ULTRASOUND GUIDED INJECTION PROCEDURES OF THE SHOULDER

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• Jerod Cottrill, DO
• Alfred Gellhorn, MD
• . . . . My third grade teacher
DISCLOSURES

Consultant Philips Ultrasound
INDICATIONS – WHY USE US GUIDANCE?

• Improve **Accuracy** with
  • Deep target
  • Difficult to ID target
  • Avoid adjacent structures (fat pad, Aorta)
  • Diagnostic injection
  • Injectant localization – (eg. Synvisc, PRP)

• Improve **Efficacy**
  • Failed unguided procedures
  • Body habitus – poor landmarks
  • Higher risk
    • Neurovascular
    • Anti-coagulation

• Avoid radiation
SHOULDER USG INJECTION DATA REVIEW
WHY IS THIS CRITICAL REVIEW IMPORTANT?

1. Shoulder US is one of the more common USG procedures
2. USG procedures are proliferating & overutilization has lead to increased costs and scrutiny
3. With cost containment as a consideration we need to continually assess efficacy and medical necessity of interventions
4. Whereas we have some supportive data on accuracy, we lack substantive data on the efficacy of US guided procedures

Dramatically Increased MSK US Use in 2000-2009

Sharpe et al. 2012
RVU CHANGES FOR 2014

- 76942
  - Global fee drop from $208.56 to $73.78
  - RVU drops from 5.16 to 1.11
- The new practice expense is based on a cheaper portable US unit and 10 minutes of intra-service time
# WHY US GUIDANCE – ACCURACY

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>US</th>
<th>Palpation</th>
<th>Fluoro</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH joint</td>
<td>95%(^1)</td>
<td>79-83%(^{1,3})</td>
<td></td>
</tr>
<tr>
<td>SA-SD bursa</td>
<td>100%(^1)</td>
<td>63%(^1)</td>
<td>60%(^2)</td>
</tr>
<tr>
<td>LHB Sheath</td>
<td>100%(^4)</td>
<td>66.6%(^4)</td>
<td></td>
</tr>
<tr>
<td>GH Jt 1(^{st}) try</td>
<td>94%(^5)</td>
<td></td>
<td>72%(^5)</td>
</tr>
</tbody>
</table>

### WHY US GUIDANCE - Efficacy

<table>
<thead>
<tr>
<th>Efficacy</th>
<th>US</th>
<th>Palpation</th>
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</thead>
<tbody>
<tr>
<td>SA-SD Bursa¹</td>
<td>VAS decr 4; ROM incr</td>
<td>VAS decr 2</td>
</tr>
<tr>
<td>SA-SD Bursa²</td>
<td>VAS decr 34.9; SFA incr 15</td>
<td>VAS decr 7.1; SFA incr 5.6</td>
</tr>
<tr>
<td>SA-SD Bursa⁴</td>
<td>Good response 81%</td>
<td>Good response 54%</td>
</tr>
<tr>
<td>SA-SD Bursa⁵</td>
<td>Sign incr abd ROM</td>
<td>No change in ROM</td>
</tr>
<tr>
<td>SA-SD/GH Jt³</td>
<td>4 x greater</td>
<td></td>
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OUTCOME REVIEW – USG INJECTIONS  

Sage et al - 2013

OUTCOME

1. PAIN - Statistically significant difference in favor of USG for pain at 6 weeks
   - 3 studies (Naredo, Ucuncu, Panditaratne)
   - USG > LMG (SMD 1.03, 95% Conf interval)
   - 2 studies (discounted) said no stat significant difference at 6 weeks (Lee, Zufferey)

2. FUNCTION - No statistically significant difference between the injection methods with respect to shoulder function
   - Shoulder Function (SFA)
   - 2 studies (Lavelle, Naredo)

3. ROM - Significant difference between interventions for shoulder abduction at 6 weeks in favor of USG
   - 2 studies (Lee, Ucuncu) – statistical significance of 2 degrees
   - No significant difference all other ROM assessments

DESIGN
- Systematic Review and Meta-analysis
- Qualitative and Quantitative study

