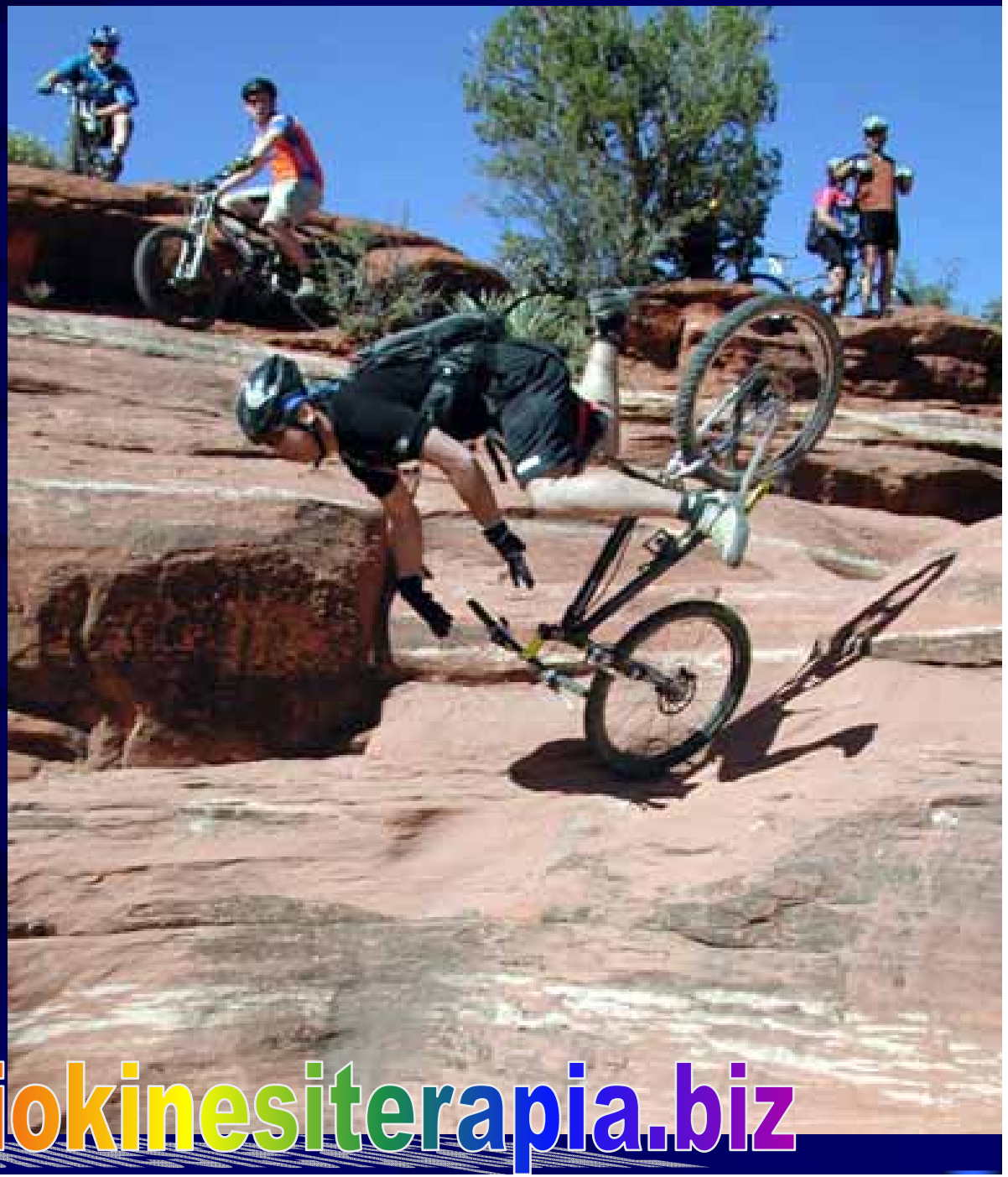
Imaging of Sports Injuries



Shoulder

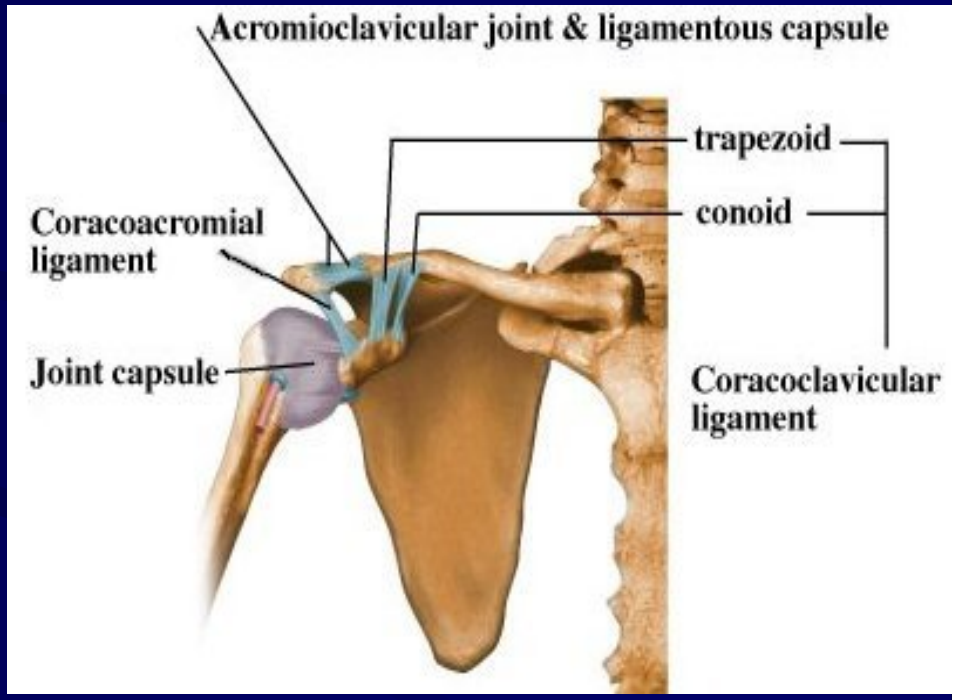
- Capable of tremendous mobility
- Paradox
  - Must be loose enough to function but stable enough to prevent symptoms
- Shoulder injuries occur when the balance between stability & mobility is disturbed.

Shoulder Injuries

- Acromioclavicular separation
- Gleno-humeral dislocation
- Rotator cuff injury

Acromioclavicular Joint

- Comprised of articular surfaces of the clavicle and the acromion
- Ligaments
  - Coracoacromial (AC)
  - Coracoclavicular(CC)
    - conoid
    - trapezoid



Acromioclavicular separation

- Direct force to superior portion of acromion
- Common in contact sports (football, hockey, rugby)
- Tenderness on palpation of joint
- Grade

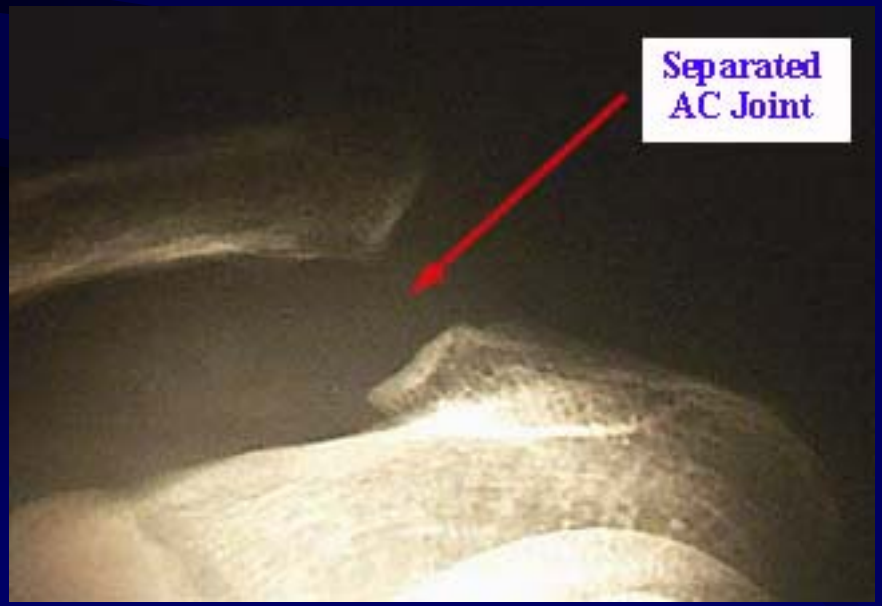
Grading AC Separation

- Allman grading system
  - Grade I
    - Most common
    - AC ligament is sprained with an intact CC ligament
    - AC joint remains stable and symptoms resolve in 7-10 days
    - Excellent prognosis
  - Grade II
    - CC ligaments are sprained and AC ligaments are ruptured
    - Most players can return within three weeks
  - Grade III
    - AC joint capsule and CC ligaments are completely disrupted
    - CC interspace is 25-100% greater than the normal shoulder
    - New grading system (Rockwood) further differentiates grade III separations

Imaging AC joint

- Plain radiographs
  - Useful for initial assessment
- Ultrasound
  - Limited usefulness
  - Used only if CT or MRI not available
- CT
  - Excellent visualization of bony structure
  - Helpful in work up of trauma patients
- MRI
  - Soft-tissue injuries (ligamentous tears & cartilaginous injury

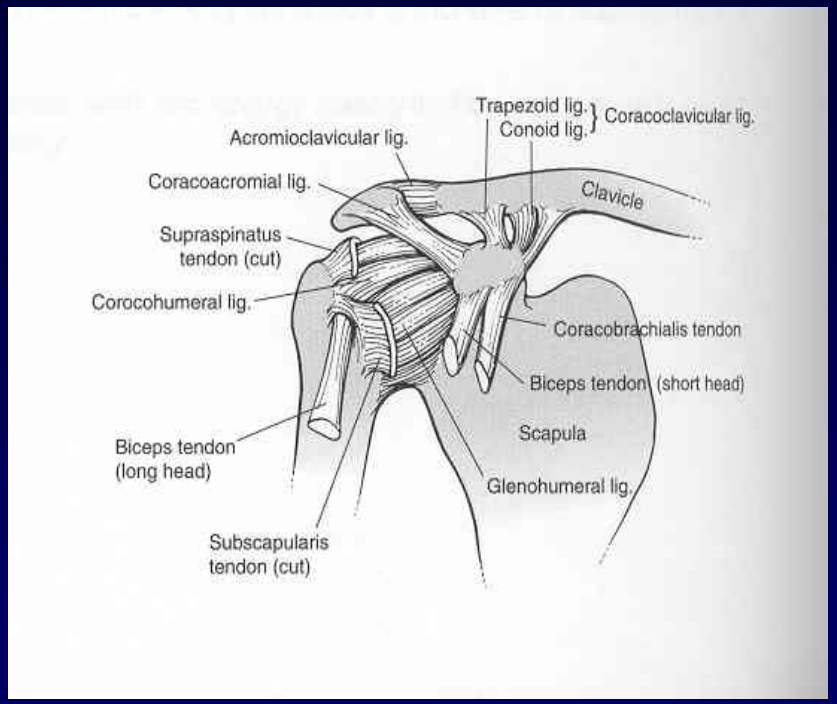
Examples



Traumatic acromioclavicular joint separation in a 24 y/o woman. Oblique coronal image demonstrates superior displacement of the clavicle *(straight arrow)* relative to the acromion with signal hyperintensity in the intervening disrupted ligaments *(curved arrow)*.

