Musculoskeletal Ultrasound In the Office Setting: Shoulder

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Why Consider Shoulder Musculoskeletal Ultrasound ?

- Low cost problem-solving tool
- Few technical limitations (unlike MRI, compatible with implanted devices)
- Safe-No significant risks except minimal risk of increasing the temperature of insonated tissues (no radiation exposure)
- Real time dynamic studies and interventions
- Immediate patient feedback
- Readily accessible

Disadvantages of US

- Highly operator-dependent, steep learning curve
- Difficult to reproduce like studies with different operators or at different institutions (must scan anatomy in two planes, watch for technical artifact such as anisotropy)

Limitations of ultrasound

- Image quality can be reduced by
  - excessive body hair
  - excessive adipose tissue
  - large muscle mass
  - prior tissue damage/post surgical alteration of tissue
  - prosthesis
  - bone, metal-can’t see beyond
  - Inadequate technique

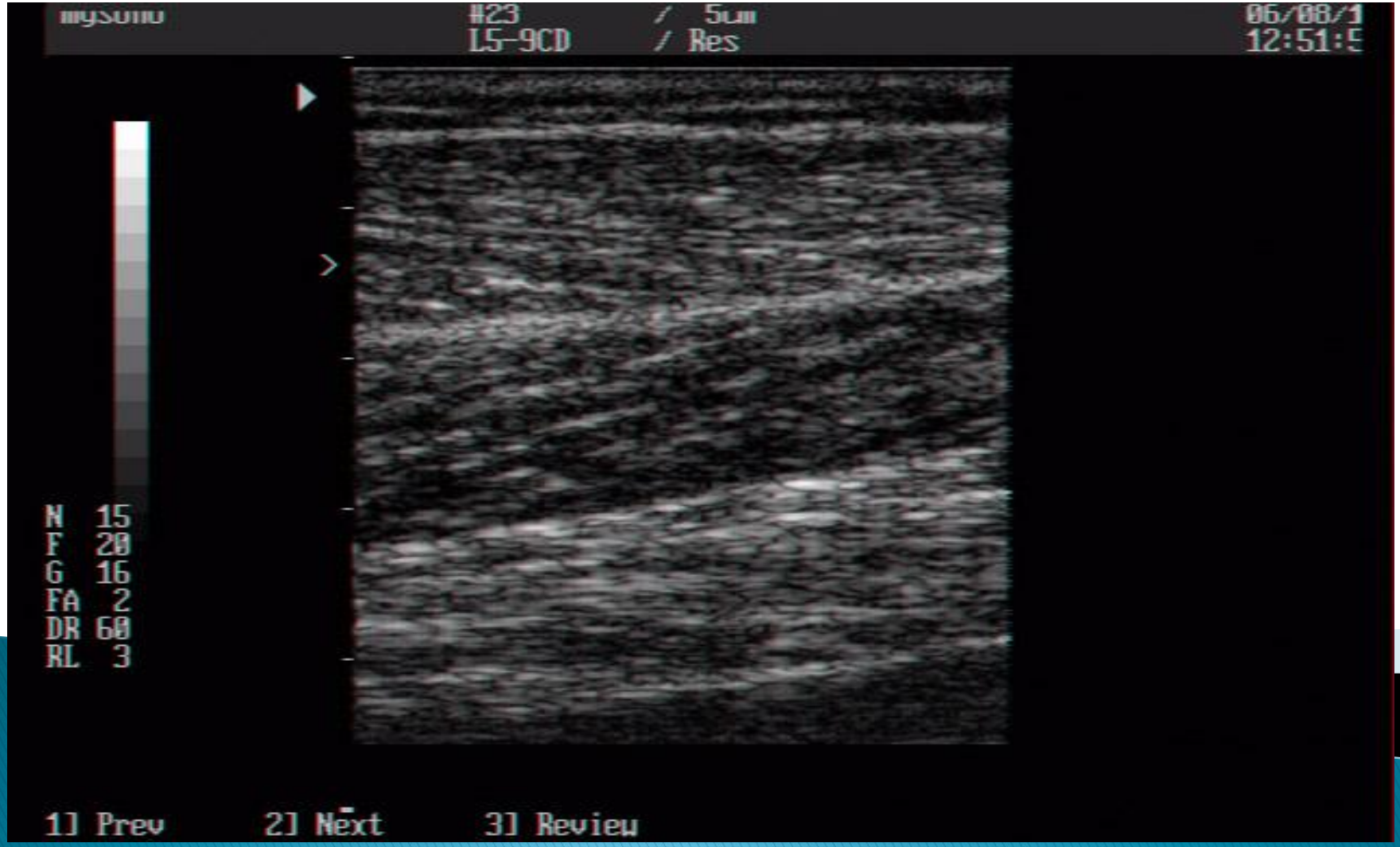
Hx of MSK US Use

- 1972-First reported use: Baker's Cyst vs DVT
- 1978-First demonstration of knee synovitis in RA
- 1979-First reported shoulder US (Seltzer)
- 2005-93% of British Rheumatologists use in pt management, 33% performing it themselves(Cunningham Ann Rheum Disease 2007)
- 2010-47% of American Rheumatologists use in pt management (Samuels)
- At present, many ongoing trials for a variety of neurologic, rheumatologic, musculoskeletal and sports medicine applications

