Current Concepts in Magnetic Resonance Imaging of the Hip

Ray Hong

Overview

- Technique
- Basic Anatomy/Normal Variants
  - Osseous
  - Soft Tissue
- Pathology
  - FAI
  - RC/Hamstring Tears
  - Ligamentum Teres
  - Adhesive Capsulitis

Technique

- Surface coil used to optimize SNR

Coronal	Transverse	Sagittal
T1-weighted T2-weighted FS	T1-weighted T2-weighted FS	T1-weighted

MR Arthrography

- Imaging

Coronal	Transverse	Sagittal
T1-weighted FS T2-weighted FS	T1-weighted FS	T1-weighted FS

*Special Axial Oblique Sequence used to measure femoral Head-neck offset

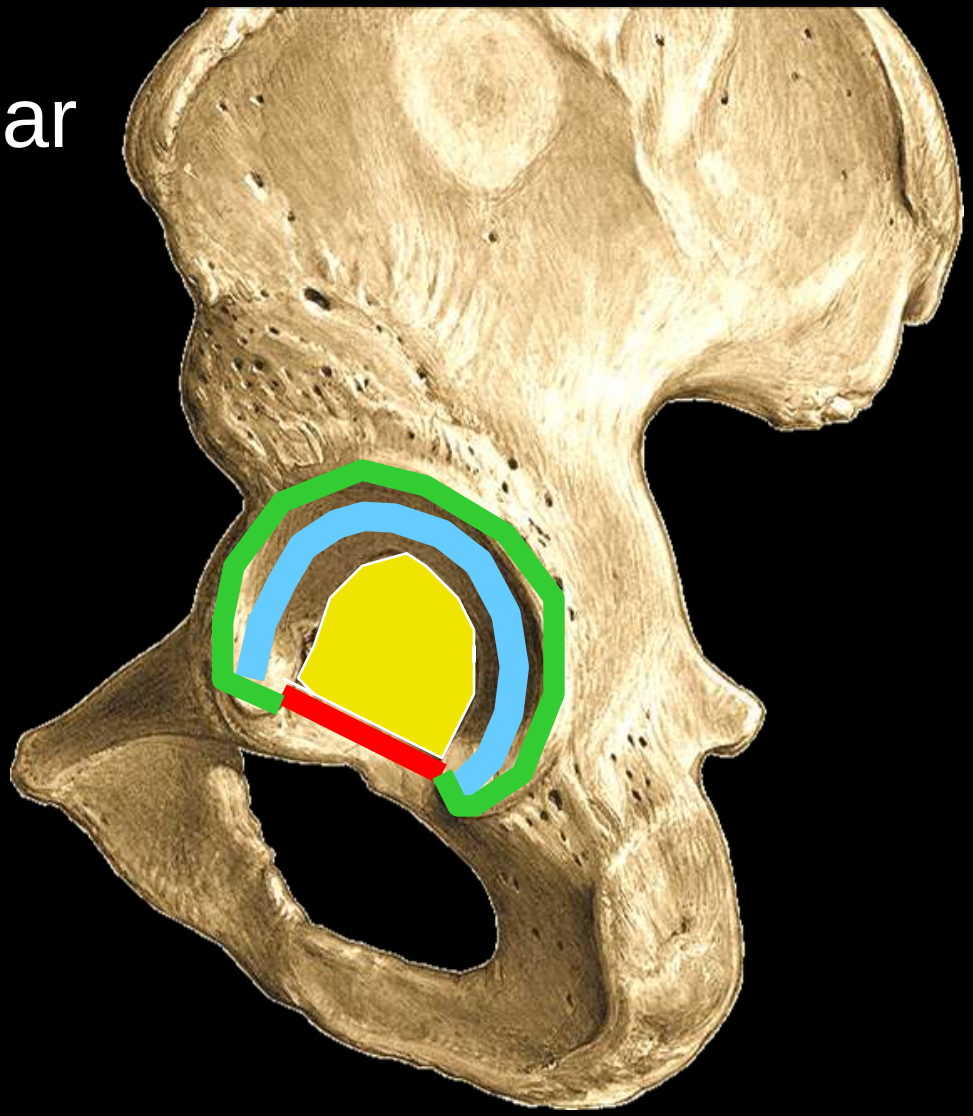
Axial Obliques

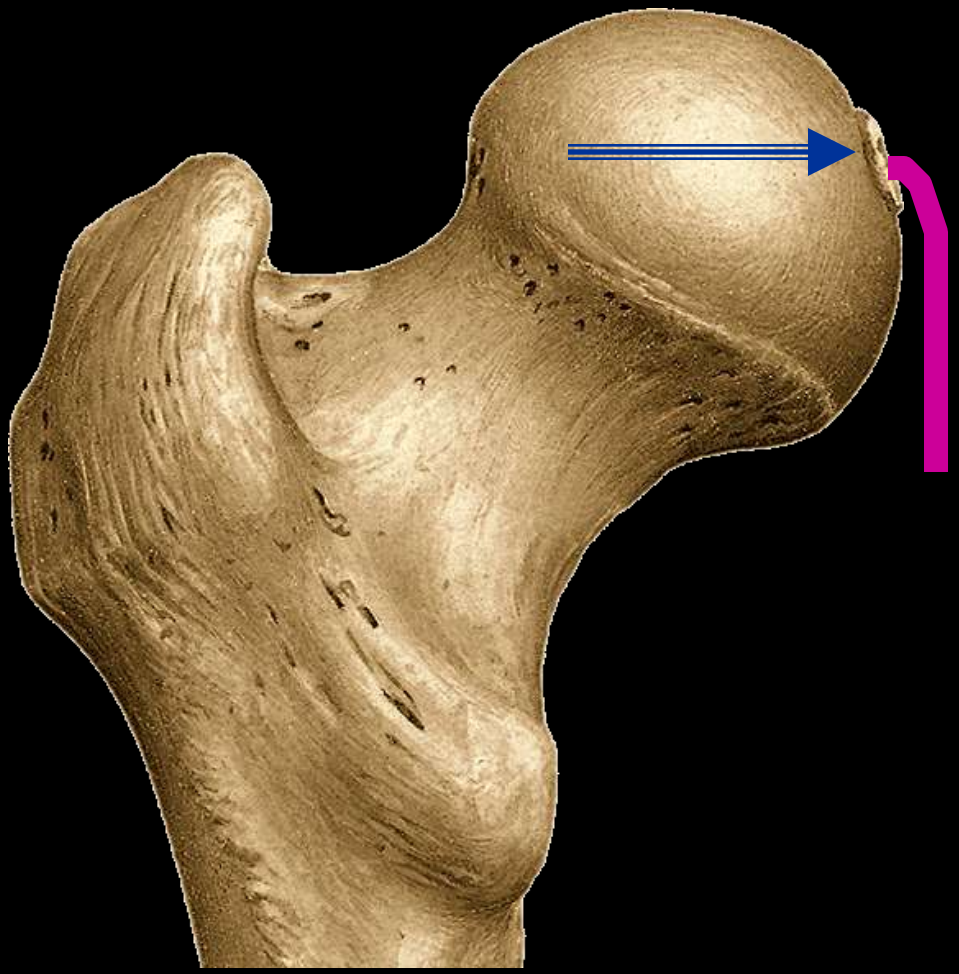
Normal Osseous Anatomy

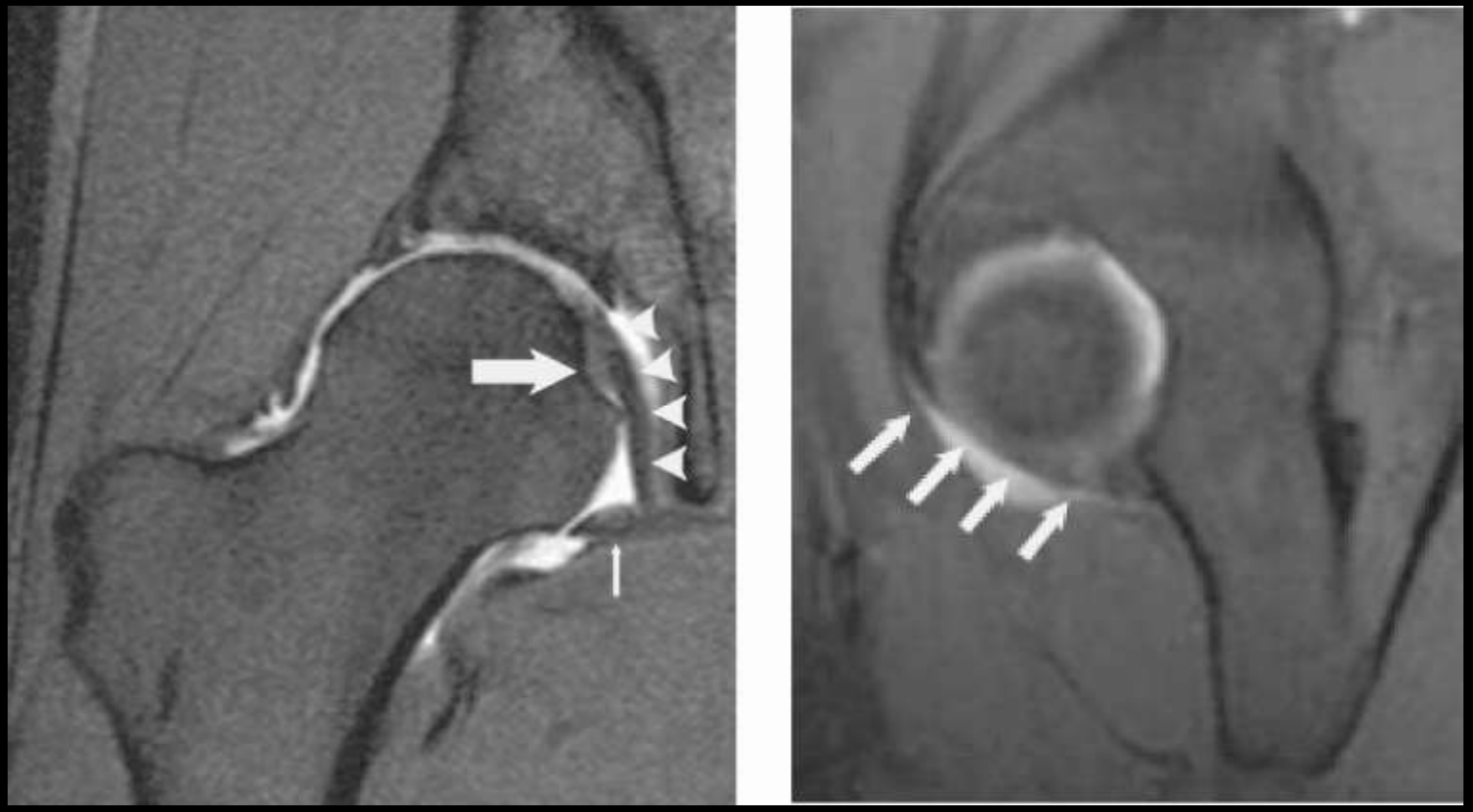
- Hip is ball and socket joint stabilized by its intrinsic anatomy

