

MRI of the Rotator Cuff with US Correlation

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Disclosures

- Consultant: Bioclinica
- Contractor: POCUS PRO
- Book Royalties: Elsevier
- I no longer follow Nicki Minaj on Twitter

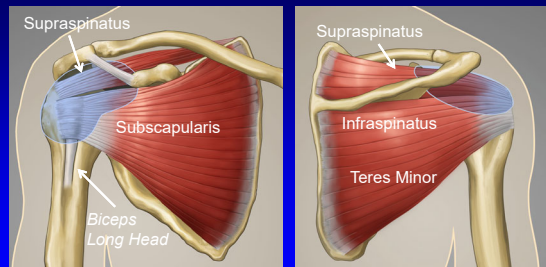
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Outline:

- Anatomy
- Rotator cuff tears
- Post-operative cuff
- Calcific tendinosis

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Rotator Cuff

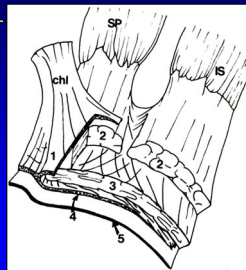


Note: Subacromial-subdeltoid Bursa (light blue)

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Rotator cuff: 5 layers

- #1: Superficial fibers coracohumeral ligament
- # 2: SST & IST fibers
- # 3: Smaller tendon fascicles 45°
- # 4: Connective tissue, deep coracohumeral lig
- # 5: Capsule and rotator cable

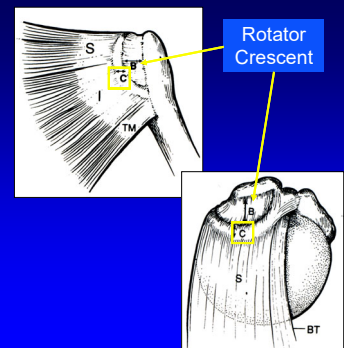


From: RadioGraphics 1999; 19:685

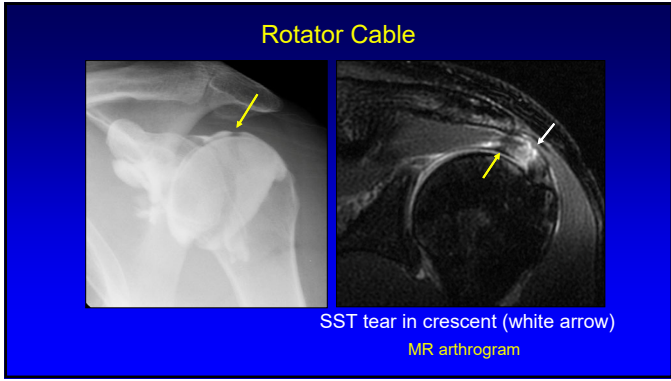
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Rotator Cable

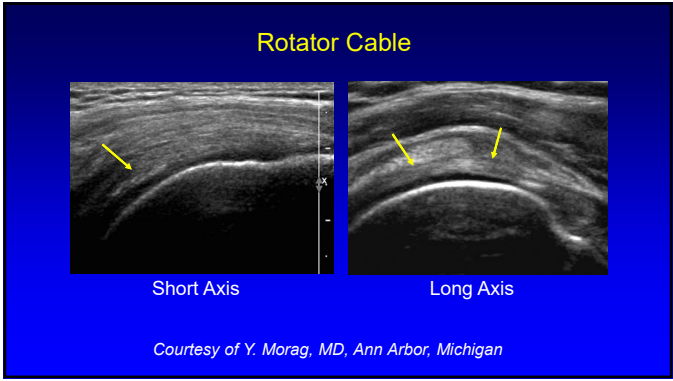
- Thickened strip of tissue: layer 5
- Perpendicular to SST & IST tendon fibers
- Outlines rotator crescent
- Cable dominant patients: retain range of motion in spite of a full-thickness tear



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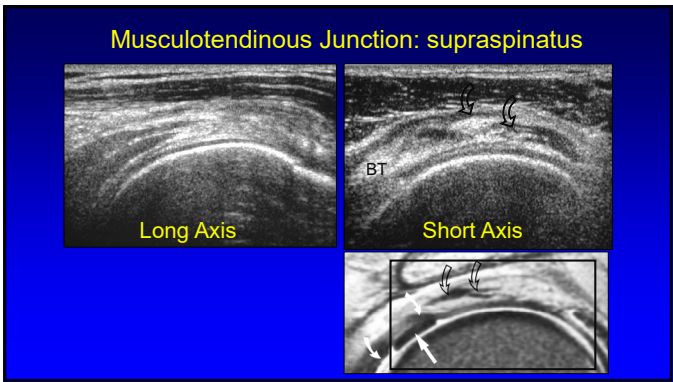


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Rotator cuff: *structure*

- Supraspinatus: 2 tendons
 - Anterior cylindrical tendon
 - Posterior flat tendon
 - Joins infraspinatus 15 mm proximal to insertion
 - Converges, does not interdigitate
 - Infraspinatus overlaps supraspinatus

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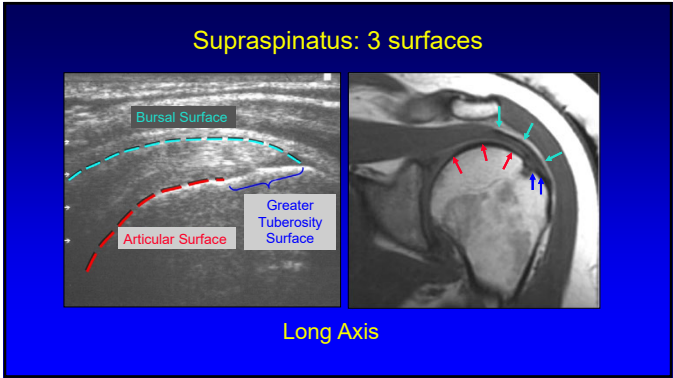


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Rotator Cuff: *insertion*

- Lesser tuberosity: subscapularis
 - Multipennate
 - Inferior 1/3: muscle to its attachment
- Greater tuberosity: 3 facets
 - Superior: supraspinatus
 - Middle: supra- and infraspinatus
 - Inferior: teres minor