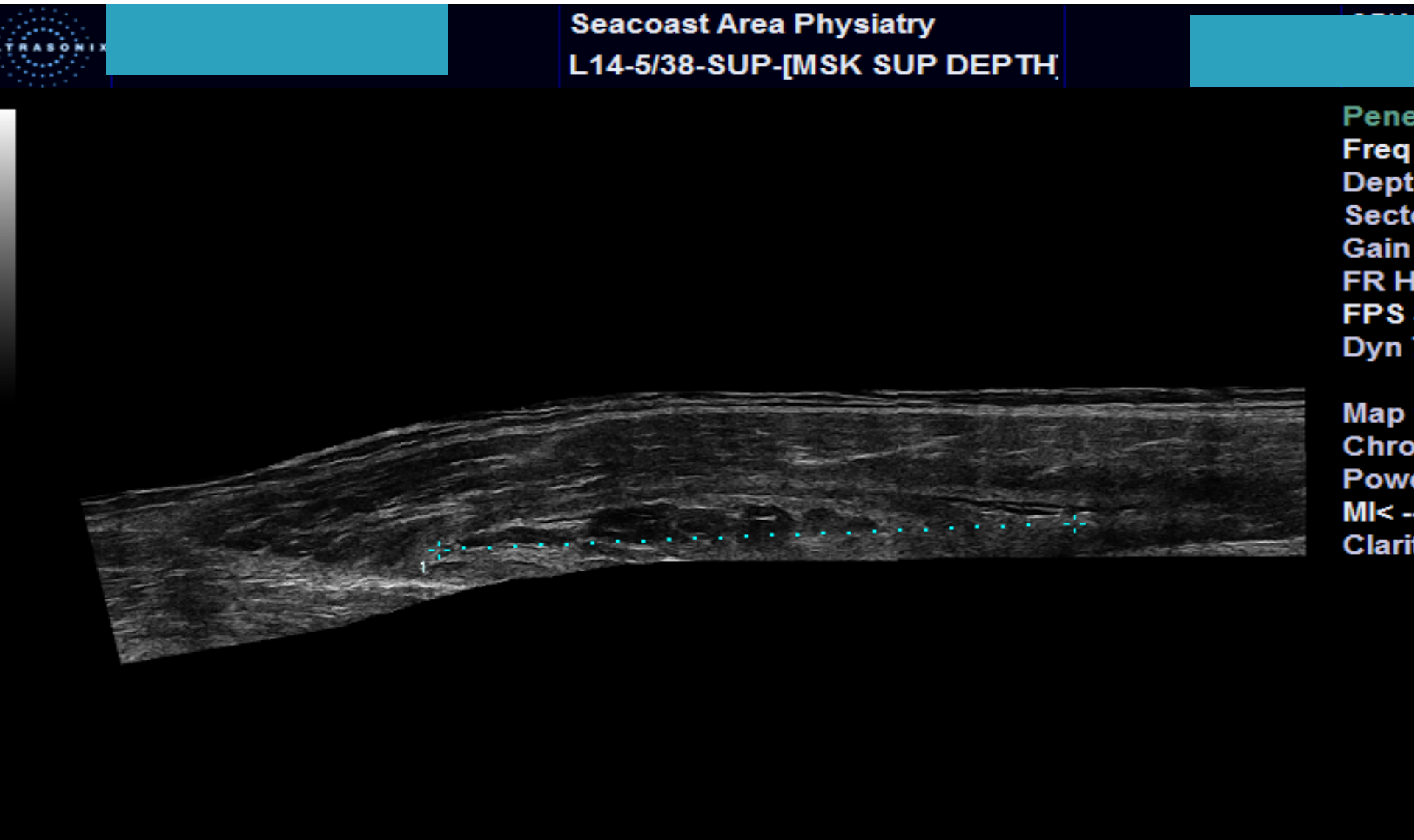
Ultrasound appearance:

- Tendon: hyperechoic, fibrillar
- Muscle: relatively hypoechoic
- Bone cortex: hyperechoic, shadowing

Ultrasound of muscle



Extended Field of View



MRI vs MSK US (Teefey et al, JBJS 2004)

71 pts w/shoulder pain had US and MRI then arthroscopy

US & MRI had comparable accuracy for identifying and measuring size of partial and full thickness tears

MRI slightly more sensitive

MSK US evaluation of shoulder pain-3rd most common musculoskeletal disorder after back and neck pain

- In 504 patients referred for MRI of the (symptomatic)shoulder who were also routinely evaluated with MSK US, no statistically significant difference was seen between a full sonographic protocol, a long axis sonographic view of the rotator cuff, and MRI
- Conclusion: Sonography is reliable for detecting RTC abnormalities. Exclusive long axis view seems appropriate as a screening tool in symptomatic shoulders
- J Ultrasound Med 2010: 29: 1725-32

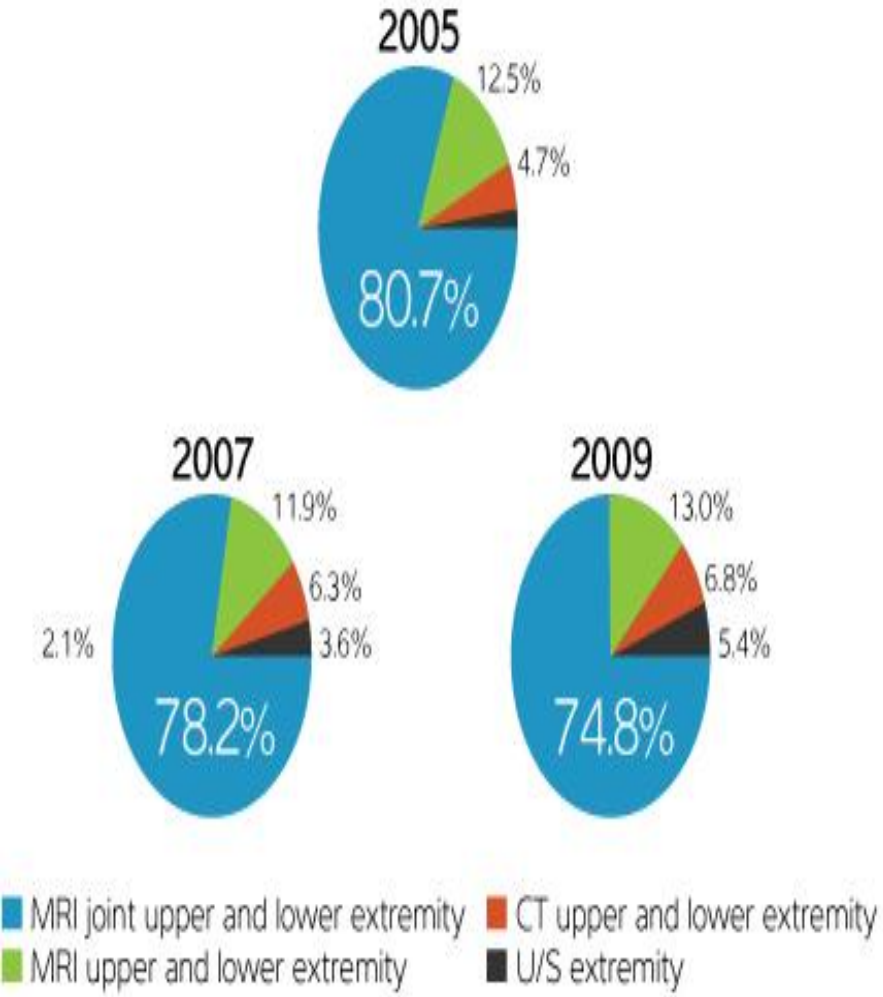
Accuracy of MRI, MR arthrography, and US in the dx of RTC tears: a meta analysis (65 studies)

- MRI arthrography is the most sensitive and specific technique for diagnosing both full and partial thickness RTC tears (ROC 0.935)
- US (ROC 0.889) and MRI (0.878) are comparable in both sensitivity and specificity
- deJesus, Am J Roentgenol, 2009; 192(6) 1701-7

