

Ultrasound Evaluation of Shoulder Pathology

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Disclosures

- Consultant: Bioclinica
- Book Royalties: Elsevier
- Contractor: POCUS PRO
- Advisory Board: Philips
- Not relevant to this talk

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Outline:

- Rotator cuff tears:
 - Primary and secondary signs
 - Pitfalls
- Miscellaneous pathology

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Rotator Cuff Tears:

- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography

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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 Tears

- Tears are hypoechoic / anechoic
- Indirect signs at ultrasound:
 - Cortical irregularity: supraspinatus footprint
 - If present on radiographs, 75% have tear
 - Volume loss
- Massive tear: non-visualization

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

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Rotator Cuff Tears:

- Patients < 40 years old
 - Not common
 - Partial, articular, anterior
 - Associated labral pathology
- Degenerative tears
 - Posterior aspect of supraspinatus
 - May extend anterior or posterior

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Supraspinatus: normal

Note: bone landmarks for orientation

Long Axis

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Supraspinatus Insertion

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

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Rotator Cuff Abnormalities:

Categories:

- Partial-thickness tear
 - Articular-sided
 - Bursal-sided
 - Intrasubstance (or interstitial)
- Full-thickness tear
- Tendinosis

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Supraspinatus Tears: extent

From: Fundamentals of Musculoskeletal Ultrasound

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Supraspinatus Tears: extent

From: Fundamentals of Musculoskeletal Ultrasound

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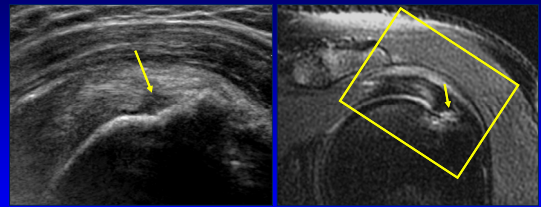
Partial-thickness Tear:

- Usually hypoechoic / anechoic
 - May see hyperechoic fiber stump*
- Articular, bursal, or intrasubstance
- Associated cortical irregularity
- Little if any tendon volume loss
 - Unless bursal location

van Holsbeeck et al. Radiology 1995; 197:443

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Articular Partial-thickness Tear: supraspinatus



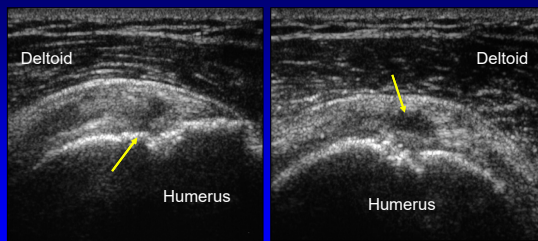
Long Axis

Note: US and MRI have inverted appearance

Coronal T2w

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Articular Partial-thickness Tear: supraspinatus



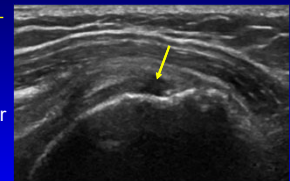
Long Axis

Short Axis

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Pitfall Alert! Anisotropy

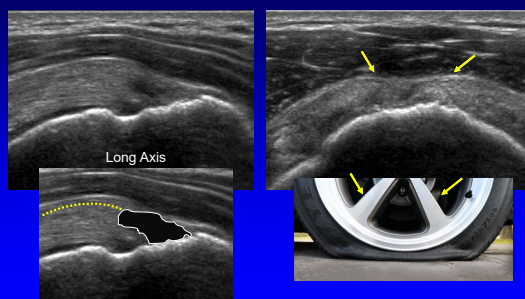
- Sound beam oblique to tendon fibers
- Artificially hypoechoic
- Most common location for this error: rim rent area



Supraspinatus: long axis

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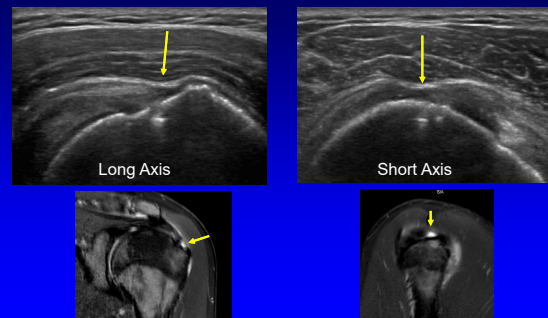
Bursal Partial-thickness Tear: supraspinatus



Long Axis

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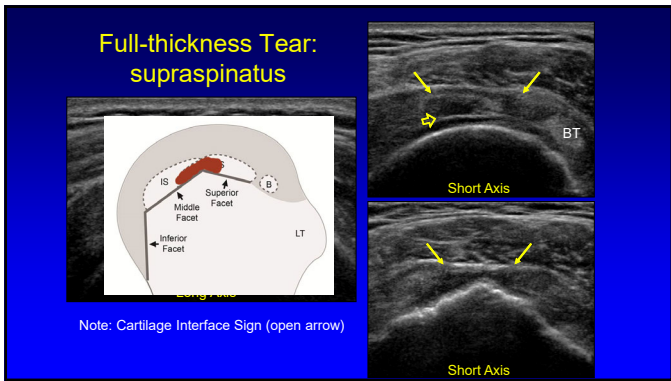
Bursal Partial-thickness Tear: supraspinatus



