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When Does Your Patient Need Advanced Imaging?

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Advanced Imaging Outline

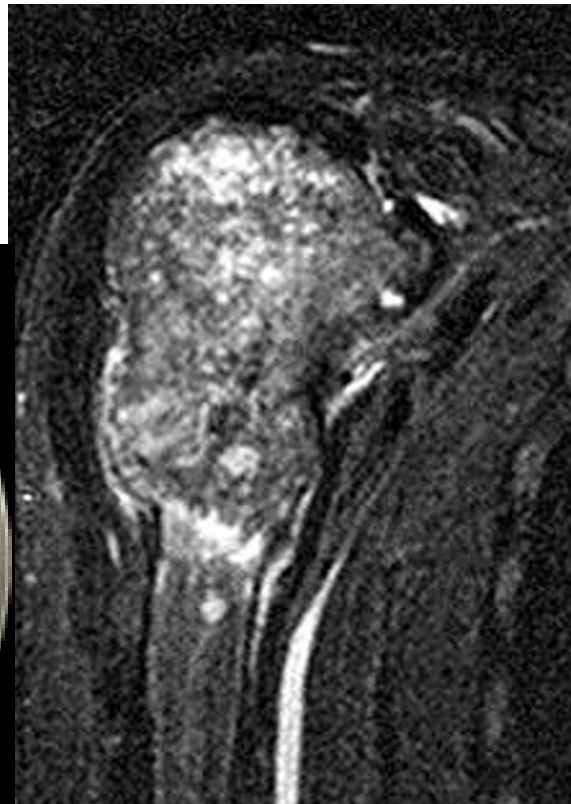
- Different Modalities for Imaging
- Interpretation of Imaging Findings
- Obstacles to Ordering Imaging
- When to Refer for Imaging

Why image?

- New injuries
- Chronic problems
- Rule out tumor
- Patient wants it!
  - “My arm hurts, I need an MRI of my whole body.”

Imaging

- Aid diagnosis
- Determine significance
- Allow treatment plan



What are the Imaging Modalities?

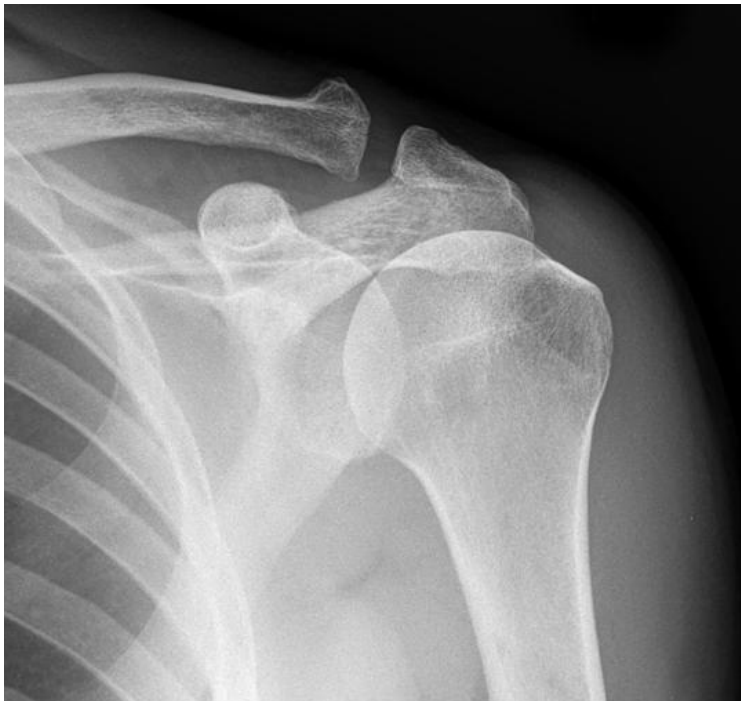
- Radiographs
- Ultrasound
- CT scan
- Bone scan
- MRI/MRA

Plain Radiographs

- Image obtained by projecting of x-ray beams onto a detector
- The amount of ‘brightness’ is a function of the radiodensity and thickness of the object
- Dense object – brighter image

Plain radiographs

- Good first line evaluation
- Need multiple views of a joint (AP and lateral)



What to look for on radiographs?

- Fractures
  - Displaced
  - Comminuted
  - Impacted
- Arthritis
  - Mild, moderate, severe
- Abnormal bone morphology
  - Spurs, OCD, deformities

When to worry?

- Displaced fractures – always need attention
- Nondisplaced fracture – can immobilize
- Stress fracture/ cannot rule out….
  - Need secondary evaluation
  - Further imaging
  - Closer follow-up

Ultrasound

- Uses high-frequency sound waves to produce images

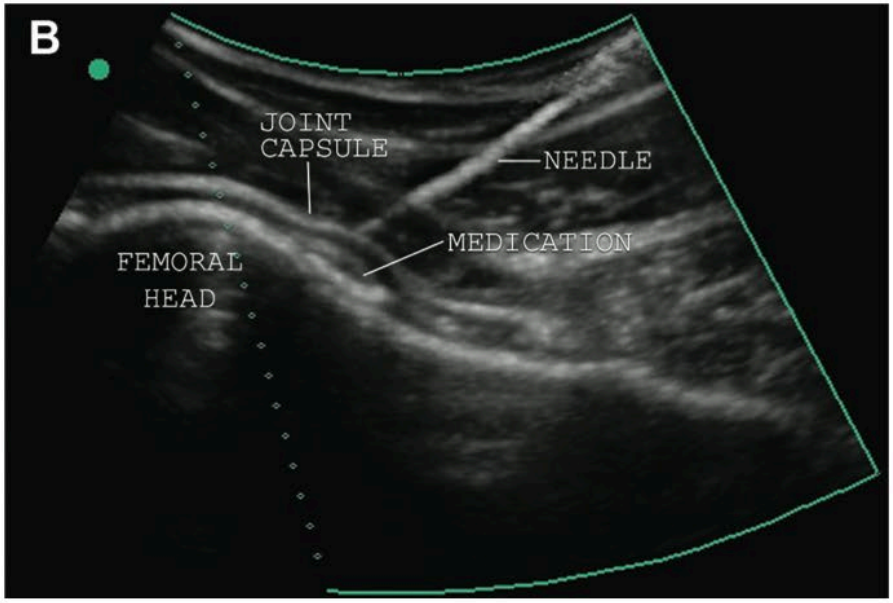
- Can be helpful to evaluate fluid such as cysts or bursitis
  - Wrist ganglions, Baker's Cyst
  - Iliopsoas tendinitis/bursitis
- Diagnose tendon tears
  - Rotator cuff tears
  - Rotator cuff repair healing
- Blood flow
  - Diagnose post-op DVT

Ultrasound

- Advantages
  - Non-invasive
  - Dynamic
    - Tendon instability
- Disadvantage
  - User-dependent
  - Cannot image deep tissue
  - Cannot image tissue within bone

Ultrasound

- Can use for targeted therapy
  - Ultrasound guided injections
    - Viscosupplementation for Glenohumeral joint
    - Calcific tendinitis
    - Intra-articular injection of the hip



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CT scan

- Tomographic evaluation of the region of interest
- Good for 3D bony anatomy
  - Glenoid and humeral bone loss
  - Acetabular and femoral version
- Complex reconstruction
- Post-traumatic bony injuries- malunions