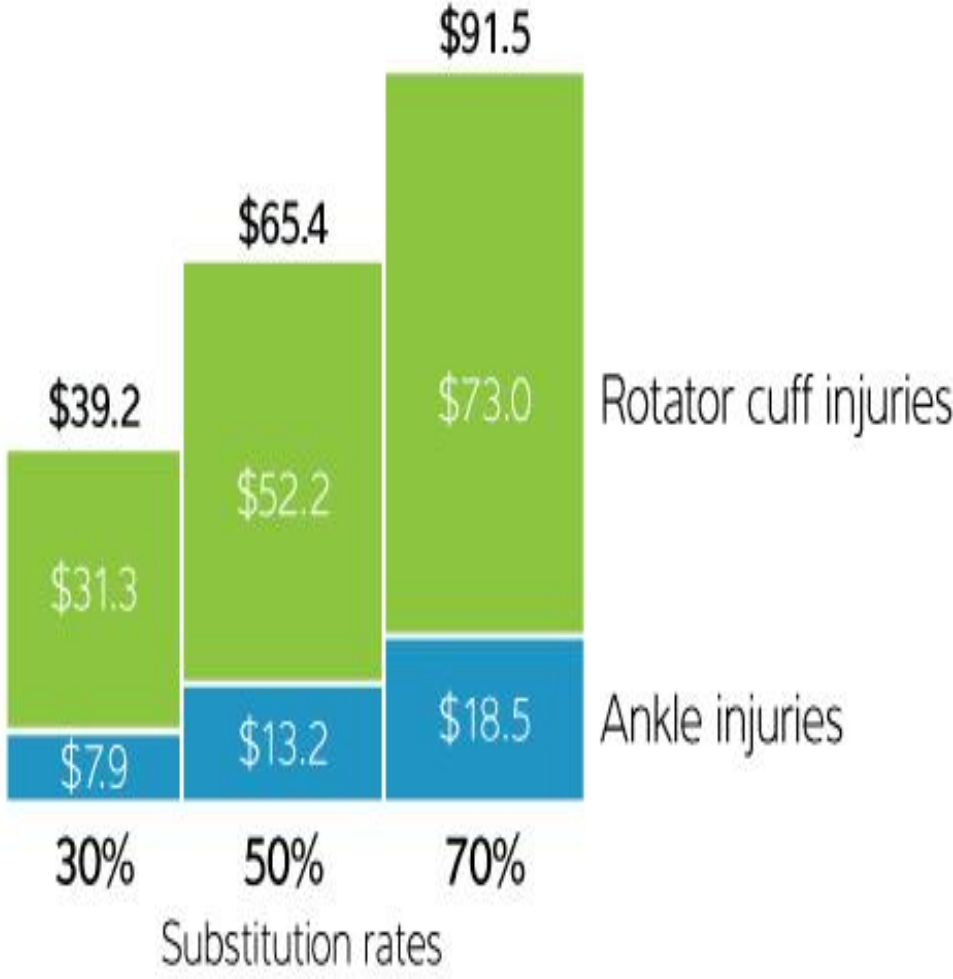
RTC Pathology

- RTC tendon “wear and tear” is the most common clinical problem of the shoulder
- > 4.5 million physician visits/year
- 2/3 of asymptomatic people over age 70 have tendon tears by US imaging
- MRI may be limited in evaluating partial tears
- Some older studies lacked fat saturation MRI and used US transducers that had low frequency
- More head to head comparisons are needed
- Kelly, US Compared w/MRI for the Diagnosis of RTC tears: A Critically Appraised Topic. Seminars in Roentgenology, 2009

Medicare Cost Saving



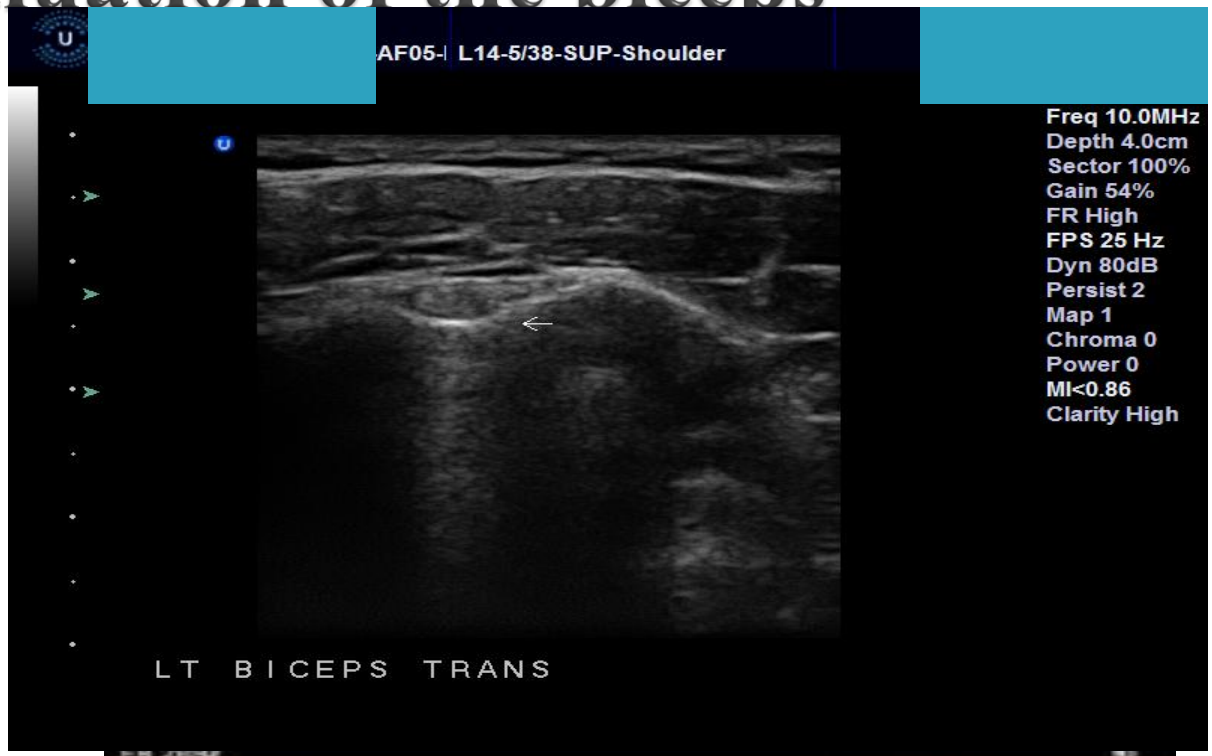
Distribution of Medicare allowed charges for extremity imaging, 2005 to 2009 (carrier billed services only)