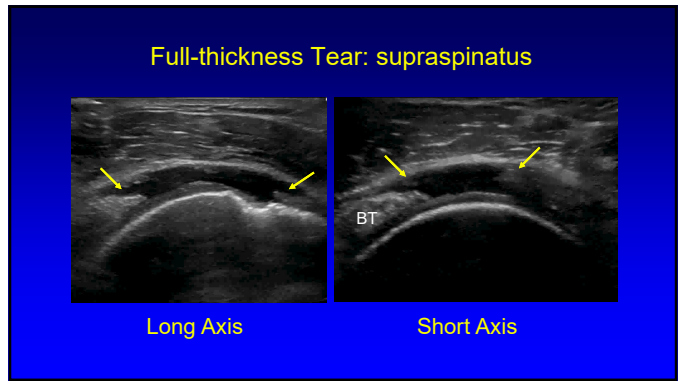
Long Axis

Short Axis

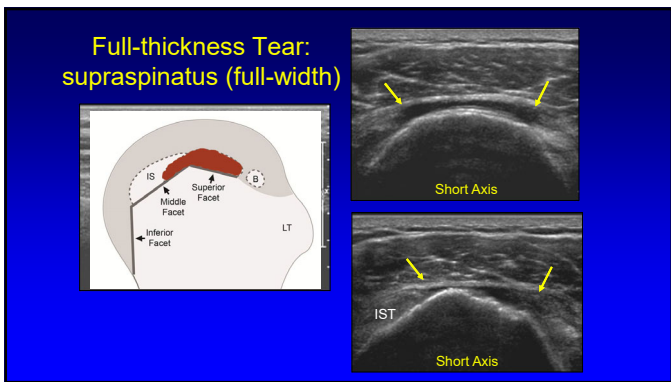
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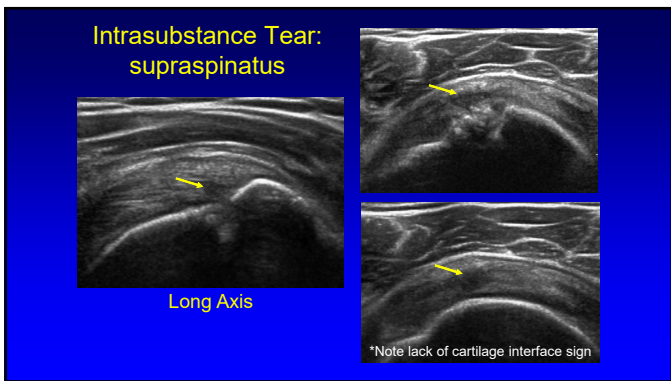
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- ### Intra-substance Tear:
- Hypoechoic or anechoic
 - Well defined
 - Does not extend to articular or bursal surface
 - Isolated greater tuberosity extension

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Tendinosis

- No inflammatory cells
 - Mucoïd degeneration, chondroid metaplasia
- Hypoechoic, ill-defined
- Possible increased thickness
- No cortical irregularity*

From: Hodler J, et al. J MRI; 2010; 32:165

*Radiology 2004; 230:234

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Tendon Tear versus Tendinosis

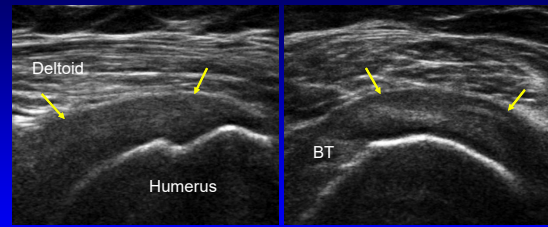
**both may appear hypoechoic*

- | | |
|-----------------------------|-------------------|
| <u>Tear</u> | <u>Tendinosis</u> |
| • Anechoic | • Hypoechoic |
| • Well-defined | • Ill-defined |
| • Homogeneous | • Heterogeneous |
| • Thinned | • Swollen |
| • Bone irregularity* | • Smooth cortex |

*At supraspinatus tendon footprint in patients over 40 years old

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Tendinosis: supraspinatus



Long Axis

Short Axis

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Fatty Infiltration and Muscle Atrophy

- Supraspinatus and infraspinatus
 - Infraspinatus: only variable to predict cuff healing¹
- Associations:
 - Chronic, large, anterior supraspinatus tears²
- Ultrasound:
 - Moderate to good correlation with MRI³
 - Improved reliability with extended field-of-view⁴

¹Chung et al. Am J Sports Med; 2013; 41:16764

²Hodler et al. Radiology 2005; 237:584.

³Khoury et al. AJR 2008; 190:1105.

⁴Nazarian et al. 2008; 190:27.

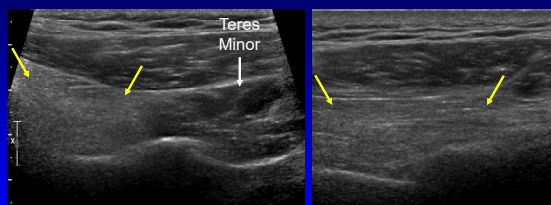
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Fatty Infiltration and Muscle Atrophy

- Indistinct tendon-muscle border
- Increased muscle echogenicity
 - Compare to teres minor
- Decreased muscle bulk
 - Compared to teres minor
 - Bone landmark: ridge in scapula
 - Short axis: infraspinatus 2x size

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Infraspinatus Atrophy

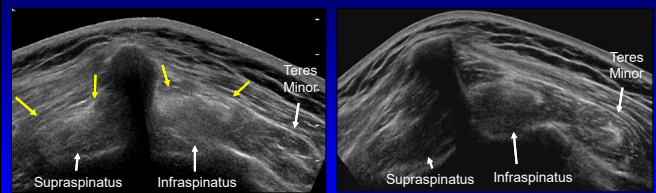


Short Axis

Long Axis

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Atrophy: supraspinatus and infraspinatus



Short Axis (extended field-of-view)

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Rotator Cuff Tears:

- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography

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Secondary Findings of Rotator Cuff Tears:

- Volume loss of tendon substance

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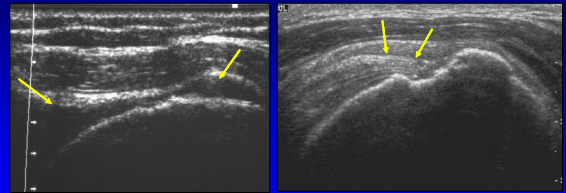
Tendon Volume Loss:

- Flat or concave outer margin of supraspinatus*
 - Deltoid muscle dips into tendon gap
- Full-thickness tears
- Bursal sided partial-thickness tears
- Not seen in tendinosis

*Hodler et al. Radiology 1988; 169:791

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Tendon Volume Loss

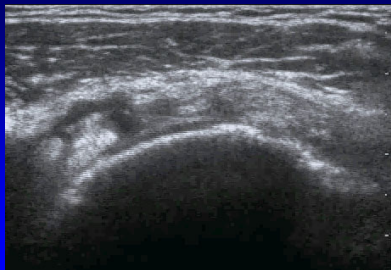


Full-thickness

Bursal Partial-thickness

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Full-thickness Tear: supraspinatus



Short Axis

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Secondary Findings of Rotator Cuff Tears:

- Volume loss of tendon substance
- Cortical irregularity

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Cortical Irregularity:

- Greater tuberosity: at **supraspinatus** insertion
- When present: 75% have rotator cuff tears
 - Patient over 40 years old
- When absent: 96% normal cuffs by sonography

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

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Tendon Tear: cortical irregularity

Full-thickness Tear Tendinosis

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Cortical Irregularity: no significance

Humerus

Long Axis Short Axis

Subscapularis Tendon

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Secondary Findings of Rotator Cuff Tears:

- Volume loss of tendon substance
- Cortical irregularity
- Effusion (articular & bursal)

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Joint & Bursal Effusions:

- Joint effusion (biceps tendon)
- Subacromial-subdeltoid bursal fluid: >1 mm distention
- If both: 95% positive predictive value for rotator cuff tear*

*Hollister et al. AJR 1995; 165:605

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Joint Effusion and Bursal Fluid

Deltoid

BT

Short Axis Long Axis

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Secondary Findings of Rotator Cuff Tears:

- Volume loss of tendon substance
- Cortical irregularity
- Effusion (articular & bursal)
- **Cartilage interface sign**

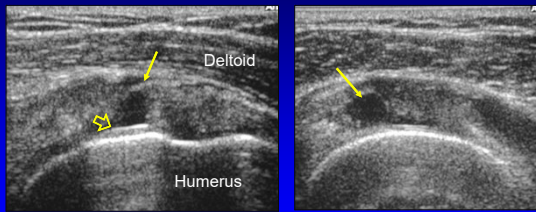
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Cartilage Interface Sign:

- Reflective interface between hypoechoic hyaline cartilage and adjacent fluid
- Indicates articular extension of tear
- Limited value

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Small Full-thickness Tear: supraspinatus



Long Axis

Short Axis

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Rotator Cuff Tears:

- General comments
- Secondary signs of rotator cuff tear
- **Pitfalls in rotator cuff sonography**

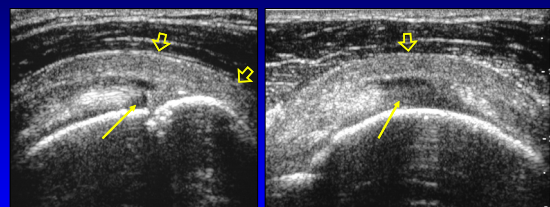
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Subacromial-subdeltoid Bursa:

- Hyperechoic synovium may appear similar to tendon fibers
- Hyperechoic thickness that extends beyond greater tuberosity is synovium and not cuff fibers

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Bursal Thickening Simulating Intact Cuff



Long Axis

Short Axis

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Miscellaneous Cuff Pathology:

- Infrapinatus tendon
- Subscapularis tendon
- Post-operative cuff
- Calcific tendinosis

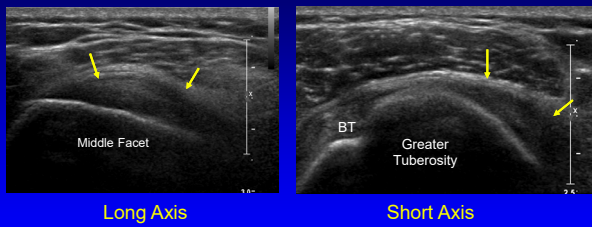
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Infrapinatus Tear:

- Isolated tear: rare, trauma
- Part of massive cuff tear:
 - If supraspinatus tear, look for extension
 - Tear extends over middle facet >1.3 cm from rotator interval on transverse image

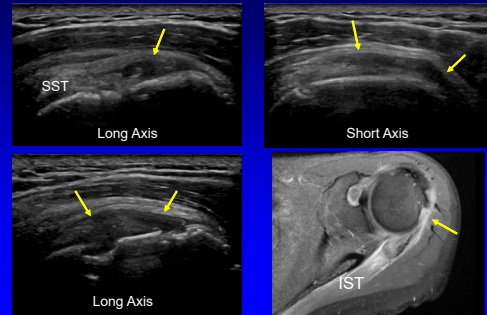
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Infrapinatus: tendinosis



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Infrapinatus Tear: full-thickness



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Miscellaneous Cuff Pathology:

- Infrapinatus tendon
- Subscapularis tendon
- Post-operative cuff
- Calcific tendinosis