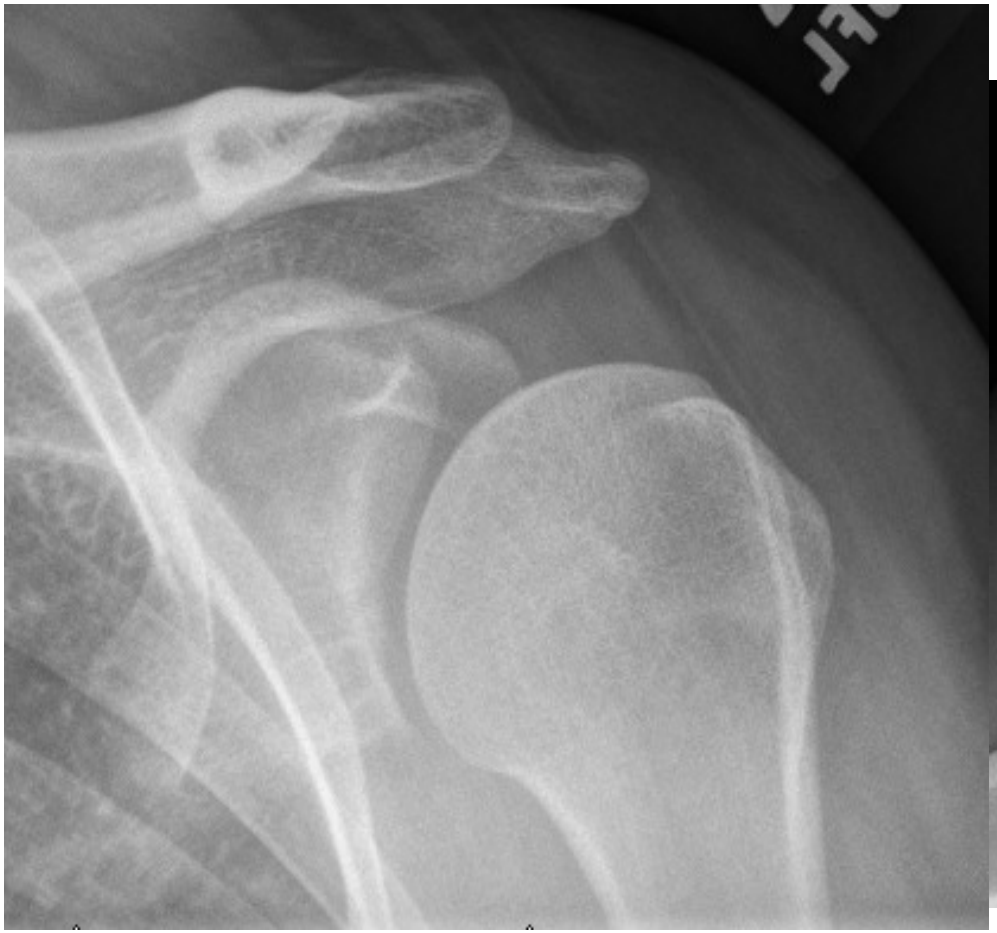
CT scan

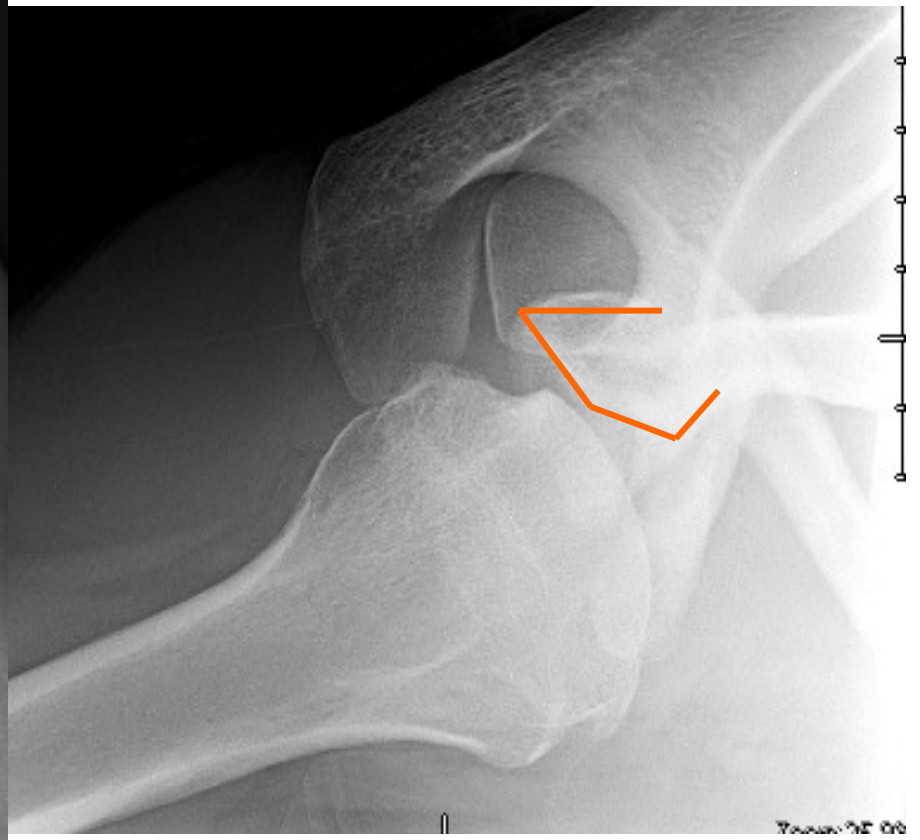
- Advantages
  - Tomographic evaluation
  - Gives detail in trabecular and cortical structures (better than MRI)
    - Measure bone loss
    - Evaluate fracture pattern
    - Evaluate healing

CT scan

- Disadvantages
  - Subject to metal artifact
  - Weight limit for obese patients
  - High radiation (1 CT = 229 Xrays)
  - Contraindicated for pregnant patients

Plain Radiographs- Shoulder Instability

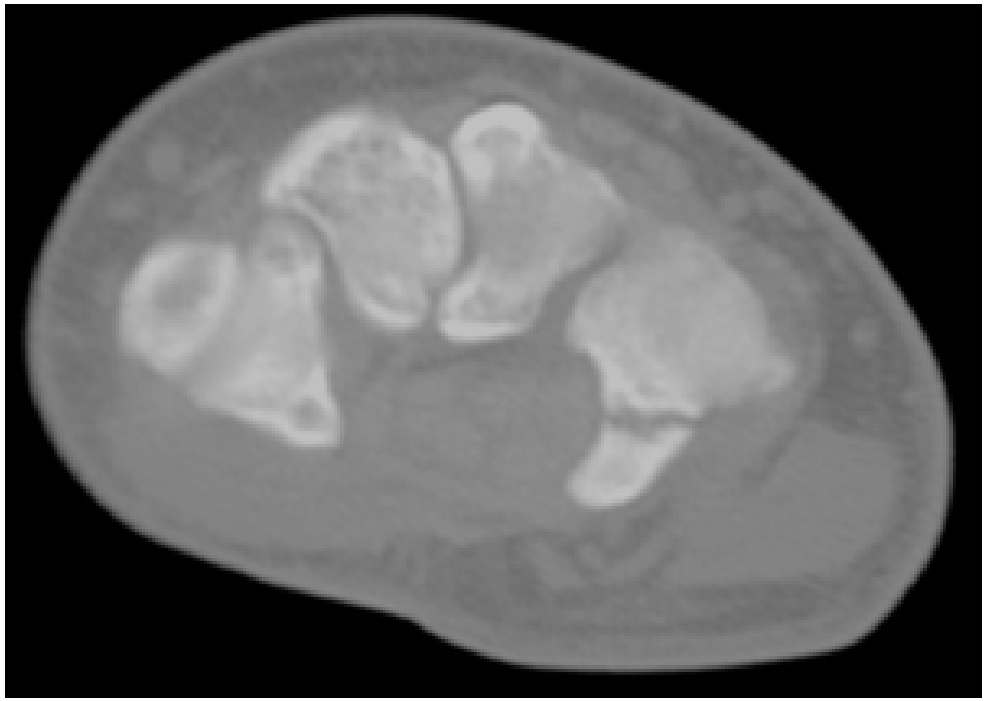




3D CT scan

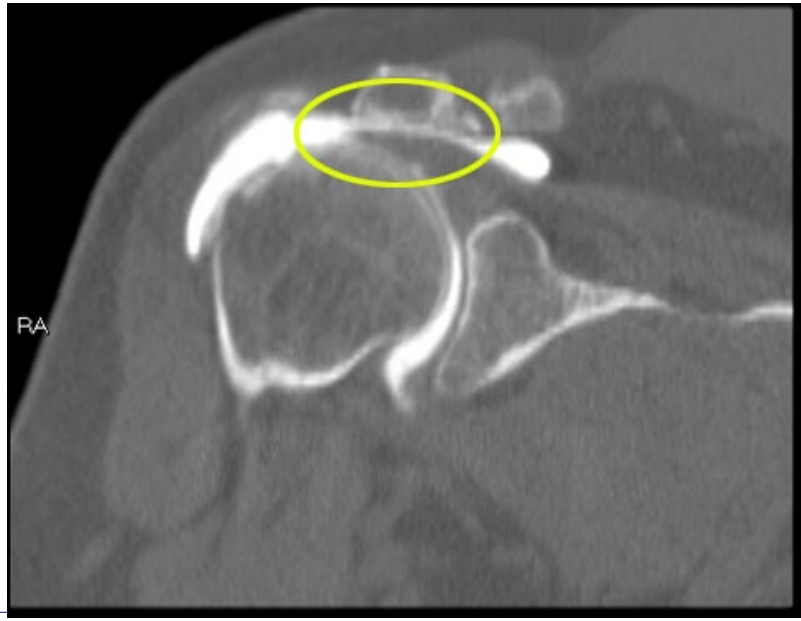
CT Scan

- Hamate Fracture



CT Arthrogram

- For patients who cannot obtain an MRI (Pacemaker, loose hardware)
- Intra-articular contrast (iodinated) injection into the shoulder or knee with CT scan can diagnose soft tissue pathology
  - Rotator cuff tear
  - Labral tear
  - ACL tear
  - Meniscus tear



Nuclear imaging

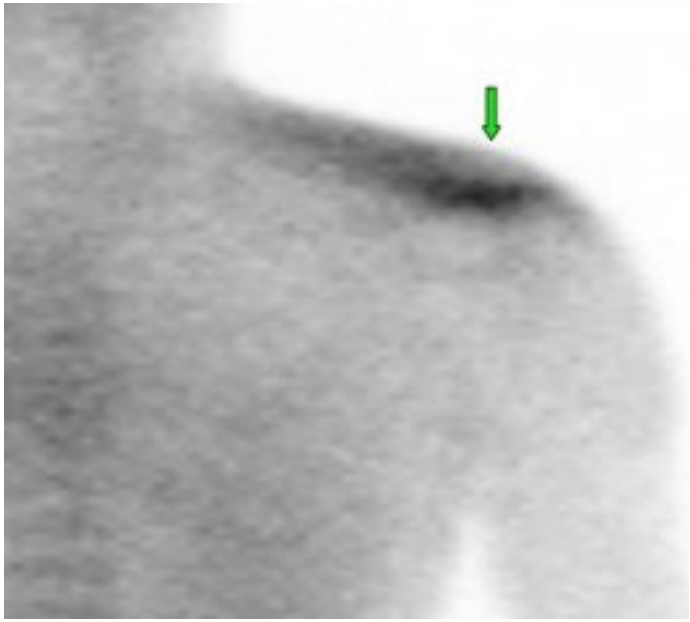
- Uses radioisotope-labeled biologically active drugs
- Radioactive tracers administered to the patient to serve as markers of biologic activity
- Images produced by scintigraphy
  - Technetium bone scan
  - FDG in PET scans
    - Measure glycolytic rates
    - Higher in tumor cells