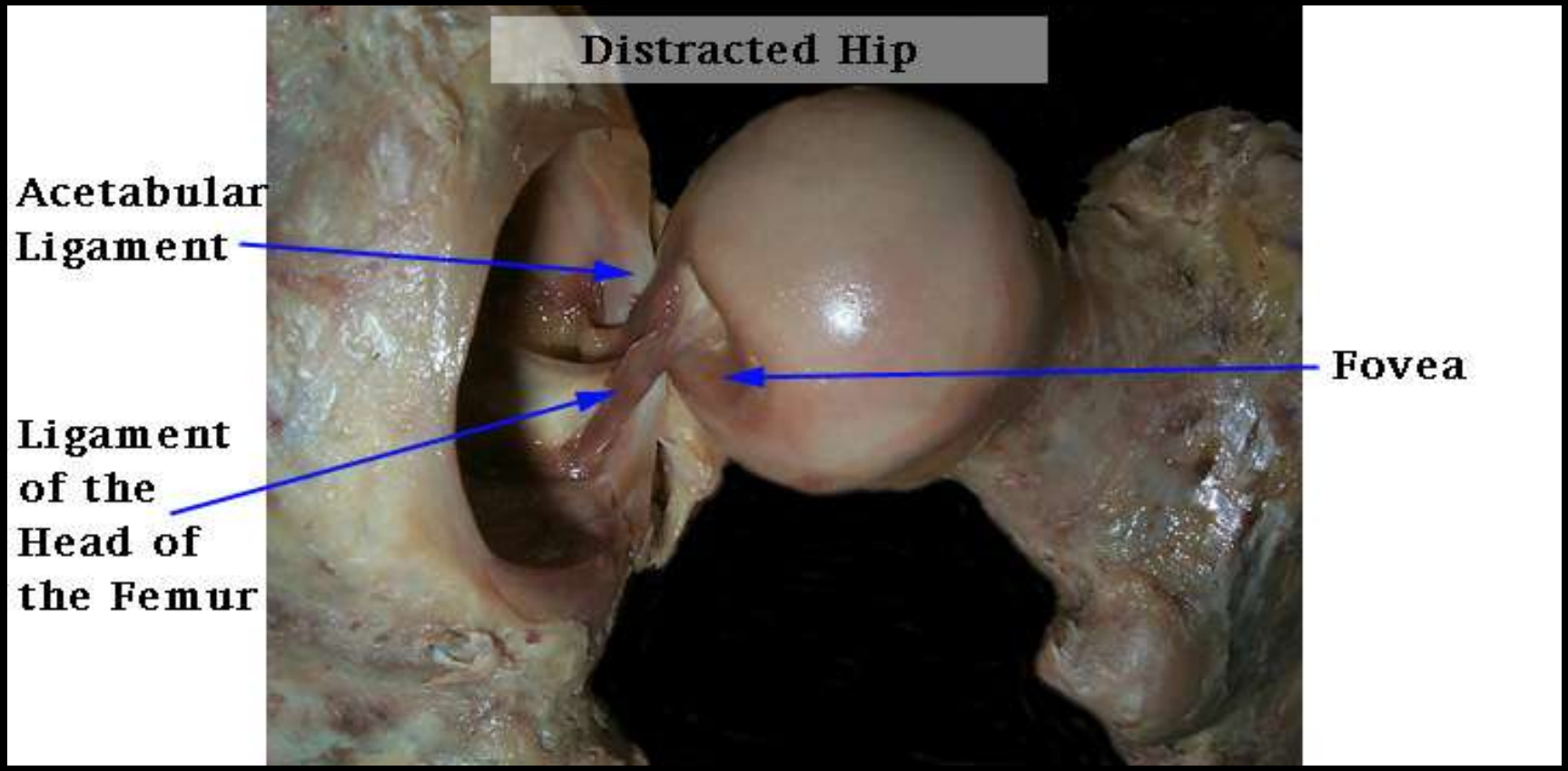
Normal Osseous Anatomy

- Acetabular notch





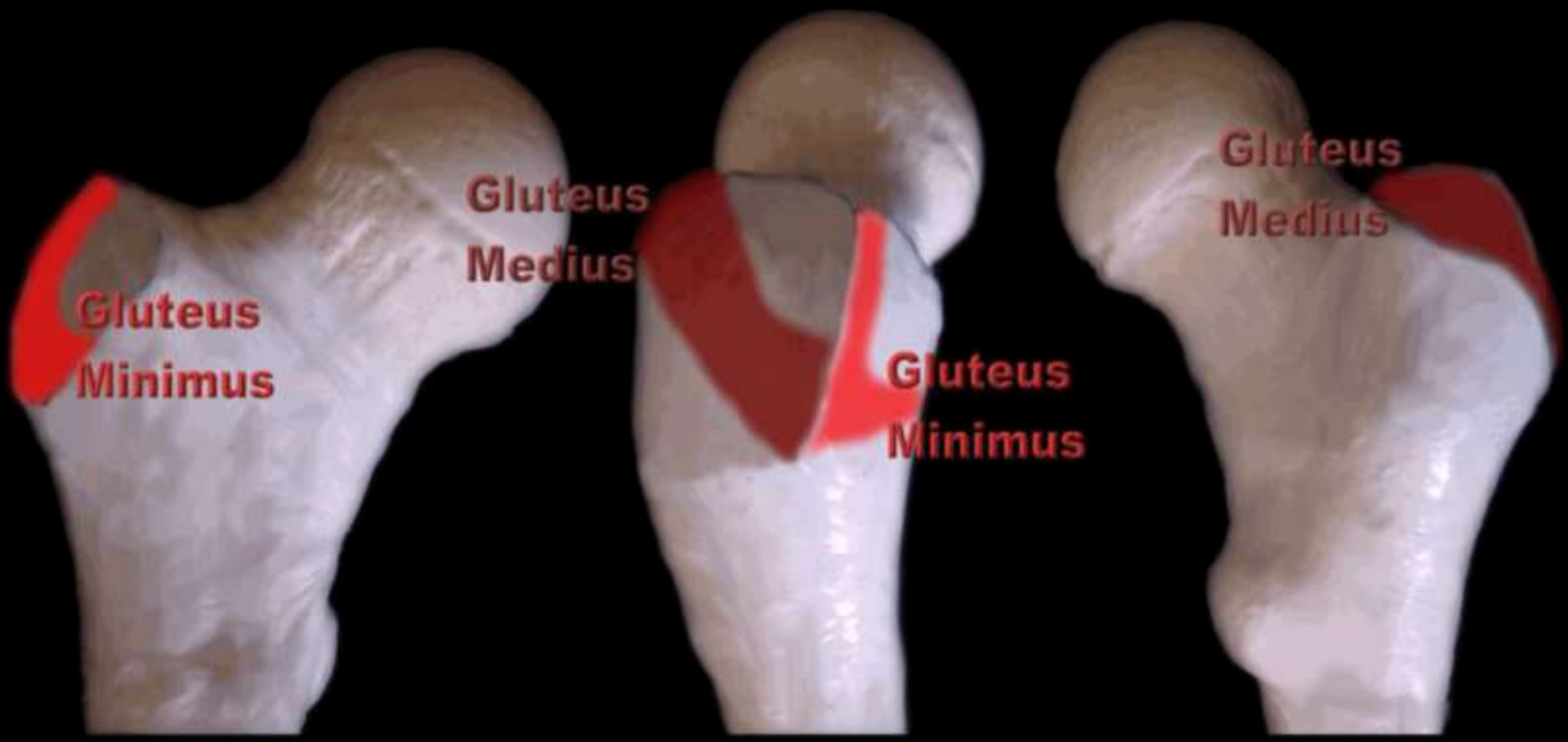



Distracted Hip
Acetabular Ligament
Ligament of the Head of the Femur
Fovea

Greater Trochanter

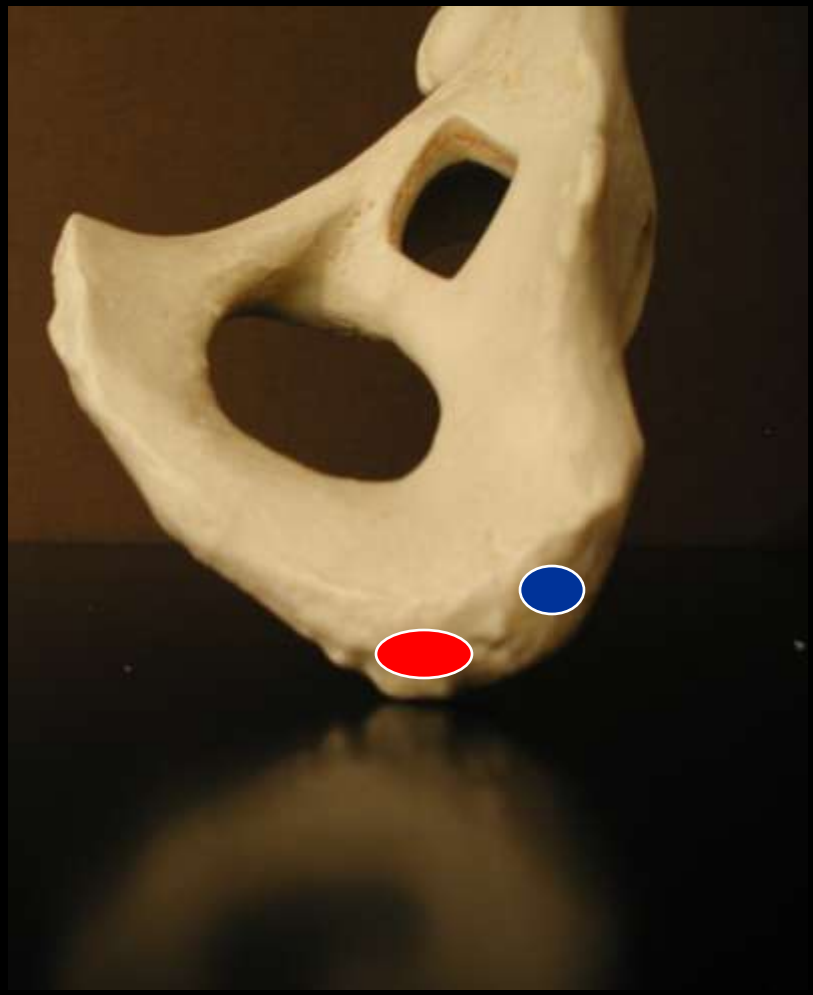
- Anterior: g. minimus attachment
- Lateral: g. medius attachment
- Posterosuperior: g. medius attachment
- Posterior: trochanteric bursa

Greater Trochanter Anatomy

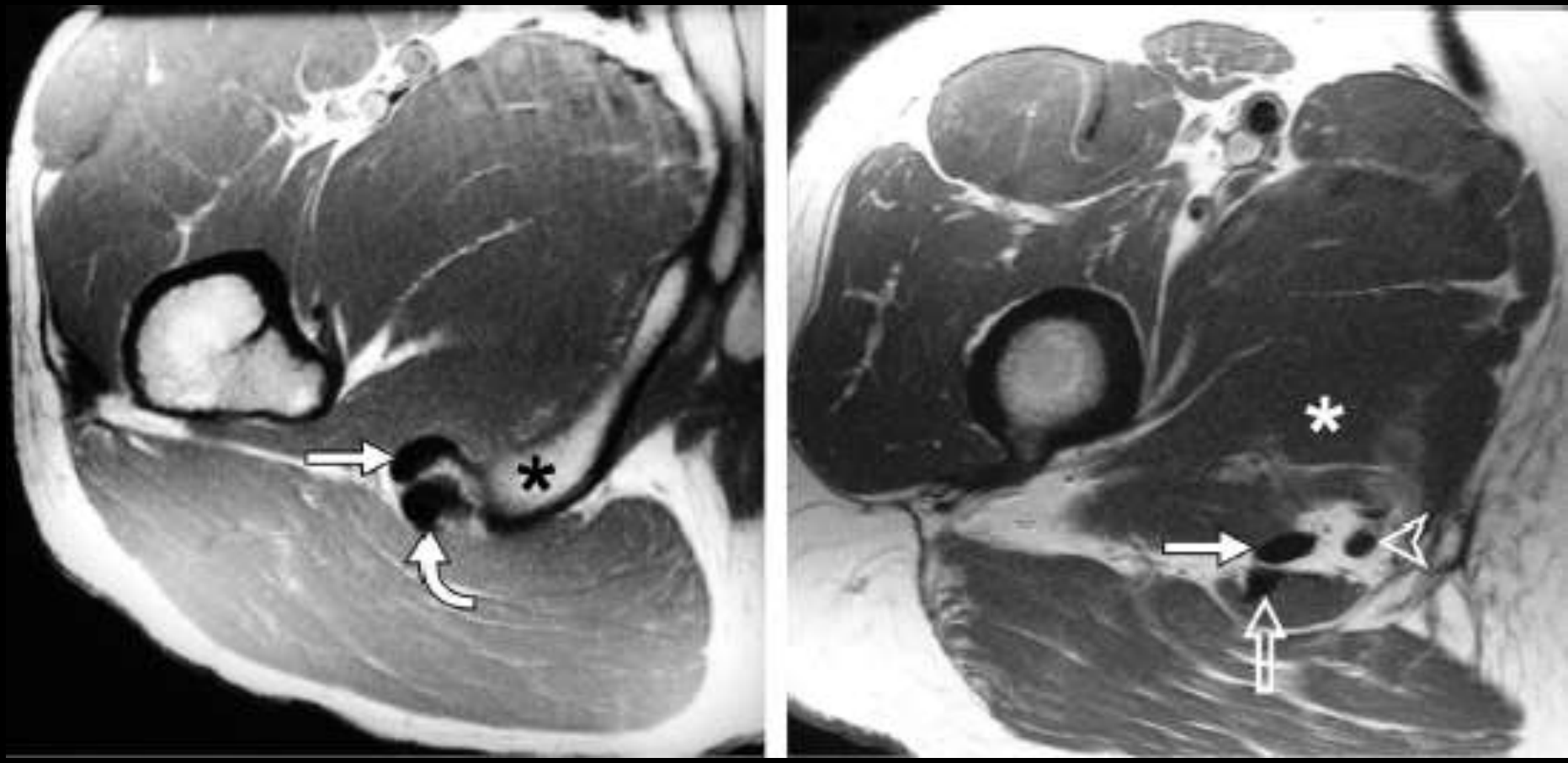


Hamstring Anatomy

- Superolateral: semimembranosis
- Inferomedial: conjoint tendon comprised of semitendinosis and long head of biceps femoris



Hamstring Anatomy



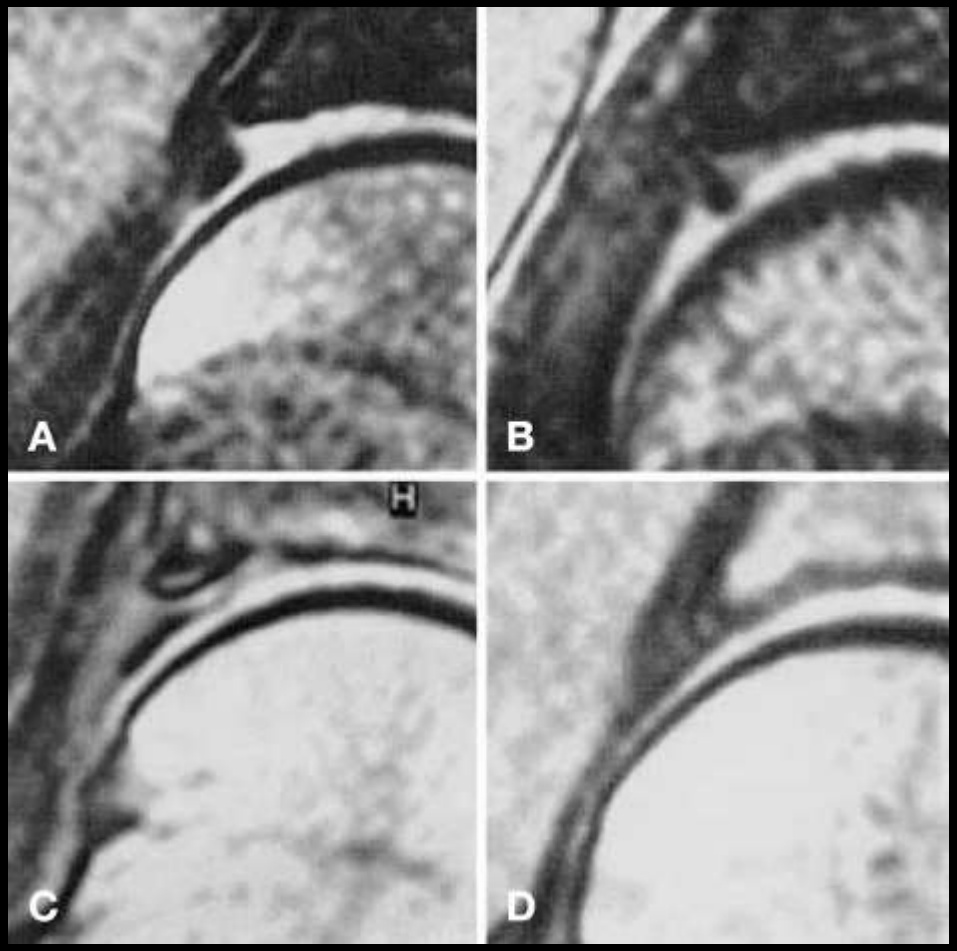
Koulouris G, Connell D. Hamstring muscle complex: an imaging review. Radiographics 2005:25:571-586.

Acetabular Labrum

- Composed of fibrocartilaginous tissue
- Primarily avascular with increased vascularity adjacent to the capsule
- Role is unknown since the hip joint is already stable
- Thickest in posterosuperior extent
- Inferiorly, coalesces with transverse ligament

Labrum

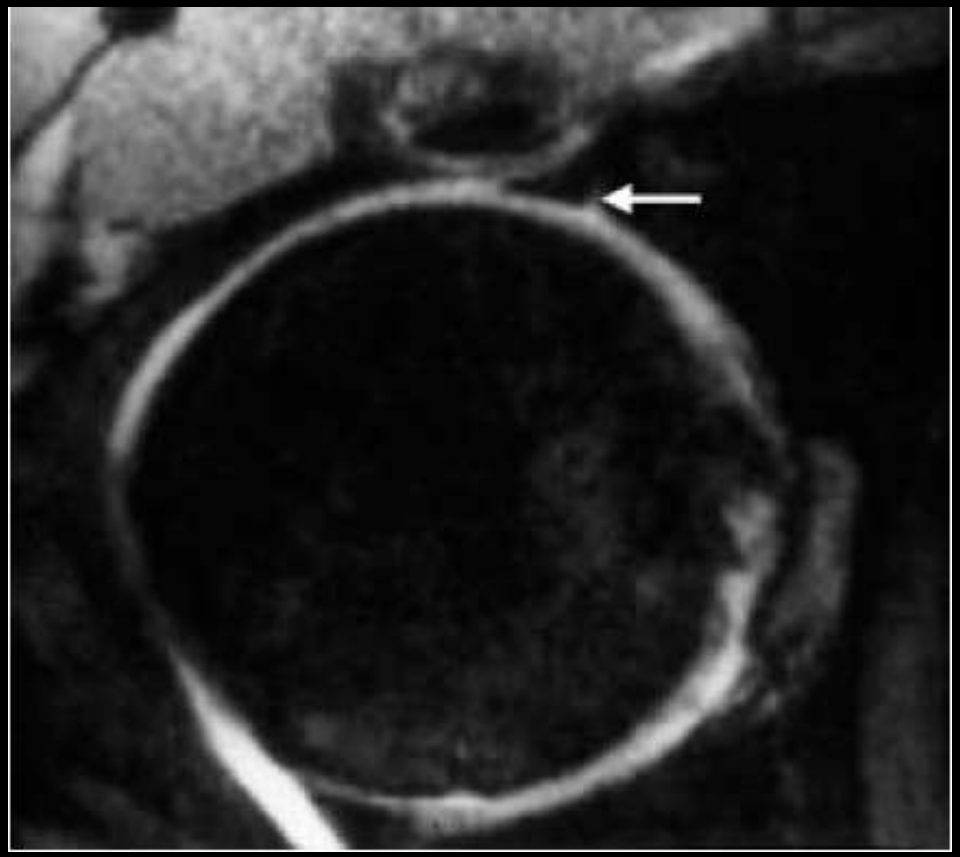
- Triangular 69.2%
- Round 15.8%
- Flat 12.5%
- Absent 2.5%



Aydingoz U, Ozturk MH. MR imaging of the acetabular labrum: a comparative study of both hips in 180 asymptomatic volunteers. Eur Radiol 2001:11:567-574.