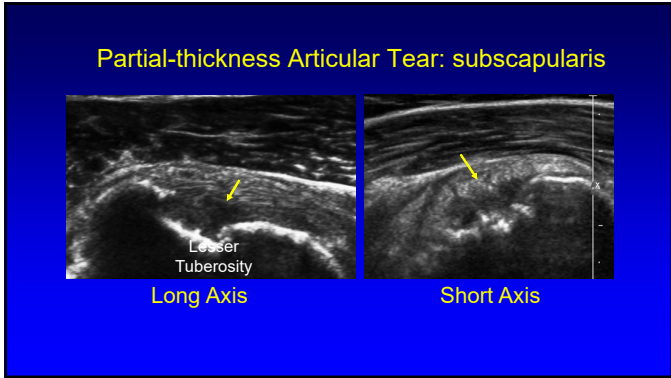
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Subscapularis Tear:

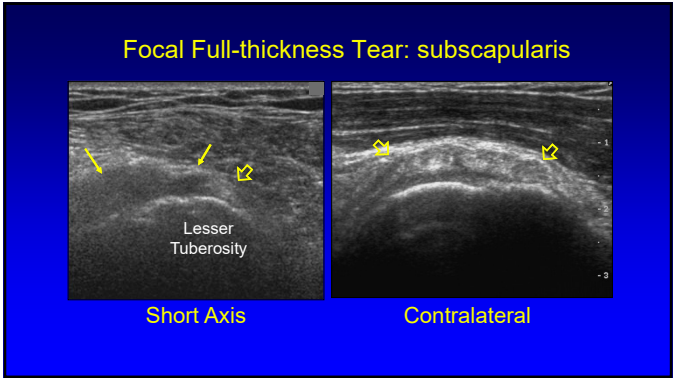
- Isolated tear: rare, trauma
- Part of massive cuff tear
- Anterosuperior cuff tear:
 - Supraspinatus and subscapularis borders of the rotator interval

Pfirrmann et al. Radiology 1999; 213:709

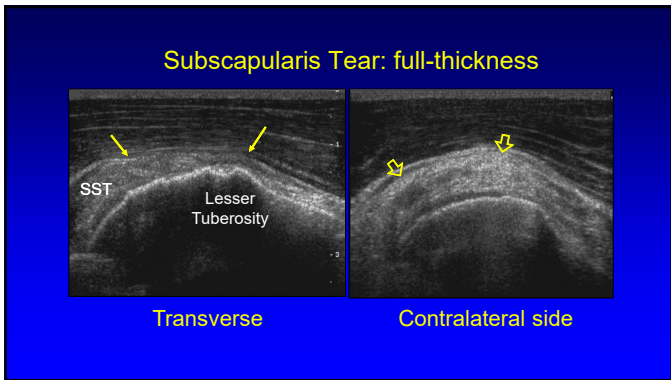
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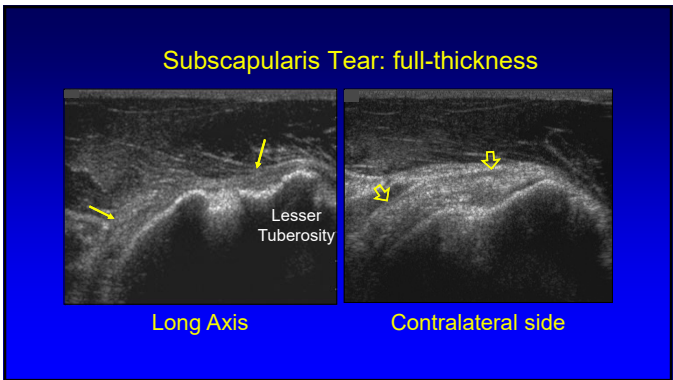
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Miscellaneous Cuff Pathology:

- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff
- Calcific tendinosis

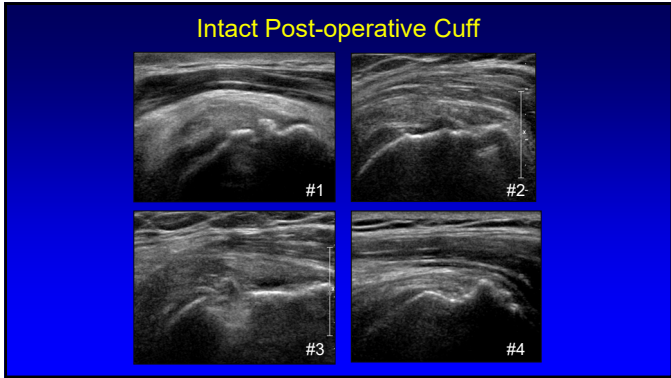
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Post-operative Rotator Cuff:

- Post-op tendon: echogenic & thin*
- Reimplantation trough
- Echogenic sutures & anchors

*Mack et al. AJR 1988; 150:1089

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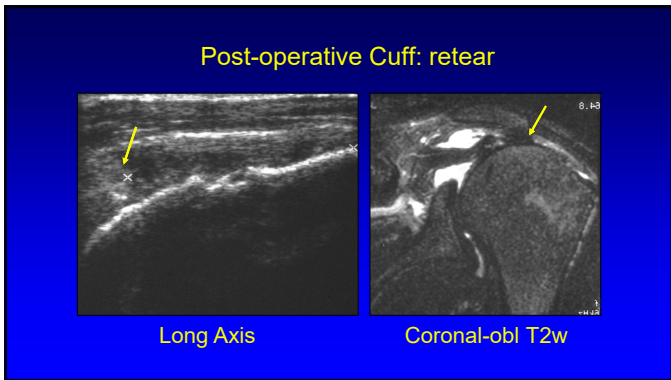