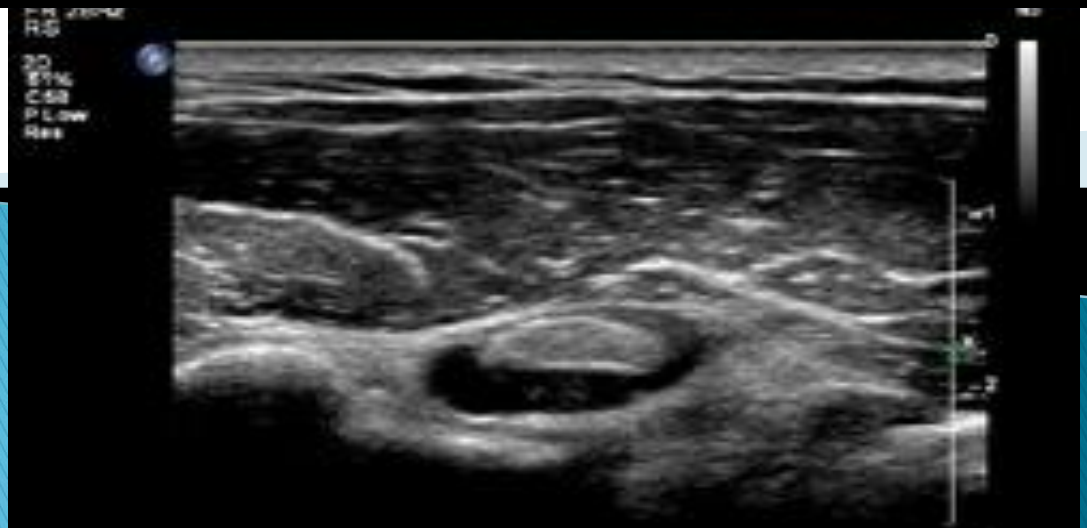


Saving money for our nation's healthcare system

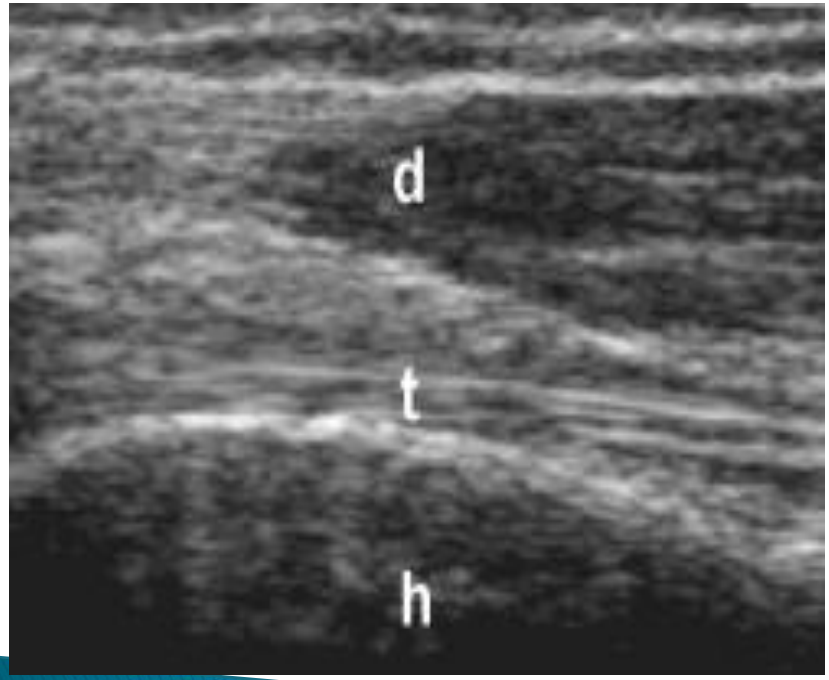
Estimated reductions in 2009 Medicare spending with substitution of diagnostic ultrasound for CT and MRI imaging (in Millions)