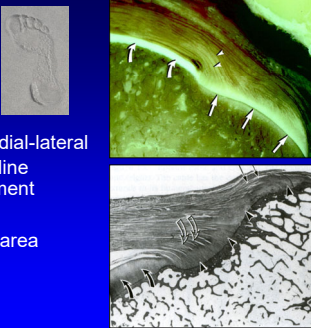
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Rotator Cuff Insertion

- Fibrocartilage insertion
- Supraspinatus:
 - Footprint or shelf 1.2 cm medial-lateral
 - 1-2 mm sulcus between hyaline cartilage and tendon attachment
- Infraspinatus:
 - Wider sulcus, irregular bare area
 - Cortical irregularity



From: Siebold et al. RadioGraphics 1999; 19:685

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Rotator Cuff: pathogenesis

- Extrinsic:
 - Repetitive microtrauma: microtears
 - Subacromial impingement
- Intrinsic:
 - Degeneration: predispose to tear
 - Avascular region: critical zone
- Usually over age of 40 years

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Rotator Cuff Tear:

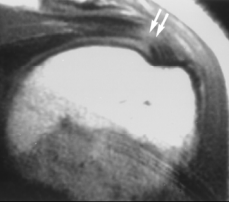
- Meta-analysis: 65 articles
- Full-thickness tears:
 - MRA, MRI, US = in sensitivity (92 – 95%)
 - MRA more specific
- Partial-thickness tears:
 - MRA most sensitive (86%) and specific
 - MRI (64%), US (67%)

de Jesus, 2009; 192:1701

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Rotator Cuff: MRI

- Normal: low signal
- Magic angle phenomenon
 - T1w and PDw (low TE)
 - Increased signal
 - Tendon 55° to field
 - T2w (long TE): normal
 - SE: >40 msec
 - FSE: >70 msec

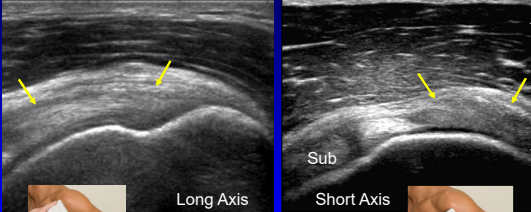


From: Siebold et al. RadioGraphics 1999; 19:685

Br J Radiology 1998; 71:31

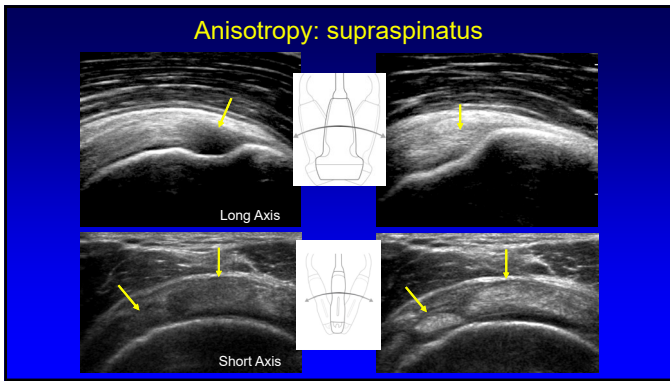
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Rotator Cuff: ultrasound



- Hyperechoic, fibrillar

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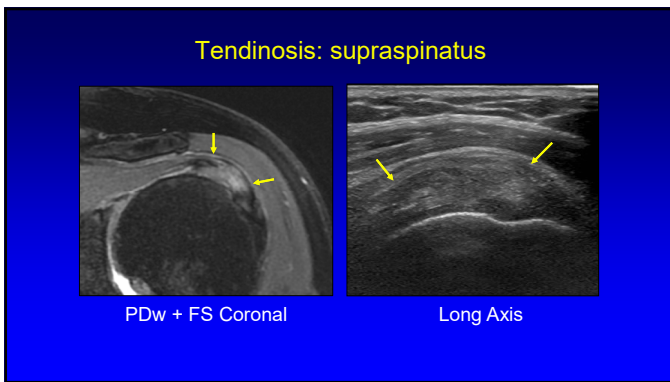
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Rotator Cuff: tendinosis

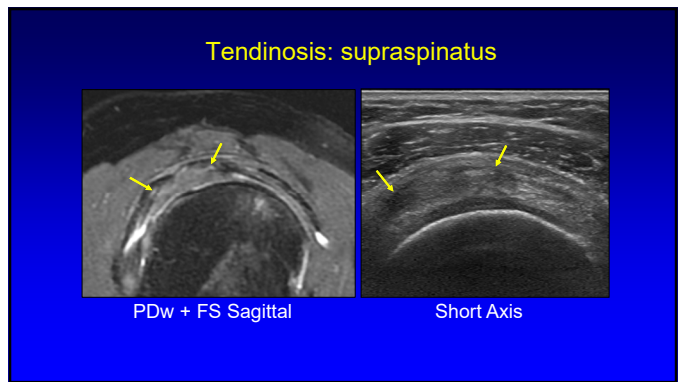
- No inflammatory cells
 - Mucoïd degeneration
 - Chondroid metaplasia
- MRI: T2w **intermediate** signal = muscle
- US: hypoechoic, thickened
- No cortical irregularity at supraspinatus footprint

Hodler J, et al. J MRI; 2010; 32:165
Jacobson, JA, et al. Radiology 2004; 230:234

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Rotator Cuff: MRI

- Tendon tear
 - T1w and PDw: increased signal
 - T2w: **fluid** signal
 - Some tears: low or intermediate signal
 - Intra-articular contrast in tendon
 - Abnormal morphology
 - Possible tendon thinning
 - Bursal and full-thickness

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Rotator Cuff Tears: ultrasound

- Most tears are hypoechoic / anechoic
- Larger tears: deltoid dips into tendon gap
- Massive tear: non-visualization
- Adjacent cortical irregularity:
 - Important indirect sign of tear
 - Supraspinatus
 - If > 40 years old

Radiology 2004; 230:234

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Cortical Irregularity:

- Greater tuberosity: at **supraspinatus** insertion
- When present: 75% have rotator cuff tears
- When absent: 96% normal cuffs by sonography

AJR 1998; 171:229
Radiology 2004; 230:234

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Rotator Cuff Tear: reporting