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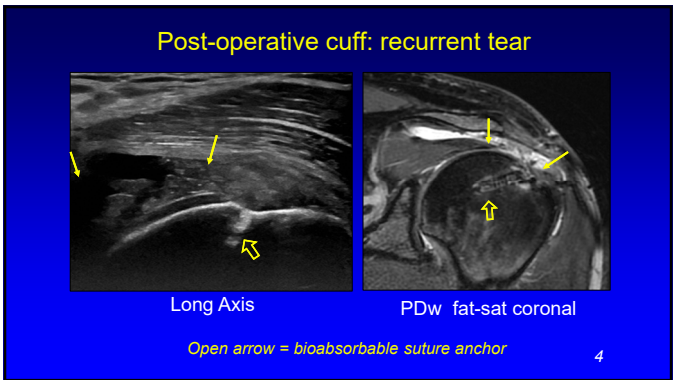
Post-operative Rotator Cuff:

- Recurrent tear: usually large with nonvisualization
- Focal hypoechoogenicity: equivocal

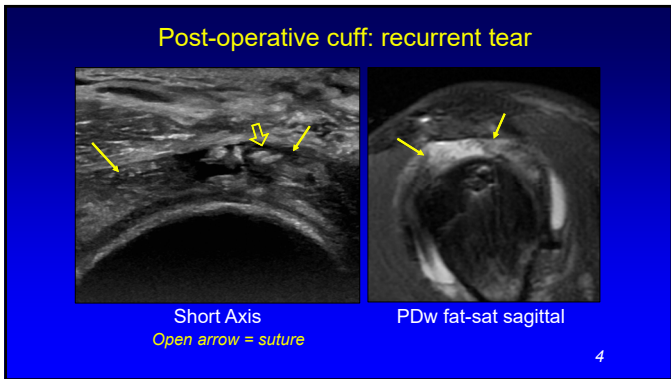
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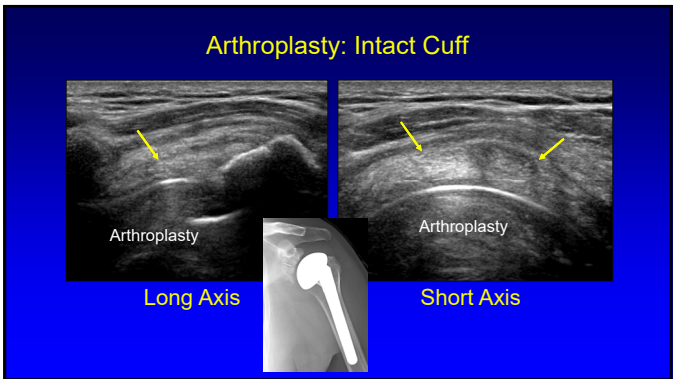
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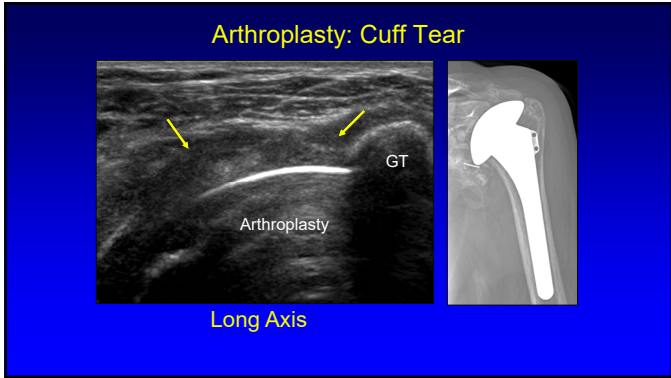
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Miscellaneous Cuff Pathology:

- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff
- Calcific tendinosis

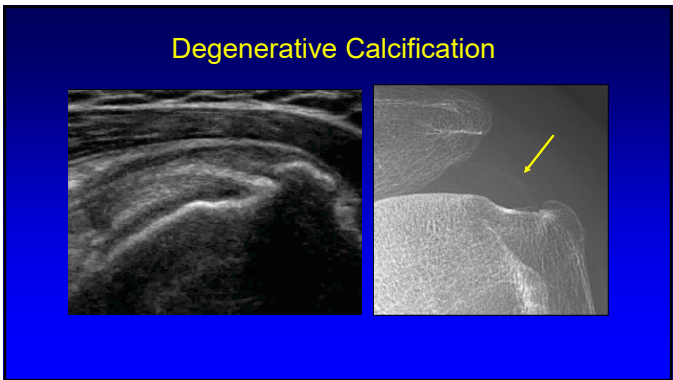
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Tendon Calcification:

- Degenerative: thin, linear deposit
- Calcific tendinosis: metaplasia
 - Formative: well-defined, dense shadow
 - Resorptive:
 - Globular, amorphous
 - Variable shadow
 - Best success with aspiration

Uhthoff. J Am Acad Ortho Surg 1997; 5:183

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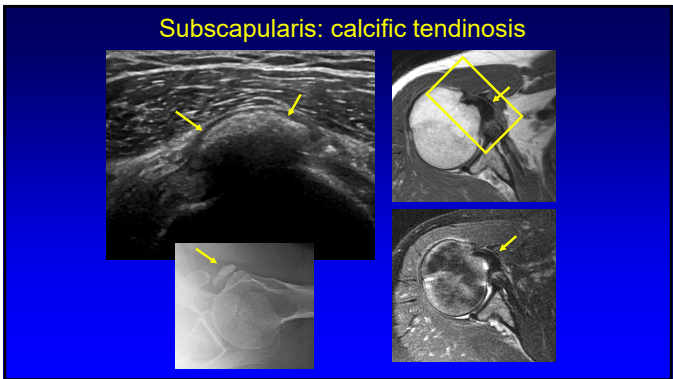
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Calcific Tendinosis

Formative
Defined, shadow

Resorptive
Amorphous, little shadow

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Miscellaneous Pathology:

- Biceps brachii tendon
- Subacromial-subdeltoid bursa
- Acromioclavicular joint

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Biceps Tendon:

- Glenohumeral joint effusion:
 - Collects around biceps tendon
 - Tendon sheath communication
 - Seen in 97% with joint effusion
 - Abnormal: > 1 mm¹