Bone scan

- Rule out tumor – multiple lesions, increase update
- Infection – tagged WBC scan
- Evaluate symptomatic joints
  - Such as arthritis
  - Nonunion
  - Stress fractures

Nuclear medicine

- Advantages
  - Imaging of metabolic activity
    - Healed fracture or nonunion
    - Arthritis
  - Diagnosis of infection
- Disadvantages
  - Lack detail and spatial resolution
  - Limited early sensitivity
    - Fractures usually takes up to several days to show
    - Low sensitivity for lytic problems
    - Multiple myeloma



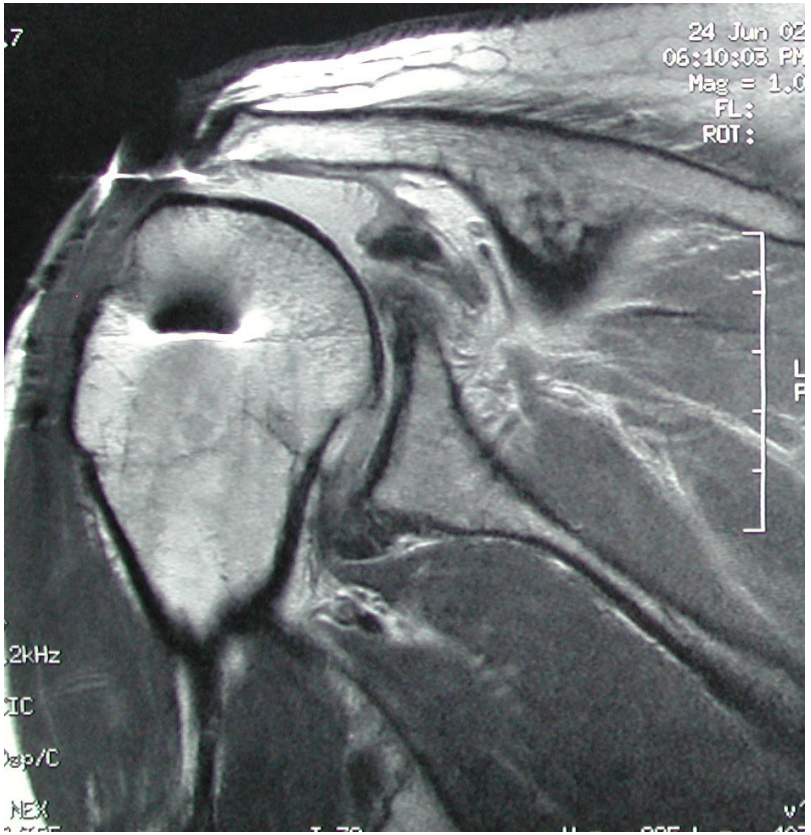
Magnetic Resonance Imaging

- Current gold standard for soft tissue injuries
  - Rotator cuff tears
  - Labral tears
  - Ligament tears
  - Cartilage injuries

- Uses a magnetic field to generate nuclear spin in hydrogen atoms
  - Relaxation times recorded as radiofrequency signal

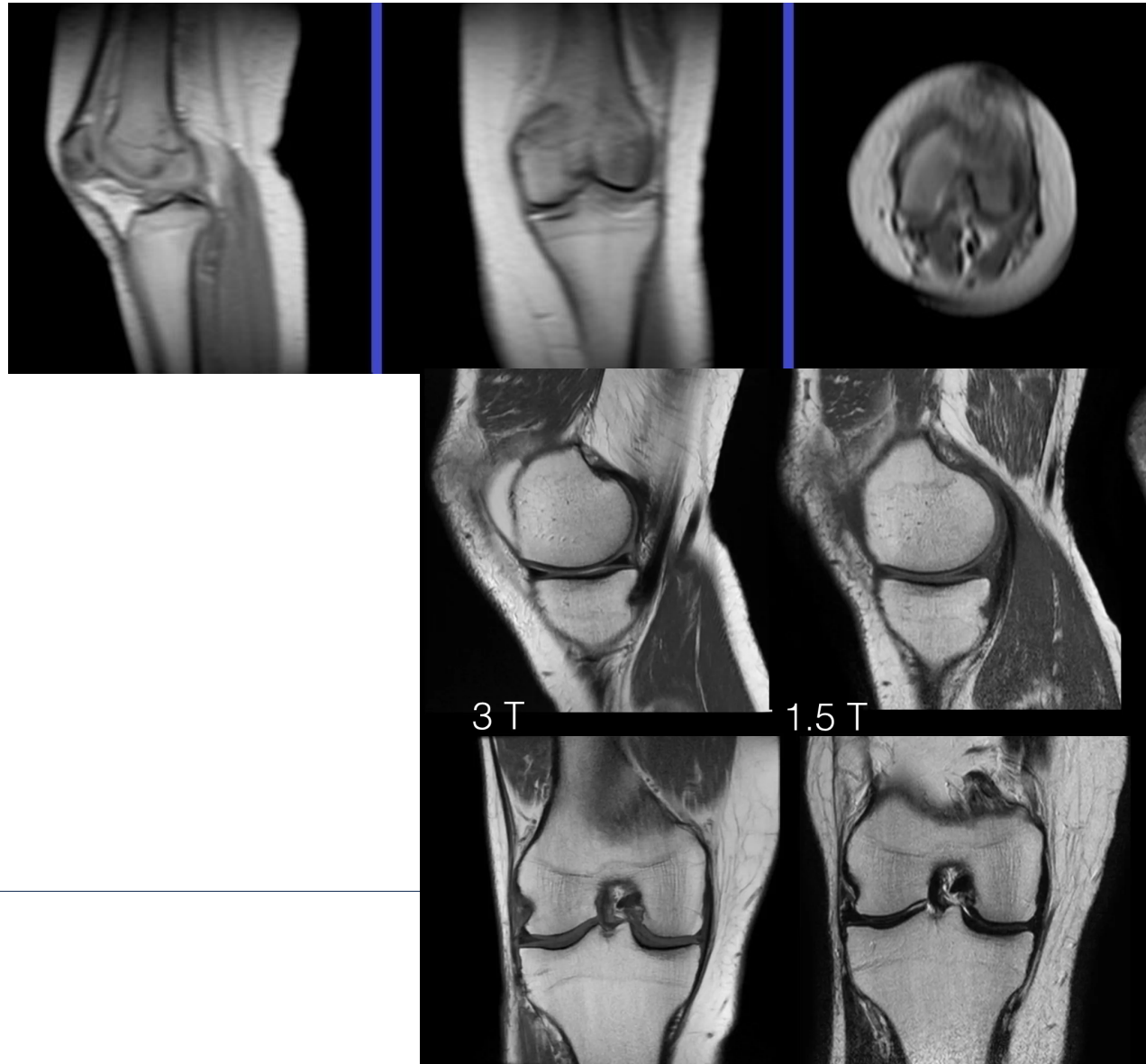
MRI

- Quality of muscle
- Tendon Tear
- Labral pathology
- Cartilage degeneration
- Fluid in bone or joint
- Tumors
- Stress Fractures