- Location
- Size
- Extent (depth)
- Shape
- Fatty infiltration and atrophy

Morag Y, RadioGraphics 2006; 26:1045

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Rotator Cuff Tear: Location

- Which tendon?
- Proximal versus distal at attachment?
- Anterior or posterior (supraspinatus)
- Most tendon tears:
 - Supraspinatus
 - Partial-thickness: anterior at rotator interval
 - Degenerative: posterior aspect

Radiology 2004; 230:234

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Supraspinatus Tears: extent

Rim-vent Tear or PASTA lesion

Partial Articular Partial Bursal

From: Fundamentals of Musculoskeletal Ultrasound

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Supraspinatus Tears: extent

Intrasubstance Full thickness

From: Fundamentals of Musculoskeletal Ultrasound

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Rotator Cuff Tear: Extent

- Partial-thickness:
 - Interstitial
 - Articular
 - Bursal
- Full-thickness, focal:
 - Extends to two surfaces
- Full-thickness:
 - Entire tendon discontinuous
 - Full width

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Rim-vent Tear or PASTA lesion

- Distal articular-sided tear of the supraspinatus at the rotator cuff footprint
- **P**artial **A**rticular **S**urface (*Sided, or Supraspinatus*) **T**endon **A**vuulsion lesion

*From: Siebold et al. RadioGraphics 1999; 19:685
Reproduced from EA Codman's Textbook 1934*

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PASTA

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More PASTA

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Rotator Cuff Tear: Extent

- Partial-thickness:
 - Grade 1: < 3 mm
 - Grade 2: 3 – 6 mm
 - Grade 3: > 6 mm (significant)
 - > 50% thickness
 - Normal cuff: 10 – 12 mm thick

Morag Y, RadioGraphics 2006; 26:1045

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Partial Thickness Tears

Articular:
MR arthrogram

Bursal

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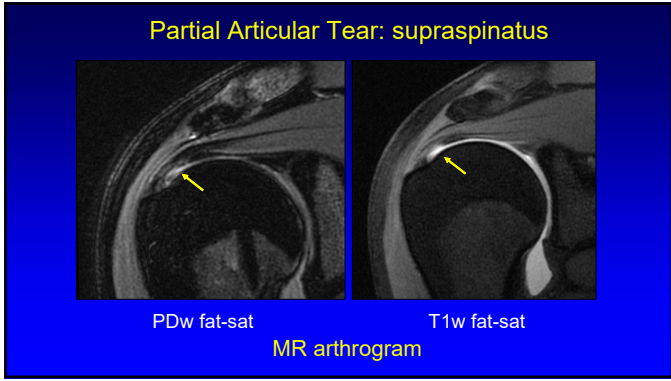
Articular Partial-thickness Tear: supraspinatus

