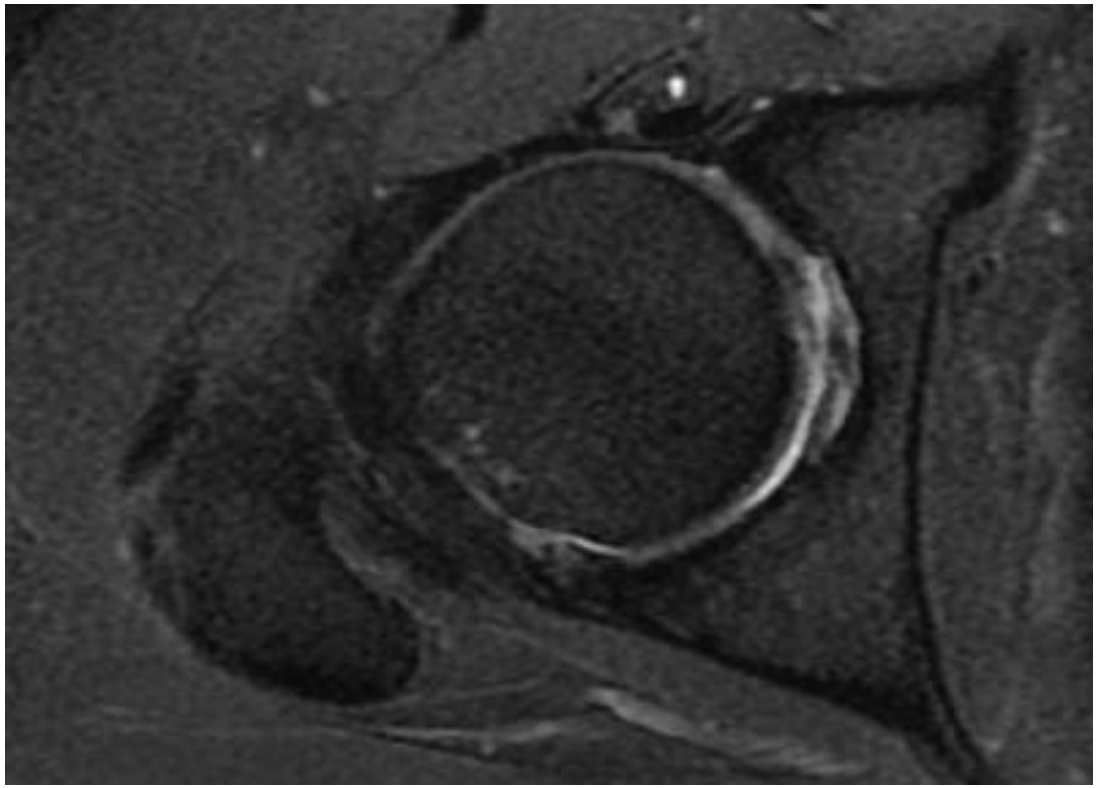
1. Measure a line that parallels the femoral neck long axis
2. Center this line in the middle of the femoral head.
3. Draw a perfect circle ROI around the cortex of the femoral head.
4. Draw a line from the center of the femoral head to where the femoral head cortical line extends beyond the ROI circle.
5. Alpha angle is the angle between lines 4 and 3.
6. Normal is < 55 degrees.
7. In this case, the MRI reported an alpha angle of 66 degrees.
8. The CT reported an alpha angle of 74 degrees.
9. My measurement (without knowing the others') was 60.1 degrees.

SAG PDFS

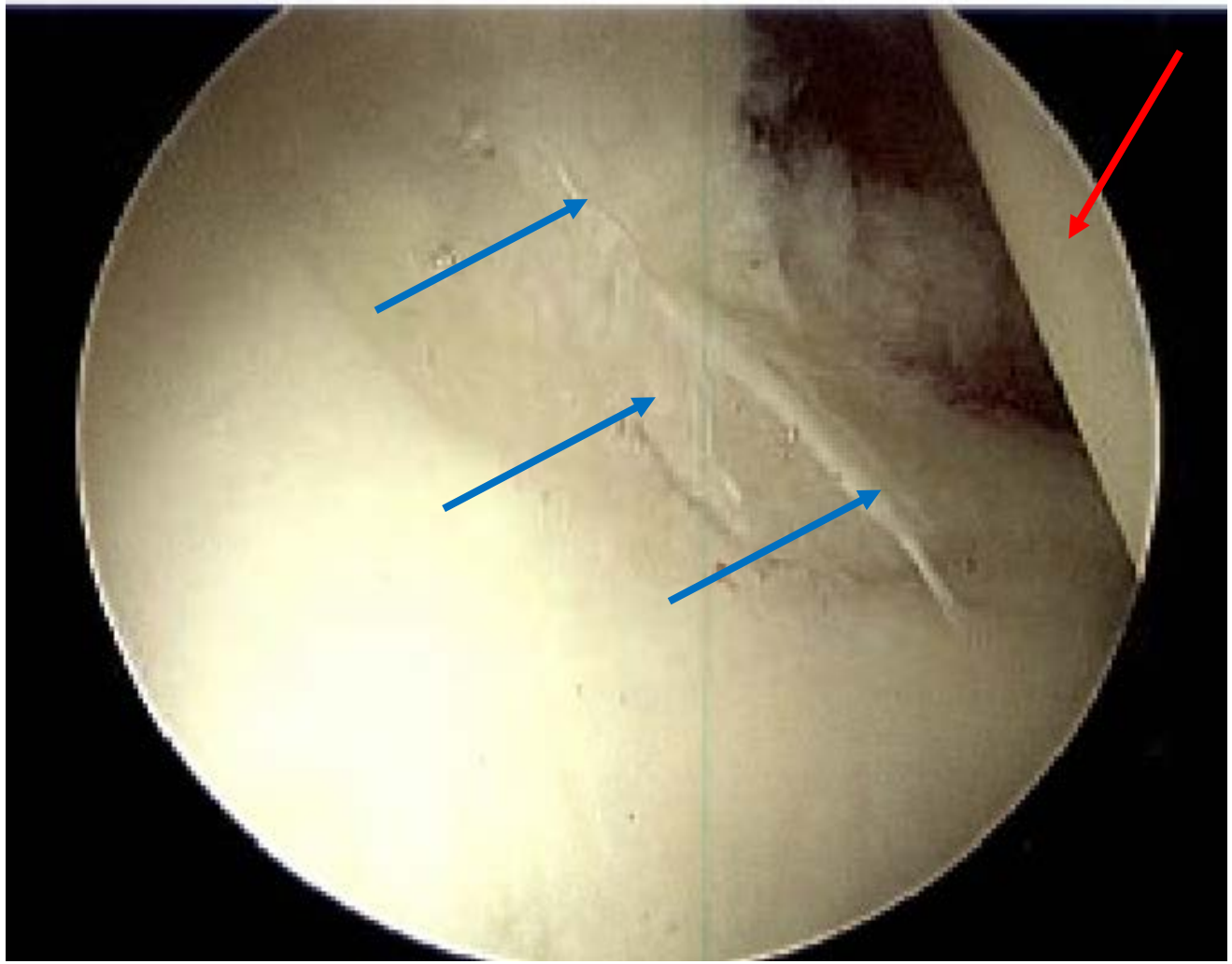


Anterior labral tear.