Pitfalls of the Labrum

- ? Normal sublabral sulcus in anterosuperior labrum
  - Pro: sulcus has sharp margins
  - Con: none have been seen in cadavers or patients but this may be due to lack of intra-articular contrast



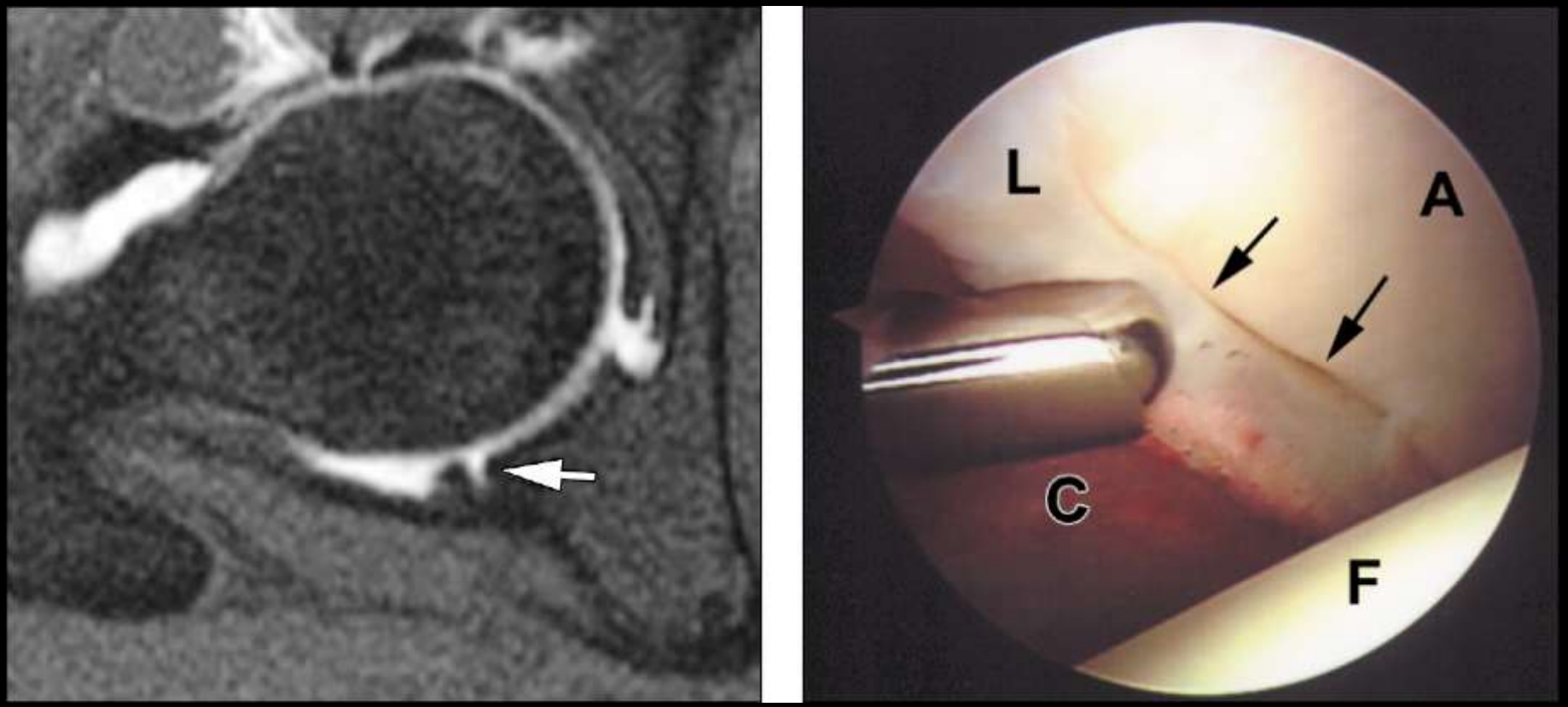
Petersilge CA. MR arthrography for evaluation of the acetabular labrum. Skeletal Radiol 2001:30:423-430.

Anterosuperior Sublabral Sulcus

- 3 criteria from a recent article:
  - If contrast doesn’t extend through entire labrum
  - If it has smooth margins
  - Also if it remains shallow (<50%)

Blankenbaker DG, Tuite MJ. The painful hip: new concepts. Skeletal Radiol 2006.

Posteroinferior Sublabral Sulcus

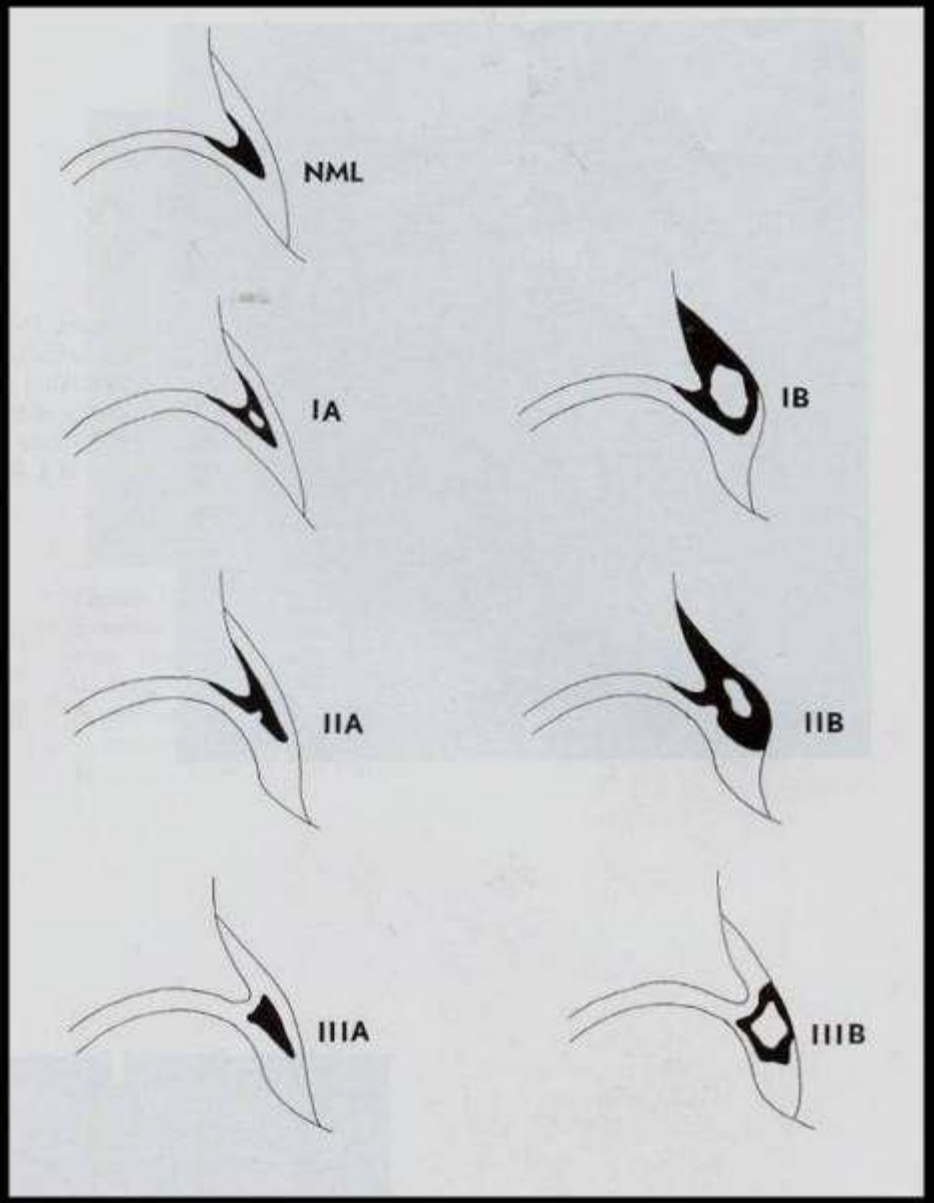


Dinauer PA, Murphy KP, Carroll JF. Sublabral sulcus at the posteroinferior acetabulum: a potential pitfall in MR arthrography diagnosis of acetabular labral tears. AJR 2004:183:1745-1753.

Labrum

- MR arthrography is a sensitive and specific tool
  - Debate on both sides of spectrum
    - Keeney et al says that arthroscopy is needed
    - Mintz et al states noncontrast is just as accurate
  - Radial imaging has been investigated with some success but low sample sizes

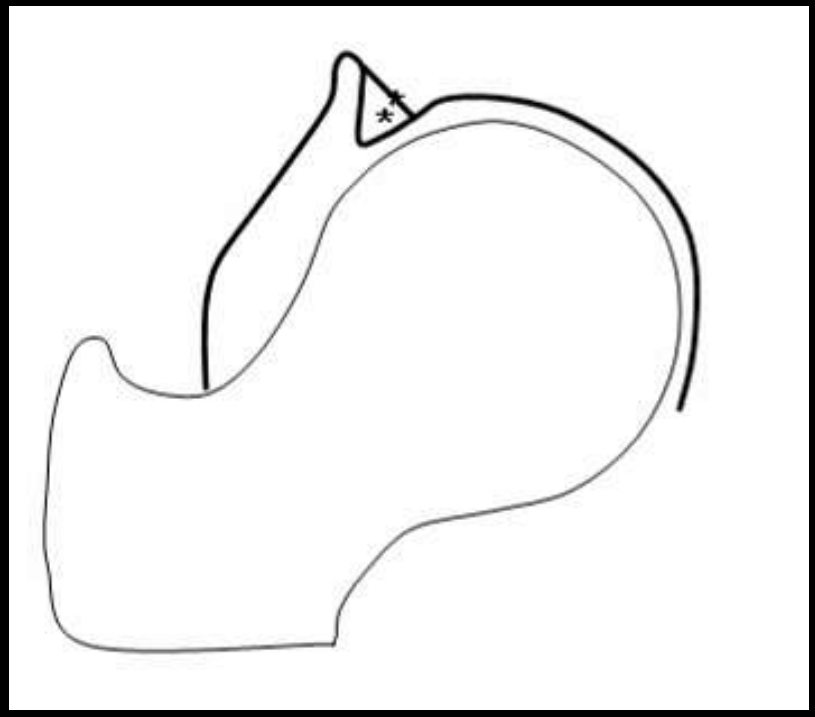
- Classified into traumatic or degenerative
  - Intrasubstance or detachment
- Classification of tears described by Czerny et al.



Czerny C et al. MR arthrography of the adult acetabular capsular-labral complex: correlation with surgery and anatomy. AJR 1999.