T2w FS

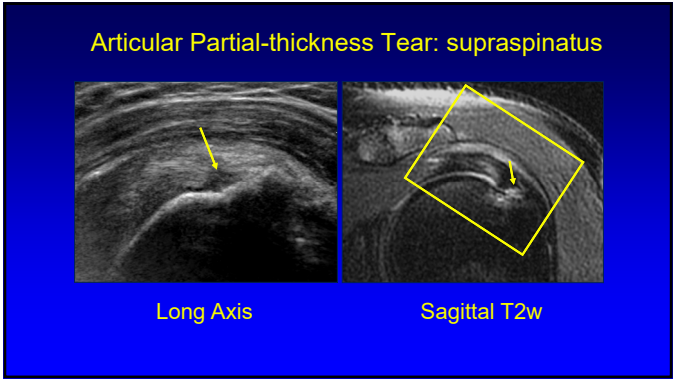
T1w FS

T1w FS

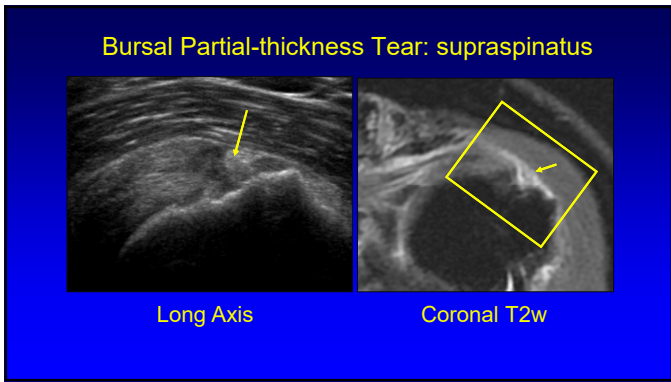
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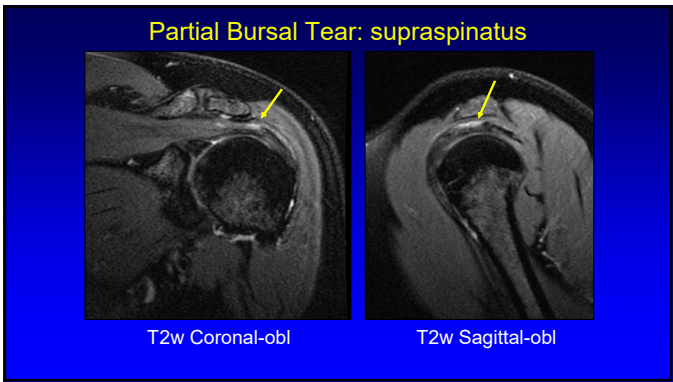
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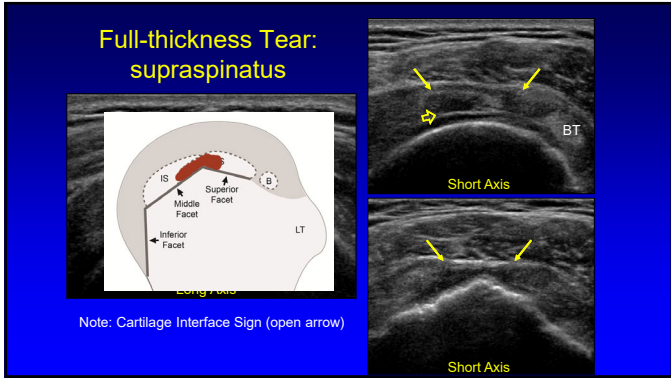
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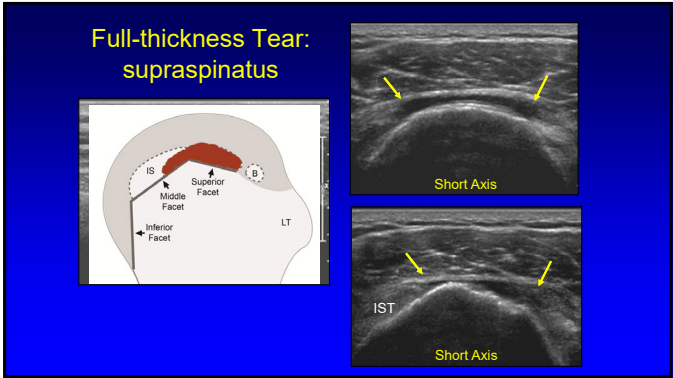
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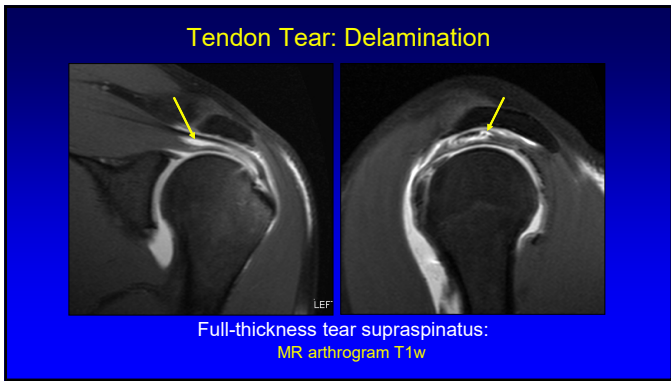
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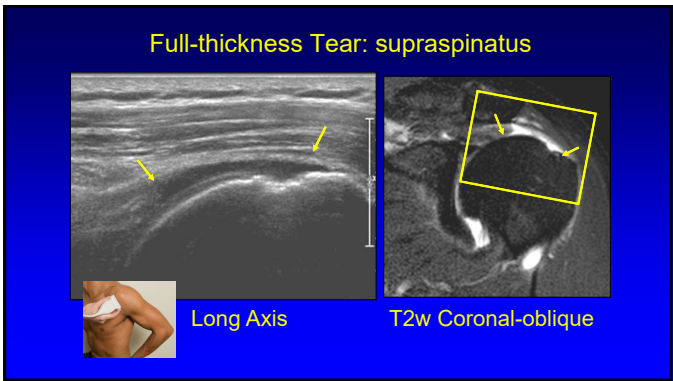
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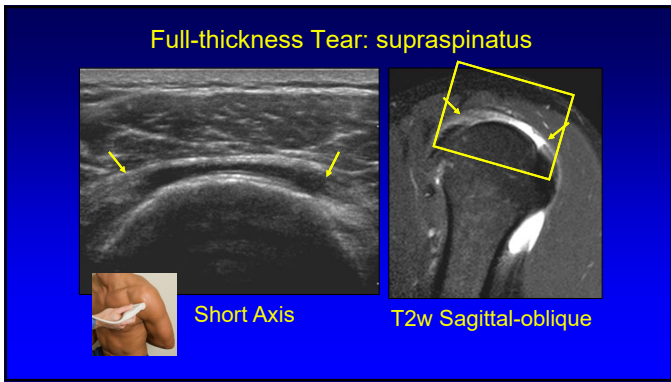
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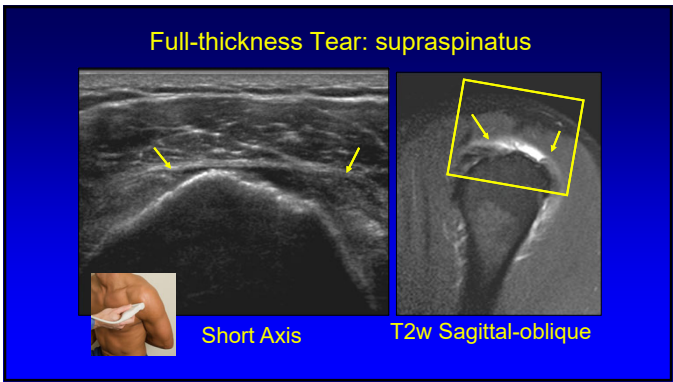
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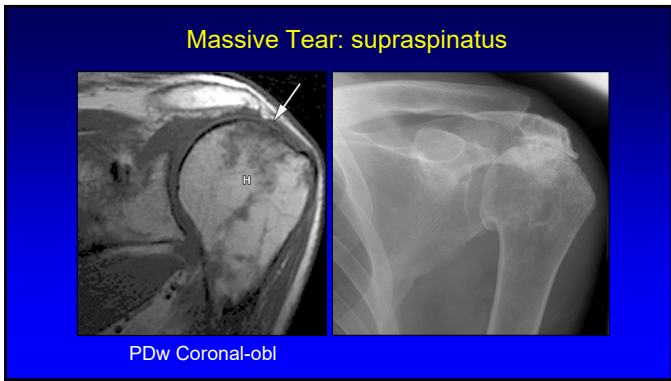
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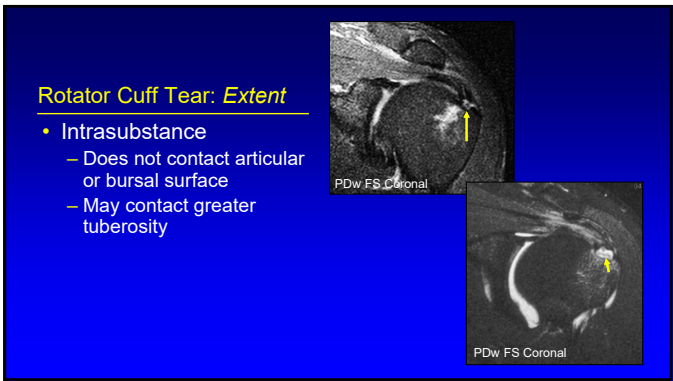
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Rotator Cuff Tear: Location