AX PDFS

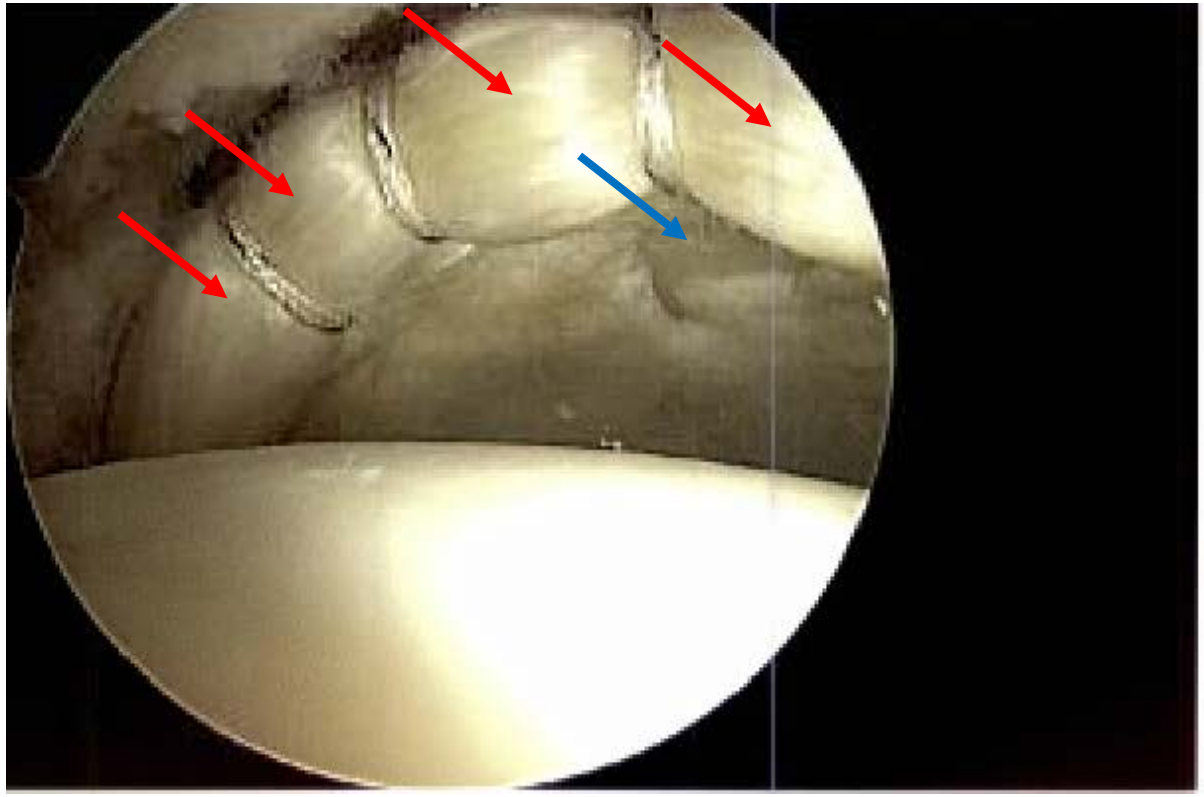


Posterior superior labral tear with cartilage thinning.



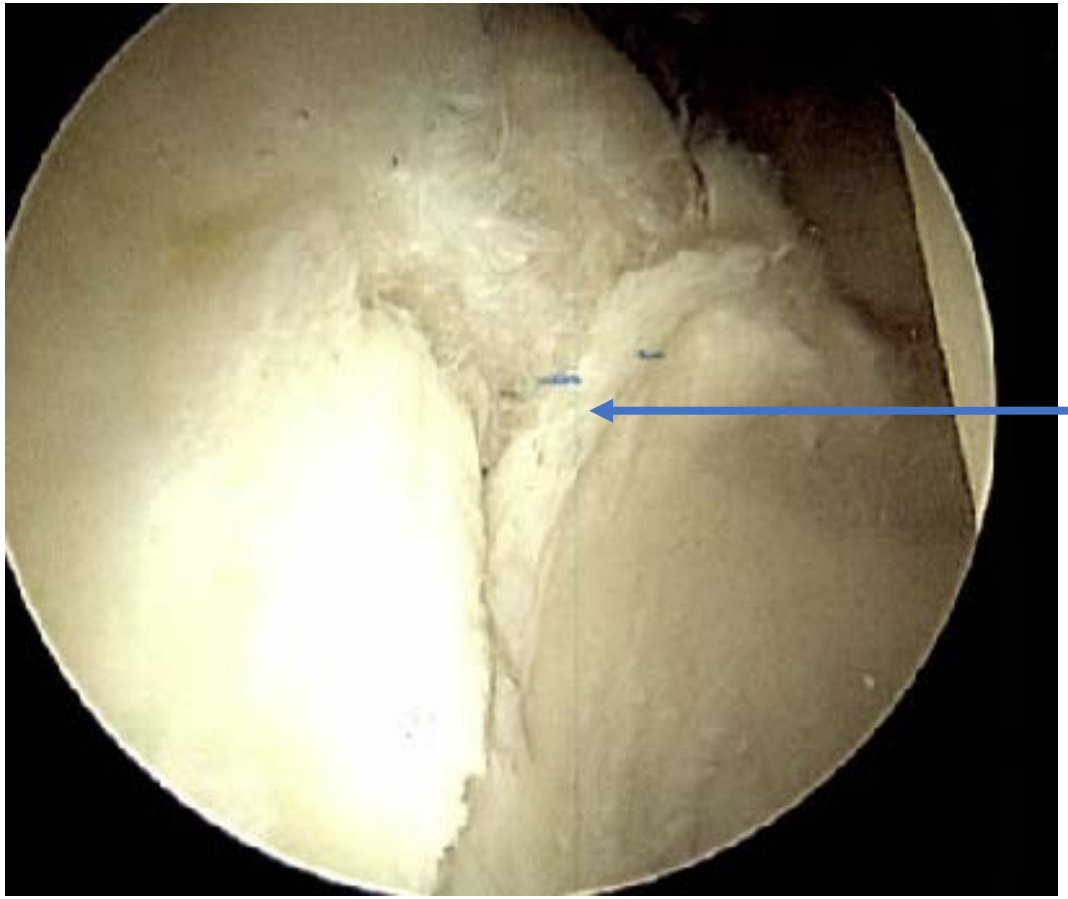
Labral tear.

Femoral head cartilage seen to the right (red arrow) with adjacent torn and degenerated labrum (blue arrows).