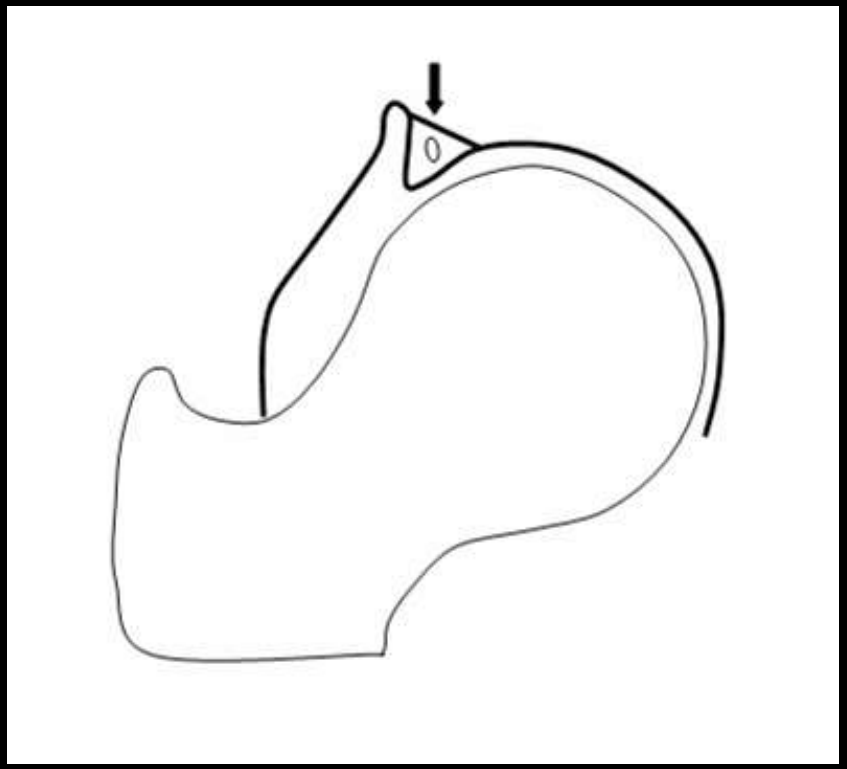
Stage 0

- Normal triangular labrum
- Normal recess



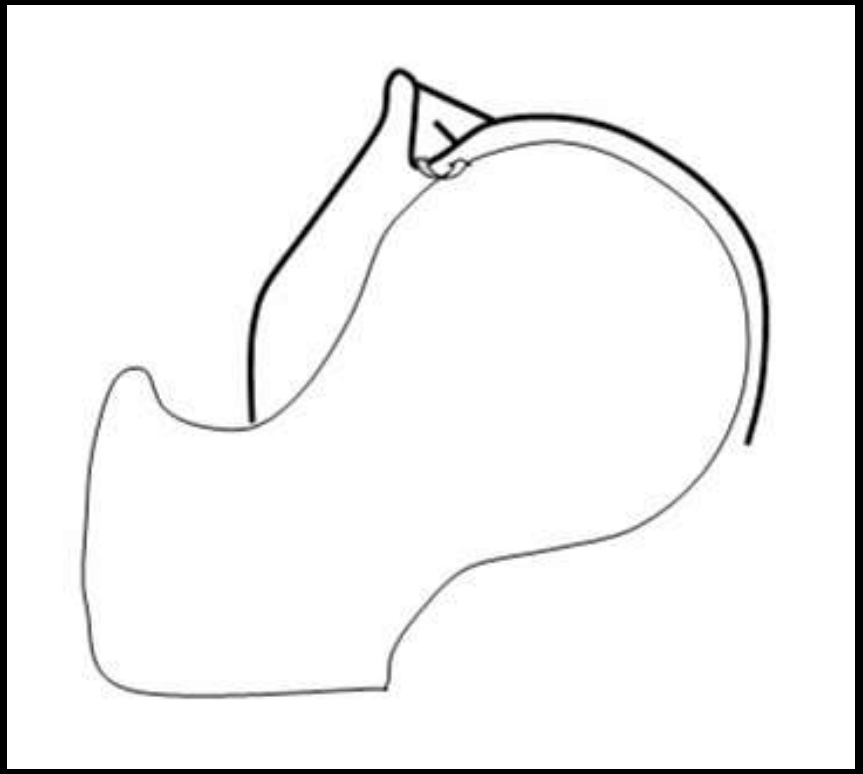
Stage 1A

- Increased intralabral signal



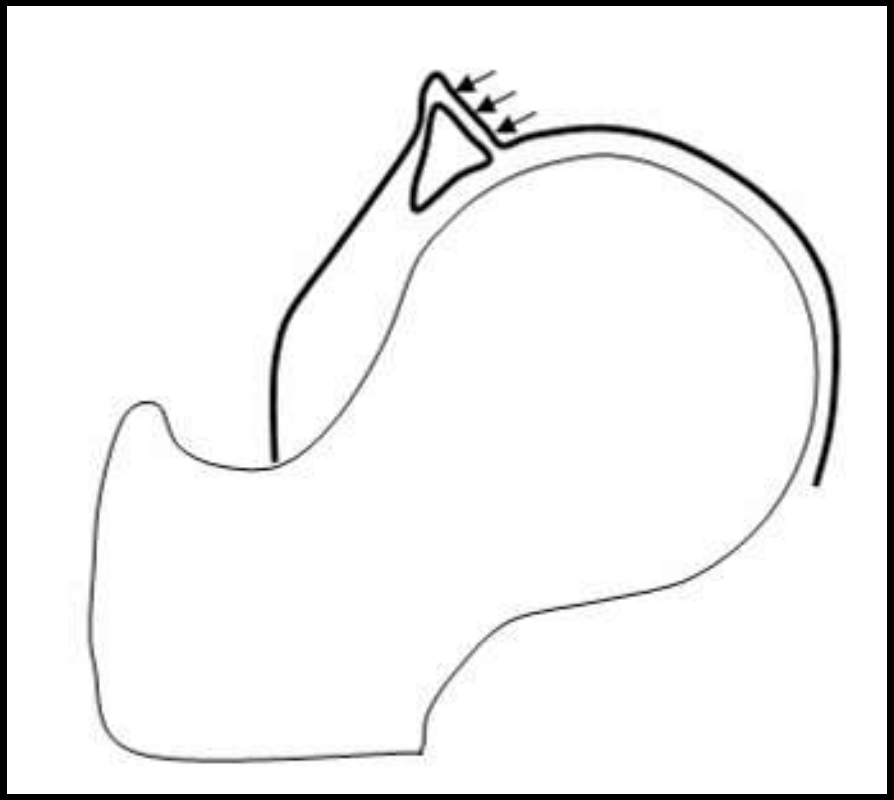
Stage 2A

- Contrast material extends into labrum

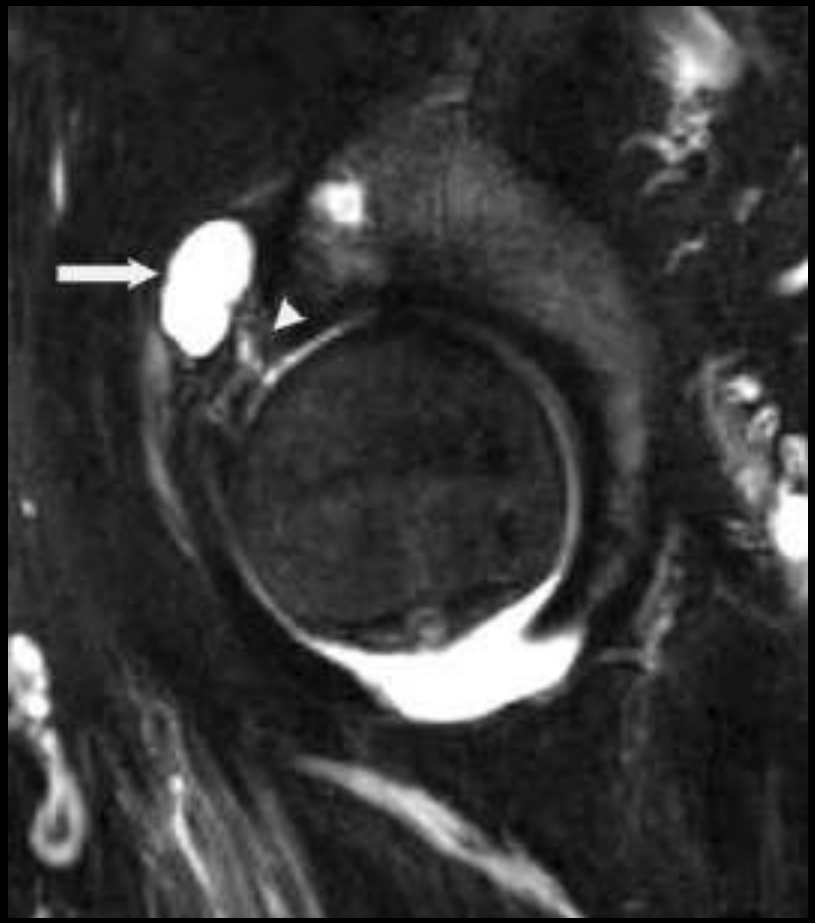


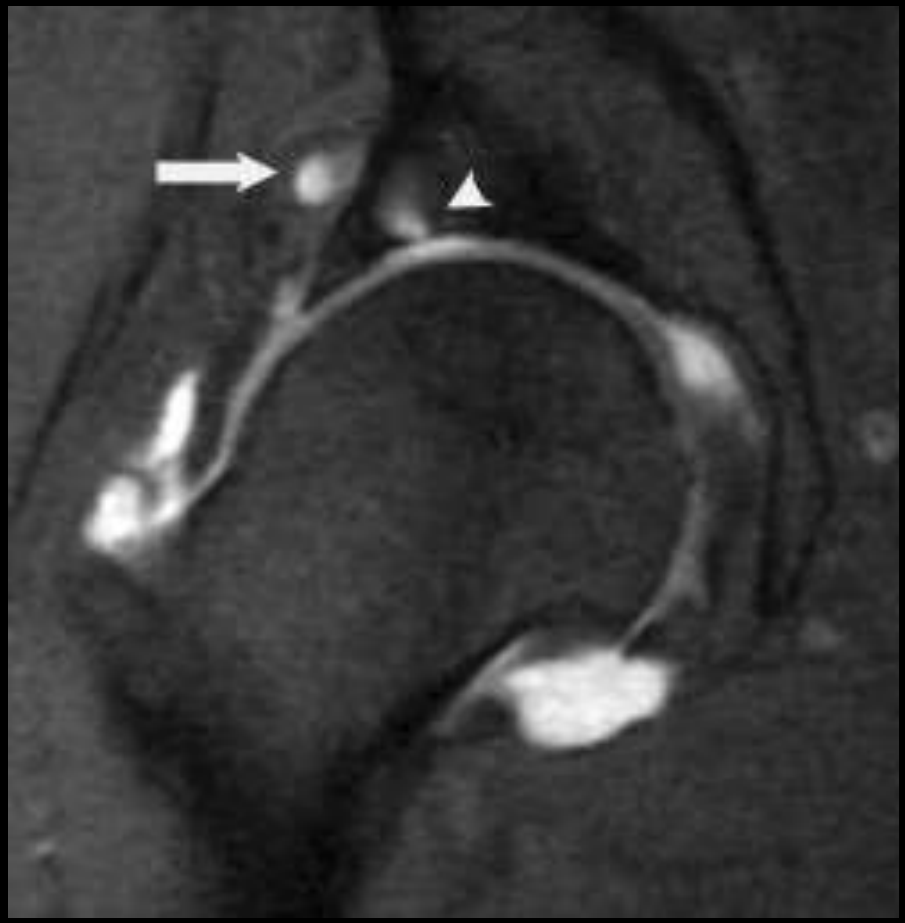
Stage 3A

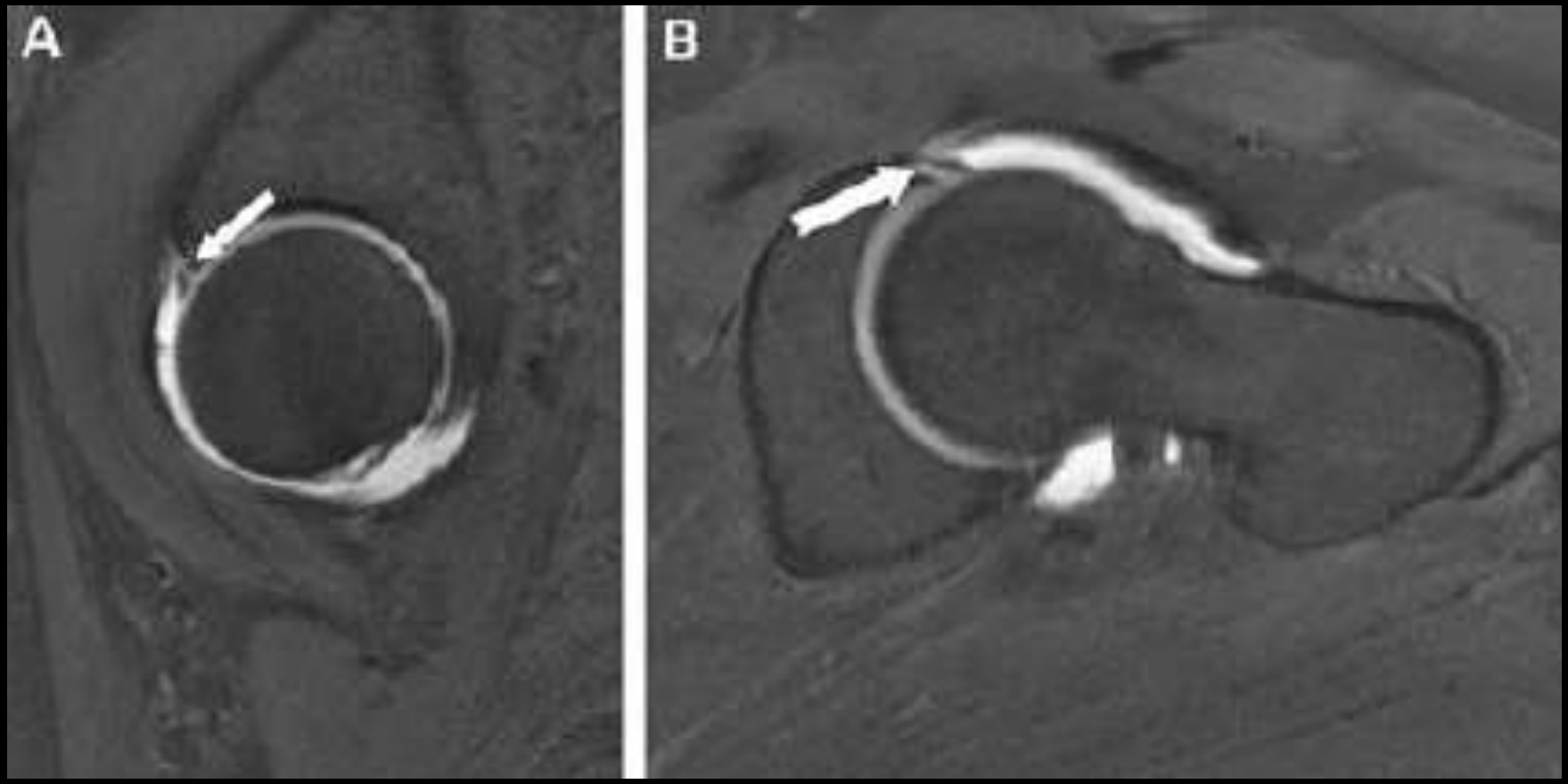
- Labral Detachment



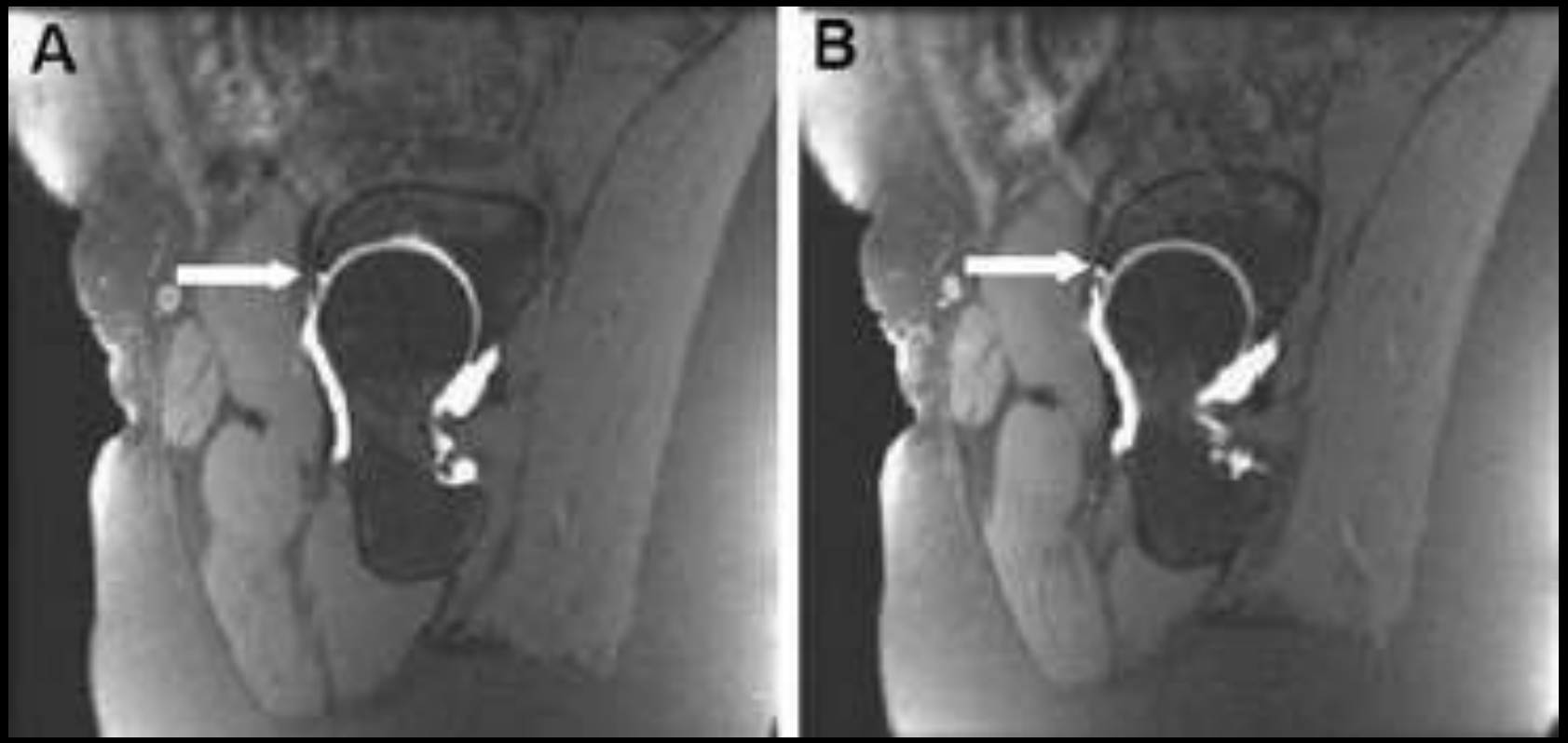
The B subtypes have a hypertrophied labrum without perilabral sulcus