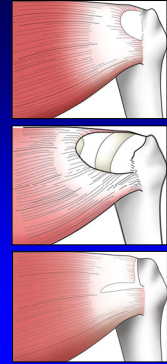
- Young patients: <40 years
 - 56% of cuff tears involved the footprint
 - 50%: PASTA or rim-rent: anterior
 - 34%: interstitial tears, posterior supraspinatus
 - 38%: SLAP or labral tears
- Older patients: 65 years +/- 10 years
 - Degenerative tears: 15 – 16 mm posterior to biceps
 - Center of rotator crescent
 - Full-thickness and larger tears

Eur Radiol 2011; 21:1477
JBJS 2010; 92:1088

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Rotator Cuff Tear: Shape

- At arthroscopy (viewed from surface)
 - Crescentic: minimal retraction
 - U-shaped: massive + retraction
 - L-shape



From: Morag et al.
Radiographics 2006; 26:1045

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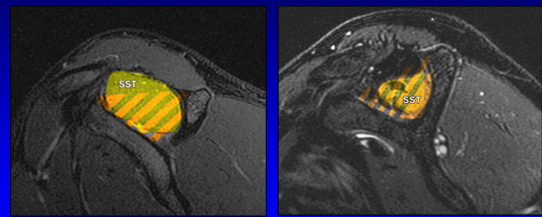
Rotator Cuff Tear: Fatty atrophy

- Related to extent and chronicity of rotator cuff tear
 - Poor surgical outcome
- MRI
 - Fatty infiltration, decreased size
- Ultrasound
 - Increased echogenicity, decreased size

JBJS 2012; 94:e83

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Supraspinatus Atrophy: scapular ratio



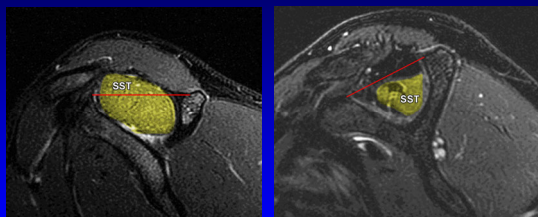
Normal: >50% of space

Atrophy: <50%

From: Morag et al. Radiographics 2006; 26:1045

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Supraspinatus Atrophy: tangent sign



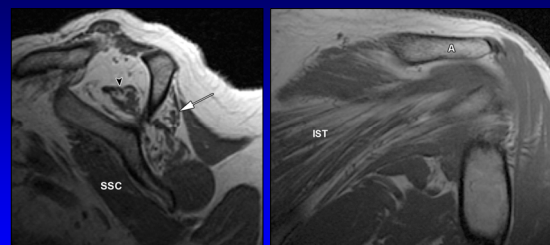
Normal

Atrophy

From: Morag et al. Radiographics 2006; 26:1045

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Supraspinatus and Infraspinatus Atrophy



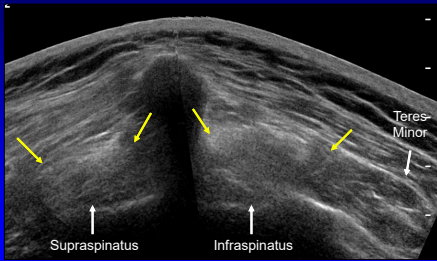
T1w Sagittal-obl

T1w Coronal-obl

From: Morag et al. Radiographics 2006; 26:1045

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Atrophy: supraspinatus and infraspinatus

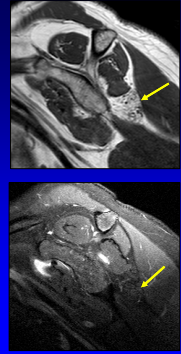


Short Axis (extended field-of-view)

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Teres Minor Atrophy

- Isolated finding: 3%
- Usually without visible pathology in quadrilateral space:
 - Mass, paralabral cyst, etc.
- May relate to variation in origin and length of teres minor innervation



Sofka, Skeletal Radiol 2004; 33:514
Friend, Surg Radiol Anat 2010; 32:243

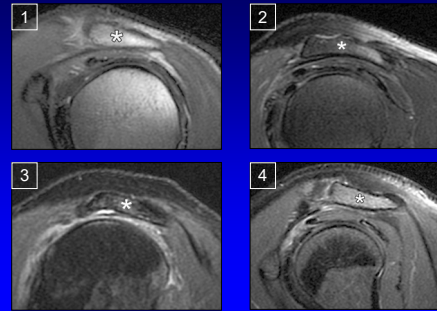
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Rotator Cuff Tear: *Impingement*

- Four acromion types:
 - 1: flat
 - 2: curved downward
 - 3: hooked
 - 4: curved upward
- Rotator cuff tears: associated with
 - Types 2 & 3, spur, os acromiale

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Acromion Types



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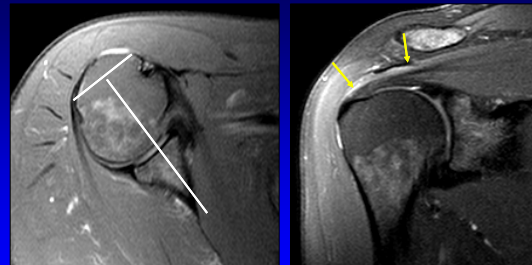
Rotator Cuff MRI: Pitfalls

- Positioning:
 - Internal rotation of shoulder
 - Causes supraspinatus to angle anterior at footprint oblique to imaging planes
 - Far anterior cuff tears: volume average with rotator interval
- Intermediate signal tear (uncommon)
- Musculotendinous junction heterogeneity

Vinson E, AJR 2007; 189:943

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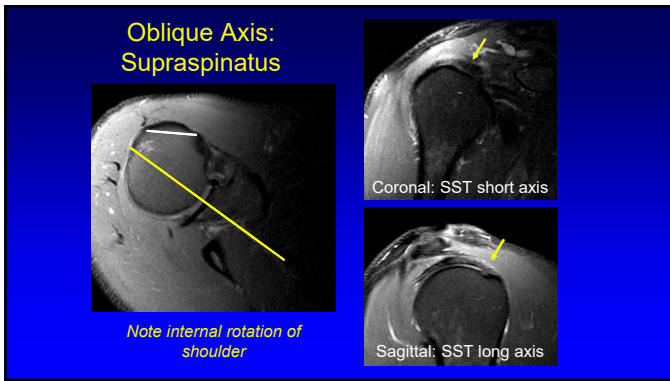
True Long Axis: Supraspinatus