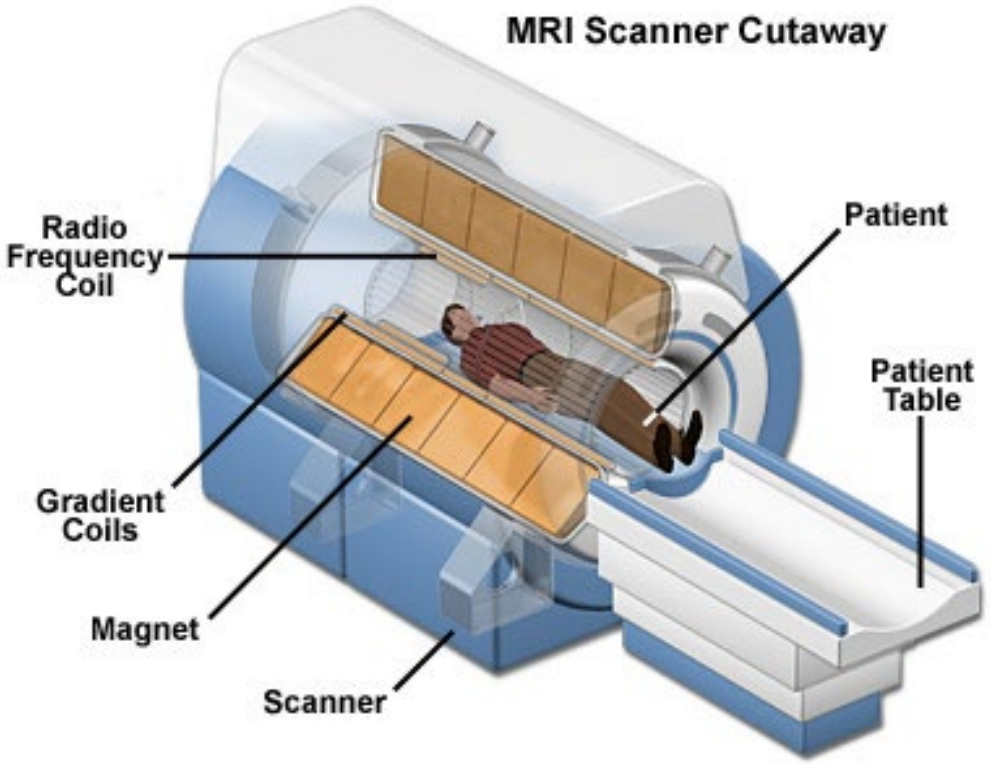
MRI Scanner

- Scanner quality affects what you can see
- 0.3 Tesla
- 1.5 Tesla
- 3 Tesla (3T)
  - UCSF
  - Radnet
  - SimonMed
  - Sutter



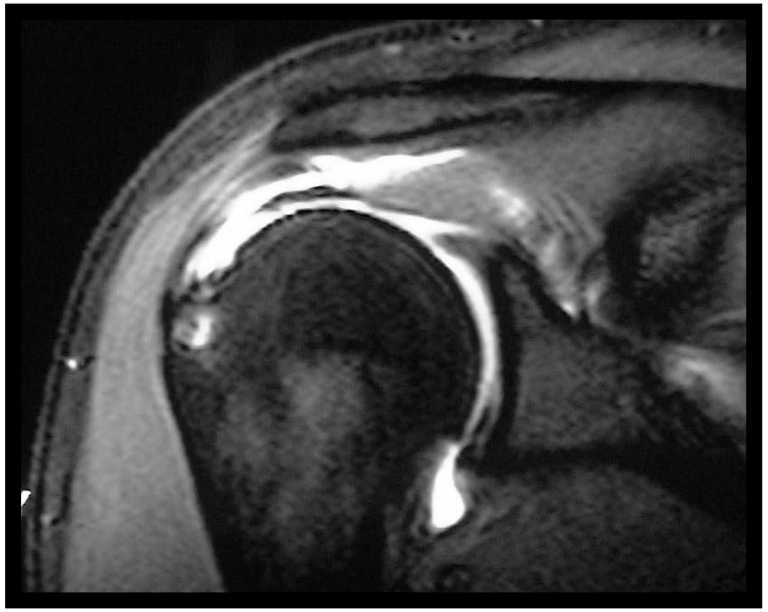
MRI Scanner

- Can worsen claustrophobia
- Loud noise
- Takes 30min to 1 hr

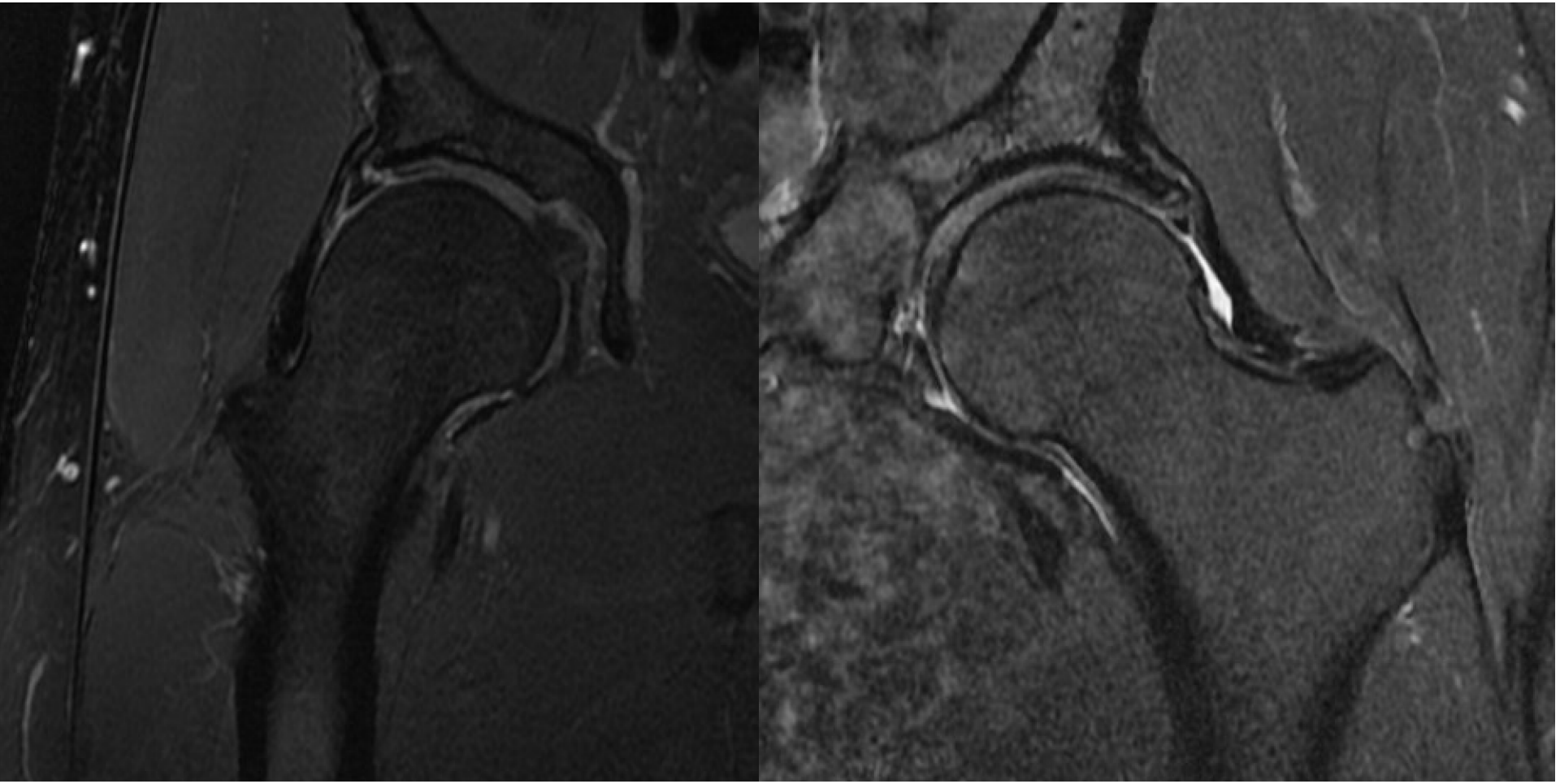


MR Arthrogram

- Intra-articular contrast- Gadolinium
  - Distends the joint
  - Enable evaluation of shoulder and hip labrum
  - Small rotator cuff tears
  - Cartilage injuries, such as TFCC
- Less common to use MRA with 3T MRI



3T MRI without contrast for Hip Labrum



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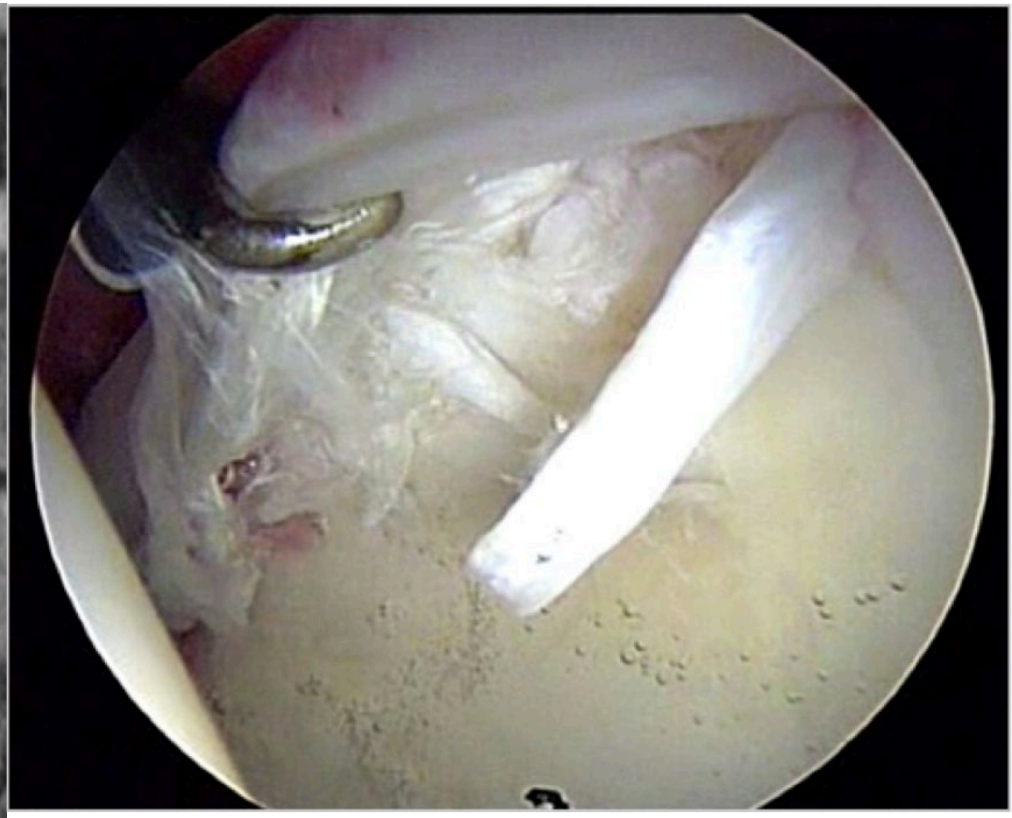
MRA for Labral Tear