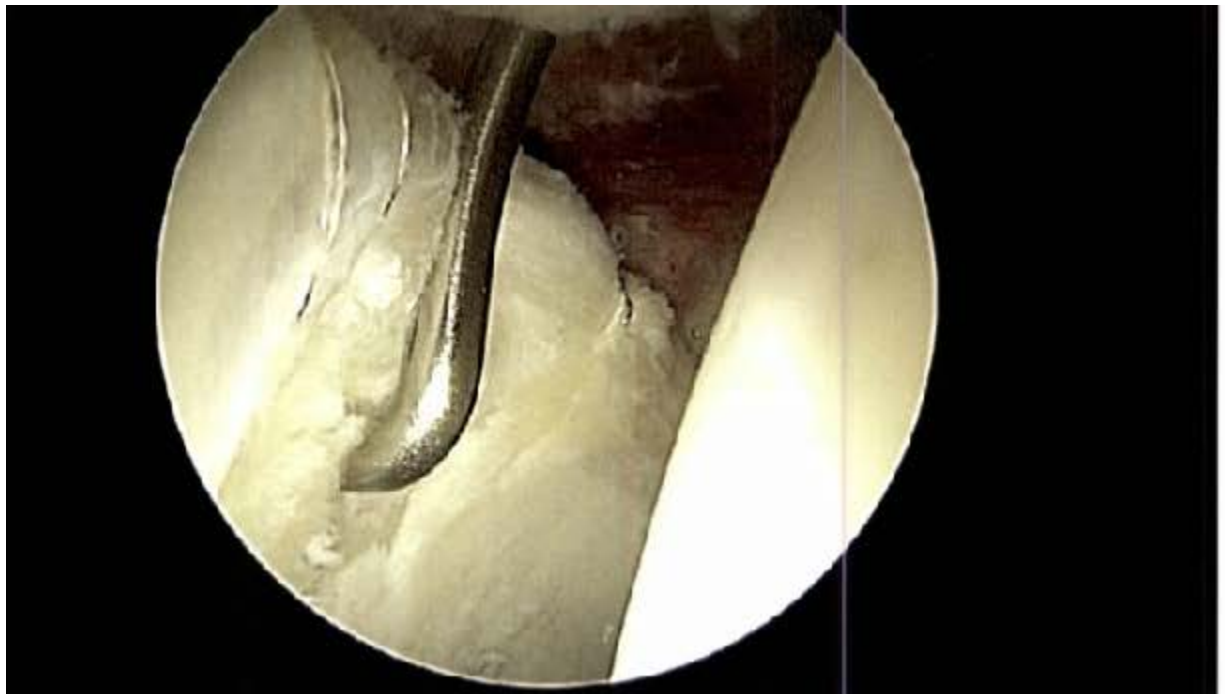


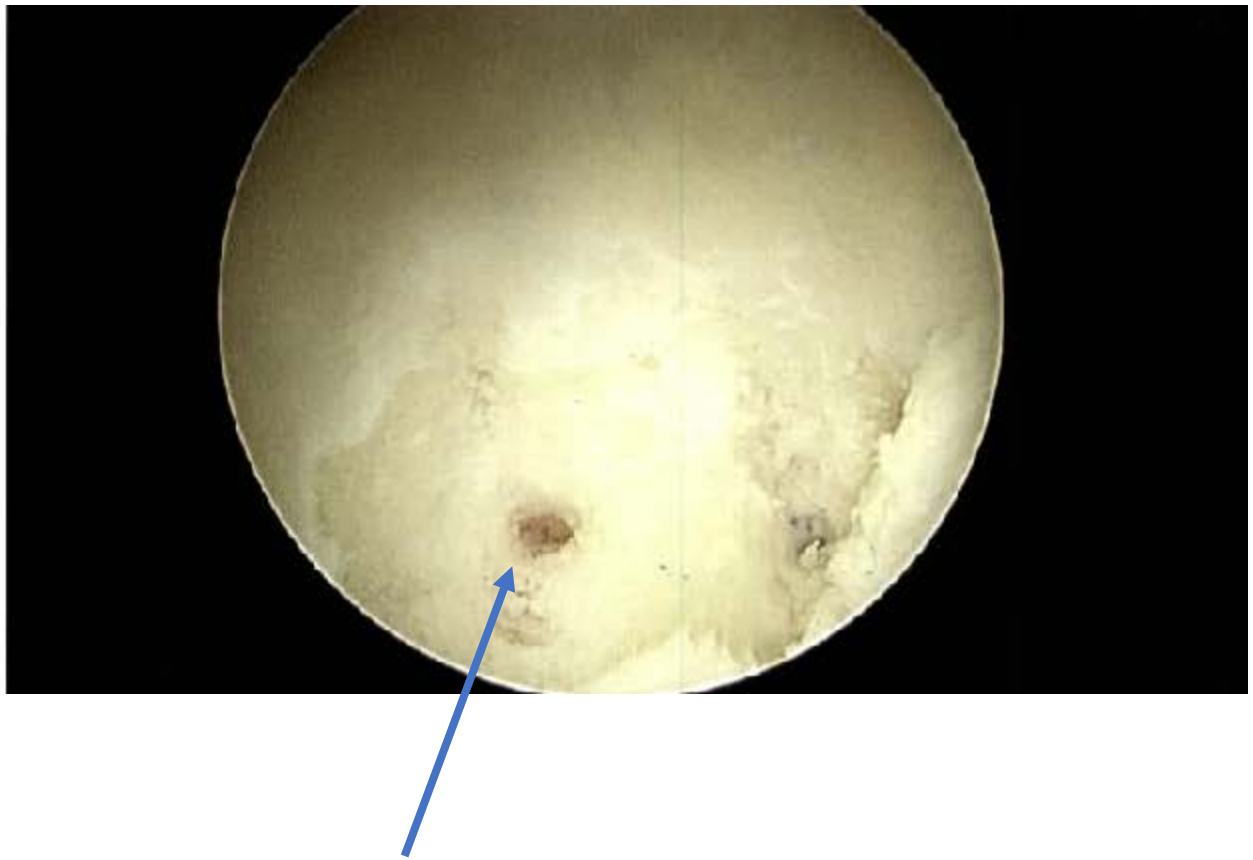
Labral repair. 4 sutures are used to bring the debrided labrum (red arrows) back down to the acetabular cartilage. An adjacent grade 4 cartilage defect is seen (blue arrow).

Close up of the grade 4 cartilage defect (blue arrow).

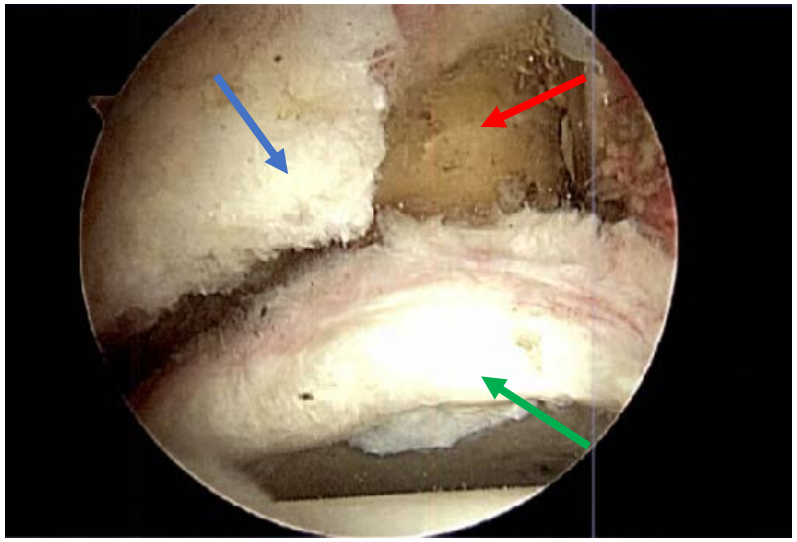


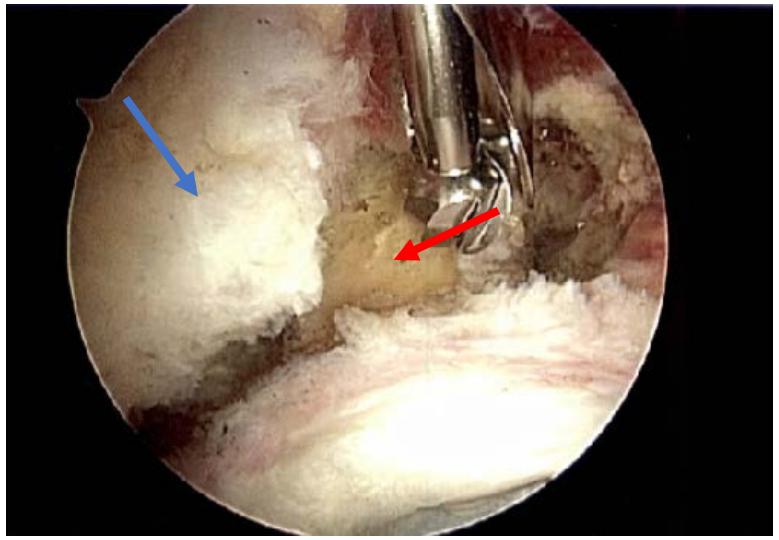
7 mm loose cartilaginous body.