¹Zubler et al. Eur Radiol 2011; 21:1858

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Shoulder Joint Recesses

- Long head biceps tendon sheath
- Posterior recess:
 - Image with shoulder in external rotation
- Axillary recess
- Subscapularis recess

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Biceps Tendon Sheath

- Intra-articular body
 - Echogenic
 - Possible shadowing
 - Single or multiple
 - Associated with glenohumeral joint osteoarthritis

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Biceps Tendon:

- Tenosynovitis
 - Unlike joint effusion:
 - Focal distention
 - Hyperemia with color Doppler
 - Pain with transducer pressure
 - No effusion in posterior recess

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Biceps Tendon: tenosynovitis

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Biceps Tendon

- Tendinosis:
 - Hypoechoic
 - Swollen
 - No inflammatory cells (not tendinitis)
 - Possible tenosynovitis

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Biceps Tendon:

- Partial-thickness tear:
 - Hypoechoic /anechoic cleft
 - Tenosynovitis
 - Sensitivity: 27%
 - Accuracy: 88%
 - Subluxation / spur
 - Important secondary signs

Skendzel J, et al. AJR 2011; 197:942

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Aponeurotic Expansion of Supraspinatus Tendon

- Up to 49% of shoulders
- Cleft: coronal plane
- Origin: supraspinatus
- Distal: pectoralis or bicipital groove

Moser et al. Skeletal Rad 2015; 44:223

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Biceps Tendon: full-thickness tear

Short Axis Long Axis Short Axis: distal

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Pitfall Alert! Pseudo Biceps Tendon

- Biceps brachii long head
- Complete retracted tear
- Visible "fibers" in groove
 - Collapsed tendon sheath
 - Aponeurotic expansion of supraspinatus
- Look for distal retracted tendon and absent tendon in rotator interval

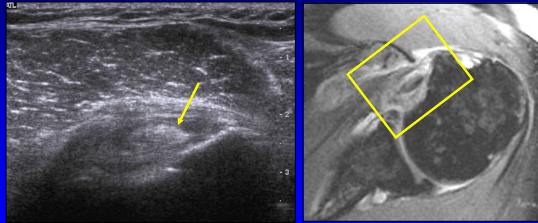
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Biceps Tendon

Subluxation Dislocation

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Biceps Tendon: Dislocation into subscapularis tendon



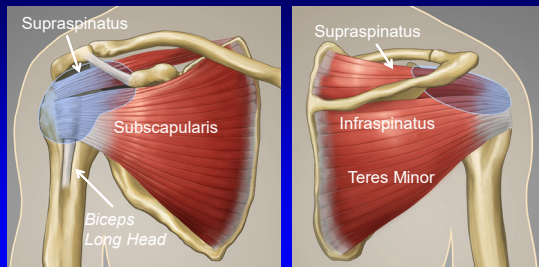
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Miscellaneous Pathology:

- Biceps brachii tendon
- Subacromial-subdeltoid bursa
- Acromioclavicular joint

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Subacromial-subdeltoid Bursa



Note: Subacromial-subdeltoid Bursa (light blue)

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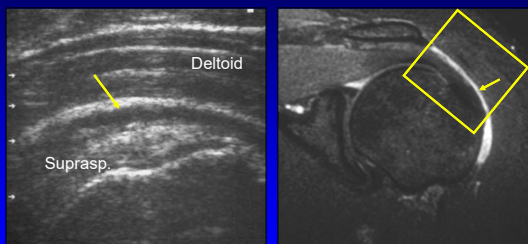
Subacromial-subdeltoid Bursa:

- Normal:
 - Thin hypoechoic layer: fluid, synovium
 - Hyperechoic: bursal walls and peribursal fat
- Abnormal: >1 mm thick*
 - Fluid: anechoic
 - Synovial tissue: hypoechoic to hyperechoic

*Invest Radiol 1985;20:311

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Subacromial-subdeltoid Bursa: fluid

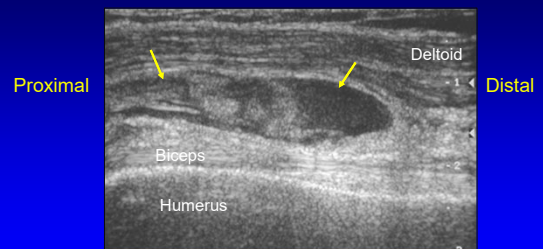


Coronal

Coronal T2w

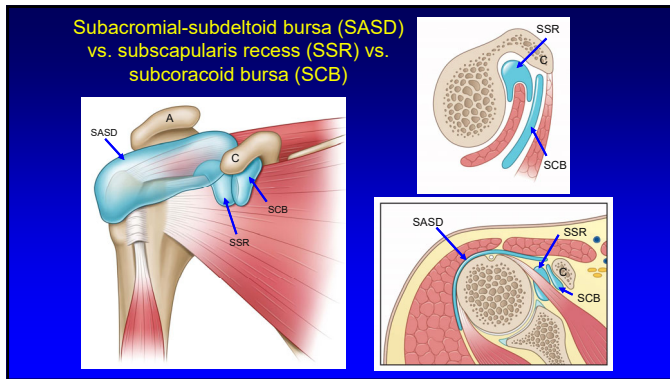
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Subacromial-subdeltoid bursa: anterior