METHODS
- Literature search 1950-2011, included if randomized or non-randomized control
- Comparing ultrasound-guided (USG) to landmark-guided (LMG)
- Meta-analysis performed when possible
- 6 out of a possible 304 studies were formally reviewed
- 3 studies used for pain score, 2 studies were used for function
DESIGN
– Randomized comparative study

METHODS
– N = 41 consecutive patients with shoulder pain
– Blind subacromial glucocorticoid vs USG glucocorticoid
– Reviewed 6 weeks postinjection
– Compared VAS and SFA scores from baseline to 6 wks post-injxn

US Dx included:
• Fluid BT sheath
• BT partial tear
• RC tendinosis
• RC partial thickness tear
• RC full-thickness tear
• RC calcification
• Increased fluid, SA-SD bursa
• RC impingement
• Degenerative changes AC joint

Response to therapy – Changes to VAS and SFA

USG (20)
• SA-SD, LHB sheath was target of injxn when fluid present in either. If both, SA-SD was the target
• Peri and intralesional injxn for RTC calcifications
• Perilesional SA-SD for tendon lesions without fluid
  – 14 pts to SA-SD bursa
  – 3 pts LHB sheath
  – 4 pts RTC calcification
CONCLUSION  Sage et al

1. **YES** - Statistical difference in favor of USG for **pain** at 6 weeks

2. **NO** - No statistical difference between USG and LMG in terms of **function**

3. **YES** – Statistical difference in **ROM** between USG and LMG

4. These differences are small and may not be **clinically useful differences**
META-ANALYSIS STRENGTHS & WEAKNESSES
Sage et al

**STRENGTHS**

- What it Evaluated
  - USG vs LMG
- Broad thorough look at the literature
- Thoughtful analysis with narrative discussion
- Focus on the shoulder

**WEAKNESSES**

- Relied largely on 2 randomized, controlled studies
- Short f/u – 6 weeks
- Did not look at the skill level of those injecting
- No participant blinding
- Sample size low - ranged from 40-65
- Considerable variation in Methodological quality
REVIEW CONSIDERATIONS  Sage et al

1. Are the Outcomes clinically relevant?
   - Concept of statistically significant vs clinically significant
     - Improved pain relief within 6 weeks is clinically relevant to me
     - 2 degrees of difference in ABD ROM is not

2. Is the difference because of improved accuracy?
   - Outcomes based evidence is mixed Rutten, Kang, and Cunnington vs Eustace

3. Are CSI’s a flawed gold standard intervention
   - Outcomes based evidence is mixed Green vs Arroll and Goodyear-Smith
   - Two systematic reviews (LE, Shoulder/elbow) – effective relief of pain within 8 weeks Krogh, Gayoux-Viala

4. Should shoulder pathology be bundled – IMPINGEMENT?
WHAT IS THE ROLE OF US FOR THE SHOULDER?

DX/tx vs dx/TX

DX/tx

• To discriminate pathology: NOT JUST IMPINGEMENT
• Identify, stratify, and develop a plan for f/u or intervention – based on individual natural history
• What is the pain generator and can we select specific pathology with our improved accuracy?
• Is there a role for Lidocaine/Bupivicaine as as “diagnostic injection”?

dx/TX

• To achieve improvement in pain, ROM, Rtn to Play
OTHER USG UTILIZATION CONSIDERATIONS
PRACTICAL CONSIDERATIONS

- Do we inject or not?
  - If so, what do we inject?
- What conditions might you use it for?
- When do you use it?
  - Accuracy/Efficacy
DO WE INJECT OR NOT
IF SO, WHAT DO WE INJECT?

Therapy
- PT vs Wait and See vs CSI
  PT is better at 52 weeks = 91%, Smidt 2002

Injectants

**Glucocorticoid**
- Early relief (under 6 weeks) vs potential long term deleterious effects and recurrence

**PRP**
- PRP > CSI at 104 weeks

**Something else**
- ABG, BOTOX, Hyaluronic Acid, Needling, Polidoconal, GAGs, Prolotherapy, Placebo

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<thead>
<tr>
<th></th>
<th>CSI</th>
<th>PT</th>
<th>W&amp;S</th>
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<tbody>
<tr>
<td>6 weeks</td>
<td>92%</td>
<td>47%</td>
<td>32%</td>
</tr>
<tr>
<td>52 weeks</td>
<td>65%</td>
<td>91%</td>
<td>83%</td>
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Smidt, 2002
WITH WHAT CONDITIONS MIGHT YOU USE US GUIDANCE IN THE SHOULDER?