Glenohumeral Joint

- Most freely moving joint in body
- Glenoid labrum composed of:
  - Joint capsule
  - Tendon of long head of biceps
  - Glenohumeral ligaments & Coracohumeral ligaments
- Most stable when humerus is abducted and laterally rotated



Shoulder Stability

- Determined by static stabilizers
  - Bony anatomy
  - Ligamentous restraints
- Dynamic stabilizers
  - Shoulder musculature
    - RTC
    - Deltoid
    - Serratus anterior

Gleno-humeral dislocation

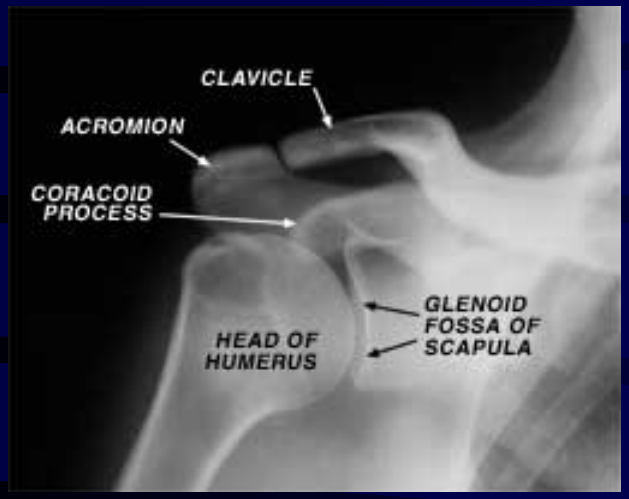
- Majority are anterior
- Usually caused by the arm being forced into abduction & external rotation
- Frequently accompanied by labrum tear (Bankart lesion)
- Head of humerus can also be damaged (Hill-Sachs lesion)

Imaging Glenohumeral Joint

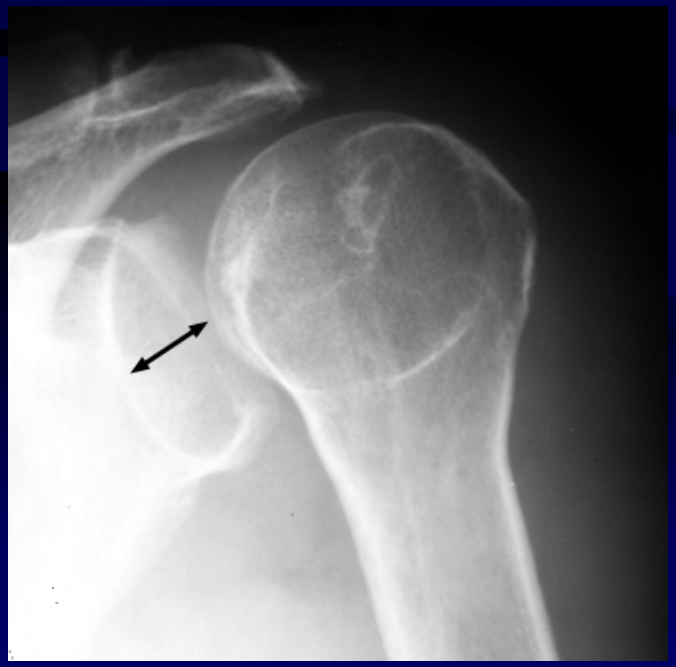
- Radiographs
  - Initial imaging
  - Lots of options for views
  - Axillary view is usually the most useful
- MRI
  - May be used to assess any soft tissue damage (anterior inferior labrum tear)
  - **Particularly useful if performed shortly after acute dislocations because of the presence of an effusion, which acts as a natural contrast agent in the shoulder joint and outlines soft tissue.**
  - MR arthrography
    - Fluid separates structures in shoulder and contrasts with structures BUT…
    - Turns a non-invasive MRI into invasive procedure

Examples

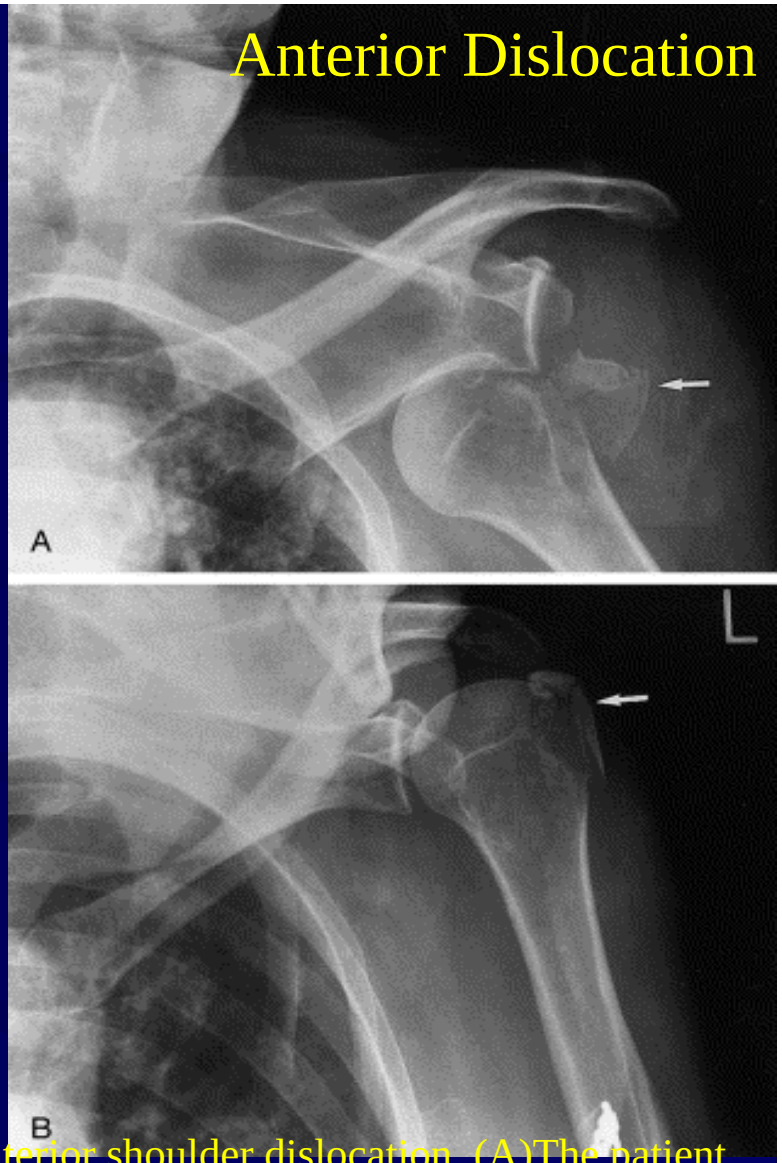
Normal view



Posterior dislocation



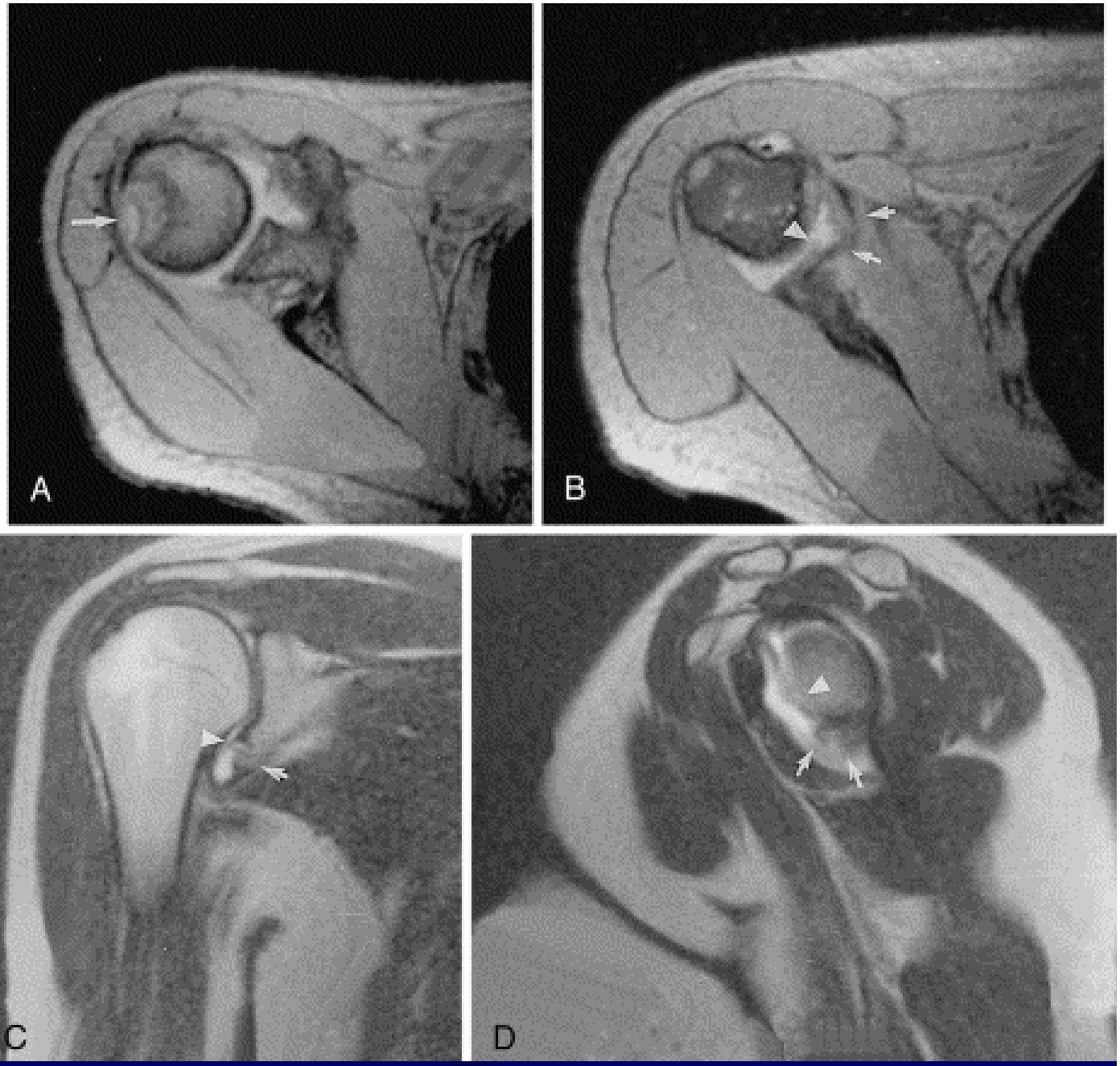
Anterior Dislocation



Acute anterior shoulder dislocation. (A)The patient has a large Hill-Sachs lesion with fracture extension into the greater tuberosity (*arrow*). (B) View of the left shoulder after reduction demonstrates anatomic approximation of the humeral head and glenoid. The fracture fragments are better approximated (*arrow*).