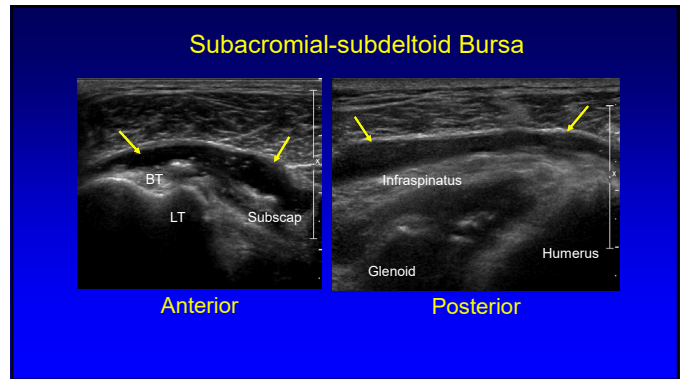


Sagittal

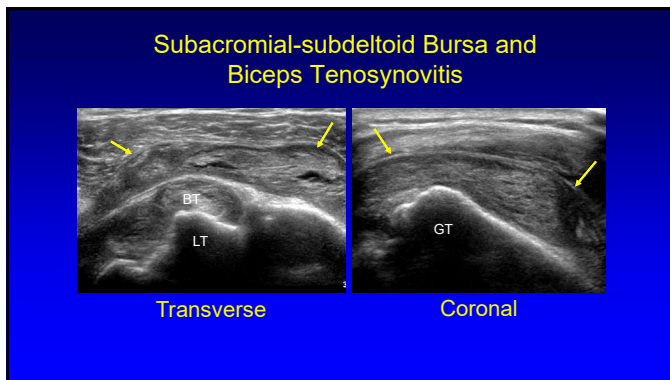
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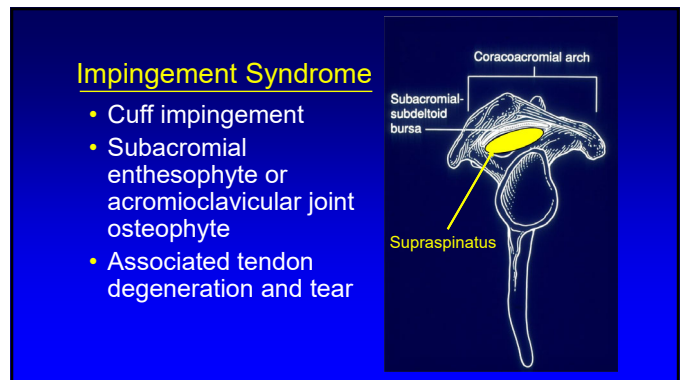
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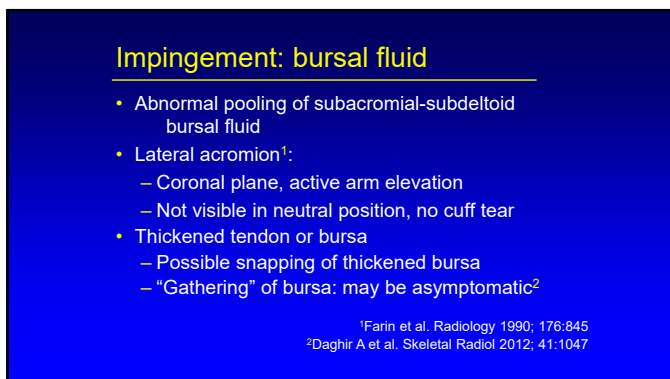
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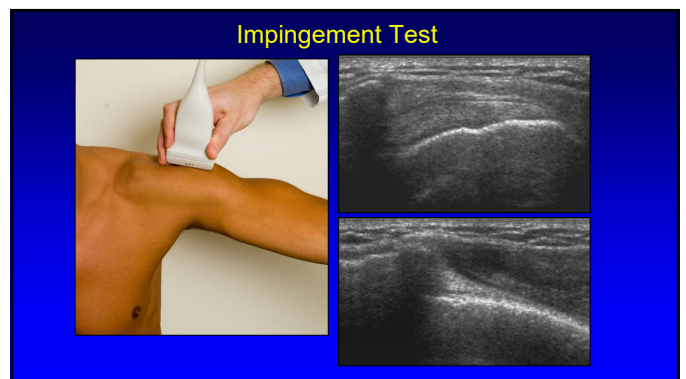
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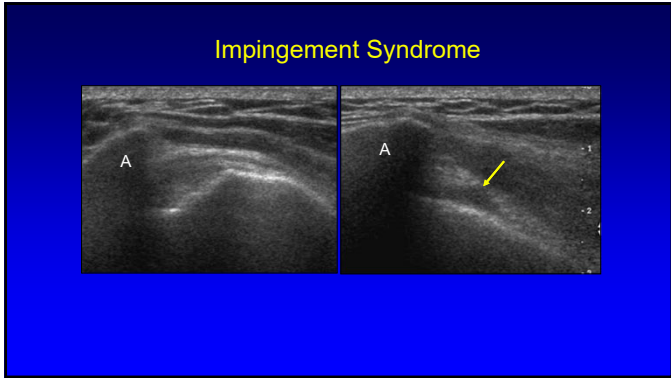
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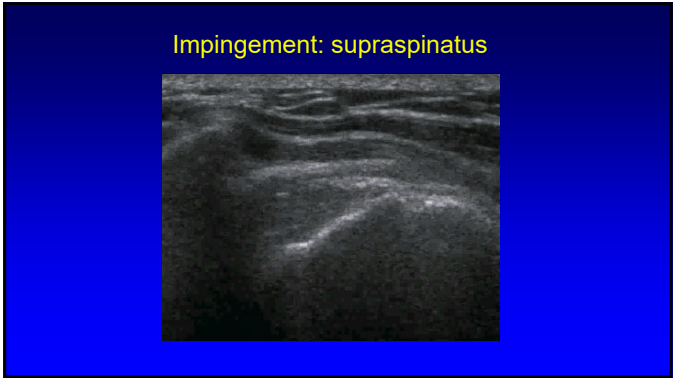
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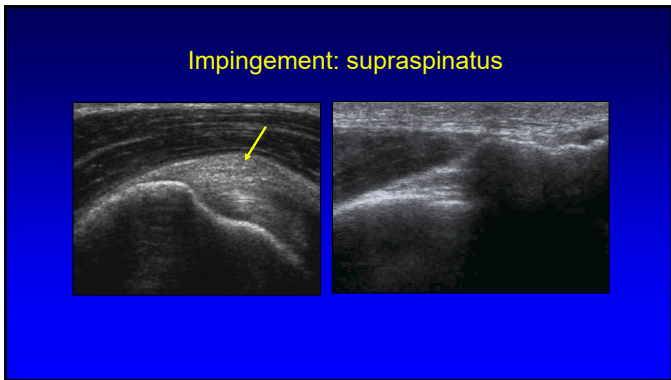
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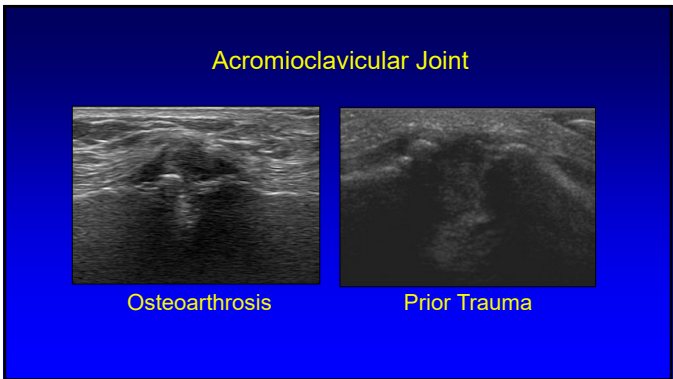
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- ### Miscellaneous Pathology:
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- Biceps brachii tendon
 - Subacromial-subdeltoid bursa
 - Acromioclavicular joint