<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>OA</td>
</tr>
<tr>
<td>Adhesive Capsulitis</td>
</tr>
<tr>
<td>Subacromial bursitis</td>
</tr>
<tr>
<td>Spinoglenoid notch cyst aspiration</td>
</tr>
<tr>
<td>Cuff Tendinopathy</td>
</tr>
<tr>
<td>Inflammatory Arthritis</td>
</tr>
<tr>
<td>LHB tenosynovitis</td>
</tr>
<tr>
<td>Edx – supraspinatus, teres minor, rhomboids –</td>
</tr>
<tr>
<td>brachial plexus eval</td>
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</table>
**DESIGN**
- Observational Study

**METHODS**
- 4 Rheum depts. – 8 experienced rheumatologists (2 at each location one MSUS one traditional)
- First visit for 86% and 89% respectively
- MSUS n= 104, traditional n = 64
- Consecutive patients 18yo or older with nontraumatic shoulder and hand complaints
- Primary shoulder pain in both groups
- Patients referred specifically for Dx US were excluded

**OUTCOMES**
- MSUS dx and therapeutic change in 53 (52%) and 55 (54%) respectively
- Local injxn rate 47% in the MSUS group (73% unexpected, 61% performed using US) compared with 21% in the traditional group
- MSUS useful in 72 cases (71%) and extremely useful in 20 cases 20%
- Physician satisfaction was higher (p<0.001)
- MSUS required fewer additional tests 38% vs 81% respectively, fewer medical visits 46% vs 84% and lower direct costs (11 vs 30 euros) than the traditional care group.
CONCLUSION Naranjo et al, 2012

When compared with Traditional Care, the routine use of MSUS can lead to improvements in care with reduced diagnostic uncertainty, improved treatment and follow-up related decisions and reduced utilization of health care resources.
1. Practical discussion of how MSUS can have an impact on your practice if your practice is similar:
   - Diagnostic clarity
   - Time 12 minutes

2. Use of health resources
   - More visits in the traditional group
   - Less imaging and lab tests
   - Resultant cost savings of 50%

3. Increased injxn rate – (almost 2x) 47% in MSUS group (73% unexpected) 25% in the traditional group

4. Reported doctor satisfaction – consider patient satisfaction in future studies

Review Considerations Naranjo et al, 2012
PLANNING CONSIDERATIONS

- Time
  - F/U appointment vs Bundled
  - Lavage and aspiration calcific tendinopathy – 45min
  - AC joint – 5-10 min
- Cost
  - USG vs Fluoro
  - Whether or not PRP, autologous blood
- Documentation
  - To AIUM standards
PLANNING THE PROCEDURE

- Takes the most time
- Ergonomics – you and patient
- Pre-scan
  - Imagine the approach and annotate it
  - Identify neurovascular structures - doppler
  - Anticipate needle placement, angle of approach and length
  - Choose Transducer – for target and needle visualization
- Save critical pre-procedure images
  - Approach and neurovascular structures
- Save image with needle position and postinjection if applicable
  - Injectant around nerve or within the tendon sheath
**UNIQUE US CONTRAINDICATIONS**

<table>
<thead>
<tr>
<th>Prohibitive limitations</th>
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<tbody>
<tr>
<td>Skills</td>
</tr>
<tr>
<td>Equipment (visualization)</td>
</tr>
<tr>
<td>Technique</td>
</tr>
</tbody>
</table>

- General procedural contraindications
- Unexpected - masses
USG SHOULDER PROCEDURES
Joint space
GH joint, LHB tendon sheath, Axillary & Subscap recess
GLENOHUMERAL JNT POSTERIOR