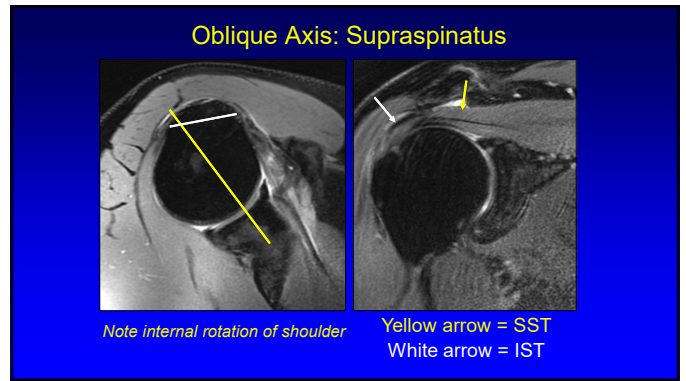
T2w + fat-sat axial

T2w + fat sat coronal-oblique

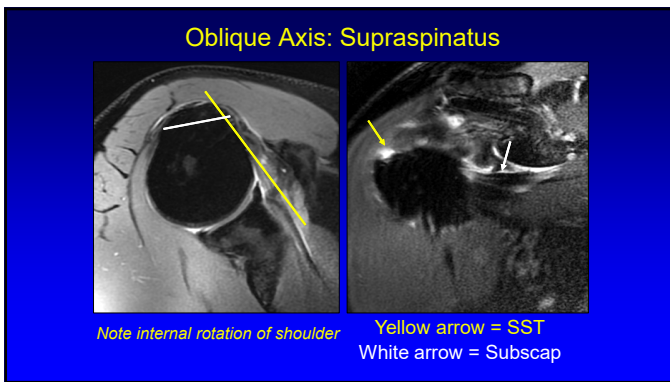
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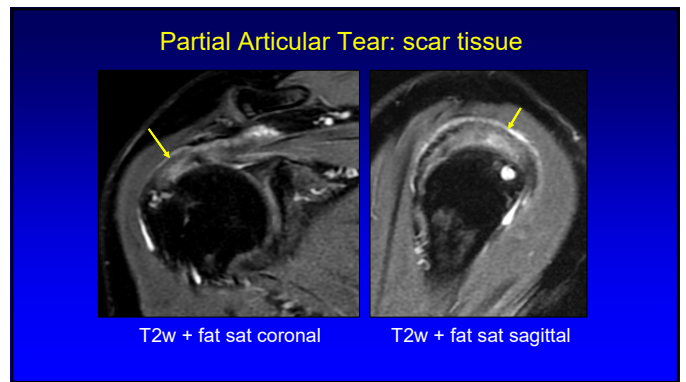
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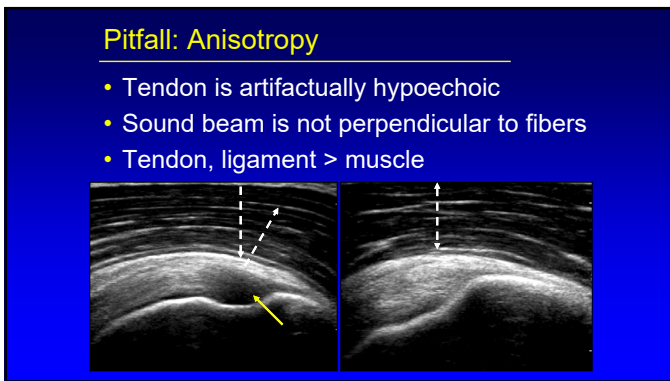
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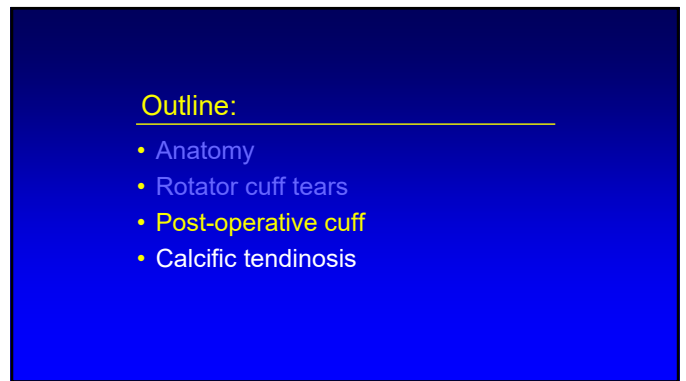
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64



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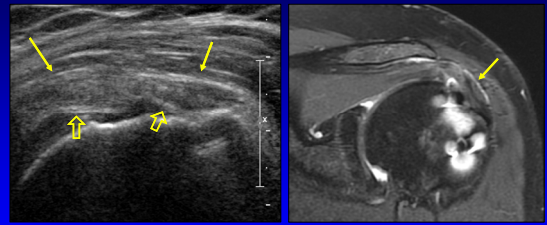
Postoperative Cuff

- Intact cuff:
 - Thinner than normal, increased T2w signal
 - MR: increased T2 signal
 - US: variable echogenicity
 - Improvement: 6 months – 3 years
- Recurrent tear:
 - 3 – 54%: does not correlate with symptoms
 - Unequivocal defect or discontinuity

Crim, AJR 2010; 195: 1361

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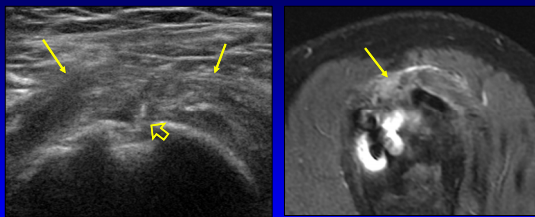
Post-operative cuff: intact



Long Axis
Open arrows = suture
T1w fat-sat coronal
MR arthrogram

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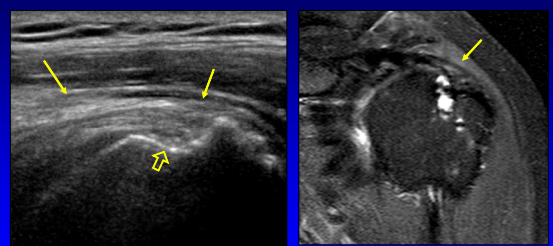
Post-operative cuff: intact