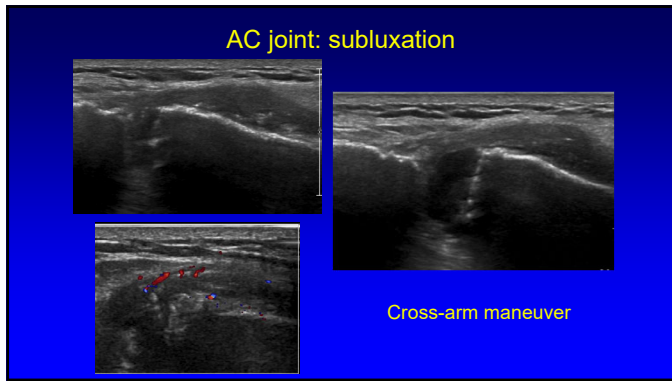
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- ### Acromioclavicular Joint:
-
- Osteoarthritis: common by age 40
 - Thick capsule > 2 mm
 - Narrow, irregular, osteophytes
 - Trauma:
 - Wide, possible subluxation
 - Thick capsule >2 mm
 - Cyst versus geyser sign
 - Geyser: joint fluid tracking through ACJ via full-thickness rotator cuff tear

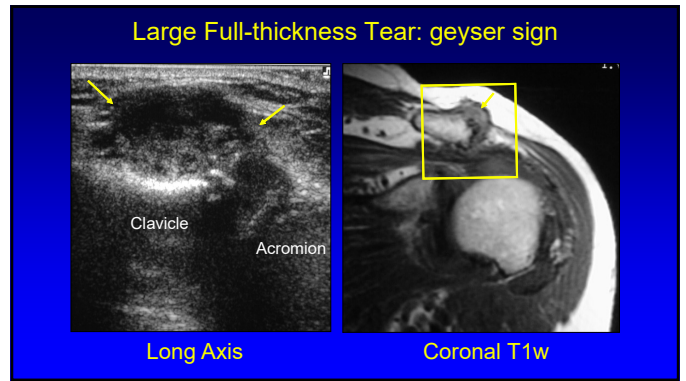
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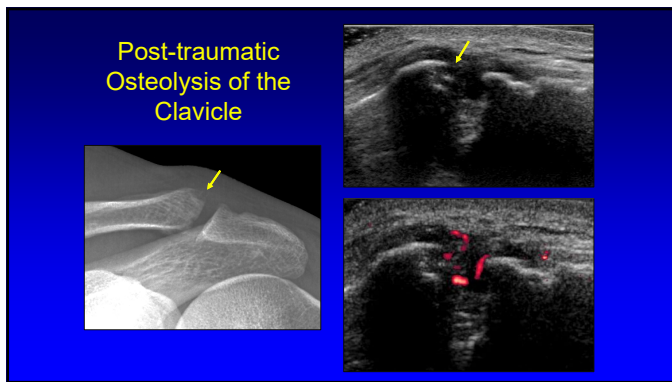
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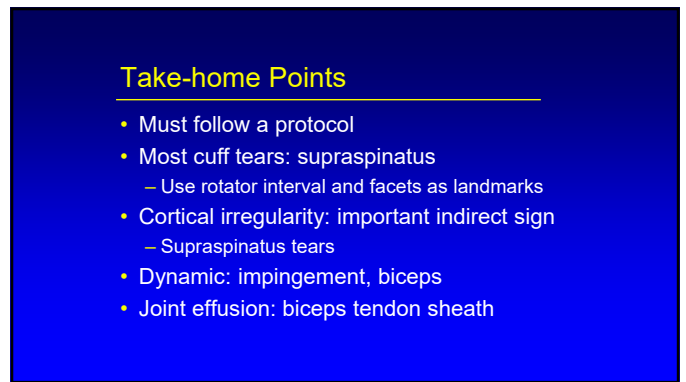
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