- Patient position
  - Side-lying on uninjured shoulder
  - Patient facing the physician
  - Arm at the patient’s side in a neutral rotation
- Transducer position (Consider curvilinear – lower frequency 1-5MHz)
  - Anatomic transverse oblique plane (same plane as infraspinatus muscle) over the infraspinatus and posterior glenohumeral joint
  - Just below and along axis of the spine of the scapula
- Needle Orientation relative to the transducer
  - Long-axis/longitudinal/in-plane
- Needle Approach
  - Superolateral to inferomedial
- Target
  - Posterior glenohumeral joint between the glenoid labrum and the humeral head
  - You are in when you are deep to IST
- Injectant – approx 5 cc of anesthetic and 1-2 cortisone
- Pearls/Pitfalls
GH INXN - POSTERIOR

- Advance needle lateral to medial
- Target between IST insertion and labrum
GH INJXN - ANTERIOR

- Advance lateral to medial
- Target between subscap insertion and labrum
AC JOINT RELEVANT ANATOMY

- Sweep anterior to posterior
- May see the RTC deep
- Nml = smooth margins
- Widest anteriorly
- Articular disc and capsule
  - Hyperechoic fibrocartilage
- < 3mm capsular distention

CT axial cut

Superior AC lig
Articular disk

clav
acrom

Hieers, 2007

Coronal plane

Chi, Acr
AC JOINT INJECTION

- **Patient position**
  - Seated or supine
  - Arm at patient’s side in neutral rotation
- **Transducer position**
  - Anatomic coronal oblique plane (same plane as clavicle) over the anterior aspect of the AC joint
- **Needle Orientation Relative to the Transducer**
  - Short-axis/transverse/out-of-plane
- **Needle Approach**
  - Anterior to posterior
  - Use walk-down technique if out of plane
- **Target**
  - Anterior AC joint
- **Pearl/Pitfalls**
  - Joint anatomy
AC JOINT INJXN
ALTERNATIVE APPROACHES

Site localization w/ US

Anterior long axis in-plane
US GUIDED AC JOINT INJXN

In plane - Coronal

Out of Plane - Coronal

RT AC JT INJ
SA/SD BURSA
RELEVANT ANATOMY

sonoanatomy

bursography

MRI
SUBACROMIAL-SUBDELTOID BURSA INJECTION

- Patient position
  - Side-lying on uninjured shoulder
  - Arm at patient’s side in neutral rotation
- Transducer position
  - Scapular plane
  - Over the mid-portion of the supraspinatus tendon
  - Should be able to see lateral edge of the acromion
- Needle Orientation relative to the Transducer
  - Long-axis/longitudinal/in-plane
  - 25 gauge
- Needle Approach
  - Lateral to medial
- Target
  - SA-SD bursa, which is located in the tissue plane between the deltoid muscle (Superficial) and the rotator cuff (deep)
  - Typically visualized as a hypo/anechoic line (ie: the bursa) inside of a hyperechoic line that is 2 mm thick (ie: the peribursal fat)
- Injectant – 2-4 cc
SA/SD USG INJECTION
LHB RELEVANT ANATOMY

Ascending Ant humeral circumflex artery

Prox at RTC interval

Just distal at THL
**LHB TENDON SHEATH INJXN**

- **Patient position**
  - Supine
  - Arm at patient’s side in neutral rotation

- **Transducer position**
  - Anatomic transverse plane
  - Over the anterior humerus at the level of the inter-tubercular groove

- **Needle Orientation Relative to the Transducer**
  - Long-axis/longitudinal/in-plane

- **Needle Approach**
  - Lateral to medial

- **Target**
  - Bicipital tendon sheath
  - May place needle deep and/or superficial to the bicipital tendon
  - Observe for the injectate filling the tendon sheath, creating a “target sign” of medication around the tendon

- **Pearls/Pitfalls**
  - Identify and avoid the ascending branch of the anterior humeral circumflex artery which typically lies lateral to the bicipital tendon
LHB TENDON SHEATH INJECTION

Post injxn fluid in sheath

lax

distal
RTC CALCIFIC TENDINOSIS
Calcium Hydroxyapatite deposition in rotator cuff tendons and/or subacromial-subdeltoid bursa

Material deposited is a crystalline calcium phosphate of varying composition

Distinct entity from enthesopathic calcification or ossification at tendon footprint