MRI Example

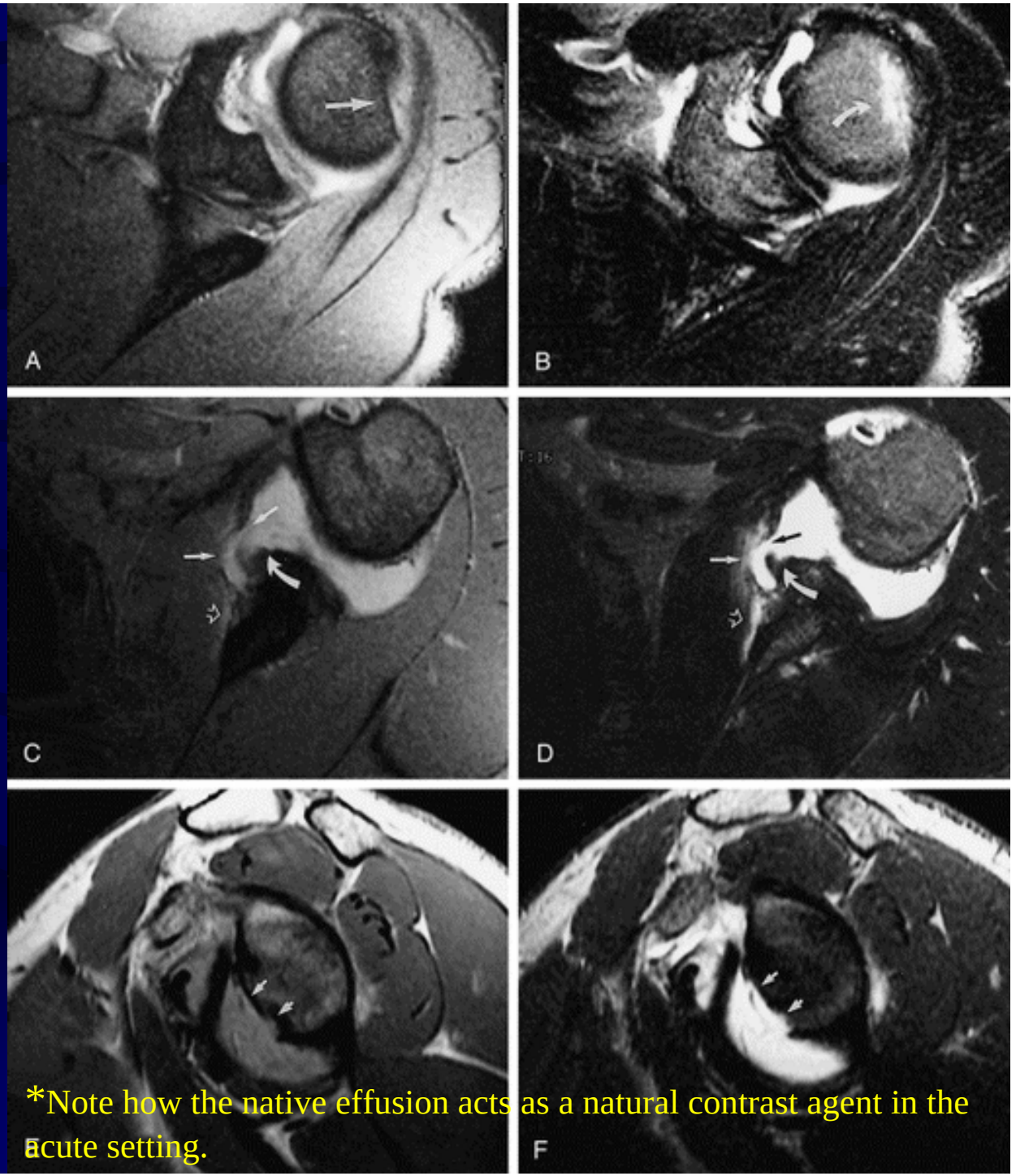
MR imaging after an acute dislocation in a 16 y/o basketball player. (A)Image of the right shoulder at the level of the coracoid process demonstrates a Hill-Sachs lesion (*arrow*). (B) Image at the level of the inferior glenoid shows a Bankart lesion (*arrowhead*) and injury to the anterior glenohumeral ligament (IGHL) at its attachment site (*arrows*). (C) Coronal and (D) sagittal images also demonstrate the Bankart lesion (*arrowheads*) and injury to the IGHL at the attachment site (*arrows*).



*Note how the native effusion acts as a natural contrast agent in the acute setting.

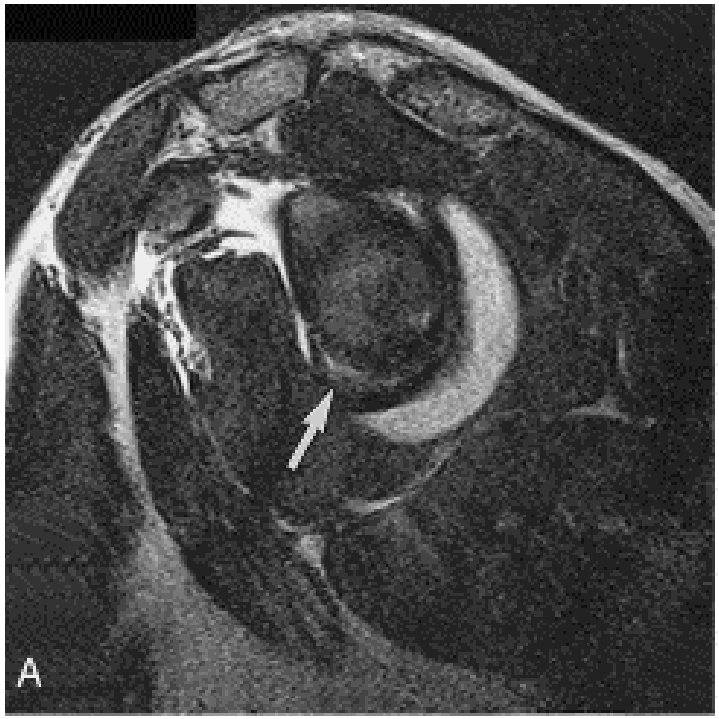
MRI Example

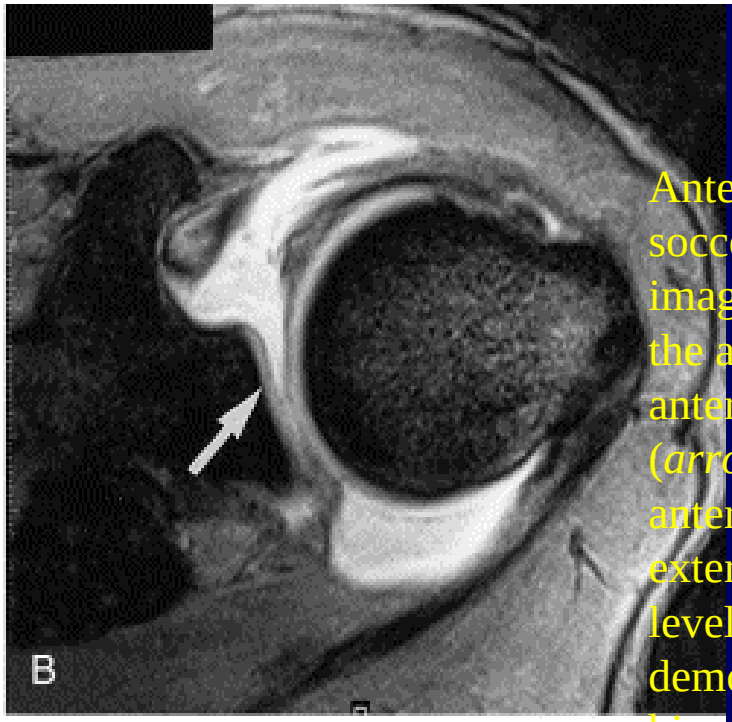
MR imaging after an acute anterior dislocation in a 19 y/o lacrosse player. (A and B) Axial images of the left shoulder at the level of the coracoid process demonstrates a Hill-Sachs deformity (*straight arrow*) and surrounding bone edema (*curved arrow*). (C and D) Axial images at the level of the inferior glenoid demonstrate a torn IGHL at its insertion on the inferior glenoid rim (*solid arrows*). Also seen is depression and disruption of the anterior-inferior glenoid indicating a Bankart lesion (*curved arrows*). Notice also the anterior capsule stripping (*open arrows*). (E and F). Sagittal images in the same patient also demonstrate the patient's Bankart lesion (*arrows*) at the prior insertion site of the IGHL.