A
B


A
B
C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Cartilage

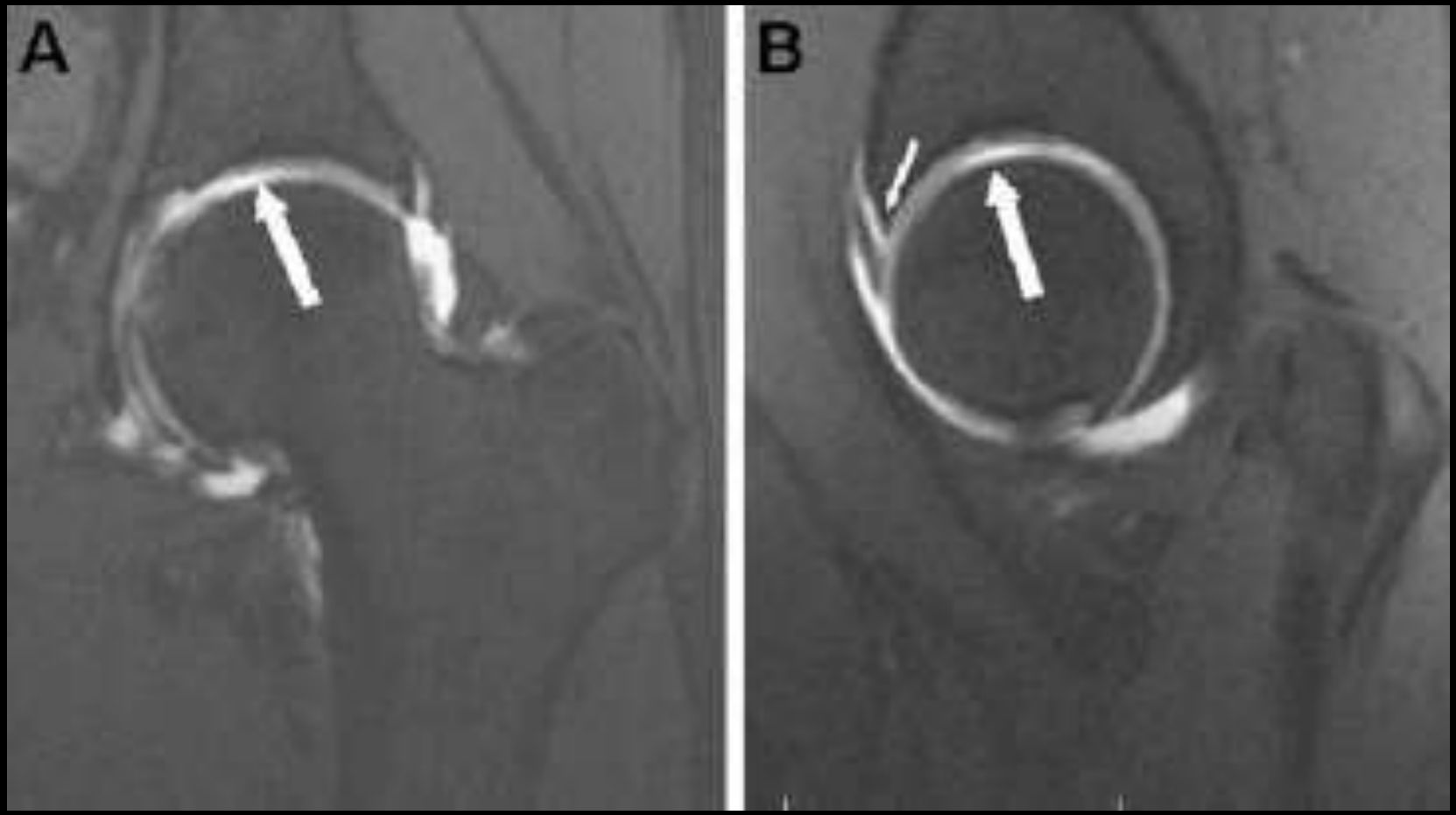
- Difficult to evaluate with standard MR imaging
  - Inseparable femoral/acetabular cartilage
  - Hip cartilage is extremely thin (1-2mm)

Cartilage

- MR arthrography
  - Schmid et al were able to detect chondral abnormalities with high sens/spec
  - Traction can also be useful
  - Special techniques: water-excitation 3D double-echo steady-state sequence

Cartilage

- MC location of abnormality is anterosuperior acetabulum
  - Can be delaminating
  - Flap > 1mm
- Treatment:
  - microfx


A
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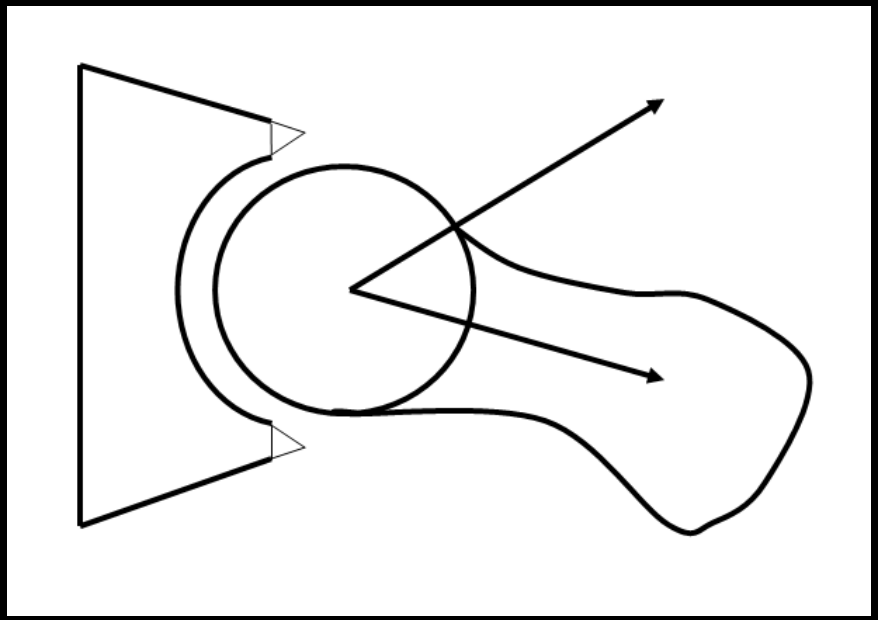
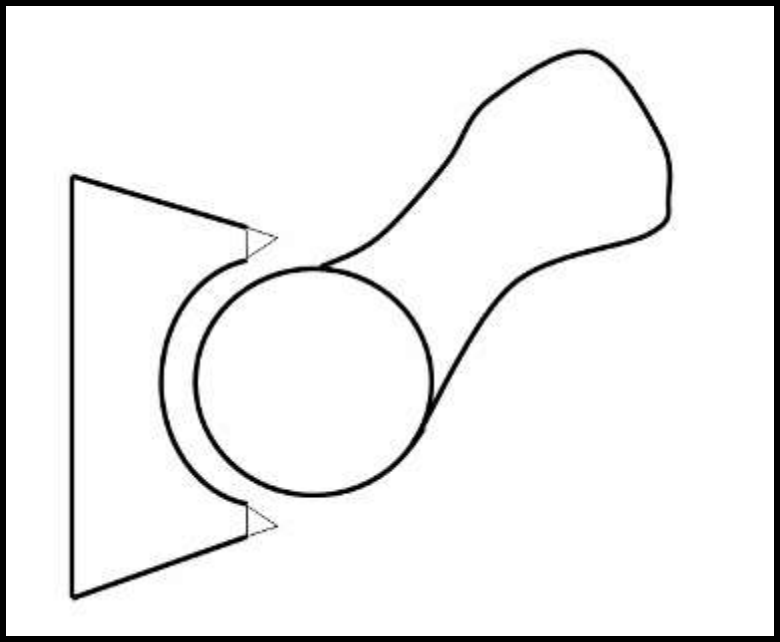
Femoroacetabular Impingement

- Cause for early degenerative changes in young pts
- Symptoms: pain on hip flexion and internal rotation
  - Key feature: PE is disproportionate loss of ROM during internal rotation
- Classified as either cam or pincer-types

Normal femoral head-neck junction and acetabulum allows clearance of femoral head during flexion

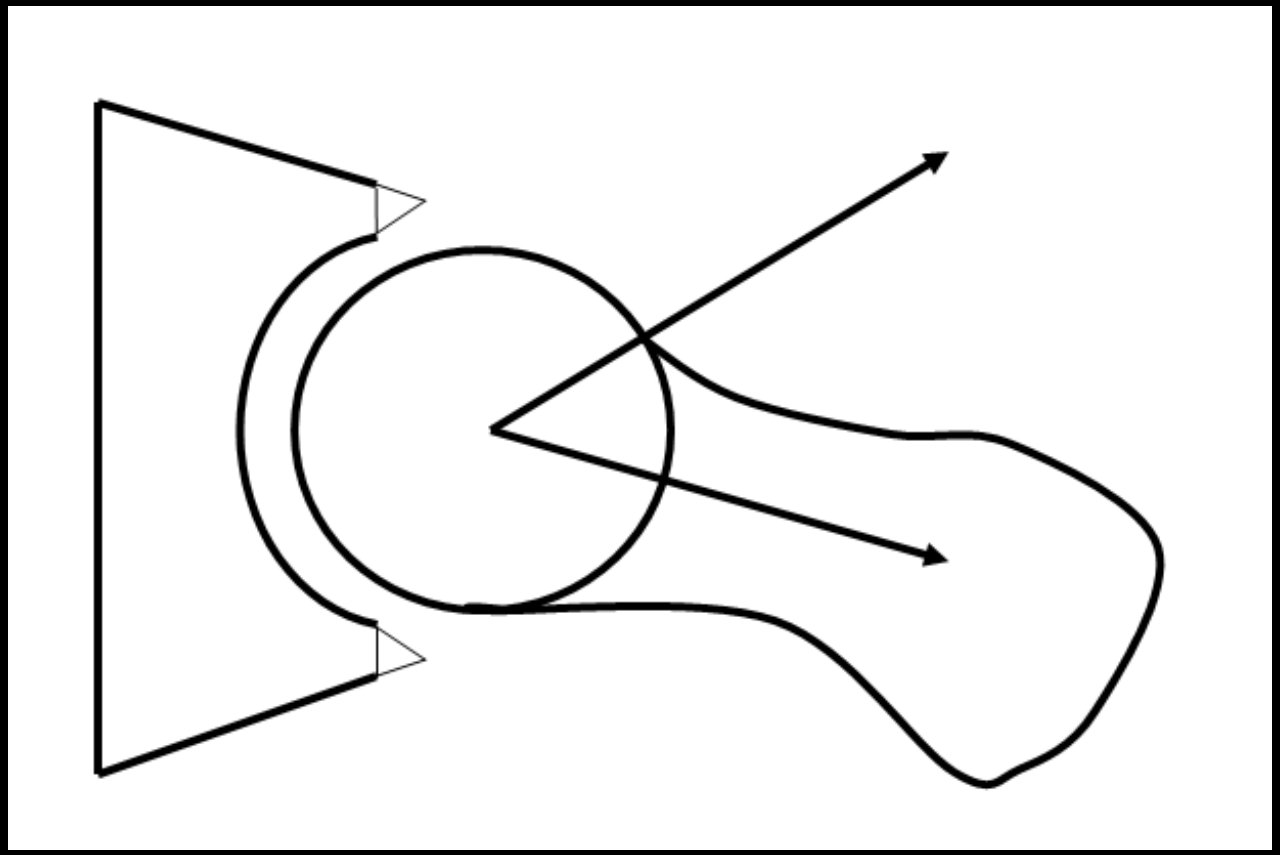




Cam-type FAI

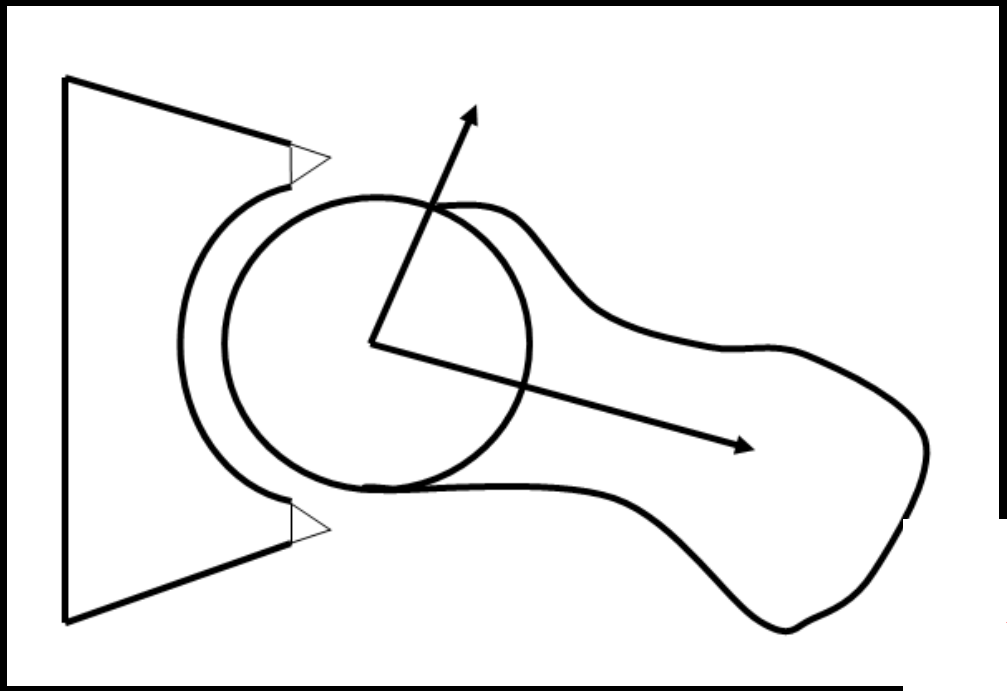
- Offset of femoral head/neck junction
- Etiologies:
  - CHD
  - SCFE
  - AVN
  - Trauma

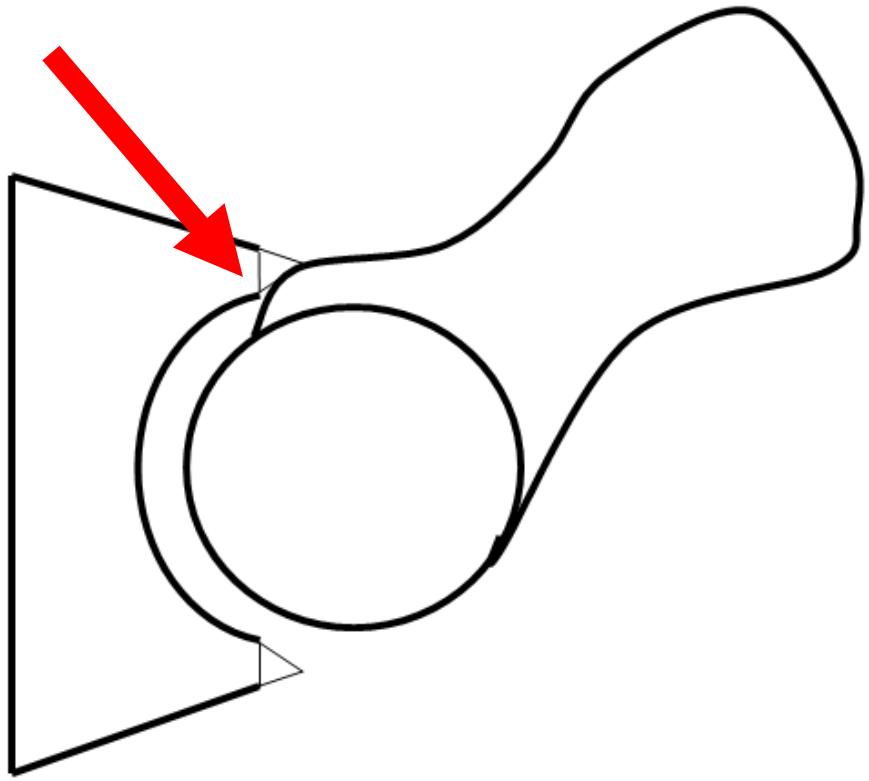
Alpha Angle



Using an axial oblique plane, alpha angle measured.