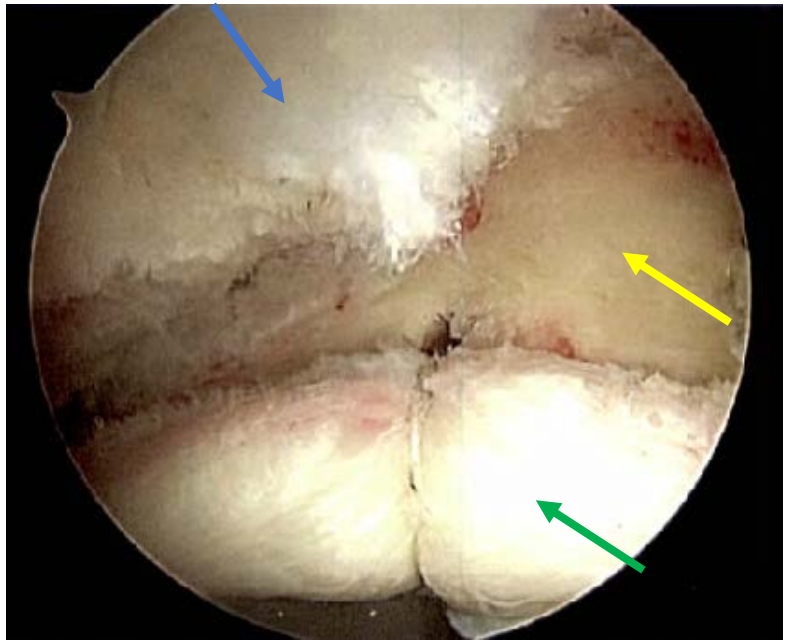




Microfracture for the grade 4 cartilage defect. Awl is used to poke holes (blue arrow) in subchondral plate to induce bleeding in hope that growth factors stimulate fibrocartilage growth and repair.







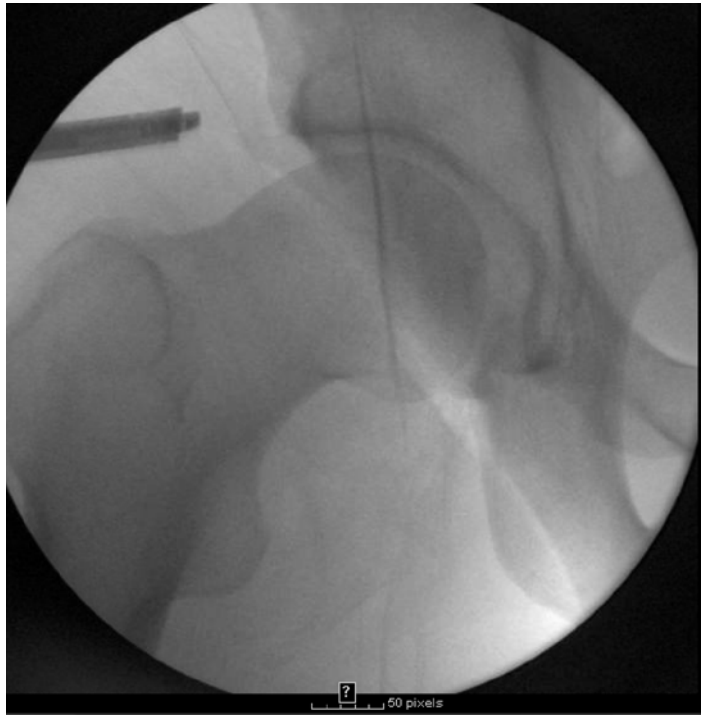
Labral preserving acetabuloplasty

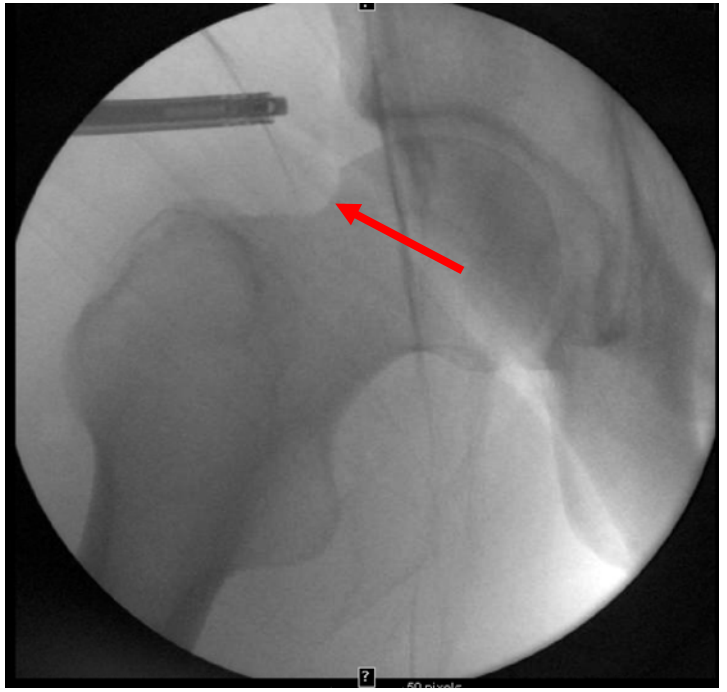
Small bony pincer lesion (red arrows) located just peripheral to the labrum (green arrow).

The first (top left) image in this sequence shows the pincer lesion before removal while the top right and bottom left show the ongoing pincer lesion removal.

The bottom right shows the end result (yellow arrow). The labrum has also been repaired in this image.

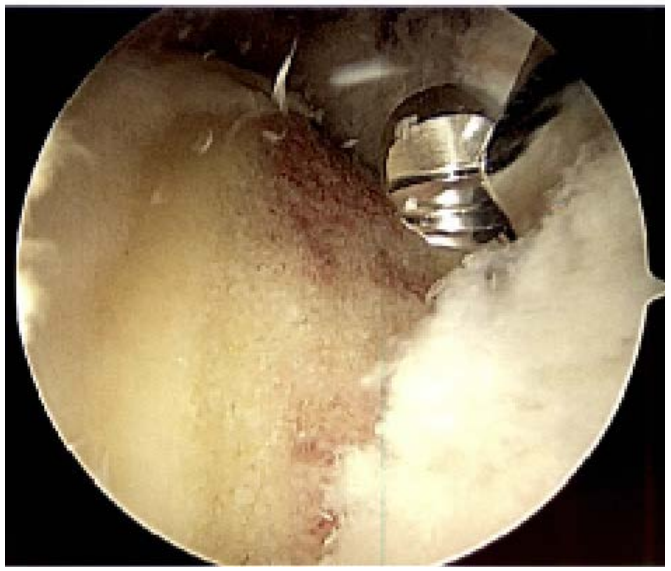
Capsular tissue is marked with the blue arrows.





Femoroplasty

Cam is resected with fluoroscopic guidance until "pistol grip deformity" converted to normal appearance. Top left and bottom left show pre-surgical appearance of cam lesion.



Top right and bottom right show appearance of femoral head neck junction after cam removed (red arrow). In this image, the femoral head is to the left and the neck is toward the right.

Case 4: Hip

Diagnosis: FAI. Labral tear. Early arthritis.

- Other findings: 7 mm intra-articular body.

- Surgery performed:
  - Femoroplasty (resection of cam).
  - Labral repair (torn from 2 to 12 o'clock).
  - Chondroplasty and microfracture (acetabular side, 4 x 6 mm grade 4 defect at 1 o'clock).
  - Labral preserving acetabuloplasty for pincer lesion.

Case 4: FAI.

- Information and Pearls:

- **Alpha angle:** > 55 degrees considered abnormal
  - However, should be noted that considerable variability in measuring the alpha angle has been described.
  - This is important for insurance as incorrectly stating an alpha angle is normal may result in a denial of surgery.
  - As 55 degrees may include a lot of asymptomatic patients, some have proposed increasing the threshold to 60 degrees (Radiology 2012;264:514-521.)

Skeletal Radiol. 2009 Sep;38(9):855-62. doi: 10.1007/s00256-009-0745-3. Epub 2009 Jun 30.