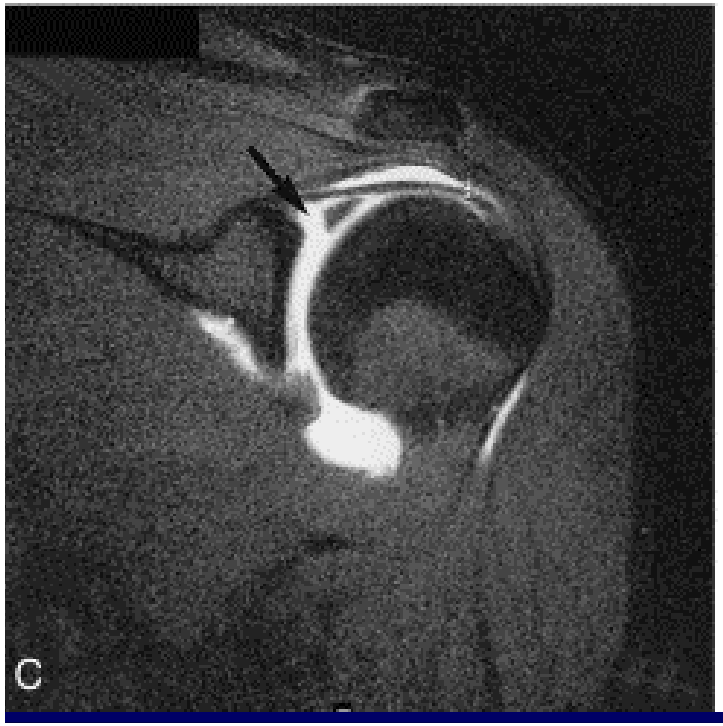


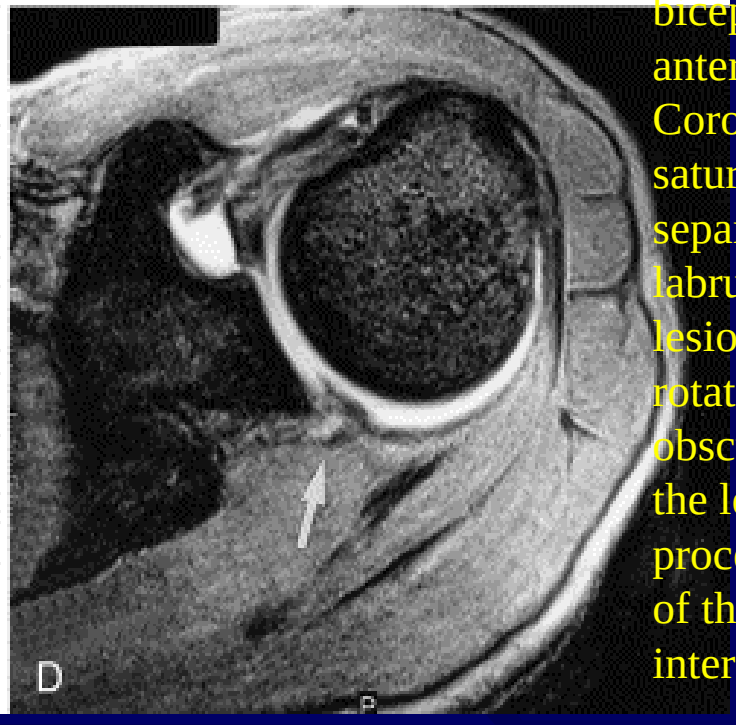
*Note how the native effusion acts as a natural contrast agent in the acute setting.

MR Arthrogram





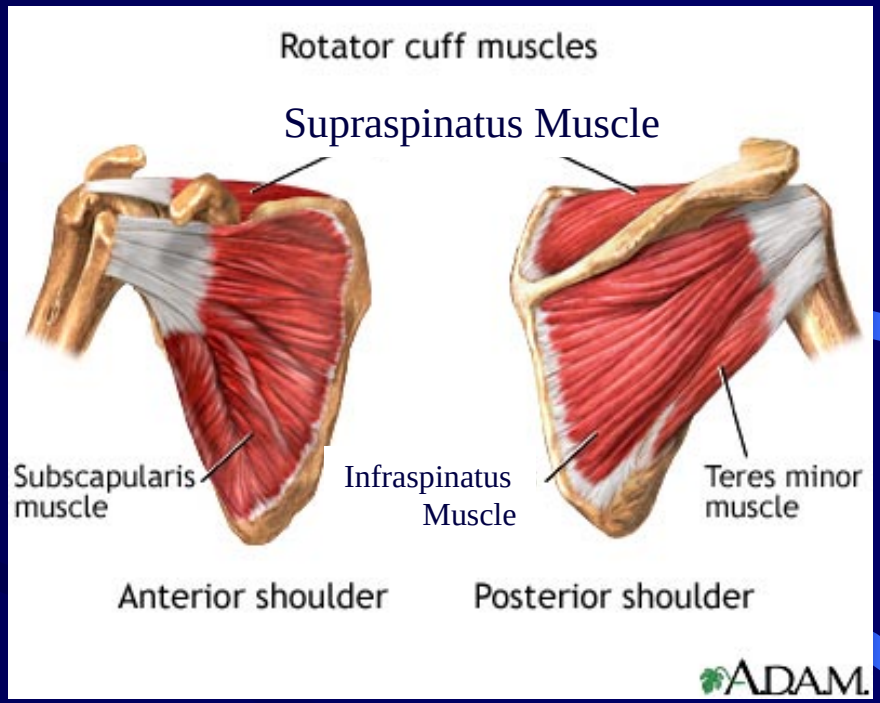




Anterior dislocation in a 16 y/o soccer goalie. (A) Sagittal image demonstrates injury to the anterior IGHL at its anterior glenoid insertion (*arrow*). This lesion causes anterior instability. (B) Axial external rotation view at the level of the coracoid process demonstrates separation of the biceps mechanism from the anterior labrum (*arrow*). (C) Coronal image with fat saturation confirms that this separation is a SLAP (superior labrum anterior to posterior) lesion. (D) With internal rotation, the SLAP lesion is obscured on an axial image at the level of the coracoid process. Note the triangulation of the posterior labrum with internal rotation (*arrow*).

Rotator Cuff

- 4 muscles (SITS)
  - **S**upraspinatus (elevator)
  - **I**nfraspinatus (external rotator)
  - **T**eres minor (external rotator)
  - **S**ubscapularis (internal rotator)
- Surround glenohumeral joint & act as **stabilizers** & **instigators of rotational movement** of the humerus
- **Supraspinatus** & **infraspinatus** pass beneath the coracoacromial arch, where they are subject to impingement and tears



Rotator cuff injury

- Etiology is controversial but involves sudden violent movement or overuse
- Possibilities include:
  - Tensile overload
  - Bony impingement of acromion
  - Instability due to ligamentous laxity (genetic)

Imaging rotator cuff

- No imaging needed when symptoms are mild and of recent onset
- Plain radiographs
  - AP, axillary lateral, & scapular "Y" view for trauma or severe or prolonged symptoms
- Ultrasound
  - Can be useful to evaluate tears, degeneration, or edema
  - Good equipment and operators essential
  - Used commonly in Europe but limited use in U.S.
- T2 weighted MRI
  - **GOLD STANDARD** for assessing trauma in rotator cuff
  - Sensitivity=84-100% Specificity=77-97% for full thickness tears
  - Sensitivity=17-90% for partial thickness tears
  - Addition of intrarticular gadolinium ⇧ sensitivity & specificity to almost 100% but also adds cost & risk of complication
- **Surgery should not be done based on imaging alone (patient must also be symptomatic)**