Short Axis
Open arrow = suture
T1w fat-sat sagittal
MR arthrogram

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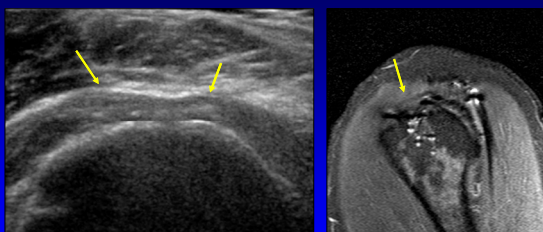
Post-operative cuff: intact



Long Axis
Open arrow = trough
PDw fat-sat coronal

70

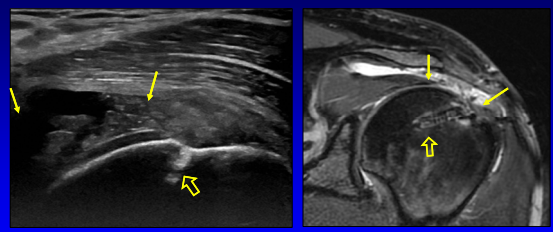
Post-operative cuff: intact



Short Axis
PDw fat-sat sagittal

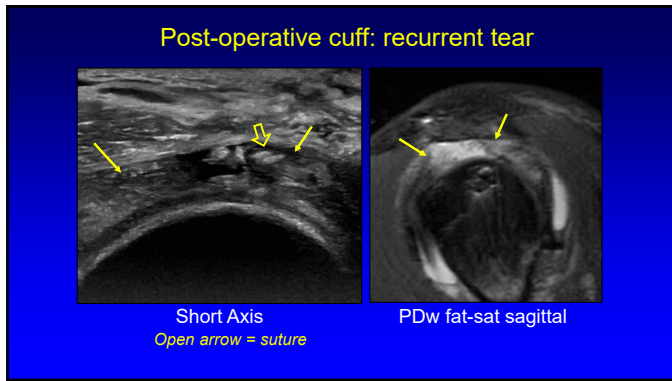
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Post-operative cuff: recurrent tear

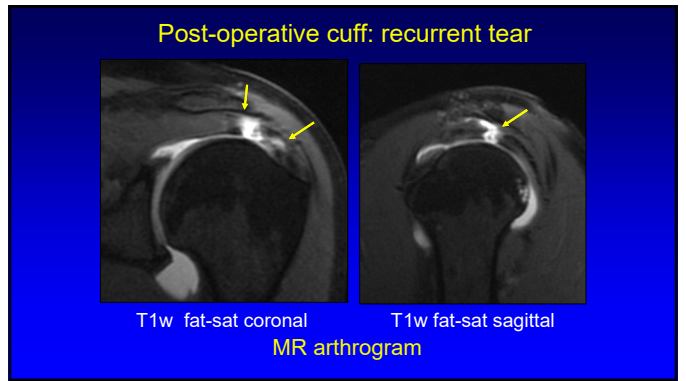


Long Axis
PDw fat-sat coronal
Open arrow = bioabsorbable suture anchor

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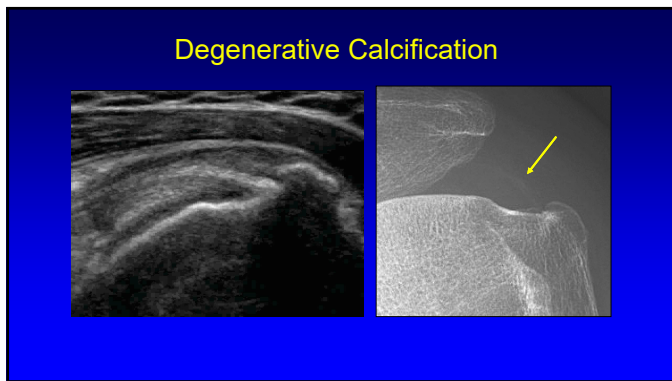
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- Outline:
- Anatomy
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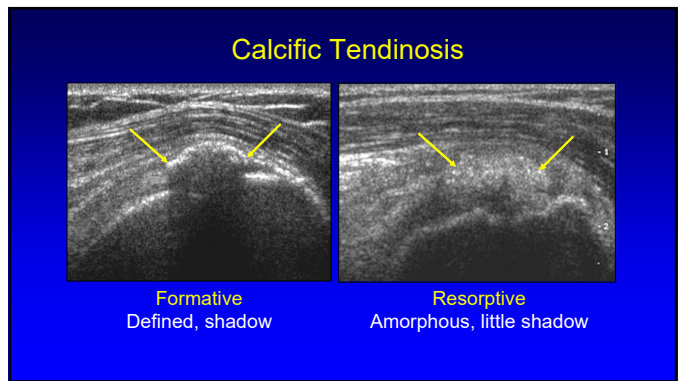
75

- Tendon Calcification:
- Degenerative: thin, linear deposit
 - Calcific tendinosis: metaplasia, hydroxyapatite
 - Formative: well-defined, dense shadow
 - Resorptive:
 - Globular, amorphous, variable shadow
 - Best success with aspiration
- Uthhoff. J Am Acad Ortho Surg 1997; 5:183