Cam-type femoral-acetabular impingement: is the alpha angle the best MR arthrography has to offer?

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Author information

Abstract

INTRODUCTION: In our institutional experience, determination of the alpha (alpha) angle at MR arthrography as an indicator of the likelihood of cam-type femoroacetabular impingement (FAI) is fraught with inconsistency. The aims of this study were to quantify the degree of variability in and calculate the diagnostic accuracy of the alpha angle in suggesting a diagnosis of cam impingement, to determine the accuracy of a positive clinical impingement test, and to suggest alternative MR arthrographic measures of femoral head-neck overgrowth and determine their diagnostic utilities.

MATERIALS AND METHODS: We carried out a retrospective analysis of MR arthrographic studies performed during a 4-year period, combined with chart analysis, which allowed identification of 78 patients in whom surgical correlation was also available. The status of a preoperative clinical impingement test was also noted. Patients were designated as having cam-type FAI (Group A, n = 39) if intra-operative femoral head-neck junction bony osteochondroplasty/arthoscopic femoral debridement was performed. Group B (n = 39) acted as controls. Three radiologists independently and blindly performed a series of measurements (alpha angle and two newly proposed measurements) in each patient on two separate occasions. An alpha angle of greater than 55 degrees was considered indicative of the presence of cam-type FAI.

RESULTS: Performance values for alpha angle measurement were poor for each observer. There was considerable (up to 30% of the mean value) intra-observer variability between the first and second alpha angle measurements for each subject. Binary logistic regression analysis confirmed that the alpha angle is of no value in predicting the presence or absence of cam-FAI. A statistically significant difference existed between Groups A and B with regard to the newly proposed anterior femoral distance (AFD; p = 0.004). Using an AFD value of 3.60 mm or greater as being indicative of the presence of cam-FAI yields a 0.67 performance measure (95% confidence interval 0.55-0.79). The second proposed parameter (femoral neck ratio) was of no value in suggesting the presence or absence of this condition. The sensitivity, specificity, and positive and negative predictive values of the clinical impingement test were 76.9%, 87.2%, 85.7% and 79.1% respectively.

CONCLUSIONS: Femoral alpha angle measurement is associated with considerable variability. This index performed poorly in our patient population and was statistically of no value in suggesting the presence or absence of cam-FAI. One of our proposed measures, the AFD, outperformed the alpha angle, though to an insufficient degree to suggest its routine incorporation into clinical practice. Our experience suggests that the clinical impingement test remains the most reliable predictor of the presence of this condition.

Case 4: FAI.

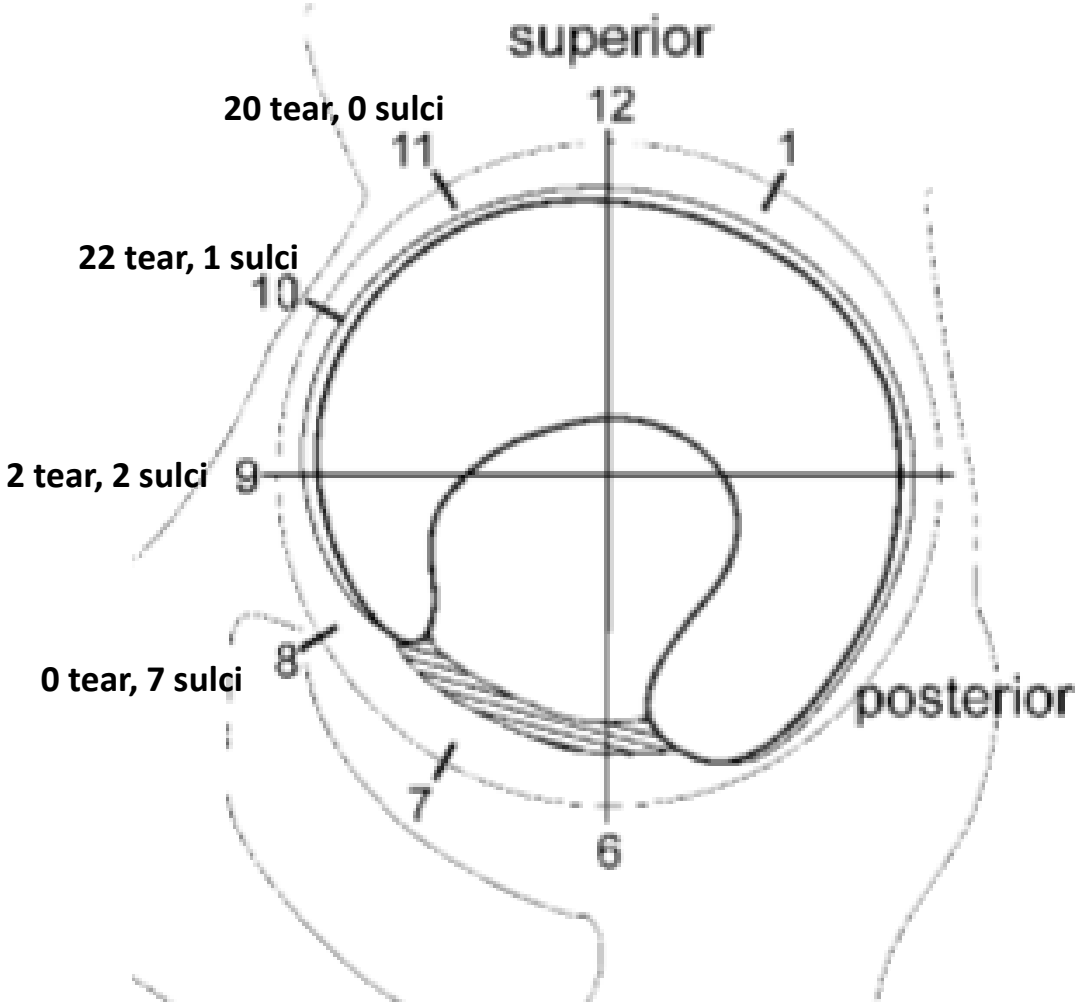
- Information and Pearls:

- **FAI**
  - May be due to cam related impingement, pincer related impingement or both (more common).
  - A significant proportion of patients with cam or pincer deformities may be asymptomatic. Therefore FAI is a clinical diagnosis.
  - Pincer deformity may be caused by os acetabuli, subspine impingment, superior acetabular retroversion, acetabular protrusion or coxa profunda.
  - Coxa profunda is a deep acetabular socket where medial wall is medial to ilioischial line while acetabular protrusio is when the femoral head and socket project medial to the ilioischial line.

Case 4: FAI.

- Information and Pearls:

- **Labral tears**
  - Labral tears, especially those in the anterior superior and anterior quadrants may be associated with adjacent cartilage disease. Carefully inspect this cartilage, though sensitivity to detect is limited with MRI.
  - Sulci do exist, but are thought to be very rare in the anterior superior quadrant.
  - Direct anterior labral tears may be associated with impingement from the iliopsoas tendon.
  - Sulci do not cut all the way through the labrum in any location.
  - Sulci are not associated with adjacent perilabral cysts, cartilage injury or osseous injury.



Radiology. 2008 Dec;249(3):947-54.