Examples

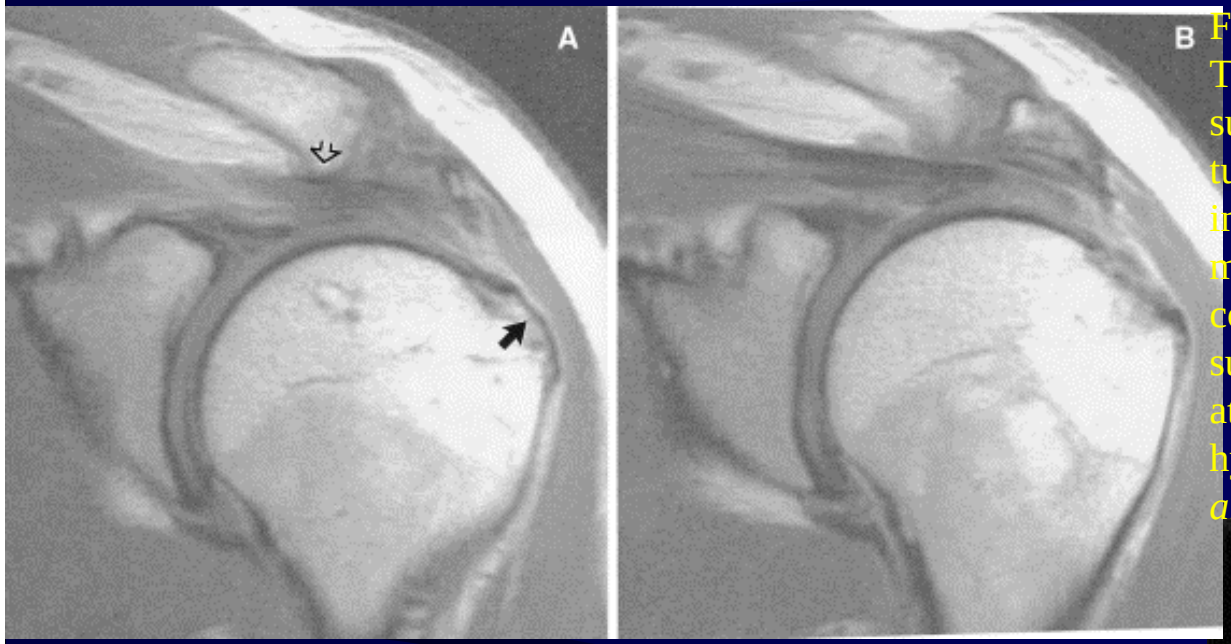
Normal

Notice low signal at the tip of the red arrow

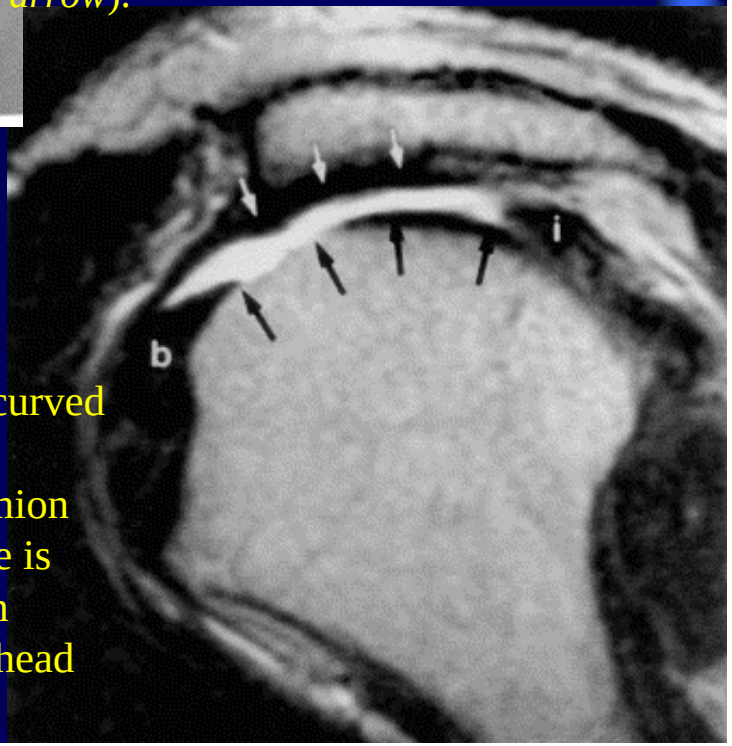
Torn Rotator Cuff

Notice high signal within black signal at the tip of the red arrow

Full Thickness Tears



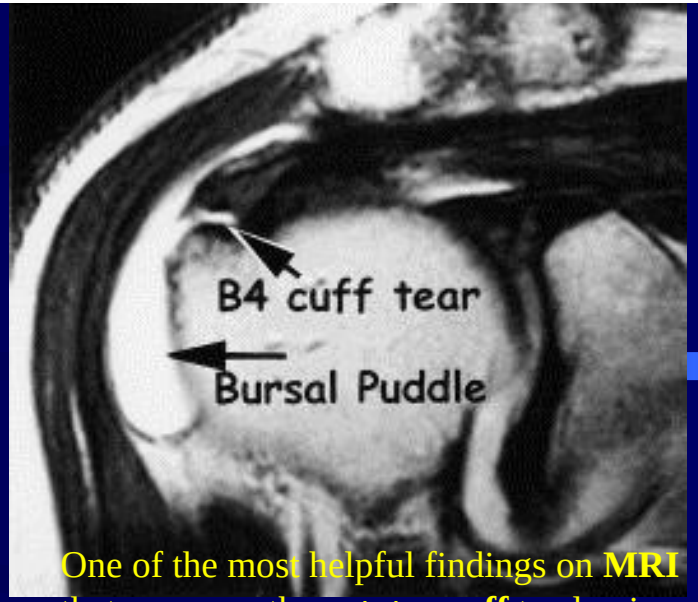
Full-thickness tear of the rotator cuff. There is a full-thickness tear of the supraspinatus tendon from the greater tuberosity on these proton-density coronal images. A spur arising from the inferior margin of the clavicle (*open arrow*) contributes to narrowing of the supraspinatus outlet. There also is mild atrophy of the supraspinatus muscle and hypertrophy of the greater tuberosity (*solid arrow*).



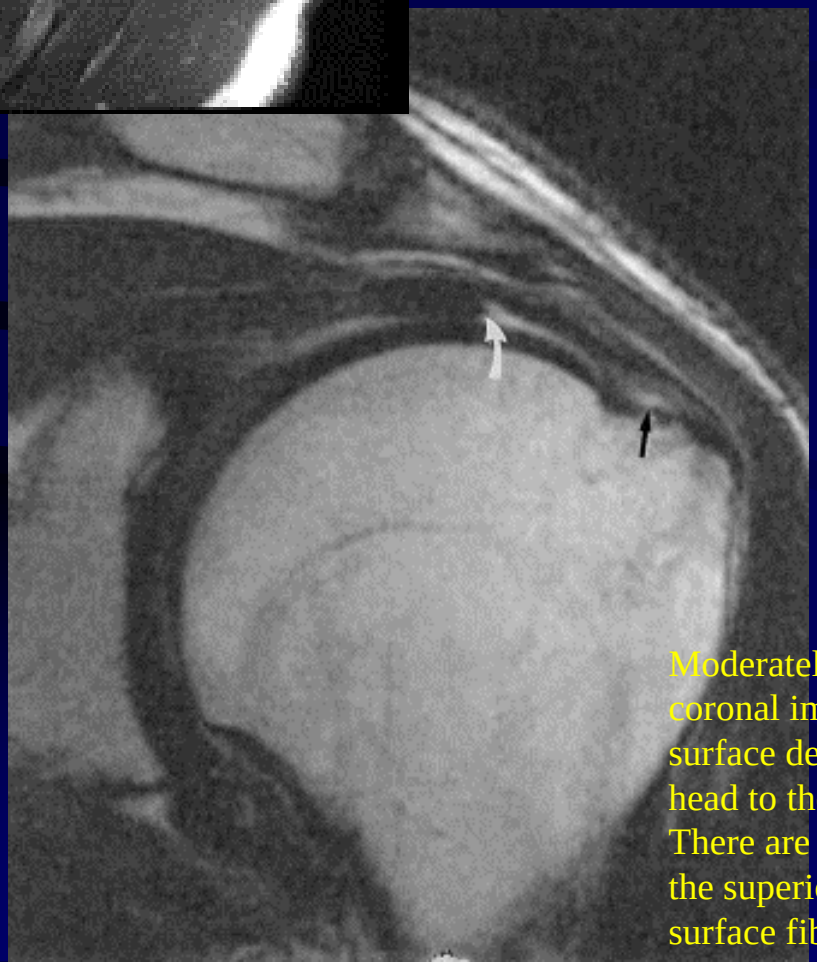
A 54 y/o golfer with a large rotator cuff tear. There is a curved type II acromial configuration with thickening of the coracoacromial ligament and inferior cortex of the acromion (*white arrows*) on this T2-weighted sagittal image. There is fluid delineating a tear of the entire supraspinatus tendon (*black arrows*) that extends from the tendon of the long head of the biceps (**b**) to the infraspinatus tendon

Examples

Axial view on MRI depicting subscapularis rupture.

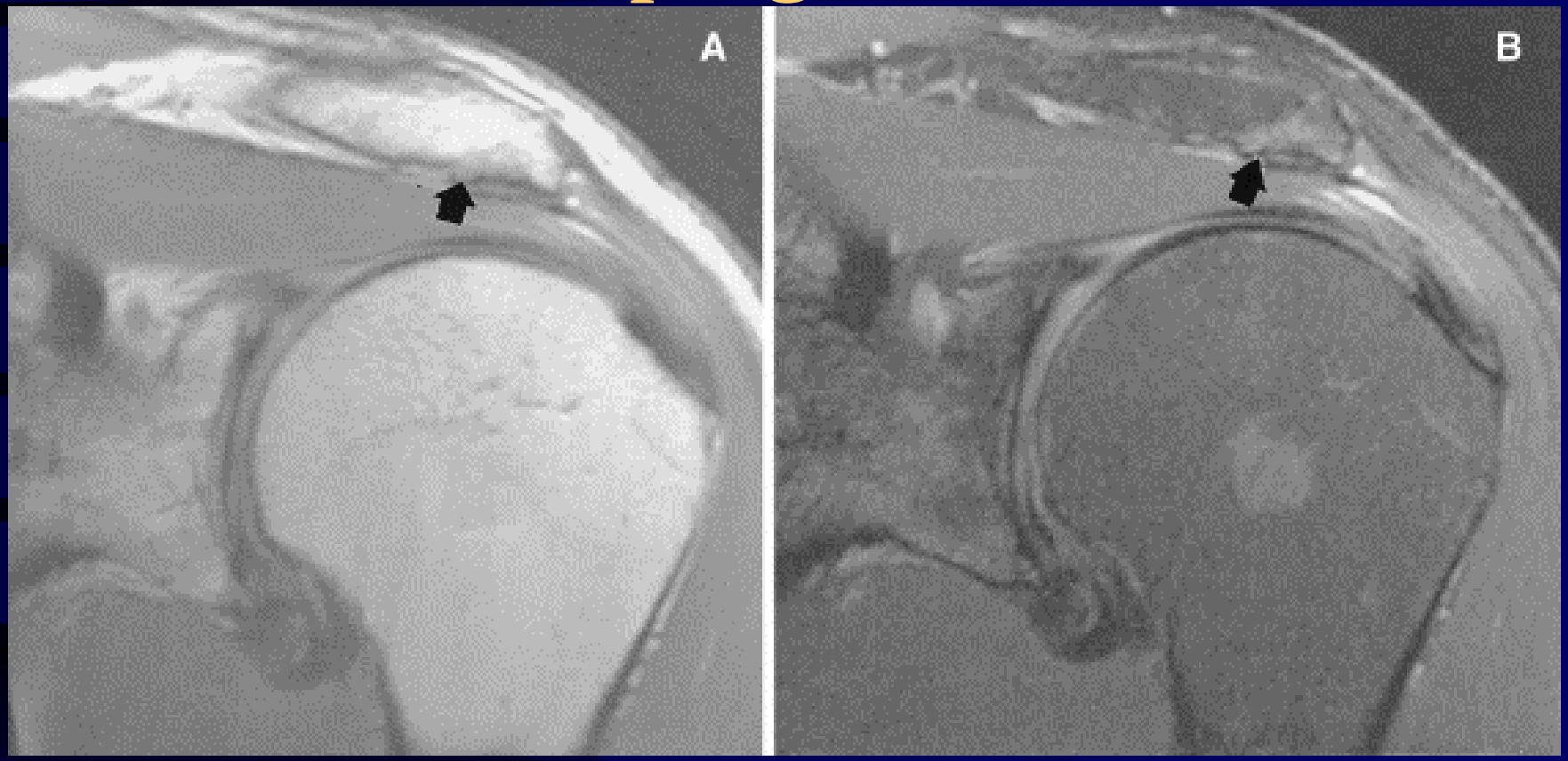


One of the most helpful findings on **MRI** that concerns the **rotator cuff** tendon is a collection of fluid (water density) in the subacromial bursa. Although every normal bursa has a small amount of fluid, it is seldom enough to form a puddle and usually is not seen. If such a collection is present and no full thickness cuff tear is noted, the diagnosis of bursal side cuff fraying is almost a certainty.



Moderately severe articular surface partial tearing on a T2-weighted coronal image. There is increased signal delineating an articular surface defect that extends from the superior aspect of the humeral head to the medial aspect of the greater tuberosity (*straight arrow*). There are medially retracted articular surface fibers (*curved arrow*) at the superior aspect of the humeral head. A thin strip of the bursal surface fibers remains intact.

Impingement



A 42 y/o golfer with impingement syndrome. There is mild increased signal throughout the supraspinatus tendon on these proton-density (A) and fat-suppressed T2-weighted (B) coronal images compatible with mild tendinosis. A small acromial enthesophyte (arrows) is seen at the attachment of the coracoacromial ligament. There is increased signal within the enthesophyte on the fat-suppressed T2-weighted image compatible with marrow edema.