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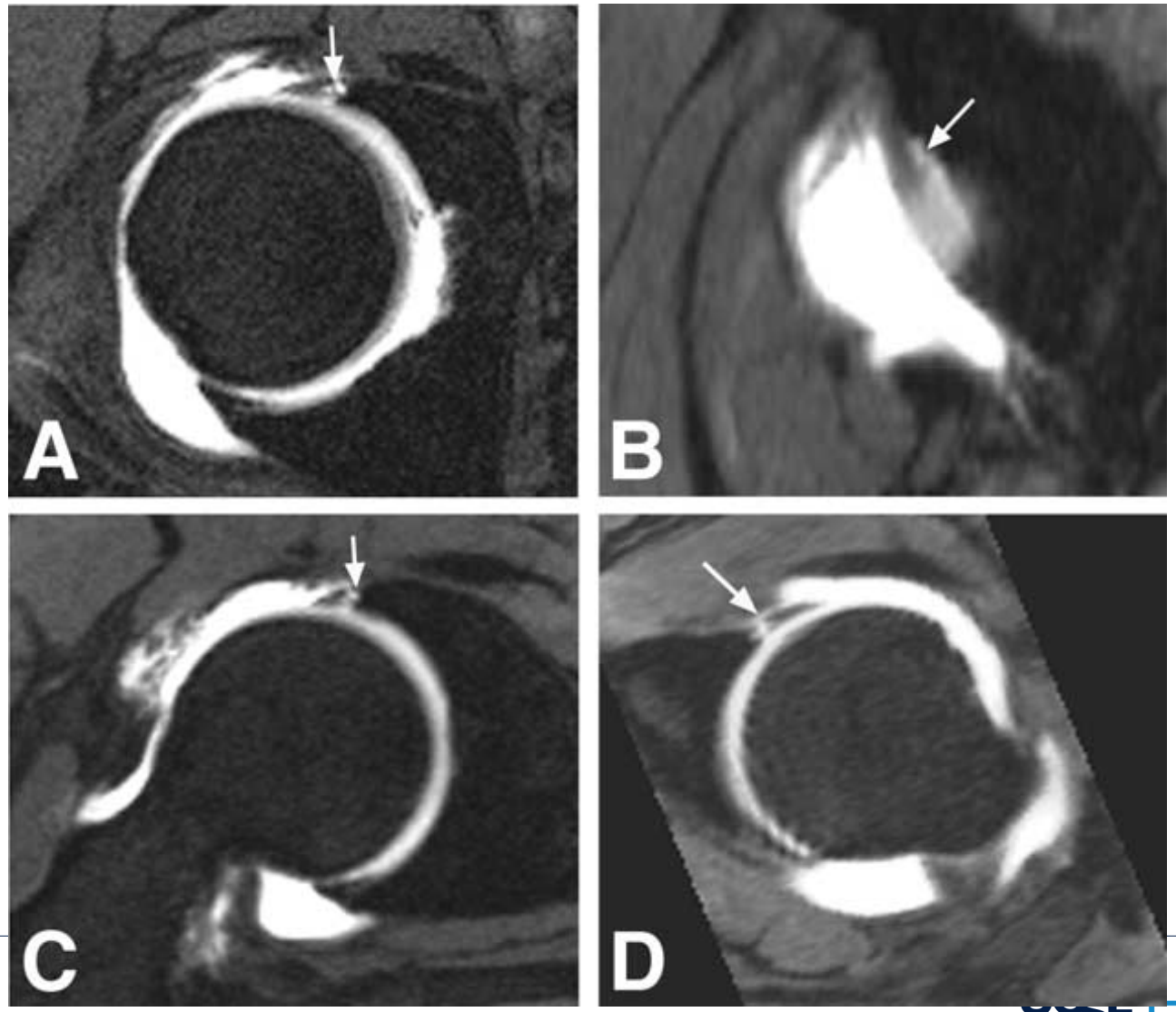
MRA for Small Labral Tear



MRI with Contrast

- Intravenous Gadolinium contrast
- Evaluate vascularity
  - Tumor
  - Post-surgical changes, such as scar tissue
  - Concern with kidney insufficiency and complications

Interpretation of MRI Findings

MR Shoulder

- Asymptomatic individuals
  - > 60 y.o. – 54% have cuff tear (28% full, 26% partial)
  - 40 – 60 y.o.– 4% full, 24% partial
  - 19 – 39 y.o. – 0% full, 4% partial

Careful with Interpretations!!!

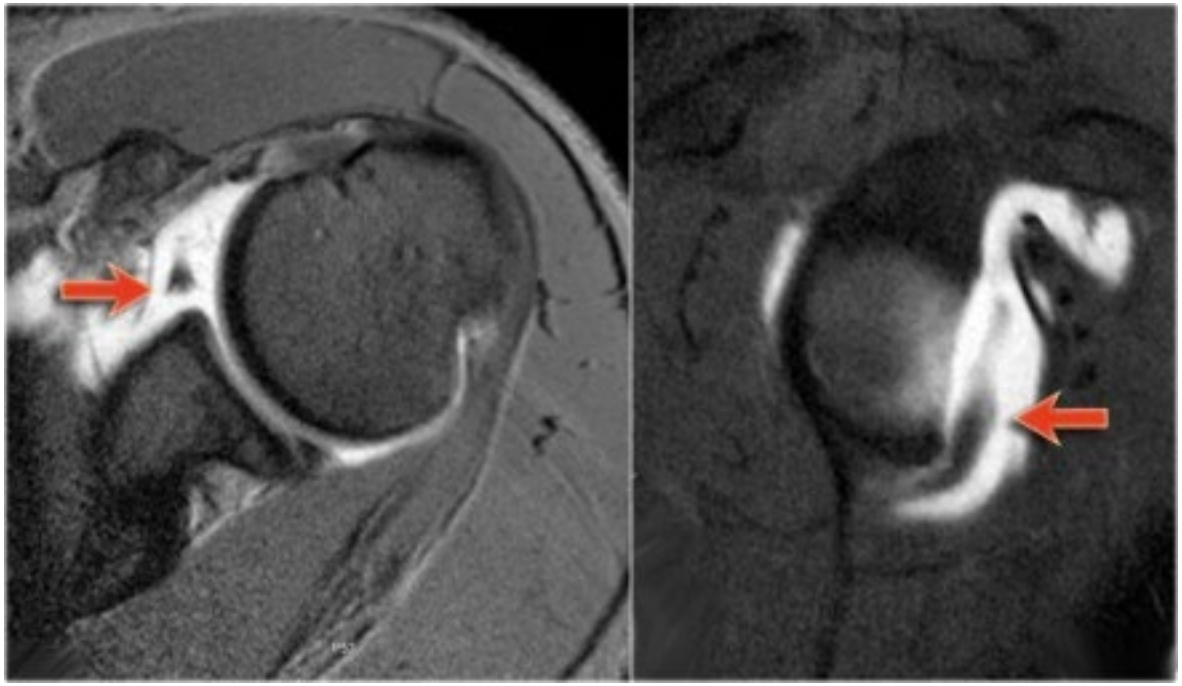
Treat the patient, not the MRI

Interpretation

- Rotator cuff tears
  - Age of patients
  - Older patients – common to have partial cuff tears
    - Conservative treatment
  - Full thickness cuff tears (esp young patient <65)
    - Referral for discussion of treatment

Labral Tears in Shoulder

- Anterior labral tears-
  - Instability, recurrent dislocations



Labral Tears

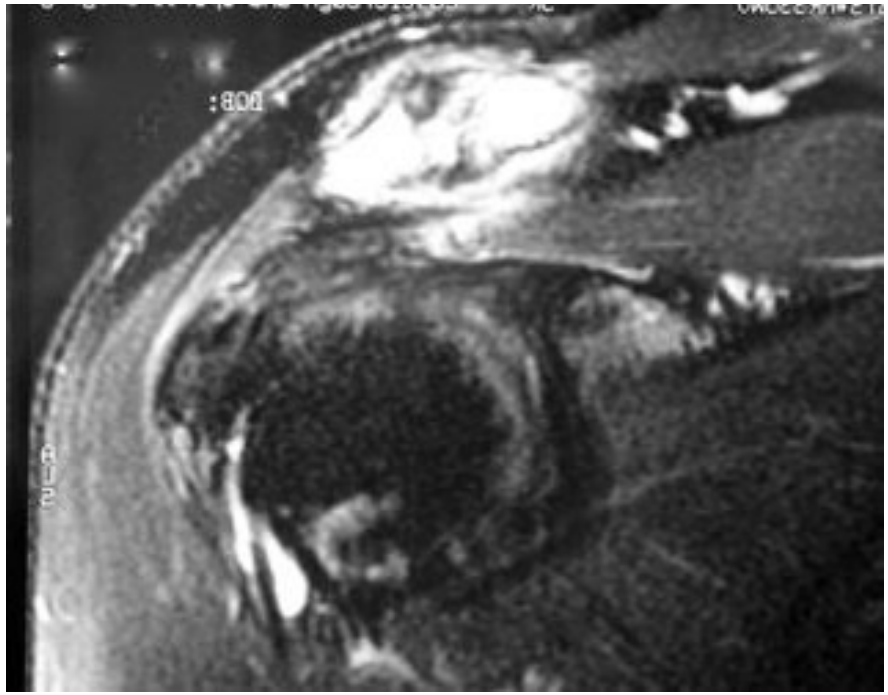
- Superior labral tear (SLAP) tear
  - Pain with overhead activity in young pt (<45)
  - Treated with PT and surgery if fails conservative treatment