Case 5: Knee

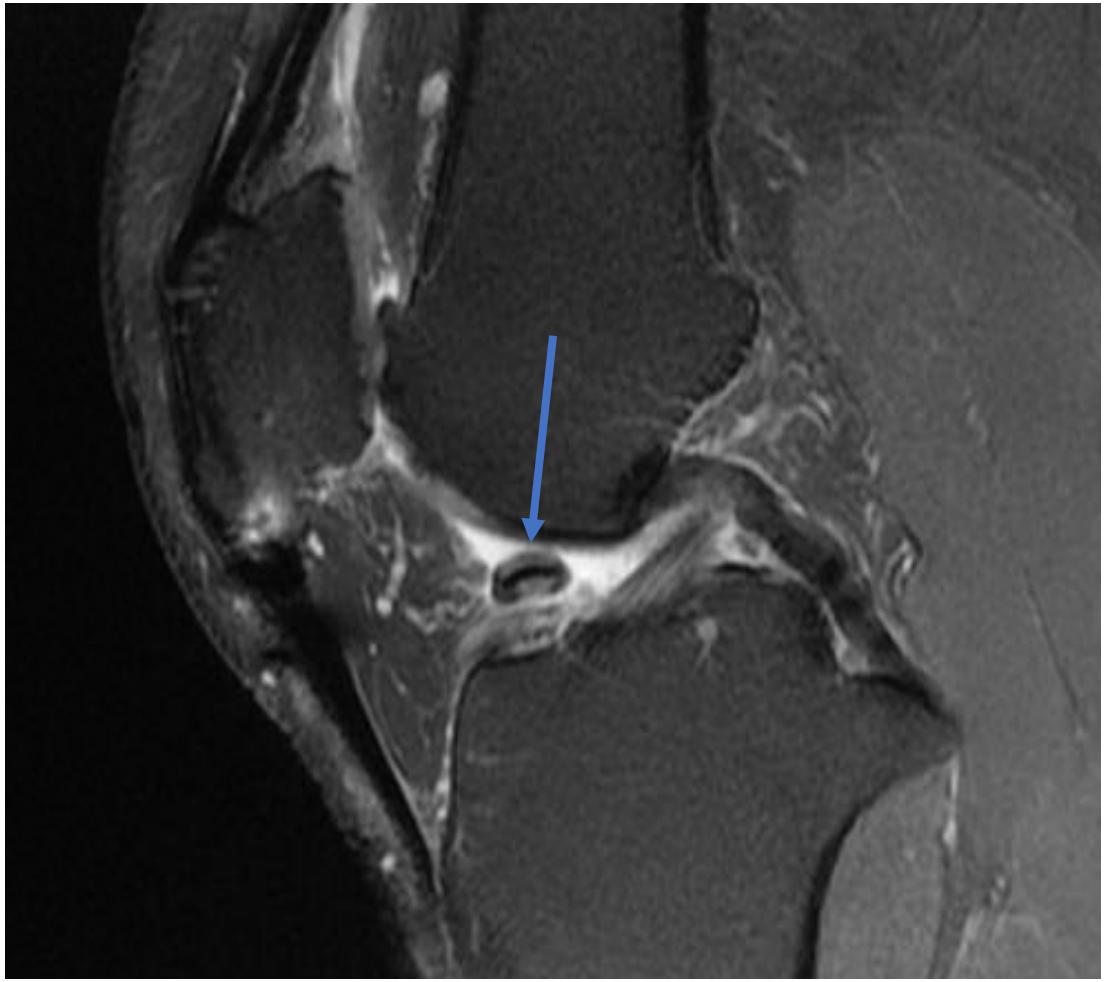
- 50 YOM with left knee pain beginning 8 months ago after a day of heavy exertion moving things around his home. On this day, he noticed that his knee started locking, popping, and clicking.

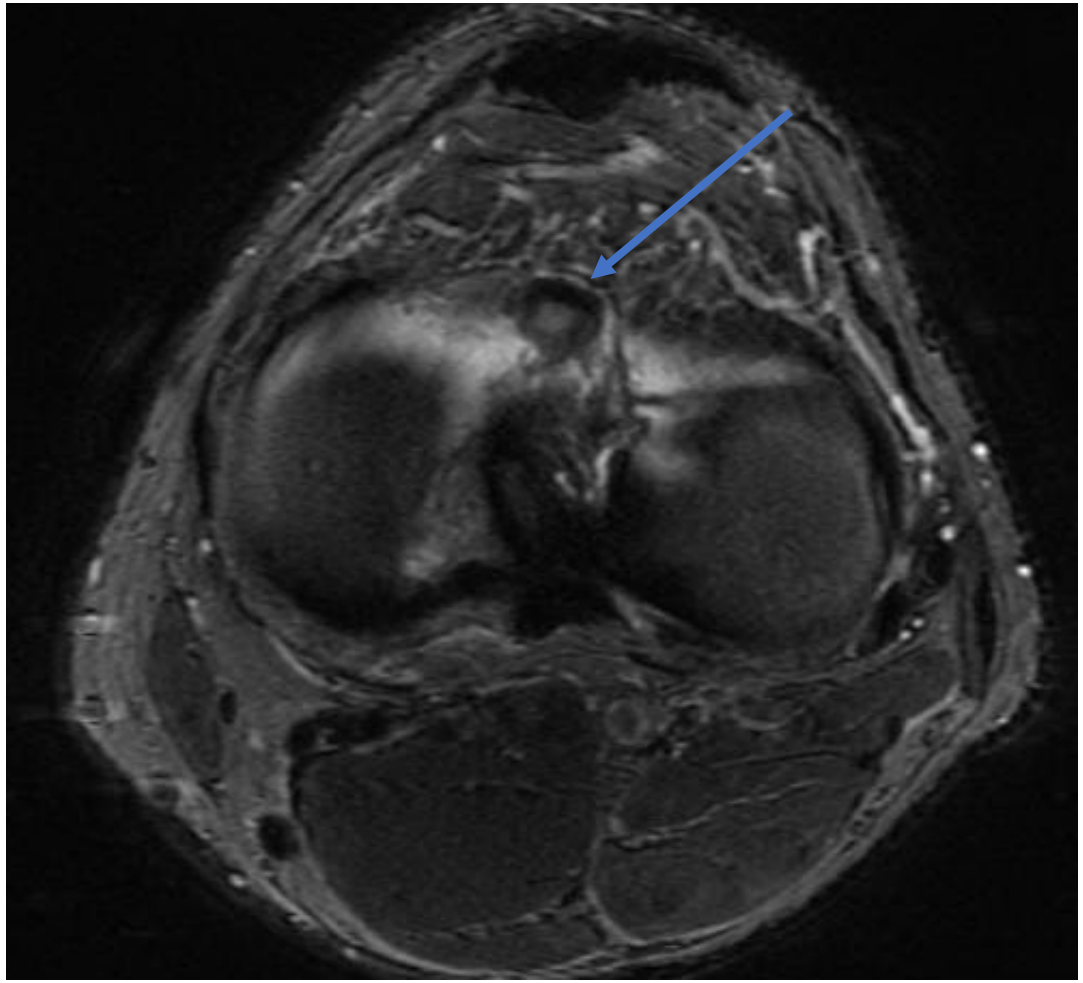
- Knee will lock occasionally in a flexed position. He states that he has tension in the posterior lateral knee.

- He started running again about 3-4 months ago and his knee has started bothering him more since he started running. He reports that his main issue is the locking especially when he increases his activity. He has to stop when this happens and protect himself from falling. He describes excruciating pain with the catching.