Supra>Infra>Subscapularis

Multiple classification systems have been proposed (Gartner, DePalma, Patte, Mole)

Very poor inter-observer variability in using these systems

Little clinical utility

Can be incidental finding

Echogenicity based on phase

Mass effect

Inflammatory
US EVALUATION - CALCIFIC TENDONITIS OF RTC

- 96 patients (20 painless, 19 mild, 20 moderate)
  - Arc-shaped, fragmented or punctate, nodular, and cystic
  - Moderate to severe pain, acute onset = resorptive phase
  - Color doppler could differentiate the formative and resorptive phases
- About 50% have pain
- Histologic classification: (McKendry, J Rheumatol 1982)
  - Precalcific, calcific, resorptive, and repair phases
- Radiographic classification: (Depalma and Kruper, Clin Orthop 1961)
  - Type 1 fluffy and amorphous usually associated with acute symptoms
  - Type 2 defined and homogenous usually associated with chronic symptoms
- Calcific
  - Formative – arc or fragmented/punctuated – mild pain
  - Resting phase – nodular – moderate to severe
  - Resorptive phase – cystic – severe pain

BILATERAL CALCIFIC TENDINOPATHY

Left symptomatic

- Punctate/Nodular
- Without shadow

Right asymptomatic

- Arc Shaped
- With Shadow

Lax
CALCIFIC TENDINOPATHY
VARIED APPEARANCES

- Fluffy and amorphous
- Cystic
- Mechanical impingement
TREATMENT OPTIONS
CALCIFIC RTC TENDINOPATHY

- Conservative – PT, NSAIDs, moist heat
- Extracorporeal Shock Wave Therapy
- Percutaneous lavage/aspiration of Calcium
- Surgical resection of calcific focus
LITERATURE SUPPORTING LAVAGE ASPIRATION

- Yoo J Shoulder Elbow Surg 2010
  - 35 patients – 71% with clinical improvement at 6 months f/u
  - ** the greater the reduction in size of calcificatins at f/u correlated with better clinical outcomes
- Del Cura Am J Roentgenol 2007
  - 67 patients – 91% showed substantial or complete clinical improvement at 1 year f/u
  - 89% showed complete or near =-complete calcium reduction
- Serafini Radiology 2009
  - 219 patients treated with 68 untreated control patients
  - 2 needle technique was utilized for all procedures
  - Substantial clinical improvement (constant and VAS scores) in treated pts compared to controls at f/u 1M, 3M, and 1 year
- Bas de Witte Am J Sports Med 2013
  - 48 patients – USG lavage + bursal injxn vs Bursal injxn alone
  - Both groups showed clinical improvement, but significantly better clinical and radiographic (decr size of calcification) improvement in the combined group
SUMMARY FOR USG LAVAGE STUDIES

- Many studies with 60-90% 1 year success rate good to excellent clinical response to the procedure
- Few complications
- RCT limited
LAVAGE AND ASPIRATION OF ROTATOR CUFF CALCIFIC TENDINOPATHY

- Patient position – dependent on calcification location
  - Supine or sidelying with painful extremity up
  - Consider supine for subscapularis
  - Arm at patient’s side in neutral rotation
  - Can be lengthy – patient and physician comfort critical

- Transducer position
  - Longitudinal relative to the involved tendon
  - Over the calcific deposit

- Needle Orientation Relative to the Transducer
  - Long-axis/longitudinal/in-plane

- Needle Approach
  - Lateral to medial

- Target
  - Advance the needle into the calcific deposit
  - Perform pulsed lavage of the calcified deposit using normal saline
  - Continue pulsed lavage until no more calcified particles return into the syringe

- Pearls/Pitfalls
  - Use large gauge (16 – 18 gauge) needle
  - Use 12 cc syringes with approximately 6-10cc of sterile saline with or without 1% lidocaine for the pulsed lavage
RTC CALCIFIC TENDINOPATHY ASPIRATION/LAVAGE