- Degenerative labral tears in older pts (>50) are common
  - Likely incidental finding

- Weakness – not correlated with labral tears

AC Joint

- High signal in AC joint
  - Common MR reading
- AC arthritis
  - Clinical diagnosis
  - Superficial joint

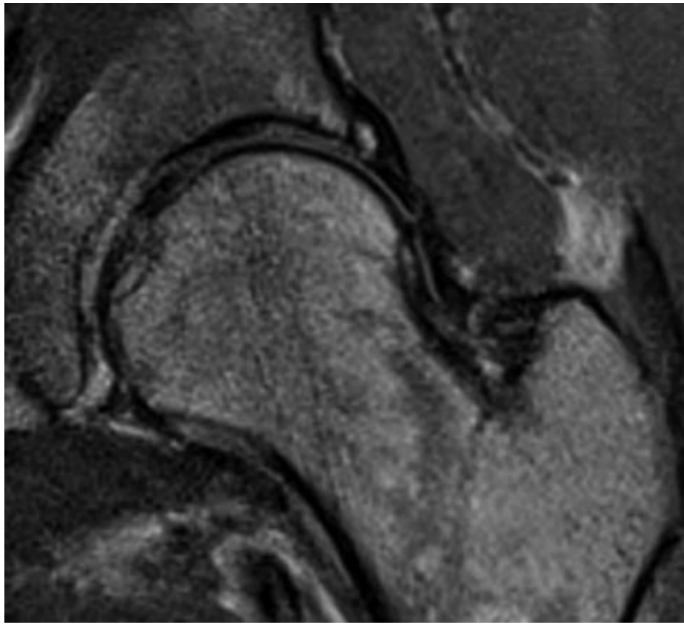


Hip Labral Tear Epidemiology

- High prevalence in asymptomatic patients

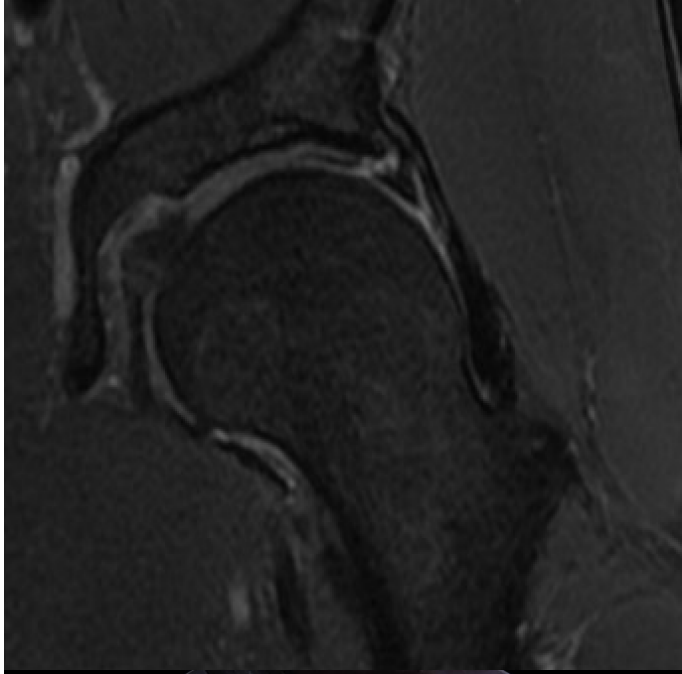
- Philippon et al 2012 AJSM
  - 45 asymptomatic patients
  - Average age 37.8
  - Labral tears identified in-
    - 69% on MRI

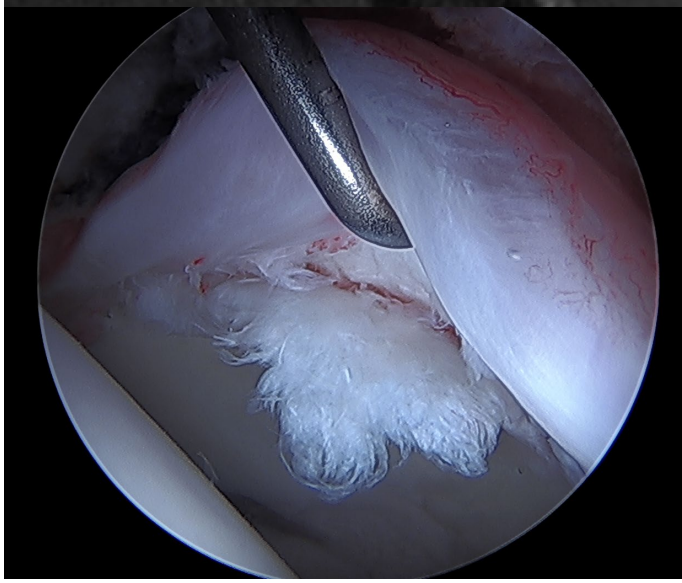
- Patients >35 y/o with isolated labral injury on MRI
  - Can be normal to have signal in labrum or degenerative labral tear



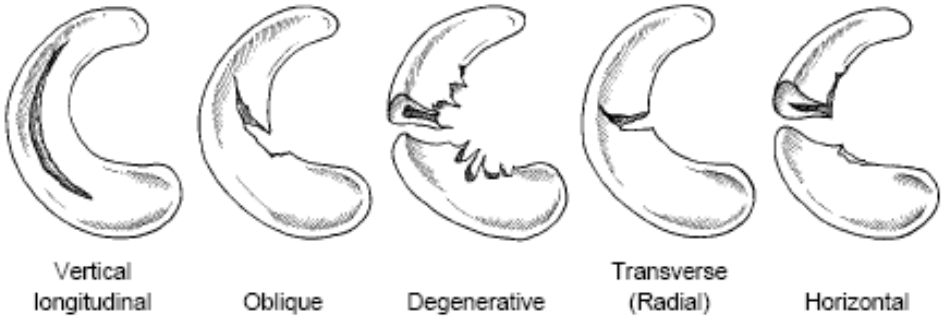
Labral Tear and FAI

- Labral tears common in FAI
  - >95% of FAI patients have labral and/or cartilage injuries (Parvizi et al CORR 2019)
  - Can cause pain and mechanical symptoms
  - Labrum may be symptomatic before cartilage





Meniscus Tears



- Degenerative Meniscus tears very common in patients >50
- Most are asymptomatic
- Meniscus tears should not be treated surgically in the setting of arthritis- no difference with PT (or sham surgery)

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Surgery versus Physical Therapy for a Meniscal Tear and Osteoarthritis

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Meniscus Tears

- Degenerative meniscus tears- horizontal cleavage/complex unlikely to improve with surgical treatment
- Displaced flap tears with pain and mechanical symptoms may be treated surgically

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Radiology Reports – Love Adjectives!

- Fraying vs Partial tear vs Full thickness tear vs Retracted tear
- Cartilage in homogeneity vs fissure vs flap vs unstable flap vs full thickness cartilage loss
- Tendon degeneration vs tendinosus vs tear

Clinical Correlation Recommended…

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What are they saying?

- CLINICAL HISTORY: 55 yo Posterior shoulder pain x1 year. Denies trauma.
- There is adequate distention of the glenohumeral joint with intra-articularly administered contrast. High T2 signal in the anterior subcutaneous fat compatible with iatrogenic injection of anesthetic.
- OSSEOUS ACROMIAL OUTLET: There is mild osteoarthrosis at the acromioclavicular joint with fluid in the joint and capsular hypertrophy.. The acromion is type 1 on sagittal imaging. There is no evidence of os acromiale. There is no Thickening of the coracoacromial ligament.
- ROTATOR CUFF MUSCLES AND TENDONS:
- Mild tendinosis of the supraspinatus tendon and anterior fibers of the infraspinatus tendon. Possible limited interstitial tearing of the posterior fibers of the infraspinatus tendon at the insertion (series 6, image 13).
- Normal signal and morphology of the subscapularis and teres minor tendons.
- Normal signal and bulk of the rotator cuff muscles.
- LABRAL AND CAPSULAR STRUCTURES: Irregularity of the anterosuperior and superior labrum compatible with degenerative changes. Blunting of the anterior labrum without discrete tear. No paralabral cyst formation.