Ultrasound Evaluation of the biceps tendon

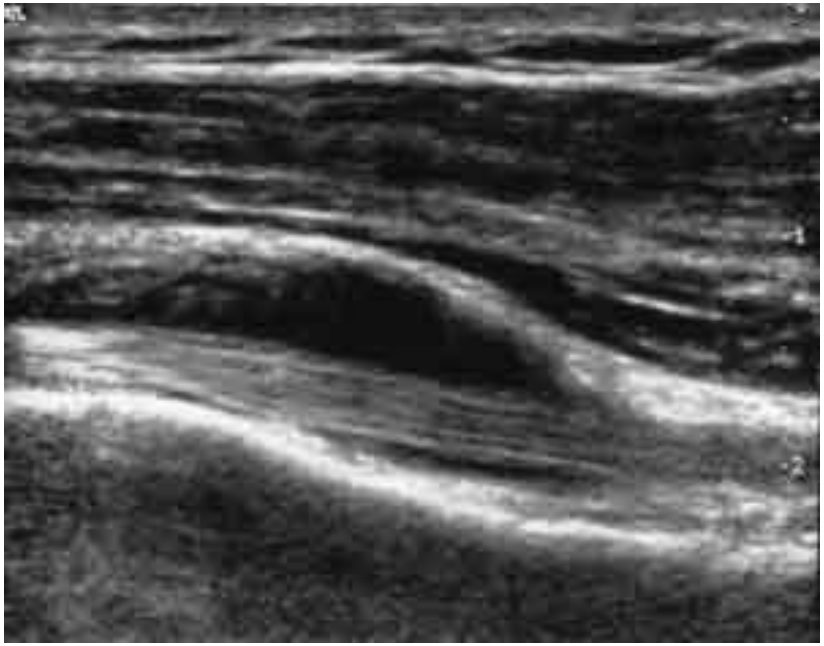




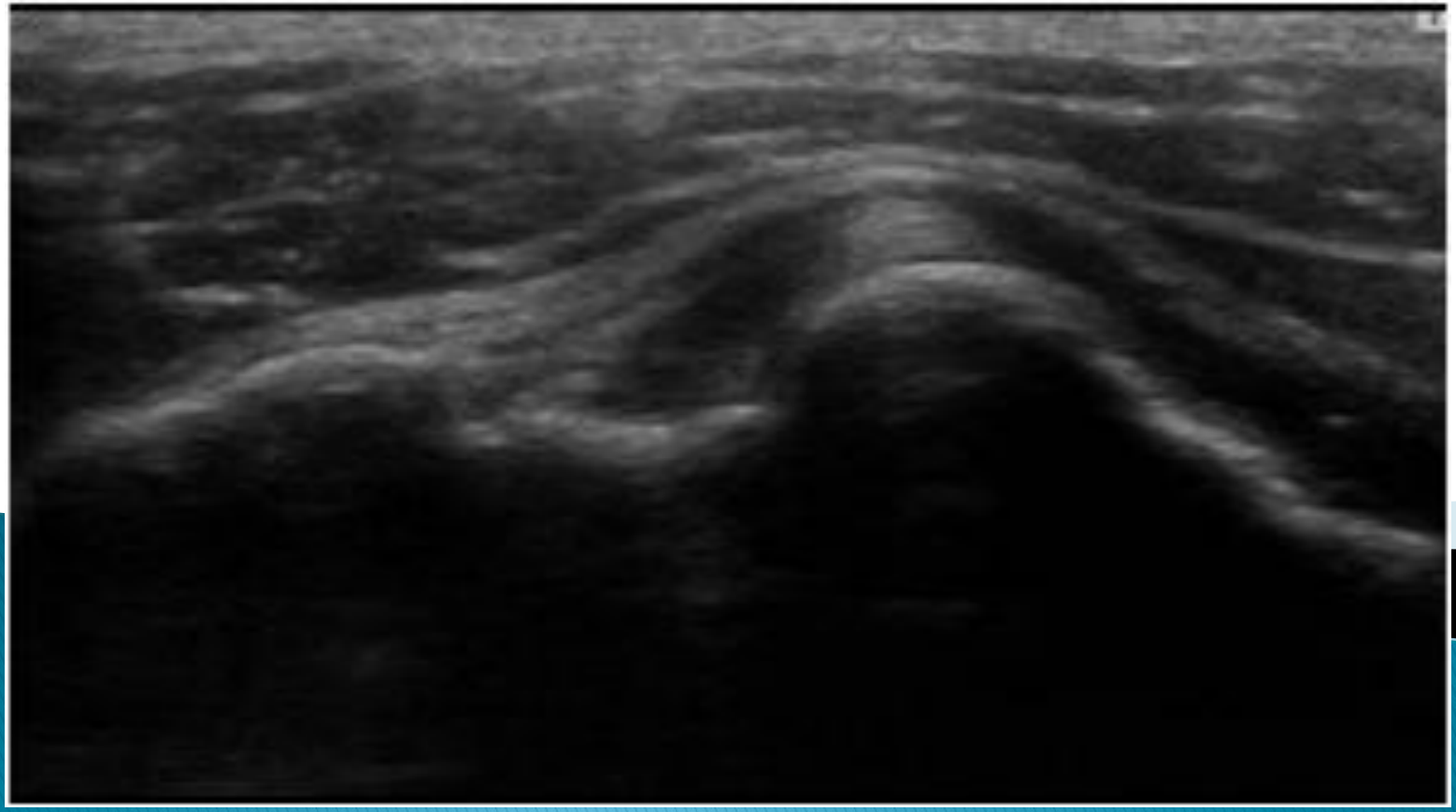
Normal Biceps