Possible osteochondral fragment projects over the intercondylar notch seen only on the frontal projection (blue arrow)

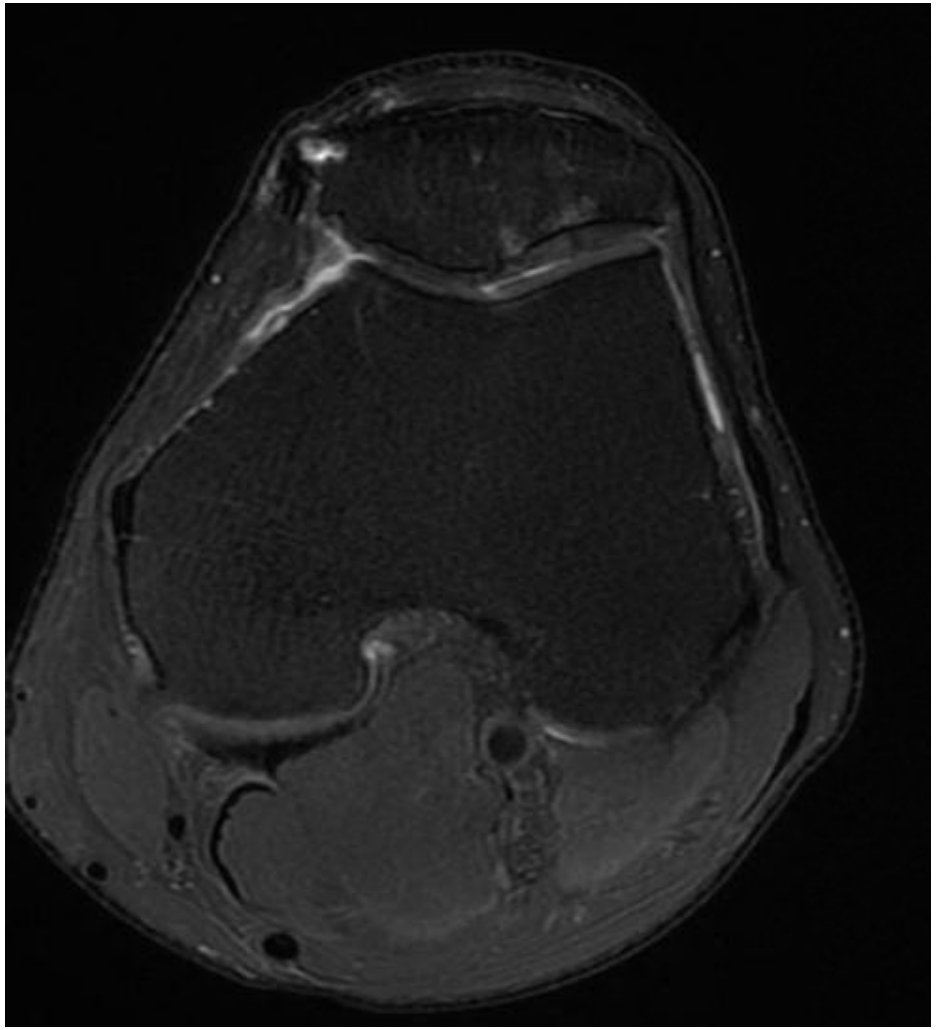
MRI confirms presence of osteochondral fragment (blue arrows) in the notch. It is predominantly surrounded by fluid suggestive of a loose body.

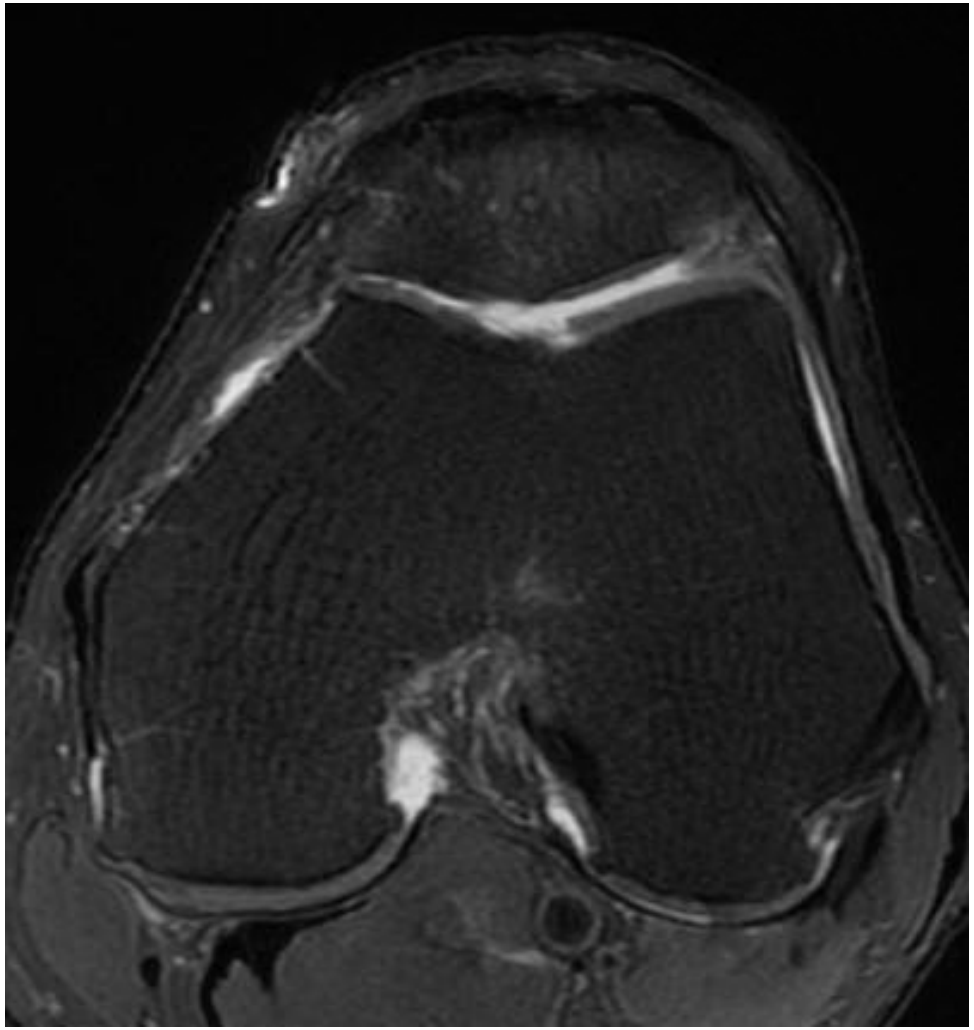




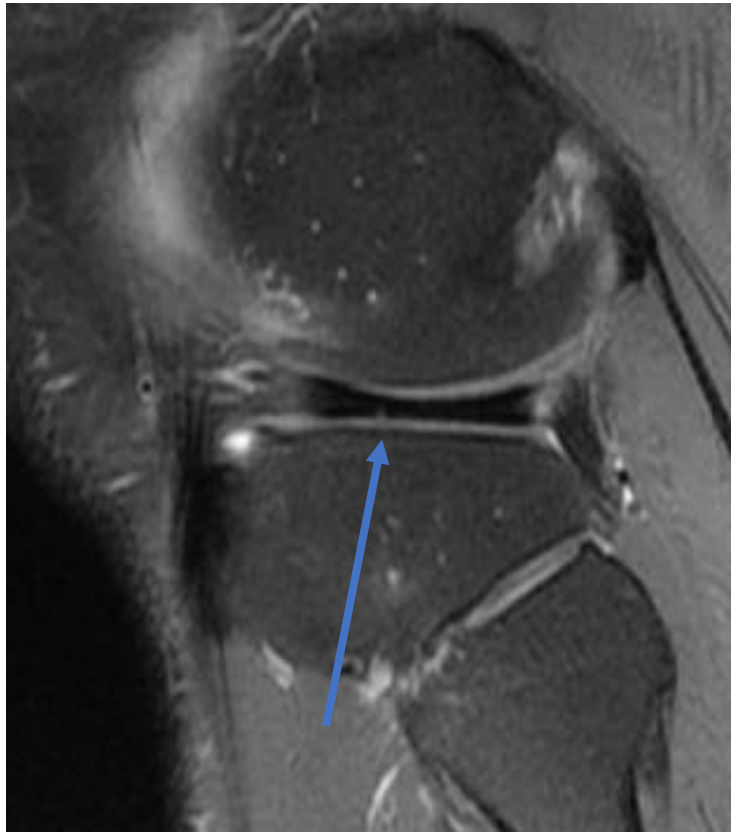
Susceptibility artifact near patella and patellar tendon related to prior surgery for patellar fracture (hardware since removed).