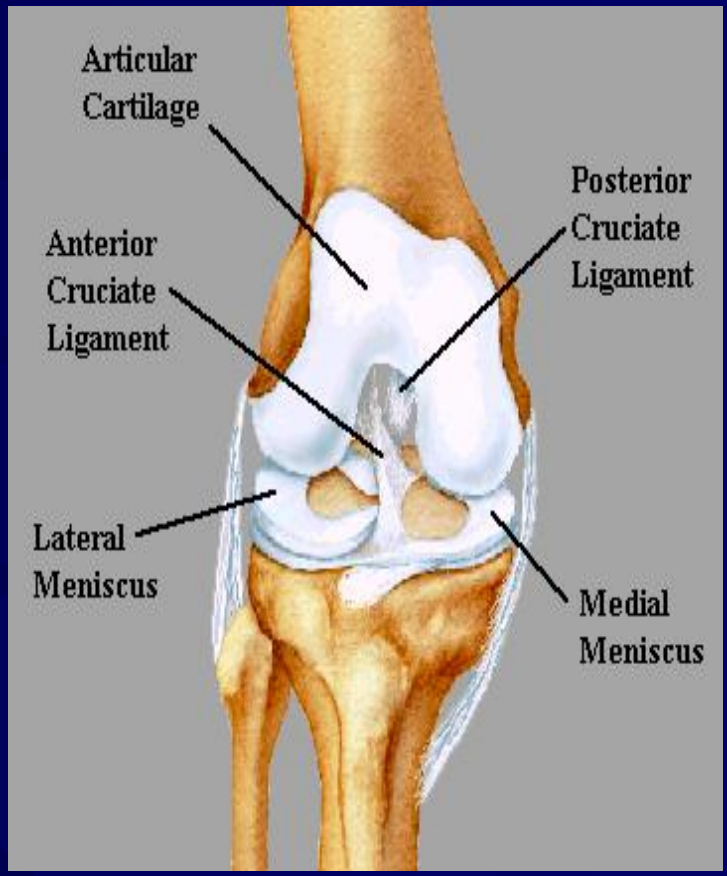
*Impingement is a clinical term and not a radiological diagnosis

Knee Injuries

- Meniscal tear
- Ligament tear

Meniscus

- Anatomy
  - Medial
    - Semicircular(C-shape)
    - Attached to MCL
  - Lateral
    - Circular(O-shape)
    - No attachment to LCL
- Function
  - Deepen articular surface
  - Distribute forces



Meniscal tear

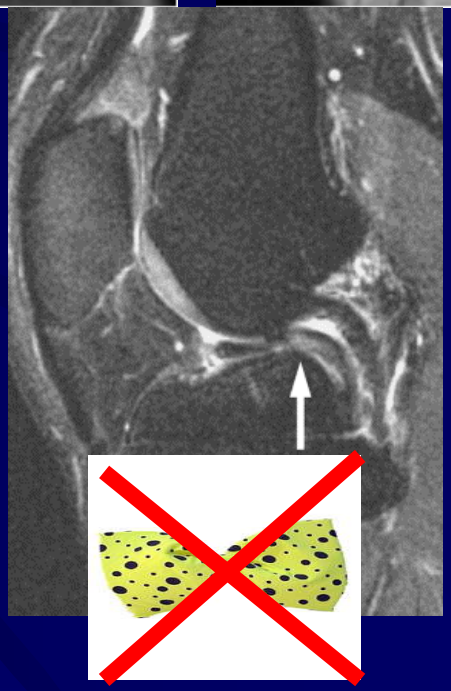
- Etiology
  - Twisting on a planted, flexed knee
- Frequency
  - Possibly most common knee injury in U.S.
  - 61 cases per 100,000
  - male-to-female ratio approximately 2.5:1

Imaging meniscal tears

- MRI
  - Abnormal signal intensity within meniscus that extends to an articular surface
  - Abnormal morphology

Bow-tie rule

- normal meniscal body should be seen as at least two consecutive "bow-ties" on consecutive sagittal images

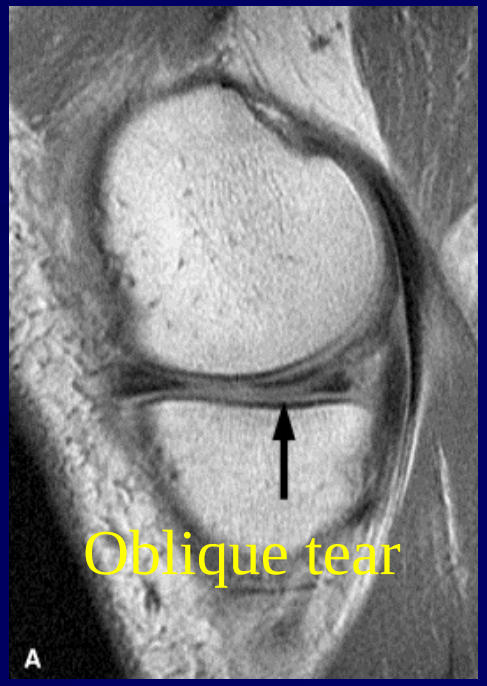


Common meniscal tears

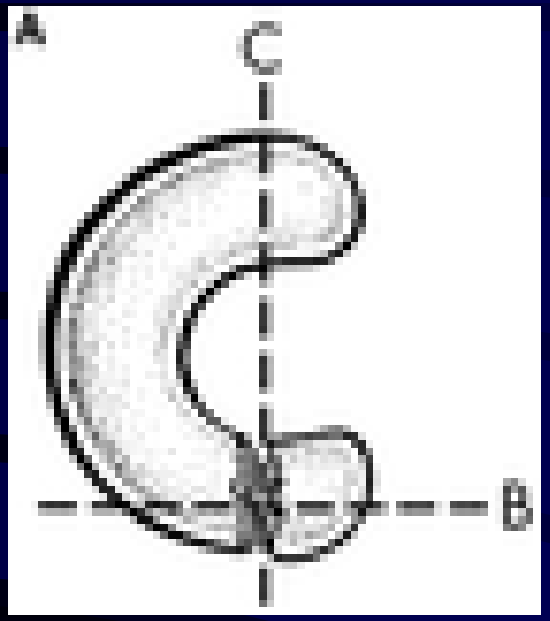
- Oblique tear
- Radial tear
- “Buckethandle” tear

Oblique (parrot beak) tears

Normal Meniscus

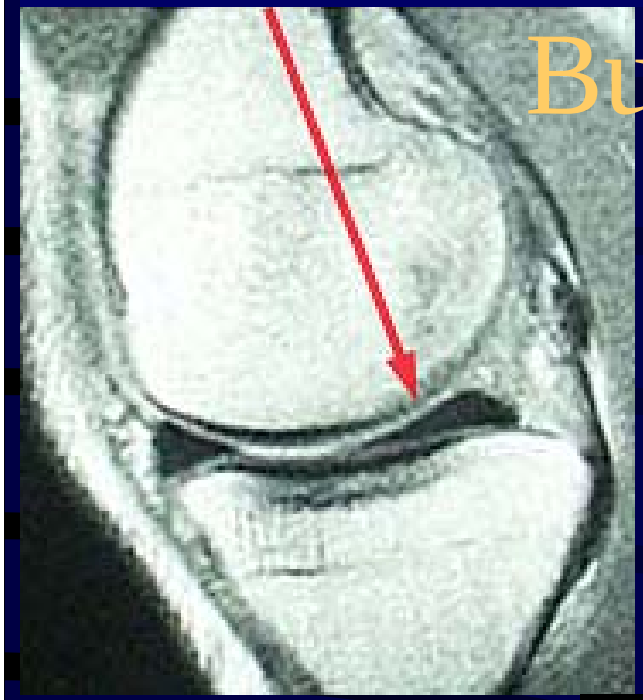


Radial tears



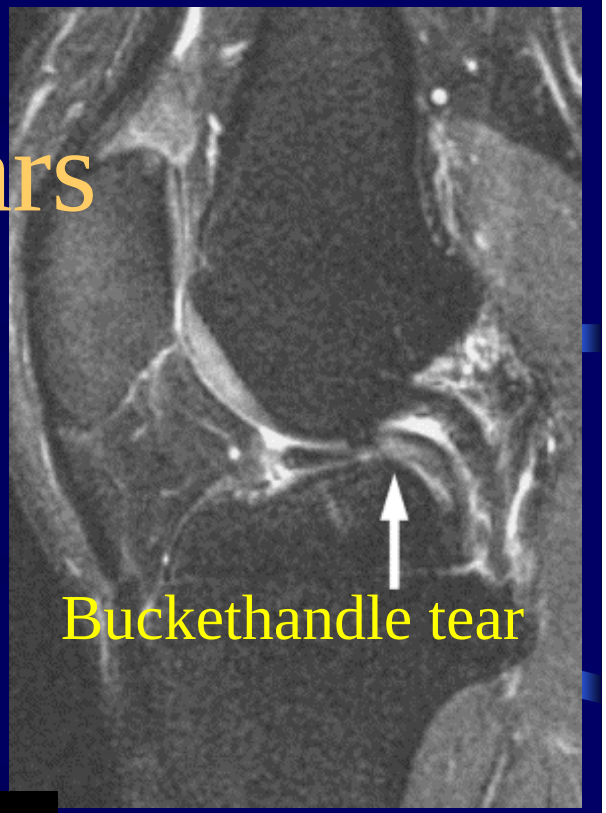
Coronal image obtained at the level of line B reveals fluid within the large tear