What are they saying?

- BICEPS TENDON AND ANCHOR: High T1 signal within the intra-articular portion of the long head biceps tendon favored to represent iatrogenic injection. The extra-articular portion of the long head biceps tendon demonstrates normal signal and morphology.
- OSSEOUS AND CARTILAGINOUS STRUCTURES: Nonspecific cystic changes at the greater tuberosity. There is no evidence of a fracture or dislocation. No focal chondral defects are identified.
- MISCELLANEOUS: There are no intra-articular bodies. The remaining muscles demonstrate normal bulk with no evidence of atrophy or edema.
- IMPRESSION:
- 1. Irregularity of the anterosuperior and superior labrum compatible with degenerative changes. Blunting of the anterior labrum without discrete tear. The posterior labrum appears intact.
- 2. Mild tendinosis of the supraspinatus tendon and anterior fibers of the infraspinatus tendon. Possible limited interstitial tearing of the posterior fibers of the infraspinatus tendon at the insertion.

55 yo with no trauma and above findings – AGE Appropriate changes

What are they saying?

- CLINICAL HISTORY: 51-year-old male with right shoulder pain after fall, rule out full thickness rotator cuff tear
- OSSEOUS ACROMIAL OUTLET: Large inferior clavicular osteophytes indent the supraspinatus. Fluid is noted in the acromioclavicular joint with reactive marrow changes. Type 2 acromion.
- ROTATOR CUFF MUSCLES AND TENDONS: Full thickness tear is seen at the anterior footprint of the supraspinatus tendon, with slightly increased intensity within the rest of the su
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- OSSEOUS AND CARTILAGINOUS STRUCTURES: Unremarkable. Normal bone marrow signal. No evidence of fractures.
- MISCELLANEOUS: The inferior glenohumeral ligament is not well defined and thickened. Fluid is also noted in the subacromial/subdeltoid bursa. Rotator interval synovitis.
- IMPRESSION:
- 1. Full thickness tear at the anterior footprint of the supraspinatus tendon with supraspinatus tendinosis.
- 2. Thickening of the inferior glenohumeral ligament as well as rotator interval synovitis may reflect adhesive capsulitis.

51 yo with fall and full thickness rotator cuff tears

Refer for treatment and repair

Obstacles to Ordering Imaging

- Many insurances have pre-authorization requirements before approving advanced imaging (none traumatic injury)
  - Conservative treatment for 6weeks+
    - PT
    - NSAIDs
    - Activity modification
  - Prior Radiographs completed
  - Physical examination with documented positive provocative maneuvers
- Usually will need Ortho to order instead of PCP

When to Refer for Imaging

Injuries with Imaging Hurdles

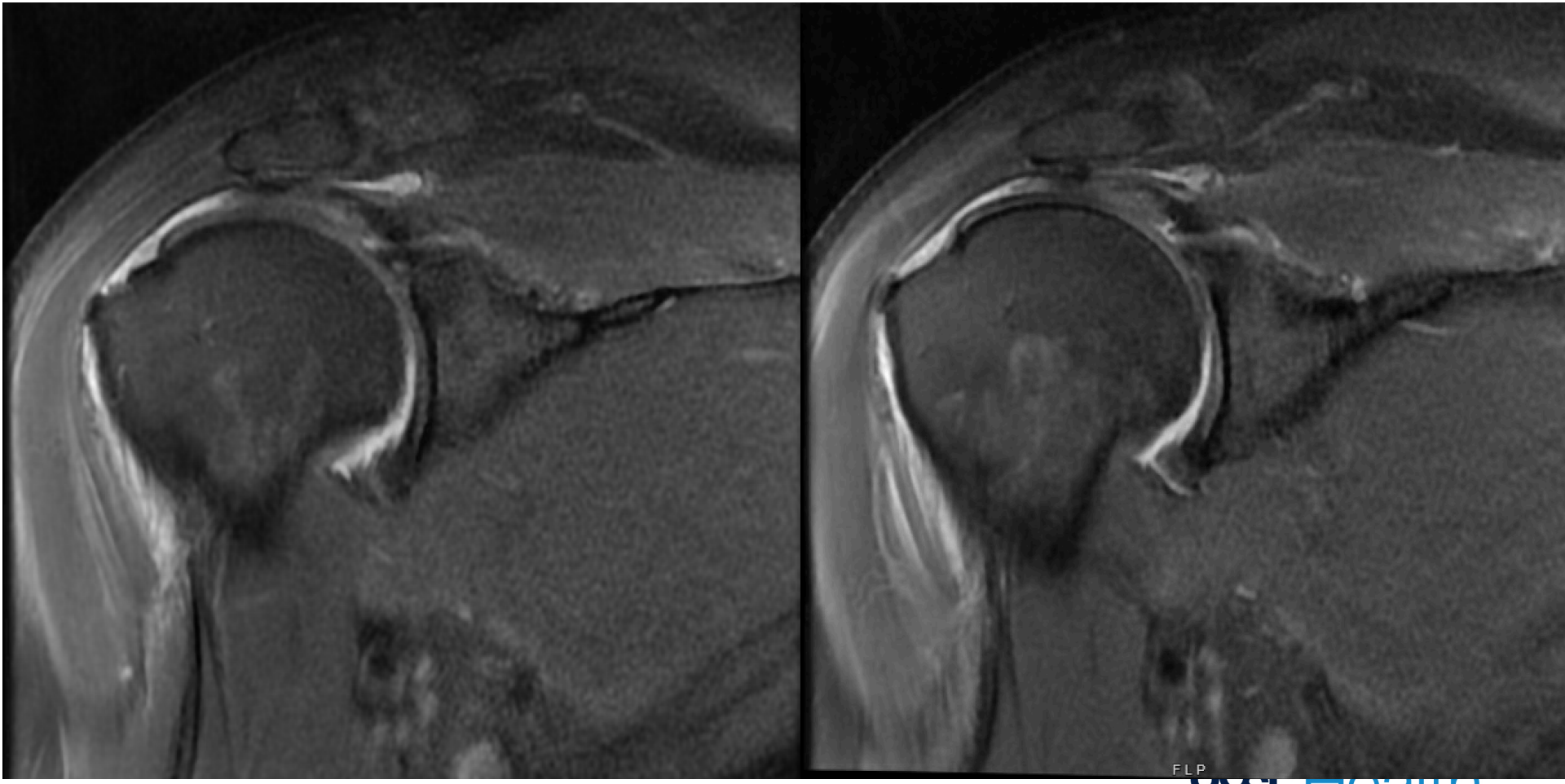
- Make sure to complete conservative treatment first
  - Meniscus tear (unless buckethandle)
  - Patellar instability
  - SLAP tear
    - Sometimes shoulder instability/labum
  - Nonacute rotator cuff tears
  - Shoulder bursitis
  - Hip FAI/labral tear
  - Gluteus/Trochanteric Pathology

Acute Injuries that Need Advanced Imaging

- Refer to Ortho for expedited/urgent imaging orders
- Traumatic knee injury and swelling
  - ACL/ligament tear
  - Patellar/quad tendon rupture
  - Fracture
- Locked knee- buckethandle meniscus tear
- Traumatic shoulder injury
  - Acute cuff tear
  - Shoulder dislocation (in patients over 50)
    - 40% with cuff tear after shoulder dislocation over age 65

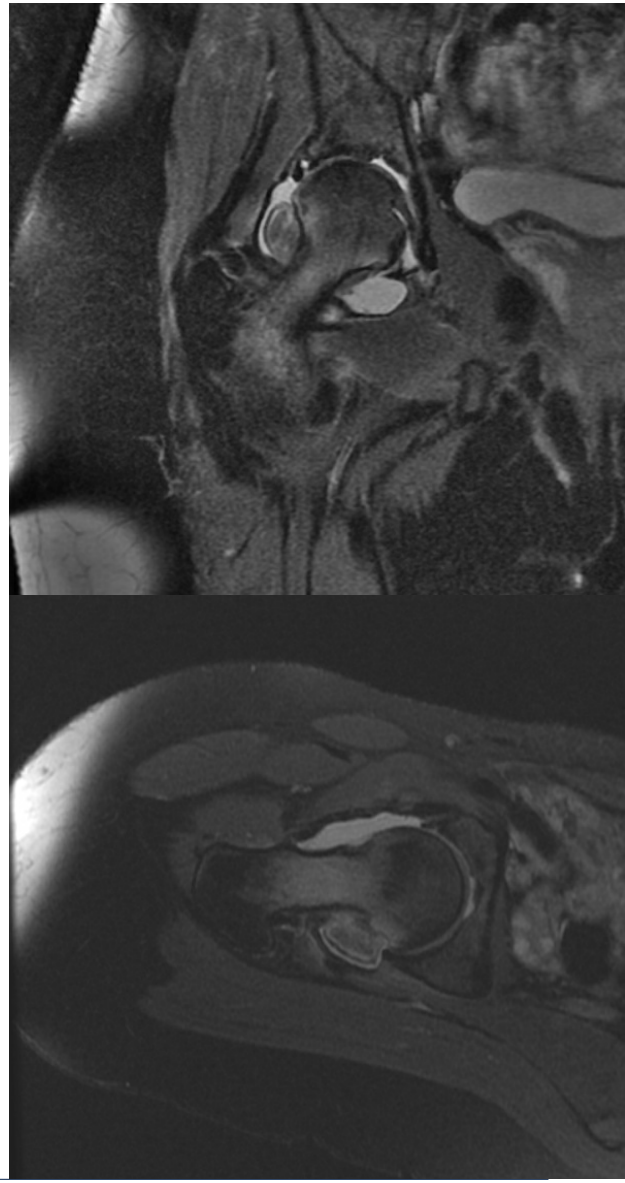
Acute Traumatic Rotator Cuff Tear

- 55 M fall of bike with shoulder pain and weakness for 7 days



Acute Imaging for Injuries

- Hip
  - Proximal hamstring tear
  - Stress Fracture
  - Acute pain and inability to bear weight
- Nerve symptoms
  - Radiculopathy with weakness