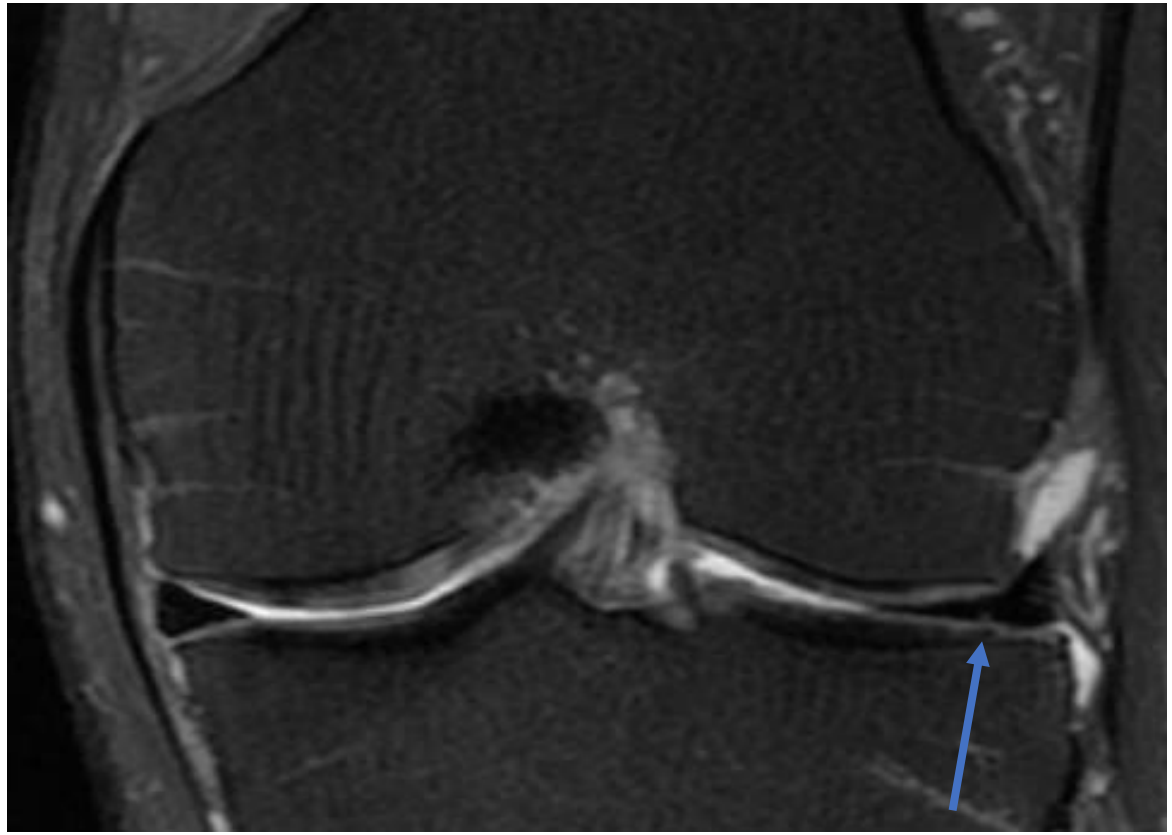
Patellofemoral compartment with multifocal (modified Outerbridge) grade 3 and 4 chondral loss.



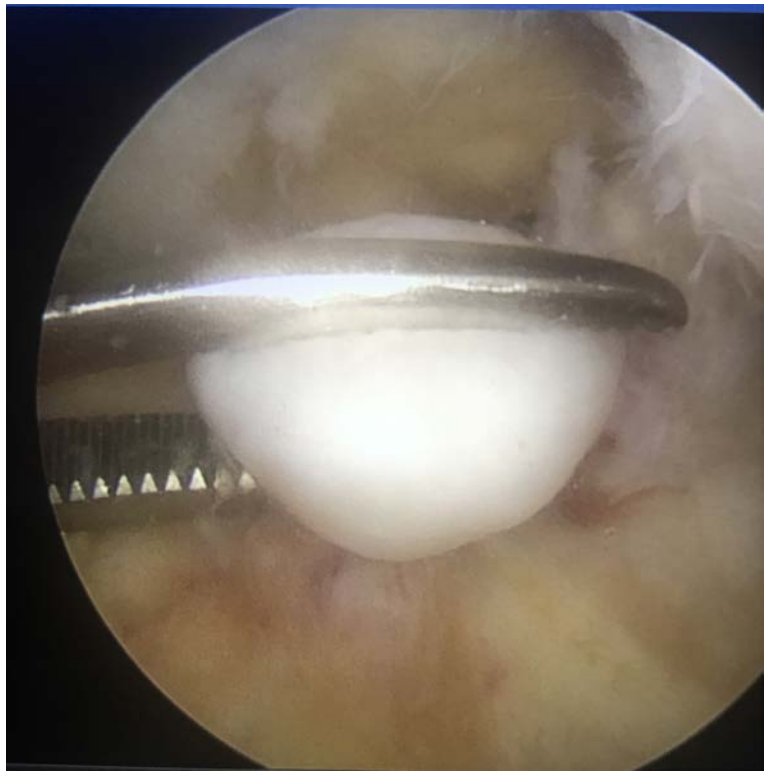


Linear high signal intensity reaching the tibial articular surface on the lateral meniscus.





Loose body being removed



Lateral meniscus – slightly more posterior than where the described small tear was located. The whole meniscus was reported as normal.

Case 5: Knee

Diagnosis: Loose body. Patellofemoral joint arthritis.

- Other findings: Normal menisci.

- Surgery performed:
  - Loose body removal.
  - Chondroplasty of the patellofemoral compartment.

Case 5: Loose body. Normal Menisci.

- Information and Pearls:

- **Two slice touch rule**
  - Reported by the Wisconsin group in 2005.
  - Method proposed to optimize accuracy of MRI to call meniscal tears.
  - According to their method, a tear should be called when there is meniscal distortion or intrameniscal high signal reaching an articular surface on two slices. If only reached on one slice, was a possible tear.
  - Displaced flaps or fragments are also considered tears, but they usually also meet the two slice touch rule.

TABLE 1: Correlation of MRI Diagnoses of Meniscal Tears with Arthroscopic Findings in 174 Patients

MRI	Arthroscopy		
	Torn	Not Torn	Total
Medial meniscus			
Torn	98	6	104
Possibly torn	3	4	7
Not torn	5	58	63
Total	106	68	174
Lateral meniscus			
Torn	53	2	55
Possibly torn	2	9	11
Not torn	16	92	108
Total	71	103	174

TABLE 2: Comparison of Diagnostic Accuracy When Considering Torn and Possibly Torn Diagnoses as Positive for a Tear Versus Considering Only Torn Diagnoses as Positive in 174 Menisci with Arthroscopic Correlation

Performance Measure	Criterion for Positive Diagnosis of Meniscal Tear		p^b
	Torn and Possibly Torn	Torn Only[a]	
Medial meniscus			
Sensitivity (%)	95 (101/106)	95 (98/103)	0.96
Specificity (%)	85 (58/68)	91 (58/64)	0.35
Positive predictive value (%)	91 (101/111)	94 (98/104)	0.37
Negative predictive value (%)	92 (58/63)	92 (58/63)	1.0
Lateral meniscus			
Sensitivity (%)	77 (55/71)	77 (53/69)	0.93
Specificity (%)	89 (92/103)	98 (92/94)[c]	0.02
Positive predictive value (%)	83 (55/66)	96 (53/55)[c]	0.02
Negative predictive value (%)	85 (92/108)	85 (92/108)	1.0

[a]Excluding possibly torn by using the two-slice-touch rule.
[b]For differences.
[c]Statistically significant increase for lateral meniscus when two or more images show abnormal finding.

AJR 2006; 187:911–914.