53yo PT
4 yrs shldr pain

Step 1 – interrogate and anesthetize
Step 2 – large needle center of mass
Step 3 – aspirate and lavage until done
Step 4 – cortisone and lido in SA/SD
RTC CALCIFIC TENDINOPATHY - ARTHROSCOPY
FURTHER CONSIDERATIONS

- Liberal use of local at skin, SA/SD bursa and around tendon margin
- Single puncture in the center
- Lavage with saline/anesthetic mixture
  - Several 10cc mixed
- Use needle to fenestrate remaining calcifications
  - sometimes this is all you can do
- Inject steroid/anesthetic mixture into the subacromial bursa
- Pain and calcification can recur
  - Repeat US to assess calcification response and subacromial bursa
POST-PROCEDURE

• Usually minimal pain for 4-6 hours
• Later – ice, NSAIDs
• Steroid response 3-7 days
• Limited shoulder activity for 72 hours
SPLINOGLENOID AND SUPRASCAPULAR NOTCH
RELEVANT ANATOMY

- Transverse scapular ligament
- Suprascapular Nerve
- Spinoglenoid Notch
- Teres Minor
- Axillary Nerve in quadrilateral space
- Triceps
- Notch
- Transverse scapular ligament
SUPRASCAPULAR NERVE BLOCK

- **Patient position**
  - Seated
  - Patient facing away from the physician
  - Arm at patient’s side in neutral rotation
- **Transducer position**
  - Scapular plane – long axis of the supraspinatus
  - Over the suprascapular notch
- **Needle Orientation Relative to the Transducer**
  - Long-axis/longitudinal/in-plane
- **Needle Approach**
  - Lateral to medial
- **Target**
  - Suprascapular notch, adjacent to the suprascapular nerve
- **Pearls/Pitfalls**
  - Avoid suprascapular nerve, artery, and vein
SUPRASCAPULAR NOTCH US APPROACHES

A – nerve
B – TS lig

Supraspinatus

with doppler
SPINOGLENOID NOTCH CYST

- Weakness ER
- Posterior pain
- Anechoic mass
- Non-compressible
- Non-vascular
  - Suprascapular vein distension with ER
- Possible extension to SS notch
- +/- Dennervation changes
  - SST + IST at suprascapular notch
  - IST at spinoglenoid notch

MRI T2
SPINOGLENOID NOTCH CYST ASPIRATION

• Patient position
  • Prone/oblique with pillow under to the anterior aspect of the patient’s injured shoulder
  • Arm at the patient’s side in neutral rotation
• Transducer position
  • Anatomic transverse plane
  • Over the posterior glenohumeral joint at the level of the spinoglenoid notch
• Needle Orientation Relative to the Transducer
  • Long-axis/longitudinal/in-plane
• Needle Approach
  • Lateral to medial
  • Needle size 18-20 guage 3.5”
• Target
  • Spinoglenoid notch cyst
• Pearls/Pitfalls
  • Avoid suprascapular nerve, artery, and vein
  • Identify vein with external rotation
SPINOGLENOID NOTCH CYST ASPIRATION
SCAPULOTHORACIC BURSA

Scapula

shadow

Rib

needle
SUBCORACOID BURSA INJECTION

- **Patient position**
  - Patient supine
  - Arm abducted 20 degrees
  - Slight humeral external rotation (ie: palm facing ceiling) is optional

- **Transducer position**
  - Anatomic axial-oblique plane (longitudinal relative to the subscapularis tendon)
  - Over the anterior aspect of the subscapularis tendon/muscle

- **Needle Orientation Relative to the Transducer**
  - Long-axis/longitudinal/in-place

- **Needle Approach**
  - Lateral to medial
  - 22 gauge 3.5" for injxn, 18 -20 gauge for aspiration

- **Target**
  - Subcoracoid bursa, which is located superficial to the subscapularis tendon, and deep to the conjoint tendon of the short head of the biceps and coracobrachialis muscles

- **Pearls/Pitfalls**
  - Identify and avoid adjacent neurovascular structures
SUBCORACOID BURSAL IMPINGEMENT

- Anteromedial shoulder pain with IR
- Common post-op
- Subdeltoid bursal fluid collection vs Subcoracoid bursa
- USG for dx/tx
QUESTIONS?