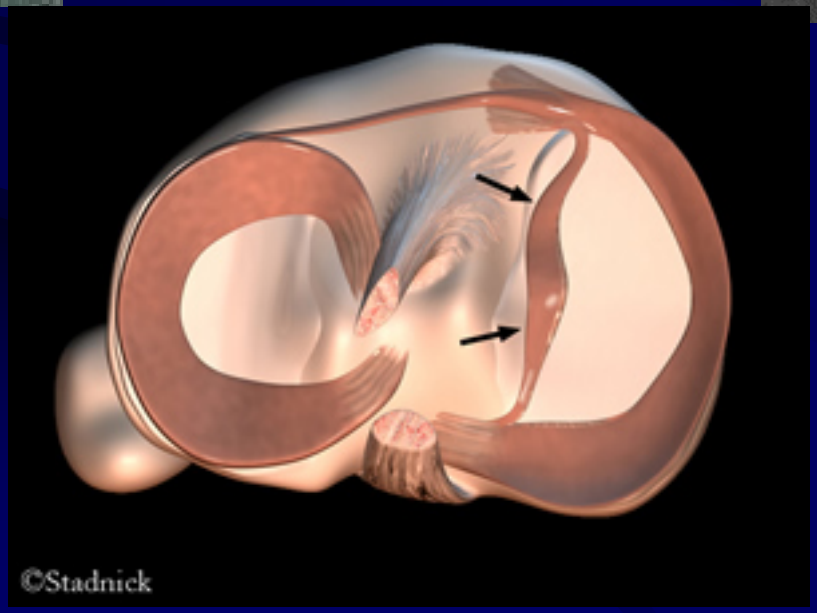
Normal Meniscus



Buckethandle tears

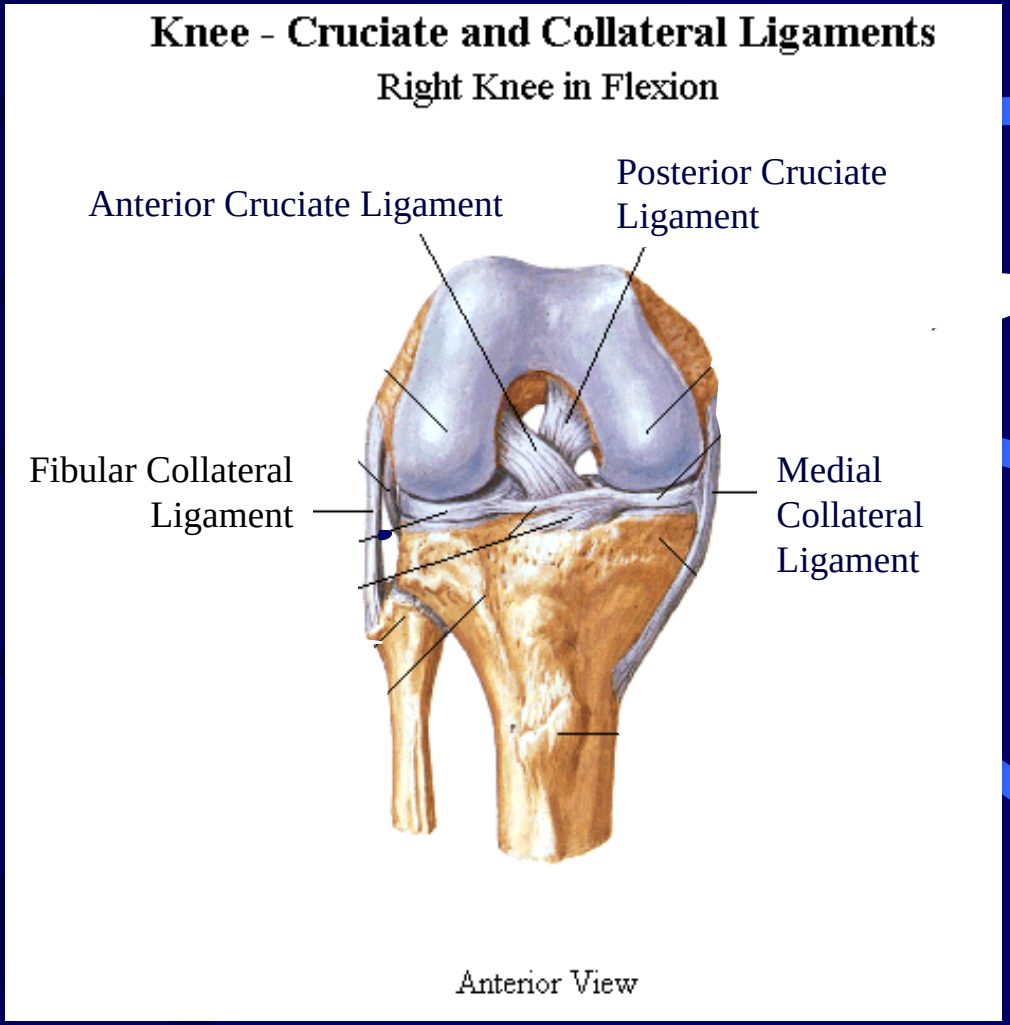
"Inner rim of meniscus pulls away from meniscal body"





Ligaments of the knee

- Anterior Cruciate Ligament
  - Prevents anterior translation of tibia
- Posterior Cruciate Ligament
  - Prevents posterior translation of tibia
  - Only 90% size of ACL but is strongest knee ligament
- Medial Collateral Ligament
  - Prevents valgus stress
- Lateral Collateral Ligament
  - Prevents varus stress



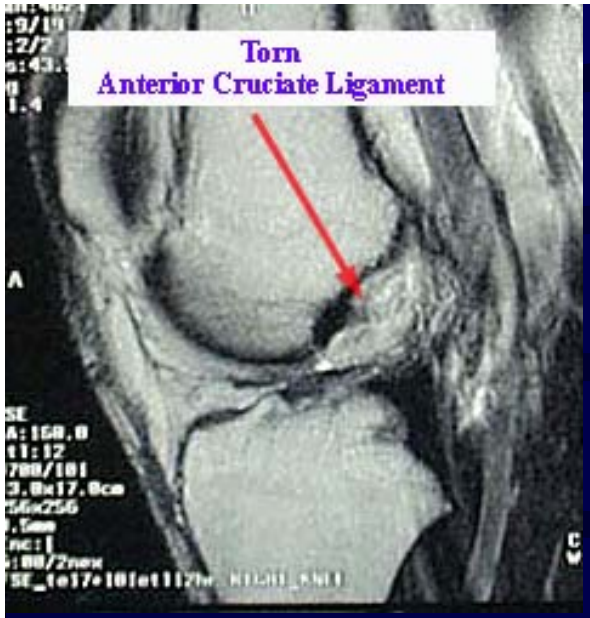
Anterior Cruciate Ligament (ACL) Injury

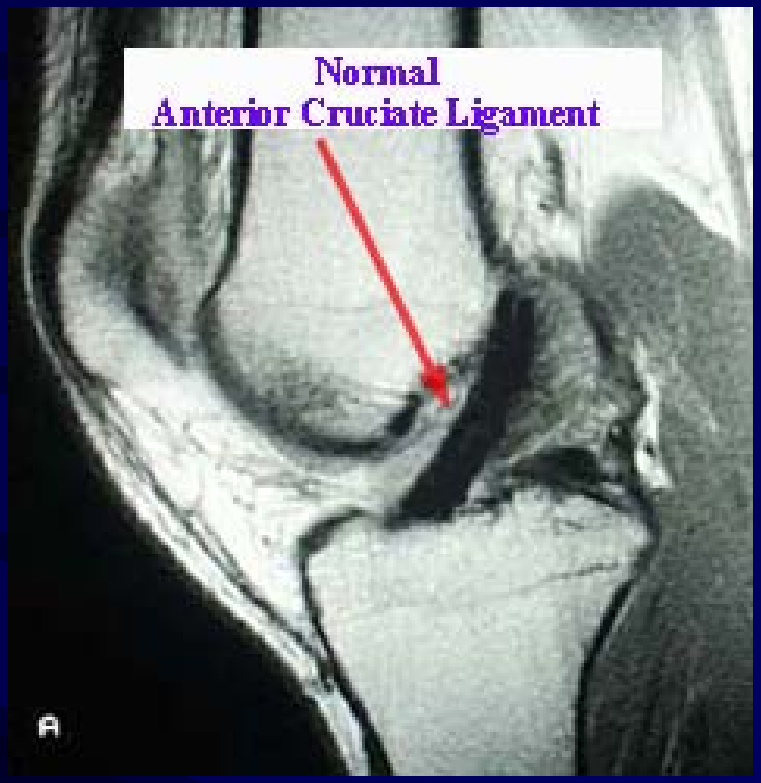
- Direct force to the anterior knee, sudden stops or direction change with a planted foot while running or a skier who "catches a tip".
- Prevalence higher in females
- 34% associated w/ audible “pop”

Imaging of ACL Tears

- Primary signs
  - Plain radiographs usually negative
  - MRI
    - proton density with fat suppression studies in sagittal, coronal and axial planes are commonly used for evaluation
    - normal ACL appears as a low signal intensity band with straight, sharply defined margins
    - acutely injured ACL will have high T2 signal intensity
    - increased T1 & T2 signal from associated hemorrhage & edema
    - sensitivity of 90-98% & specificity of 100
- Secondary signs
  - anterior drawer sign
  - buckled PCL
  - uncovering of the posterior horn of the lateral meniscus
  - bone contusions in a characteristic location
  - specific but not sensitive

Examples





ACL tear. Sagittal fat-suppressed T2-weighted MR image shows discontinuity of the midportion of the anterior cruciate ligament (*arrow*), which is filled with high signal intensity fluid and hemorrhage

Bone contusions associated with an acute ACL tear. Sagittal fat-suppressed T2-weighted MR image shows ill-defined areas of bone marrow edema involving the lateral femoral condyle (*large arrow*) and posterolateral aspect of the tibial plateau (*small arrow*). These are the characteristic locations of bone contusions associated with an acute ACL injury.

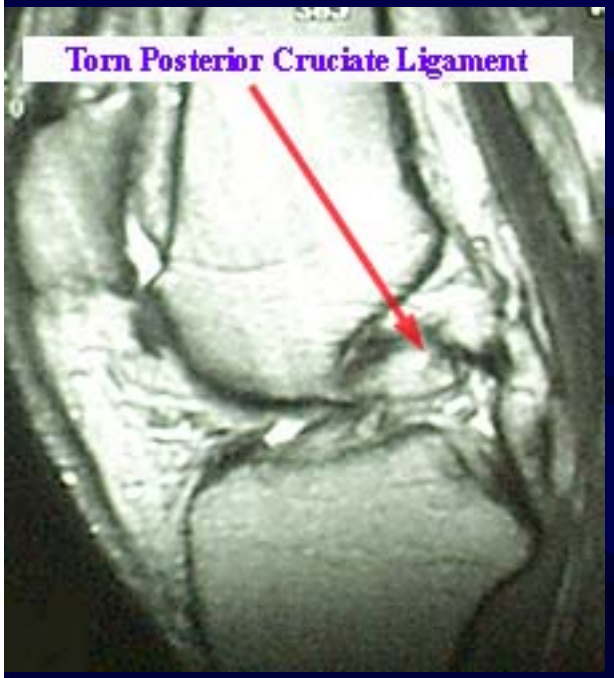
Posterior Cruciate Ligament (PCL)