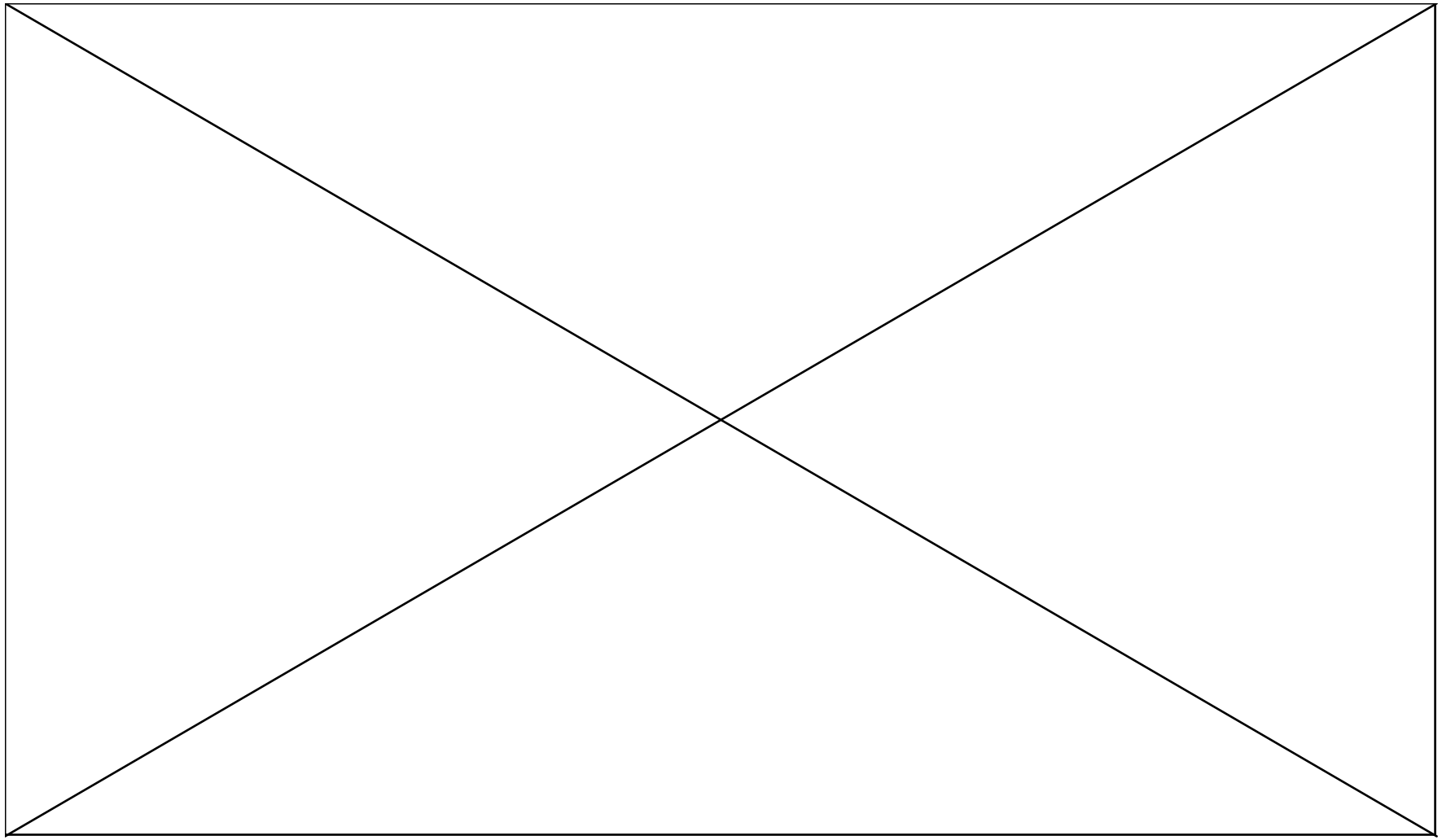


Abnormal Biceps

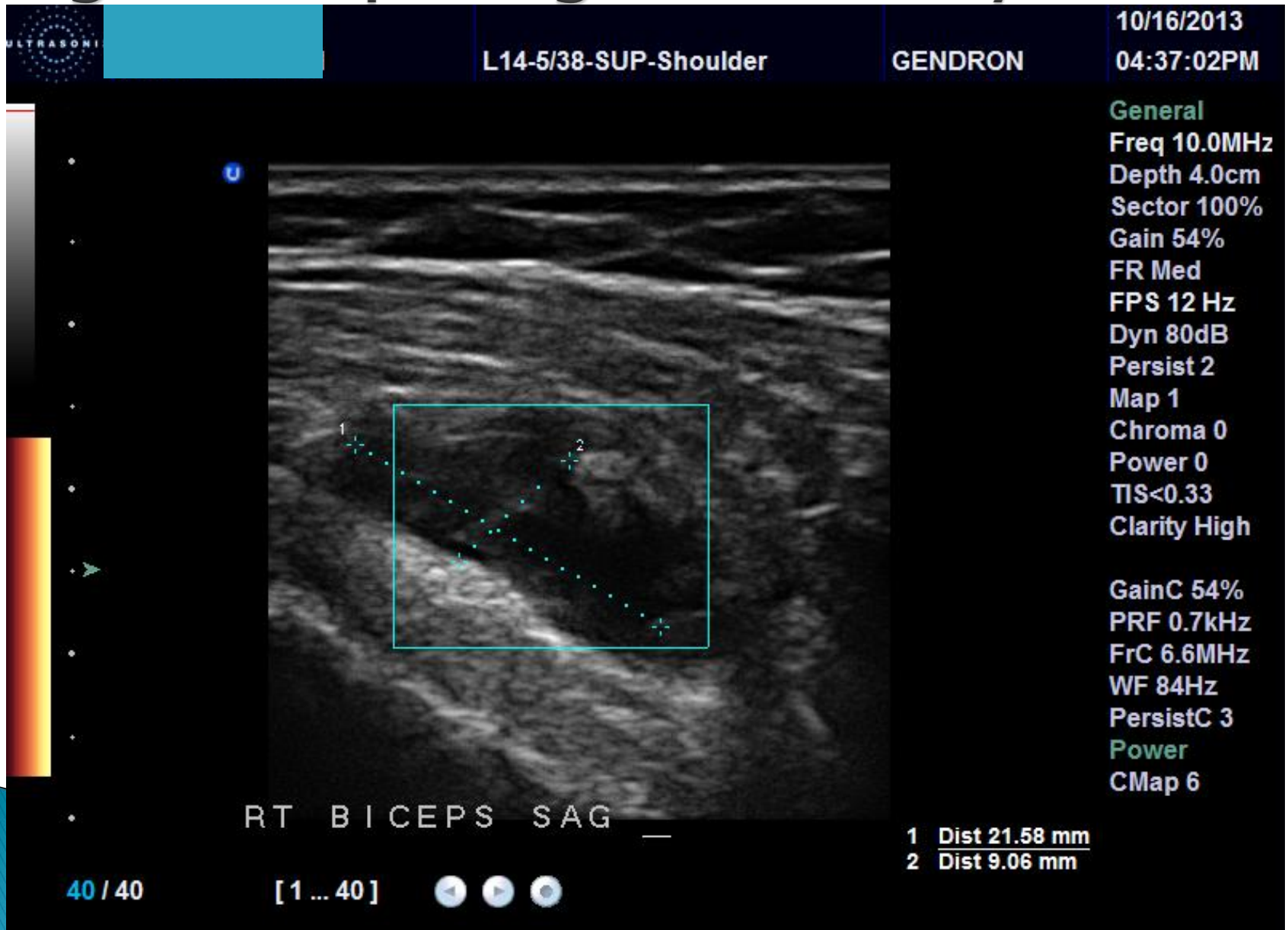


Subluxing biceps tendon