Normal is 42 degrees with upper limits of 55 degrees.



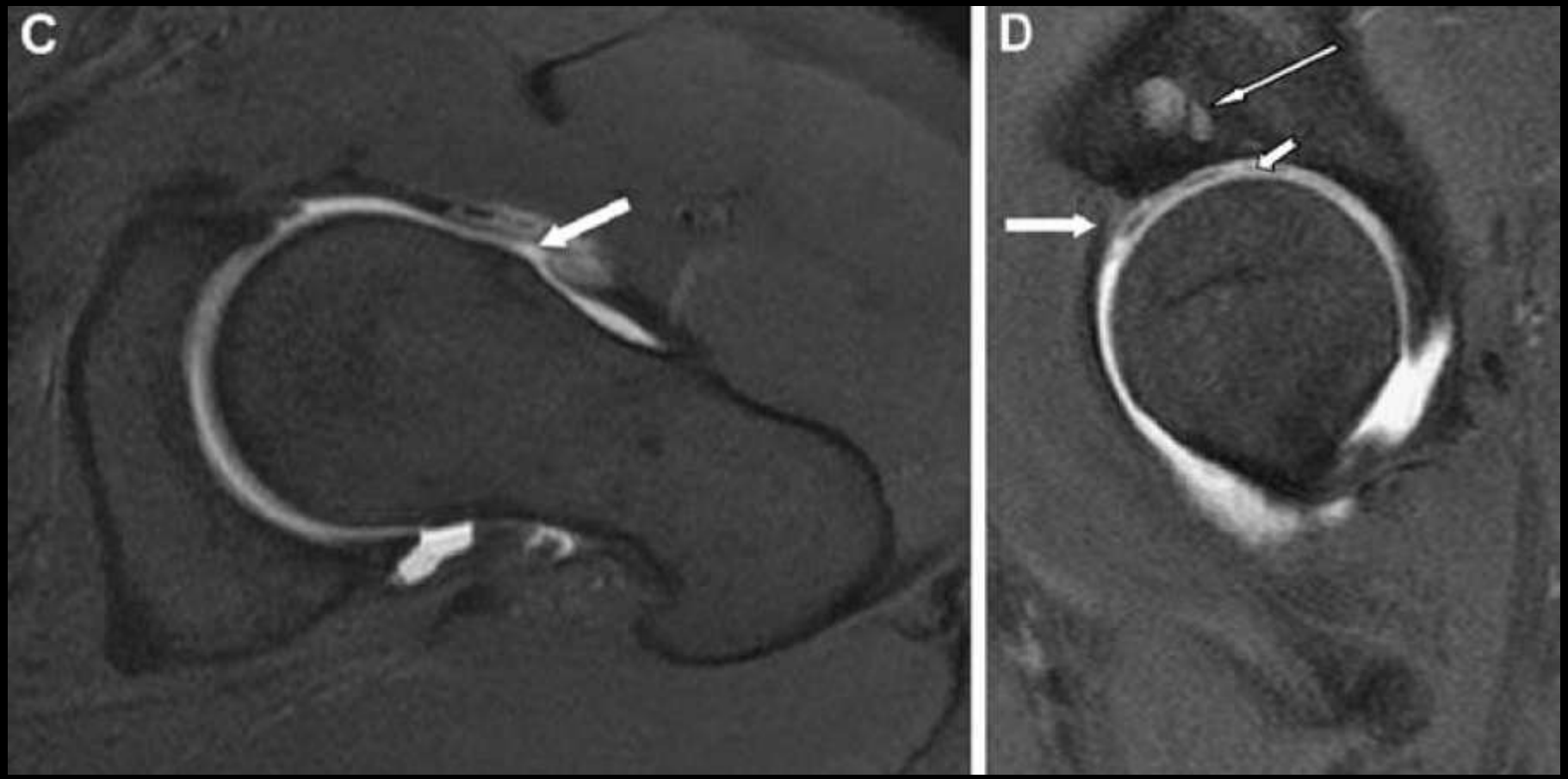


Cam-type FAI

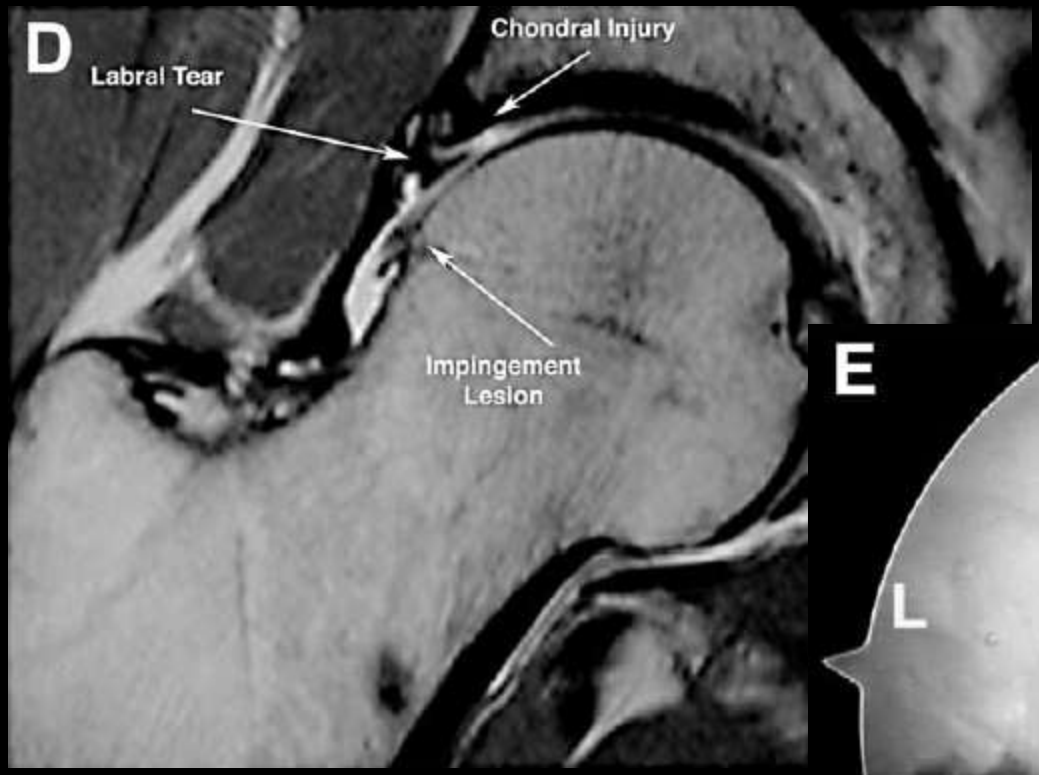
- Ganz: cartilage torn while the labrum was intact
- Kassarjian: triad of findings including cartilage and labral abnormalities
- Leunig: fibrocystic change are early manifestations of FAI

Cam Impingement

Kassarjian A, Yoon LS, Belzile E, Connoly SA, Millis MB, Palmer WE. Triad of MR arthrographic findings in patients with cam-type femoracetabular impingement. Radiology 2005:236:588-592

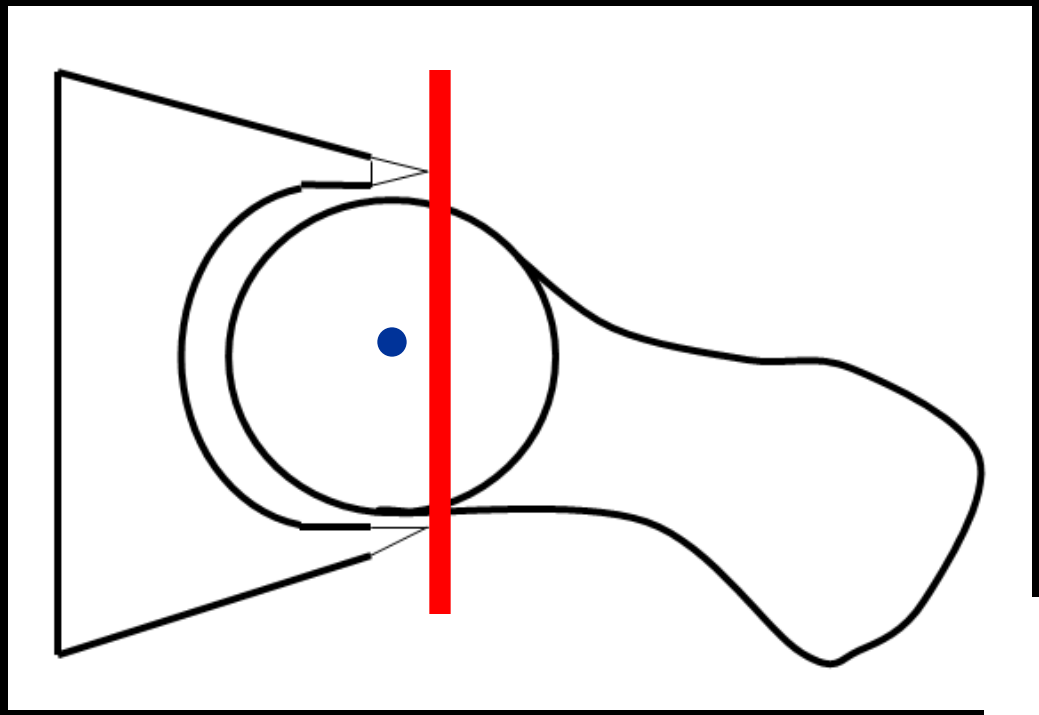

C
D

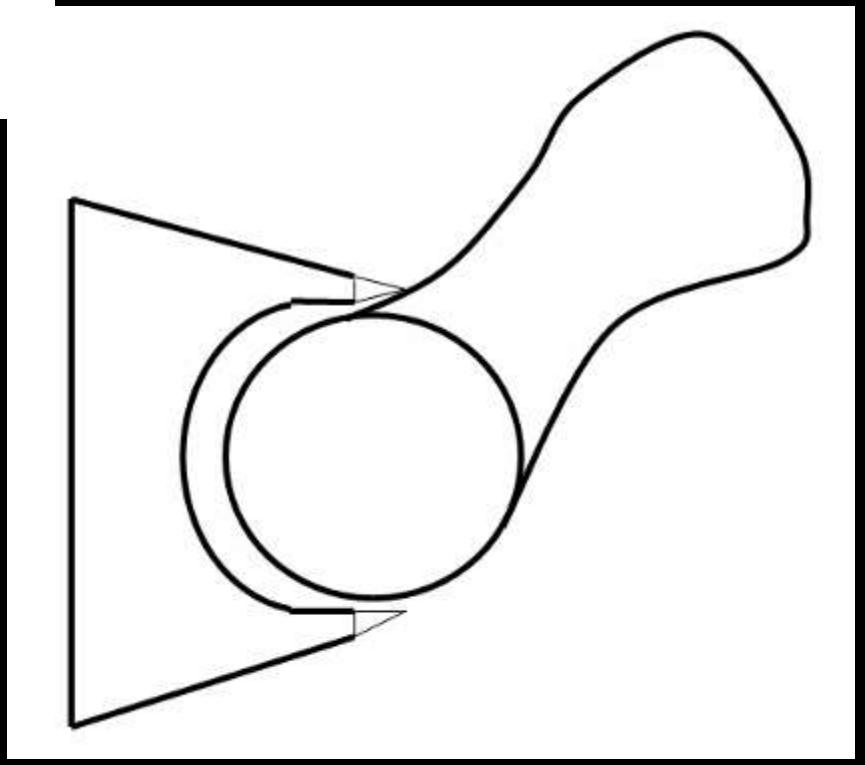
Cam Impingement



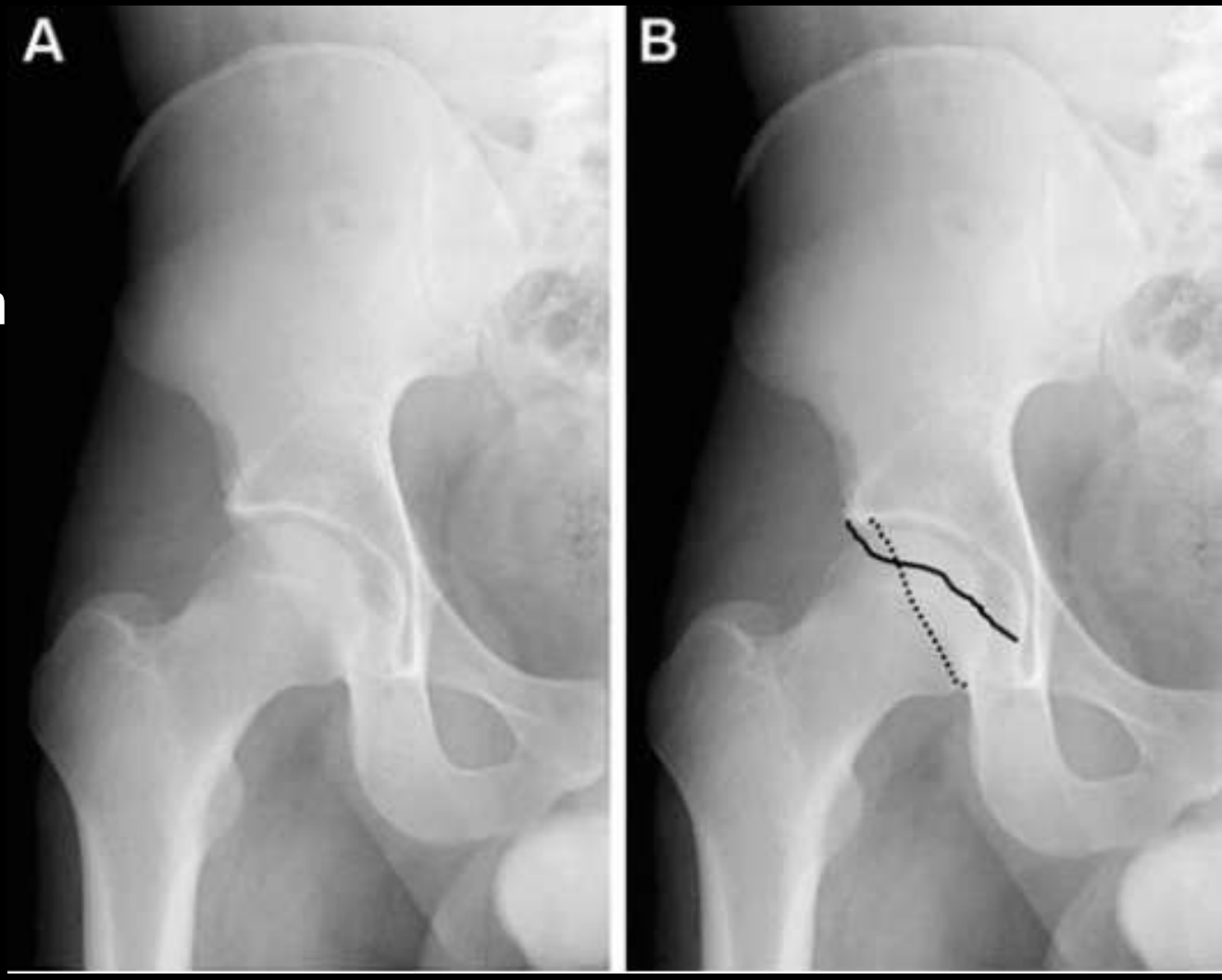
Pincer-type FAI

- Older female patient population
- Abnormal acetabular morphology
- Etiologies:
  - Coxa profunda
  - Acetabular retroversion
  - Protrusio
  - Trauma
  - Labral ossification