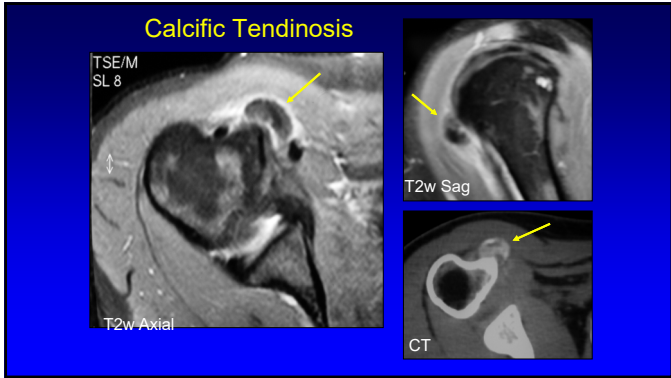
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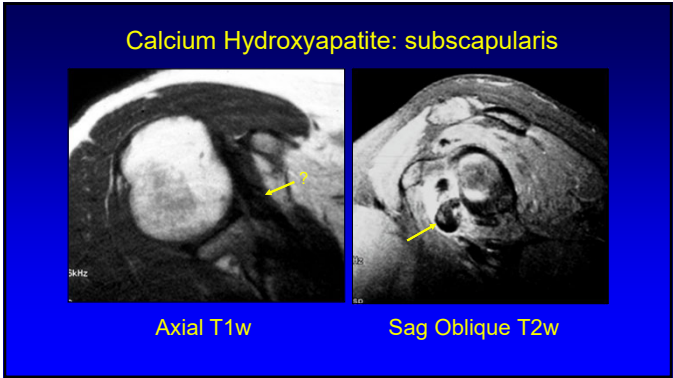
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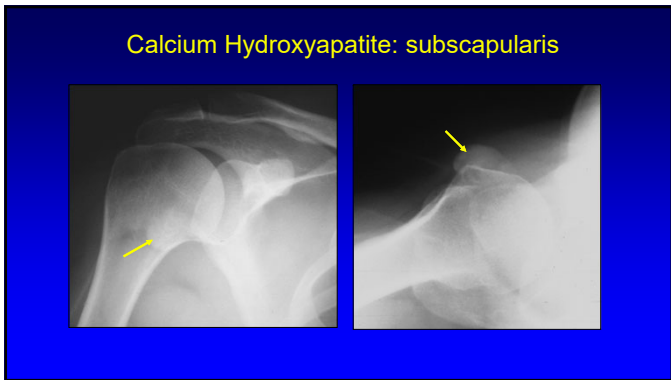
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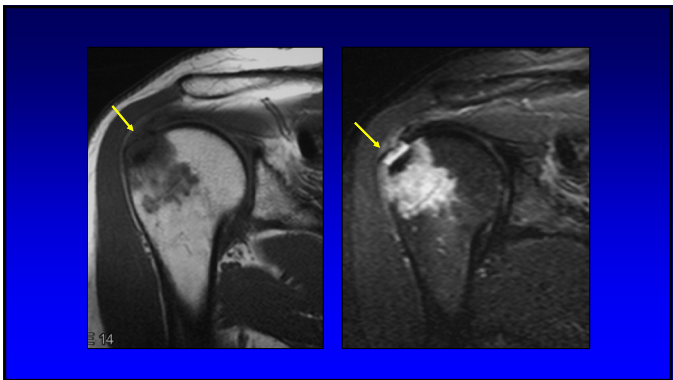
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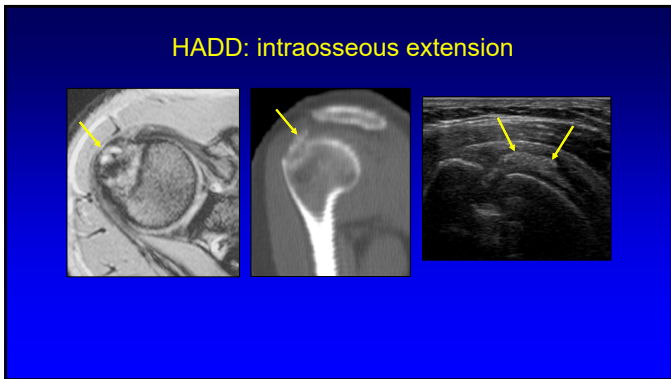
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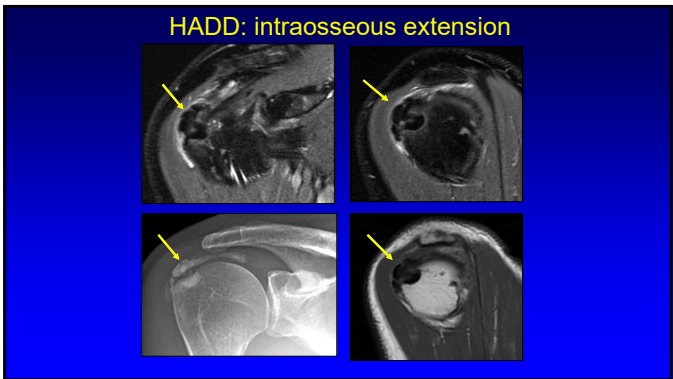
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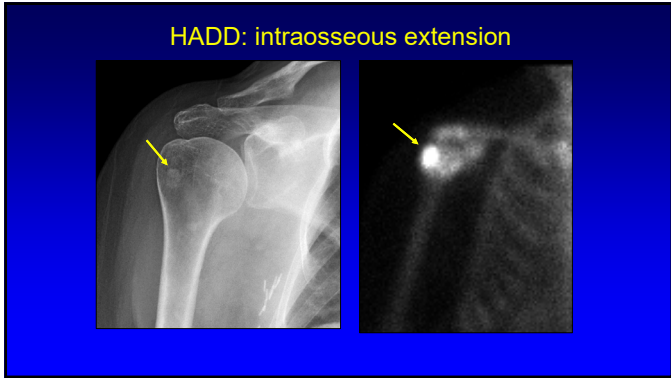
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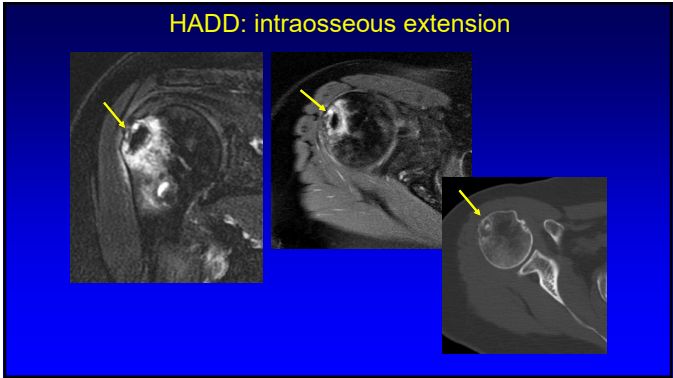
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- Take Home Points**
- Cuff tears:
 - Understand anatomy, facets, footprint
 - Standardize nomenclature for tears
 - Pitfall: shoulder rotation
 - Post-operative cuff:
 - Understand type of surgery
 - Call tear when obvious defect
 - Calcific tendinosis:
 - May be difficult to identify: radiographs
 - Intra-osseous extension

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Syllabus on line and other educational material:
www.jacobsonmskus.com
 Twitter handle: @jjacobsn

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