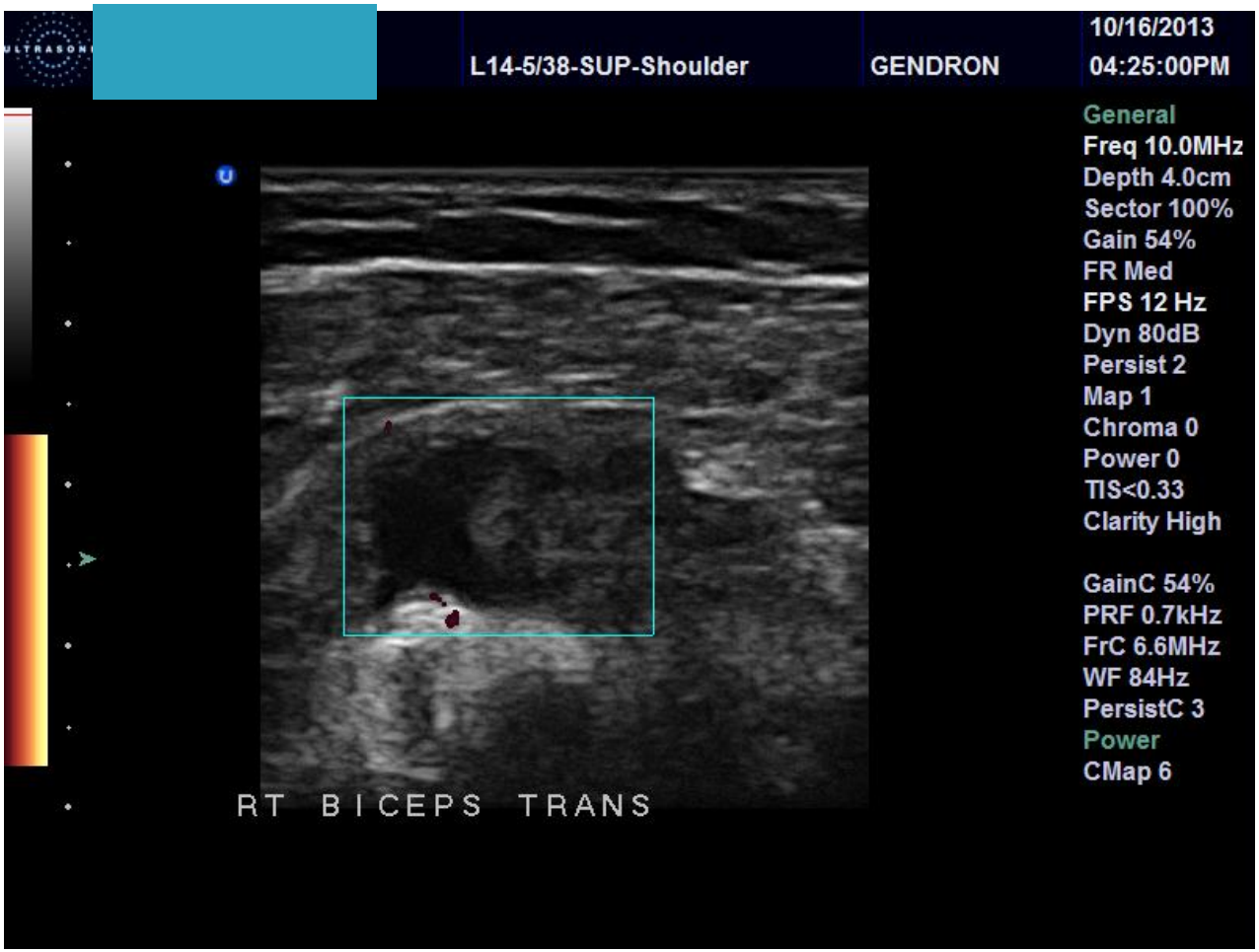




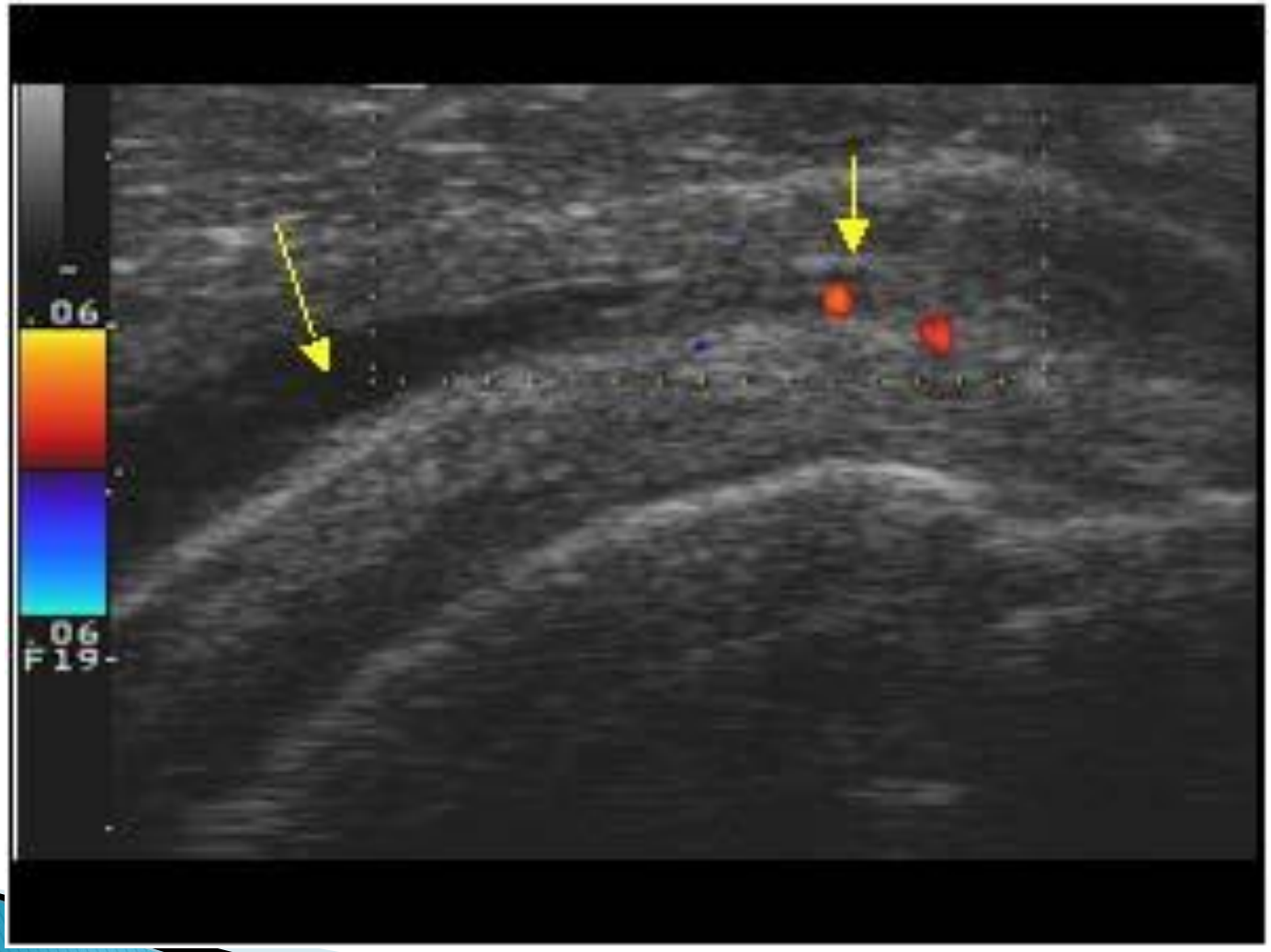
Right biceps sagittal-tenosynovitis