Proximal Hamstring Rupture

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MRI

Nerve Symptoms

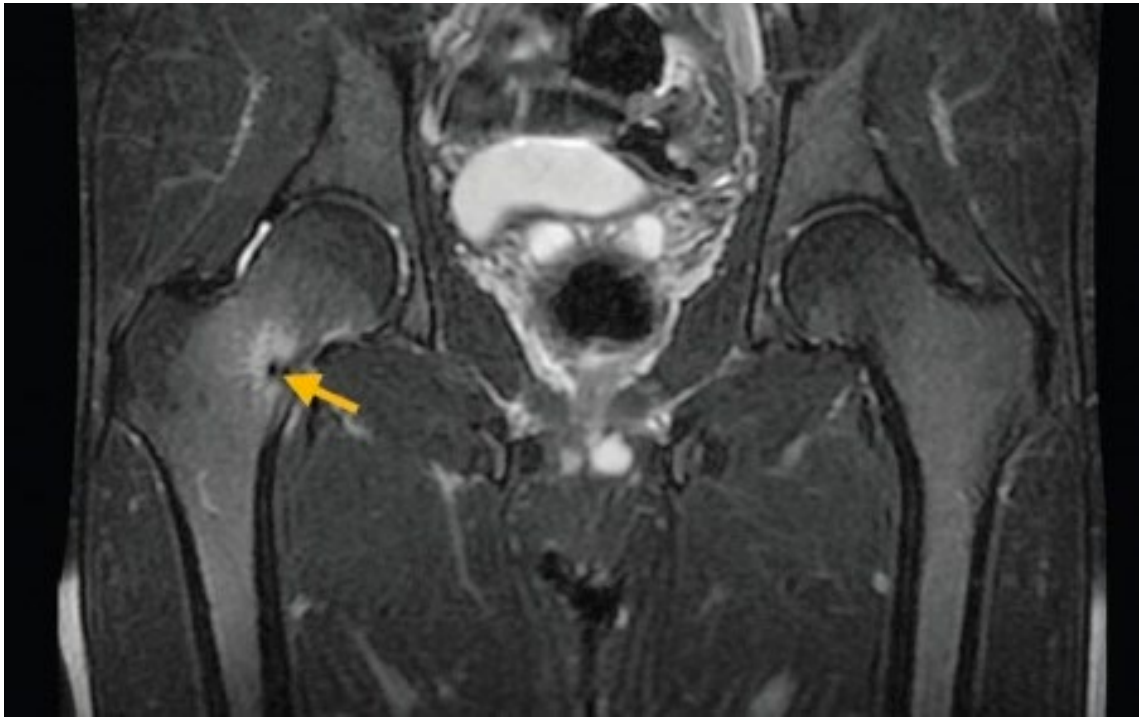
- Lumbar radiculopathy
  - Ask about radiating or shooting pain, numbness or tingling
  - Pain that shoots from the hip down past the knee is usually from the spine and not the hip
  - Obtain L-spine films first
- Cervical radiculopathy
  - Pain (numbness/tingling) past the elbow
  - High correlation with rotator cuff tear (25% of C-spine pts have cuff tear- *Zhang et al 2015*)

Stress Fracture

- Acute on chronic injury (overtraining)
- Age group 18-60 (more commonly >40 years old)
- Pain in groin, anterior thigh, deep in joint, worse with weightbearing
- PE- painful hop test
- Females >males
- Female athletic triad

Stress Fracture (Proximal Femur)

- Sports- Track and field most common
- MRI or bone scan for diagnosis
- Treatment
  - Rest, counseling, protected weight bearing (4-6 wks)
- RTP: 3-4 months



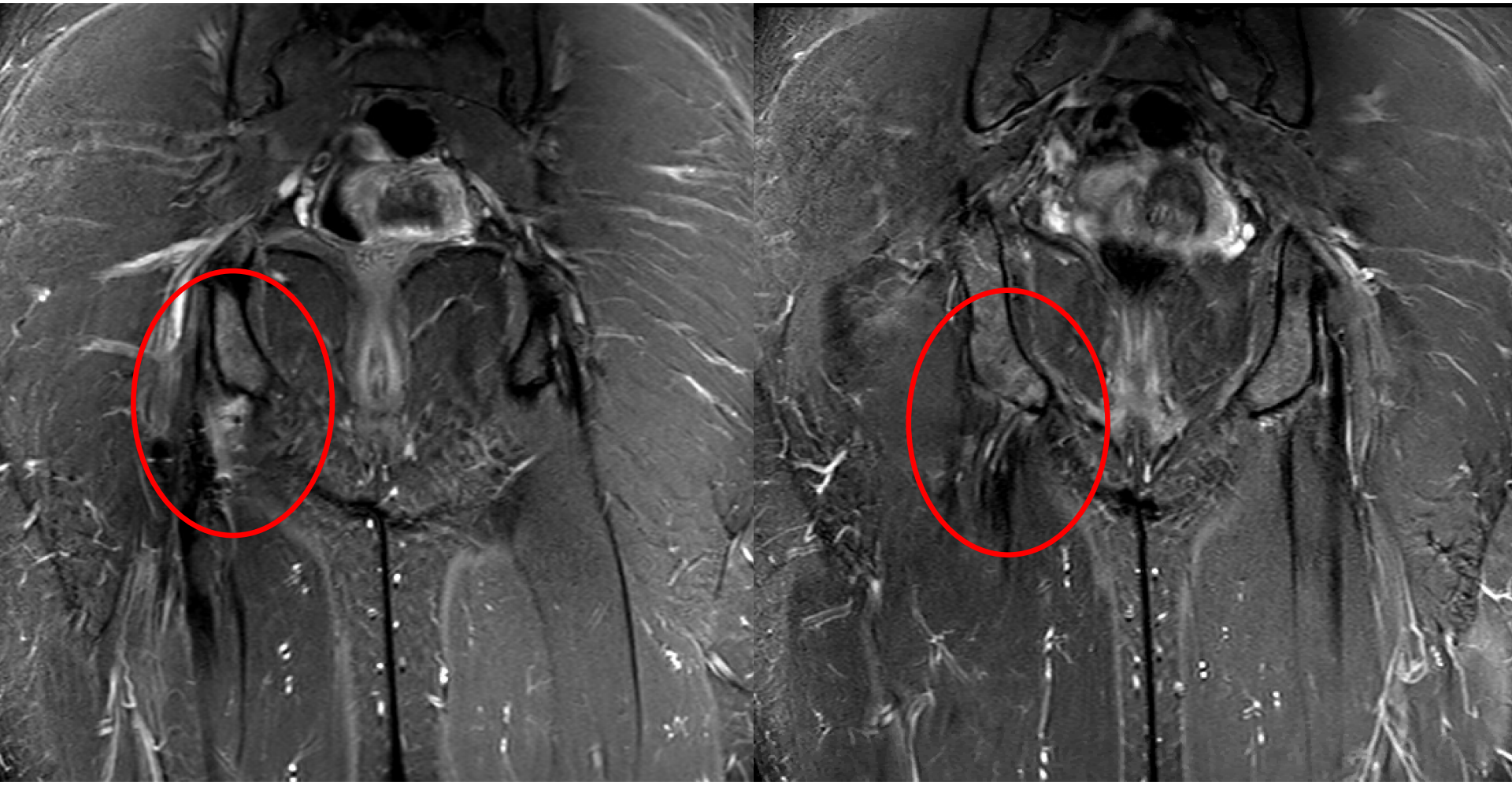
Post-Operative Imaging

- Acute re-injury after surgery
  - Fall after rotator cuff repair
- Change in physical examination
  - Strength improving after cuff repair then increased pain and weakness over time
- Signs of infection
  - Wound abnormalities, fevers, chills, malaise
- No improvement over time
  - Usually wait at least 6 months after surgery to reimage if no acute change or new injury
    - Active remodeling and fluid/scar- difficult to interpret early post-op MRI

Proximal Hamstring Repair

3 Months Post-op

6 Months Post-op



Imaging Summary

- Patients increasingly request for advanced imaging
- Important to start with plain radiography
  - Rule out pathologies (tumor/arthritis/deformity)
- Insurance push back and pre-requisites also increasing
  - Complete 6 week conservative trial for non-acute injuries
- Acute injuries
  - Refer to Ortho to urgent imaging
- Post surgery
  - Unless change in condition/reinjury, wait 6 months for routine post-op imaging

Thank You

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