- Cross-over sign
  - Sign of retroversion



Pincer-type FAI

- Coxa profunda:
  - Defined by measuring the distance of the medial acetabular wall and the ilioischial line
    - Males: > 2mm
    - Females: > 6mm
- Acetabulo protrusio:
  - Femoral head projects medial to the ilioischial line

Pincer-type FAI

- MR findings: primarily labral abnormalities
  - Cartilage rarely affected
  - Contre-coup injury to the posteroinferior acetabular labrum can be seen

Treatment

- Early diagnosis important for treatment
  - Cam-type: femoral neck osteoplasty
    - Removing redundant portion of the femoral head
  - Pincer-type: removal of the excessive acetabular portion
    - Reverse periacetabular osteotomy used for acetabular retroversion

Rotator Cuff Pathology

- Tears of the g. medius and minimus tendons
- Uncertain etiology
  - ? Friction from IT band
  - Abnormal gait
  - Repetitive stress in runners
  - Trauma
- Elderly most affected

Clinical

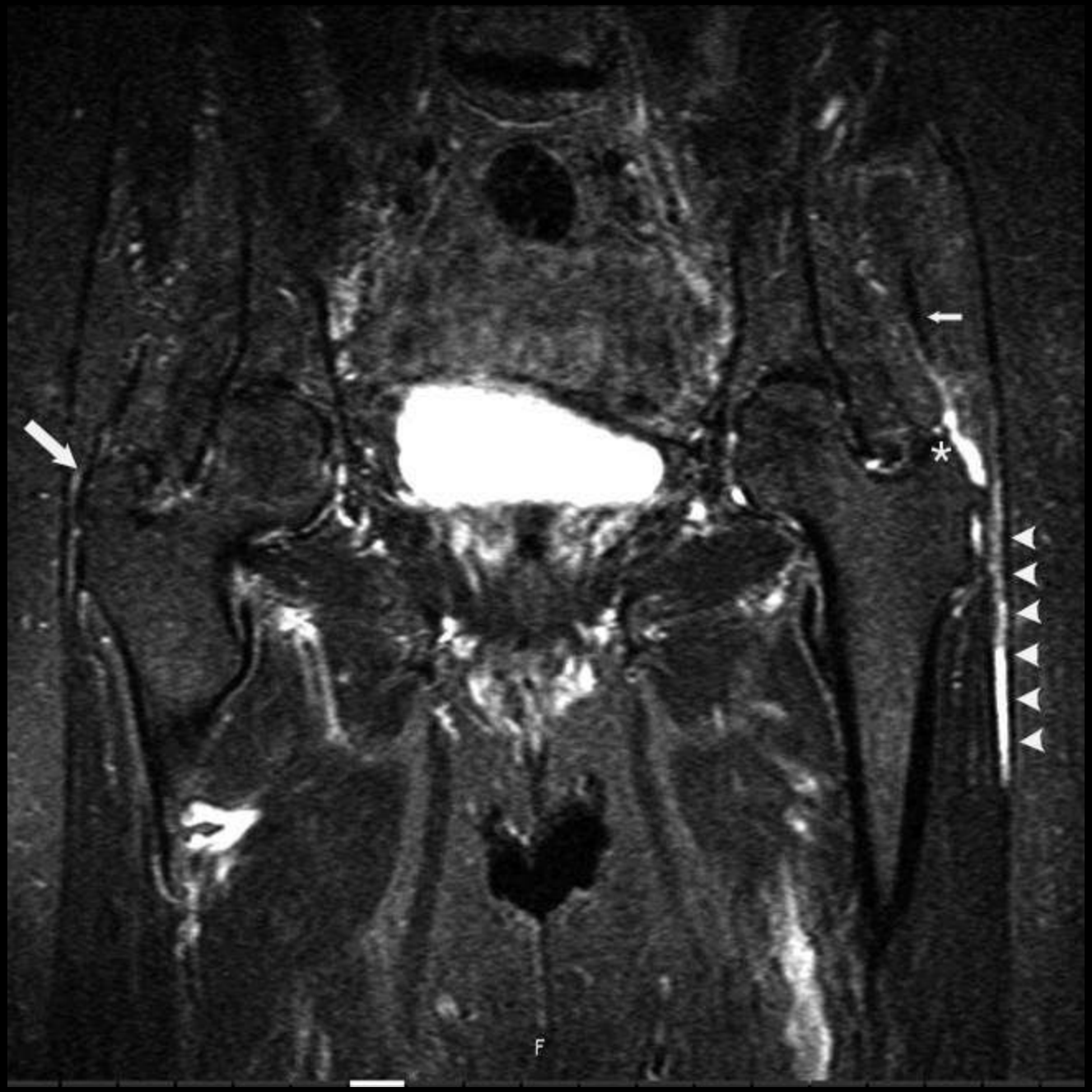
- Symptoms include lateral hip pain
  - Arthritis
  - Tendonitis
  - Insufficiency fracture
  - Muscle strain
  - Bursitis

Imaging

- MR findings:
  - Bunker: originate in g. minimus muscle with a circular or oval defect
  - Traycoff: tears usually involve the anterior aspect of g. medius
  - Kingzett-Taylor: pathology always involved g. medius with extension to minimus in minority
  - Chung: atrophy of the g. medius muscle present with tears

Imaging

- Cvitanic et al.
  - Incidence equal for g. medius and minimus
  - Small focal tears > avulsions
  - Most specific/accurate finding for tear:
    - Increased T2 signal superior to the greater trochanter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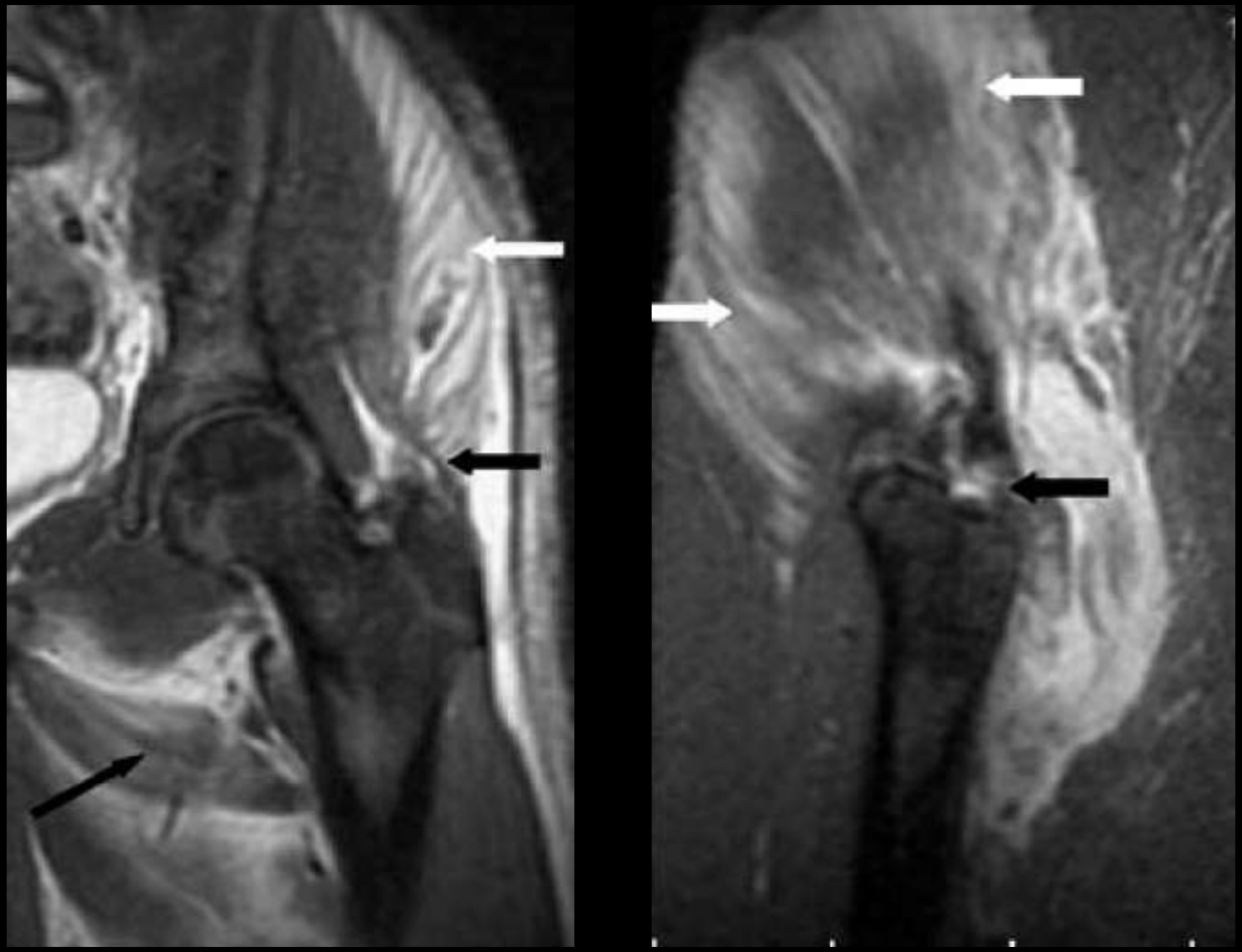


Treatment

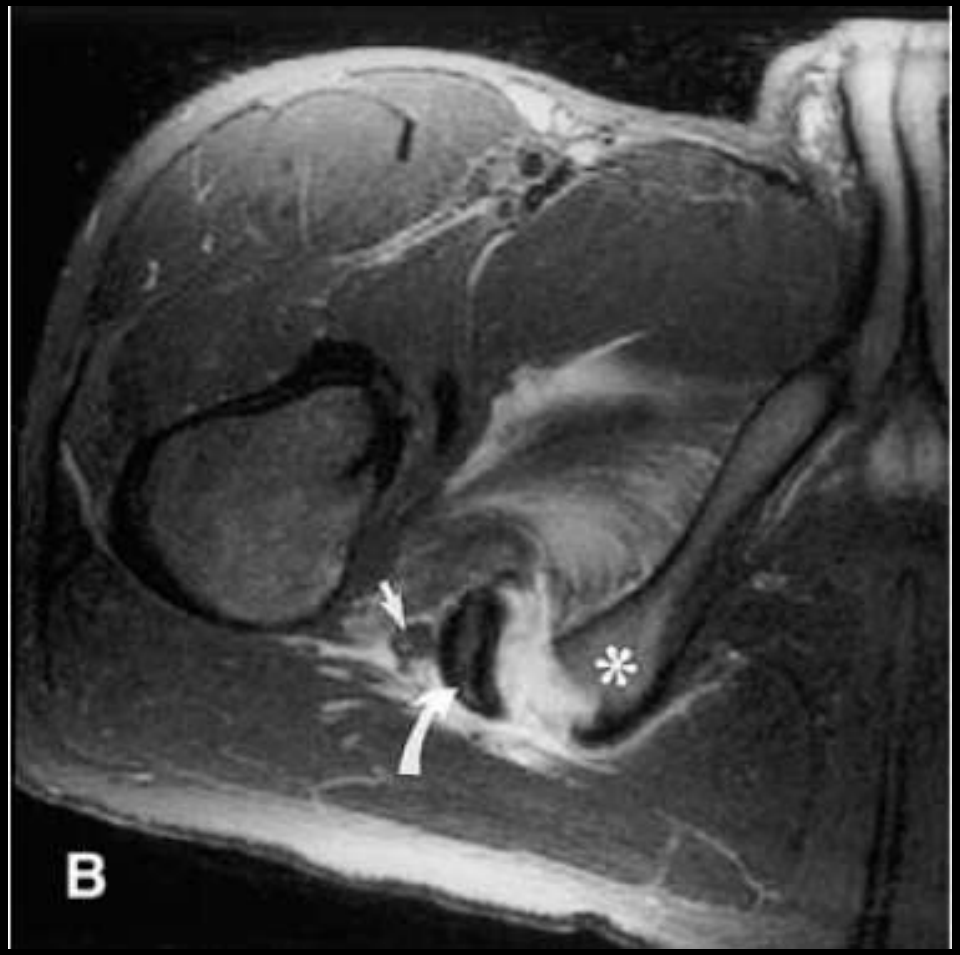
- Complete avulsion: surgical reattachment
- Tendinosis/partial tear: conservative treatment with intensive PT

Hamstring Pathology

- MC site usually involves MT junction
- Focus on pathology to the PHAC to the ischial tuberosity
- Most severe injury avulsion
  - Occurs in athletes during excessive eccentric contraction during running or jumping
  - In children, the apophysis involved

Hamstring Pathology

Koulouris G, Connell D. Hamstring muscle complex: an imaging review. Radiographics 2005:25:571-586.



Koulouris G, Connell D. Evaluation of the hamstring muscle complex following acute injury. Skeletal Radiol 2003:32:582-589.