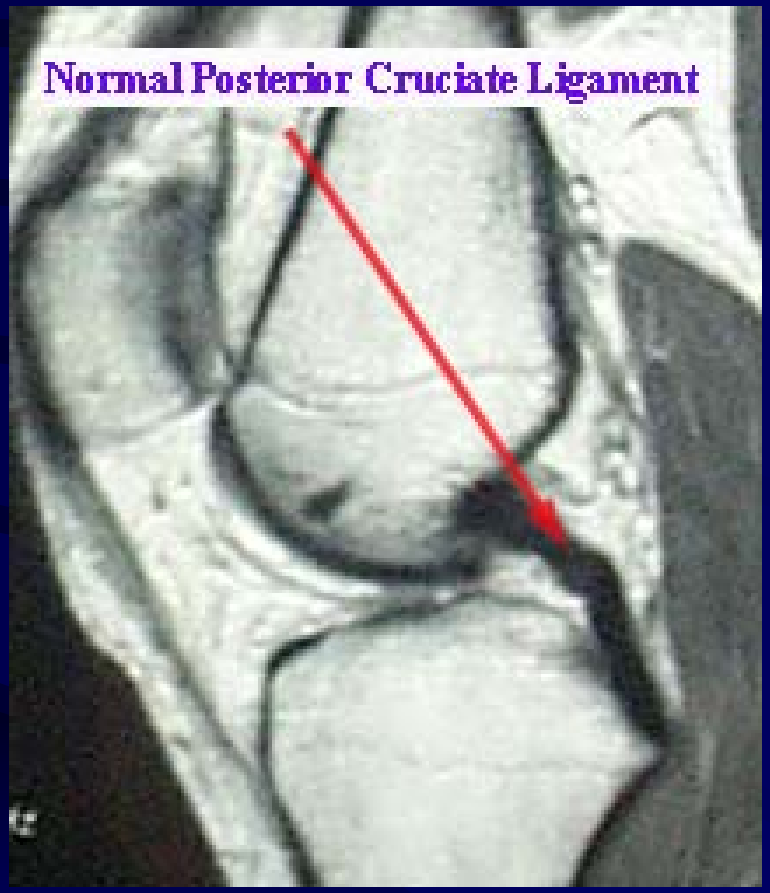
- Less common than ACL injuries
- occurs when a force is applied to the anterior aspect of the proximal tibia when the knee is flexed or when knee is hyperextended
- Often associated w/ other injuries
- Often minimal to no pain

Imaging of PCL Tears

- Plain radiographs usually negative
- MRI
  - proton density with fat suppression studies in sagittal, coronal and axial planes are commonly used for evaluation
  - performed in extension so PCL will have sharp bend (genu)
  - Acute tears most commonly manifest with diffuse widening with increased T1 and T2 signal intensity

Examples





Fat-suppressed T2-weighted MR image shows a discontinuity and gap involving the midportion of the PCL near the Genu (*arrow*), which is filled with high signal intensity fluid.

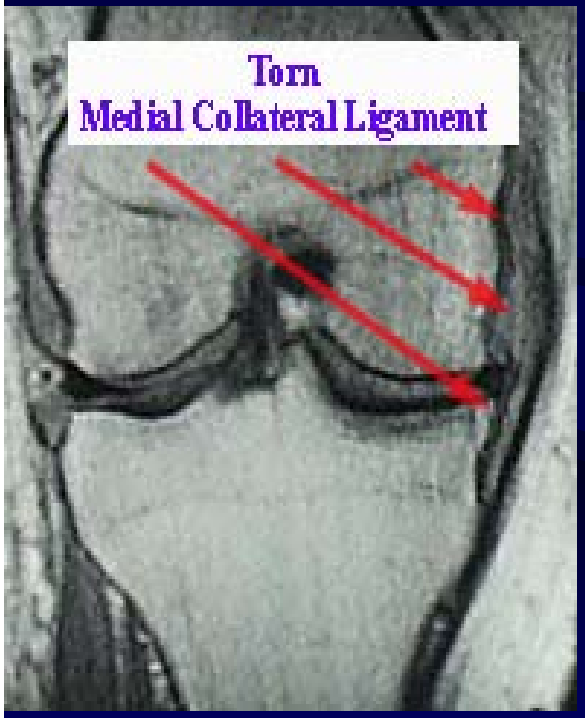
Medial Collateral Ligament (MCL) Injury

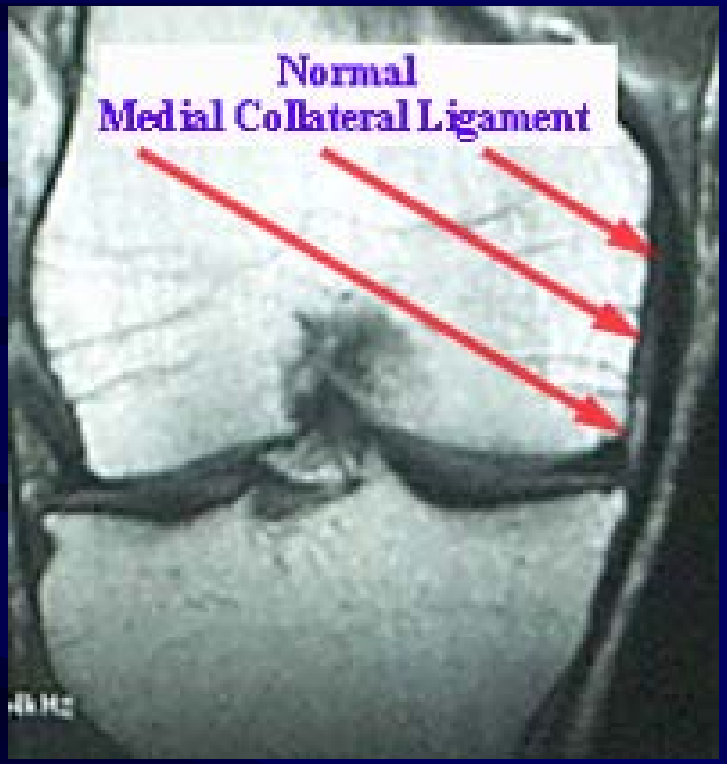
- Most commonly injured knee ligament
- Commonly associated w/ other injuries of knee (medial meniscus, ACL)
- Contact injuries
  - direct valgus load to the knee
  - usual mechanism in a complete tear
- Noncontact injuries
  - deceleration, cutting, and pivoting motions
  - tend to cause partial tears
- Overuse injuries
  - have been described in swimmers
  - whip-kick technique of the breaststroke
  - repetitive valgus loads across the knee

Imaging of MCL Tears

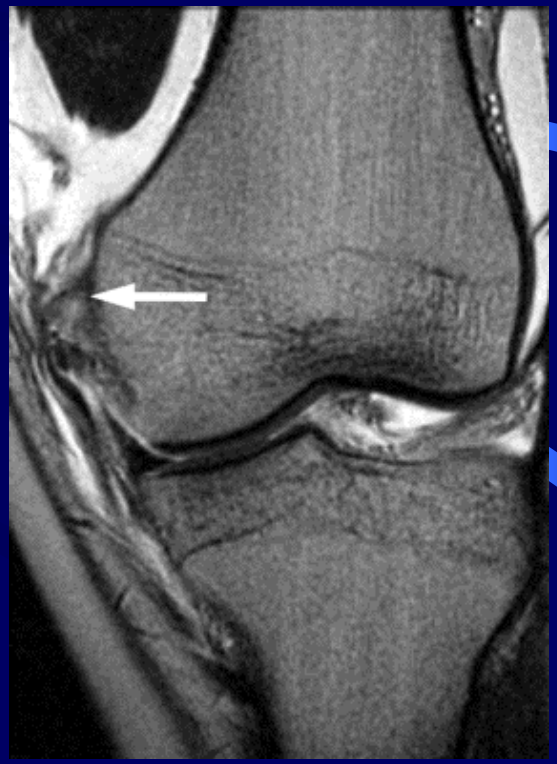
- Plain radiography
  - should be performed to rule out fractures of the tibial plateau, patella, or distal femur
- MRI
  - coronal images are more accurate than axial images for grading injuries
  - most sensitive signs are fascial edema and loss of demarcation from adjacent fat

Examples





MCL tear. Coronal T2-weighted MR image shows high-signal intensity along the medial aspect of the knee. The medial collateral ligament shows an undulating course with avulsion off of the femoral attachment (*arrow*).



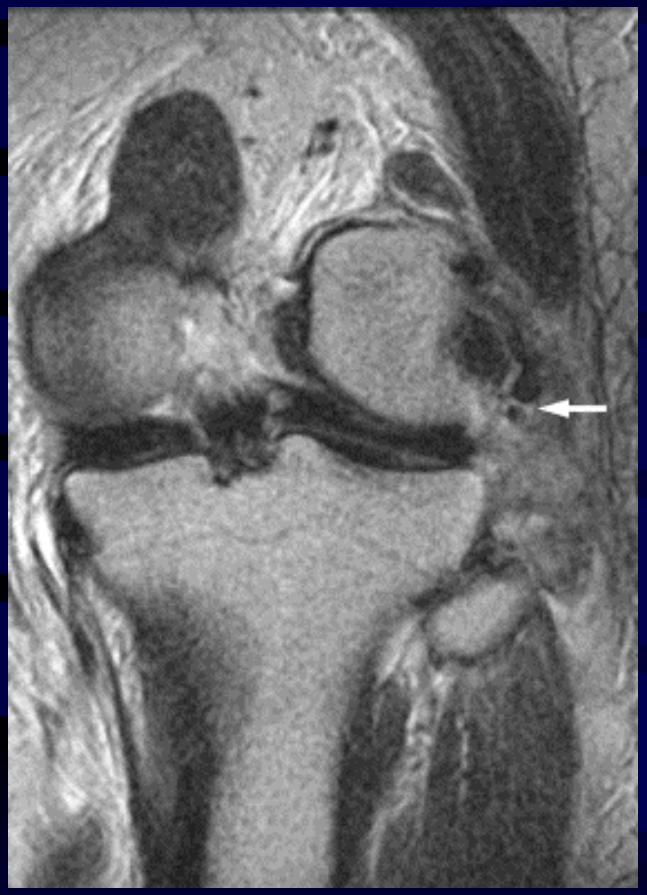
Lateral Collateral Ligament (LCL) Injury

- Much less common than MCL injury
- Caused by pure varus force
- Usually involved in more severe knee injuries
- Rare enough I couldn’t find a picture

Imaging of LCL Tears

- Plain radiographs
  - should be obtained to rule out more common injuries
- MRI
  - procedure of choice for meniscal and ligament evaluation

Examples



Coronal T2-weighted MR image shows complex signal along the lateral joint margin. The LCL is torn and retracted proximally (*arrow*).

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