MR findings

- Most avulsions involve conjoint tendon with partial tearing of SMB
- Ragheb et al:
  - 82% of pathology involved all 3 tendons
  - SMB most common to be torn in isolation

Treatment

- Early surgical intervention required
  - To avoid complications such as gluteal sciatica from localized scarring or neuritis from displaced hamstrings

Ligamentum Teres

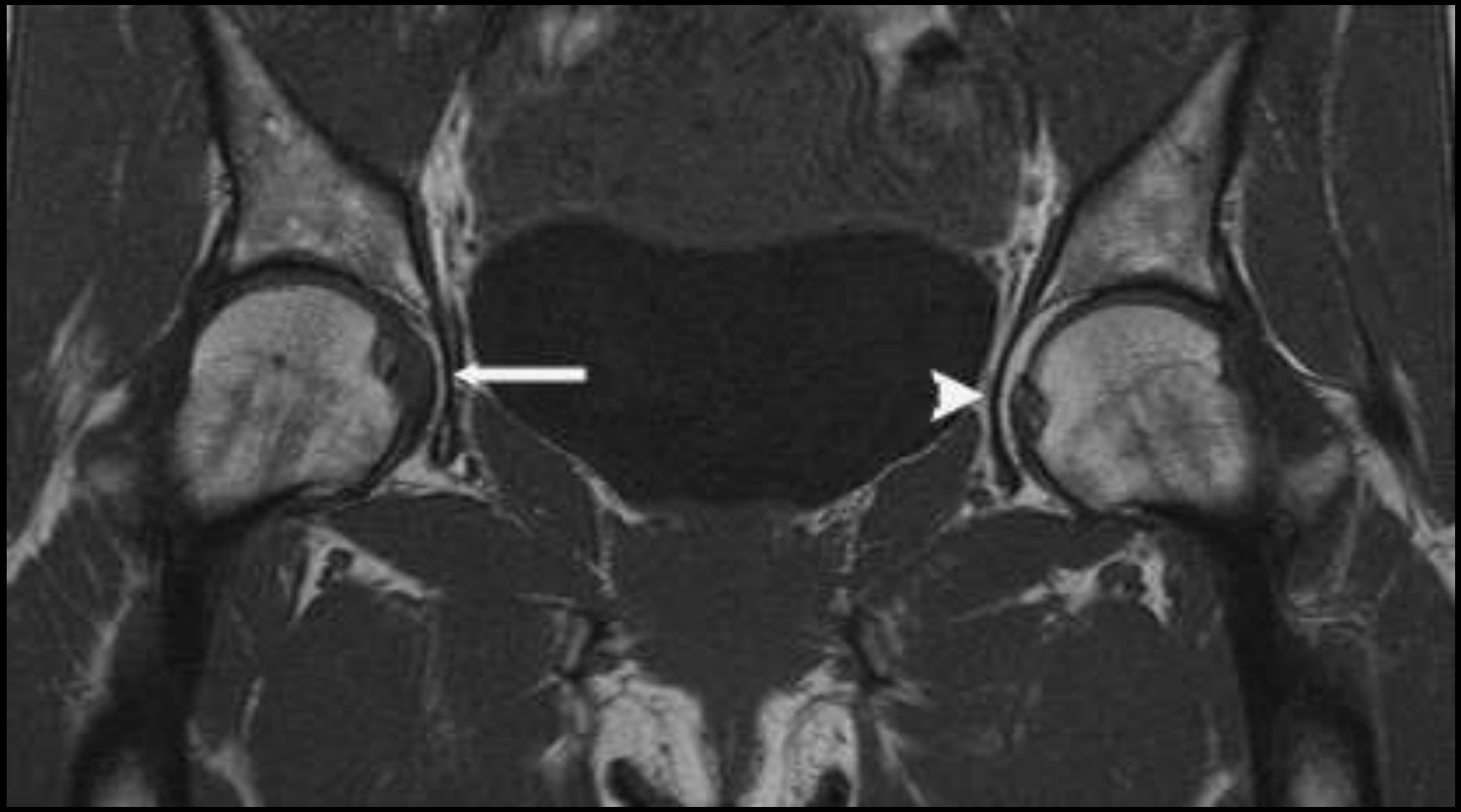
- Increasingly recognized as a source of hip pain
- Function unknown: unlikely stability
  - Proprioception
  - Nocioception
  - Spreading synovial fluid like a windshield wiper

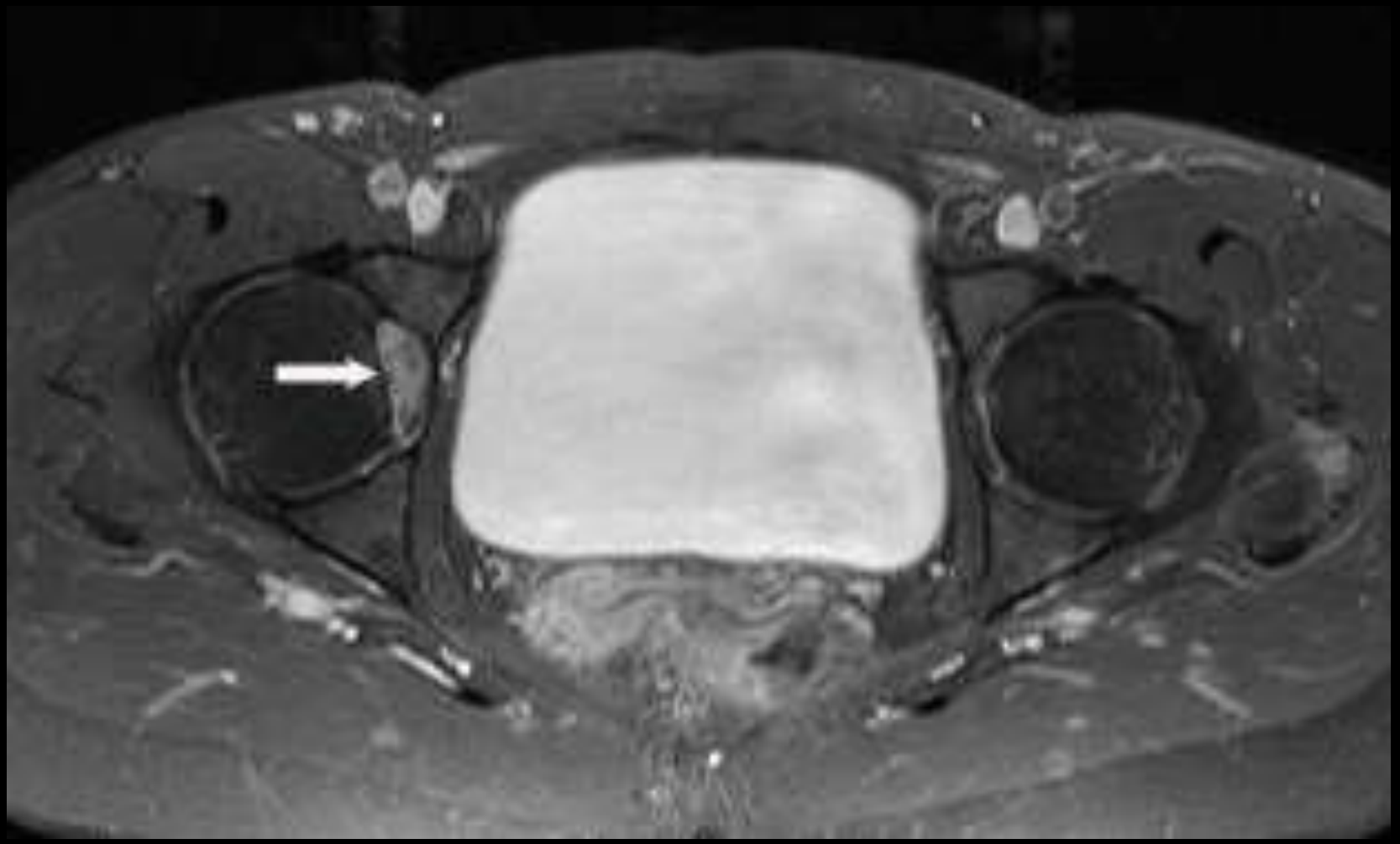
Ligamentum Teres

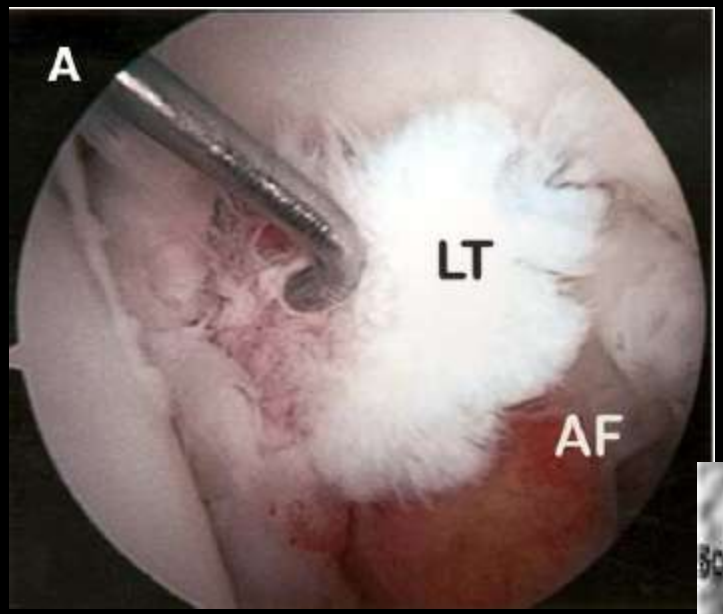
- Difficult to visualize on arthroscopy
  - 3rd most common finding arthroscopically in athletes
  - Deep anterior groin pain
- Gray et al described 3 types
  - Complete rupture from trauma/surgery
  - Partial tear in pts with chronic sx's
  - Degeneration in young pts
    - RF's include LCP and SCFE

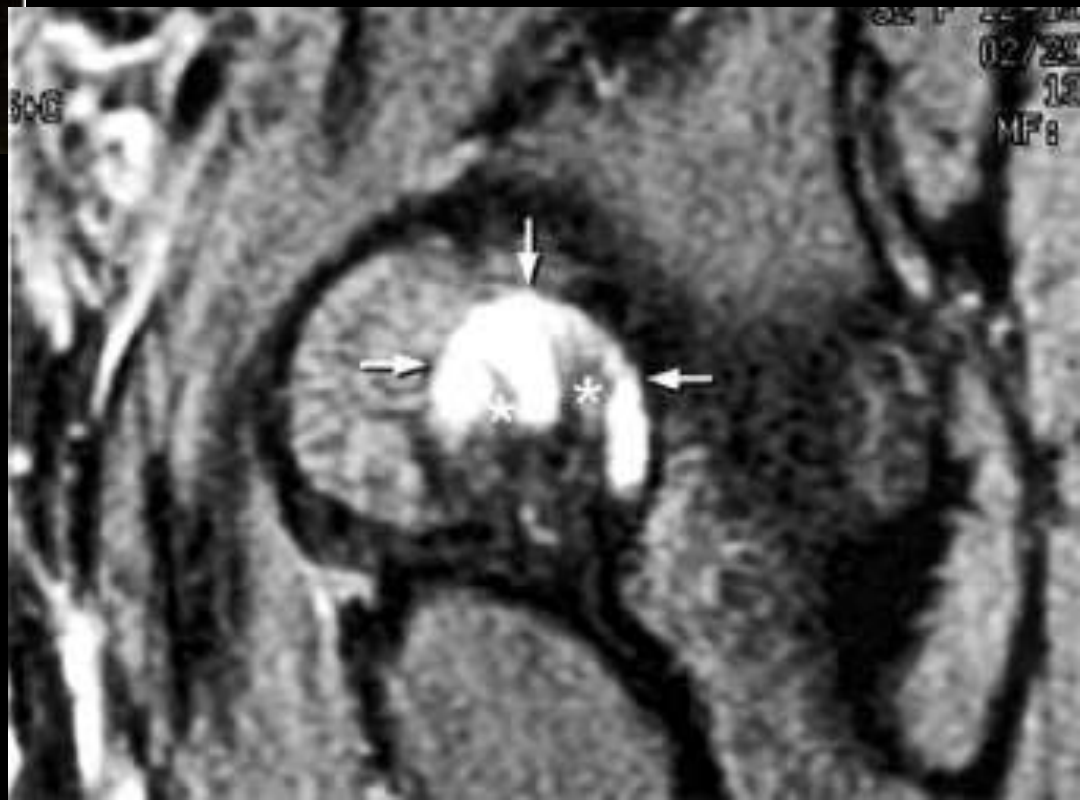
Gray et al. The ligamentum teres of the hip: an arthroscopic classification of its pathology. Arthroscopy 1997 Oct.

Ligamentum Teres









Byrd JWT et al. Traumatic rupture of the ligamentum teres as a souce of hip pain. Arthroscopy 2004.

Treatment

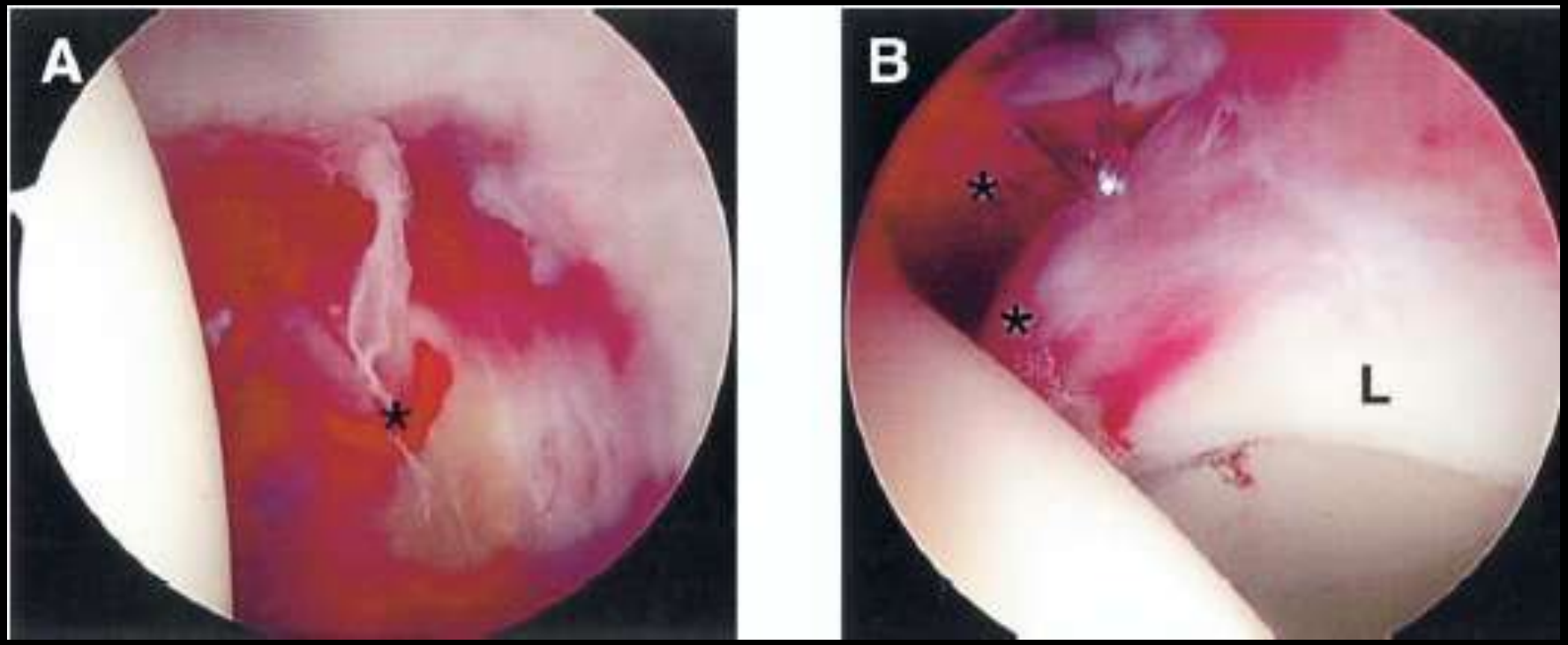
- Debridement and washout
- Total hip arthroplasty performed when conservative treatment fails

Adhesive Capsulitis

- Clinically: painful restricted motion
- Imaging: normal radiographs/MR's
  - Tightness during arthrography
    - Failed arthroscopy
- Etiology: idiopathic
  - Secondary to pathology (i.e. synovial chondr)
- Demographics: middle aged women

Byrd JWT et al. Adhesive capsulitis of the hip. Arthroscopy Jan 2006.

Adhesive Capsulitis of the Hip



Conclusion

- Normal Anatomy:
  - Osseous: ischial tuberosity and greater trochanter
  - Labrum: pitfalls and variants
- Pathology:
  - Labral tears in association with FAI
  - Hamstring/Rotator cuff tears
  - Ligamentum teres
  - Adhesive capsulitis