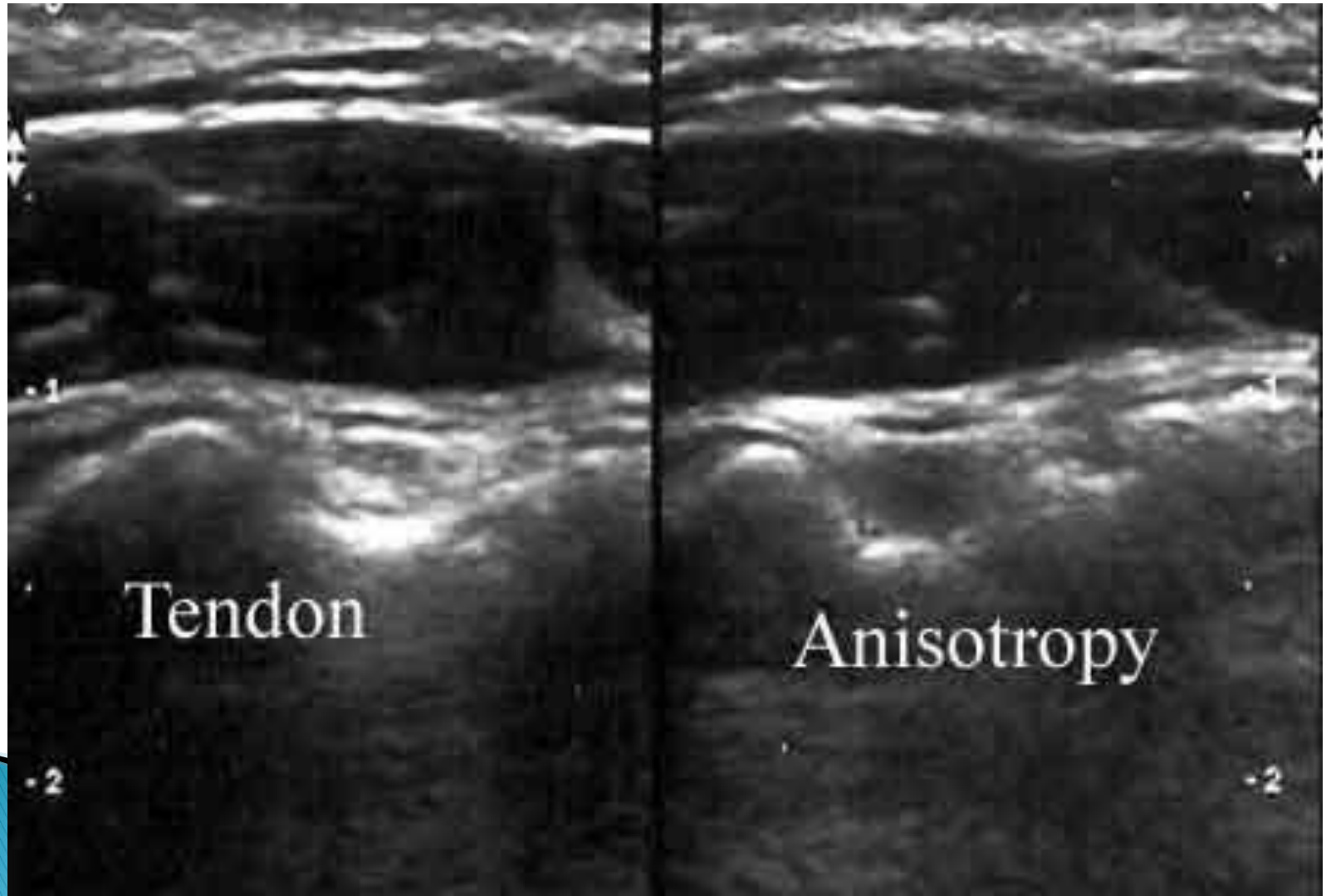
Right biceps transverse



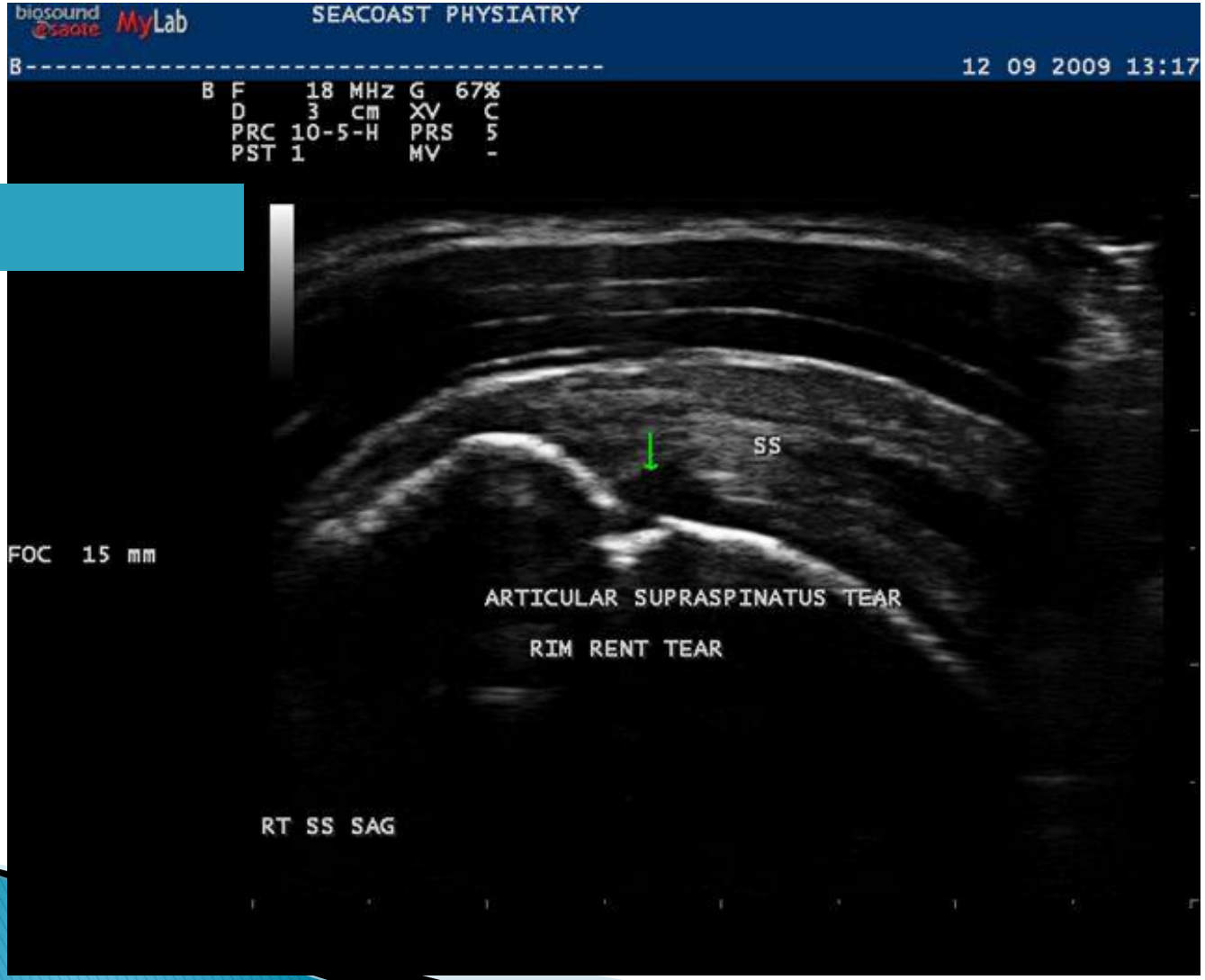
RA with bursitis and synovial thickening



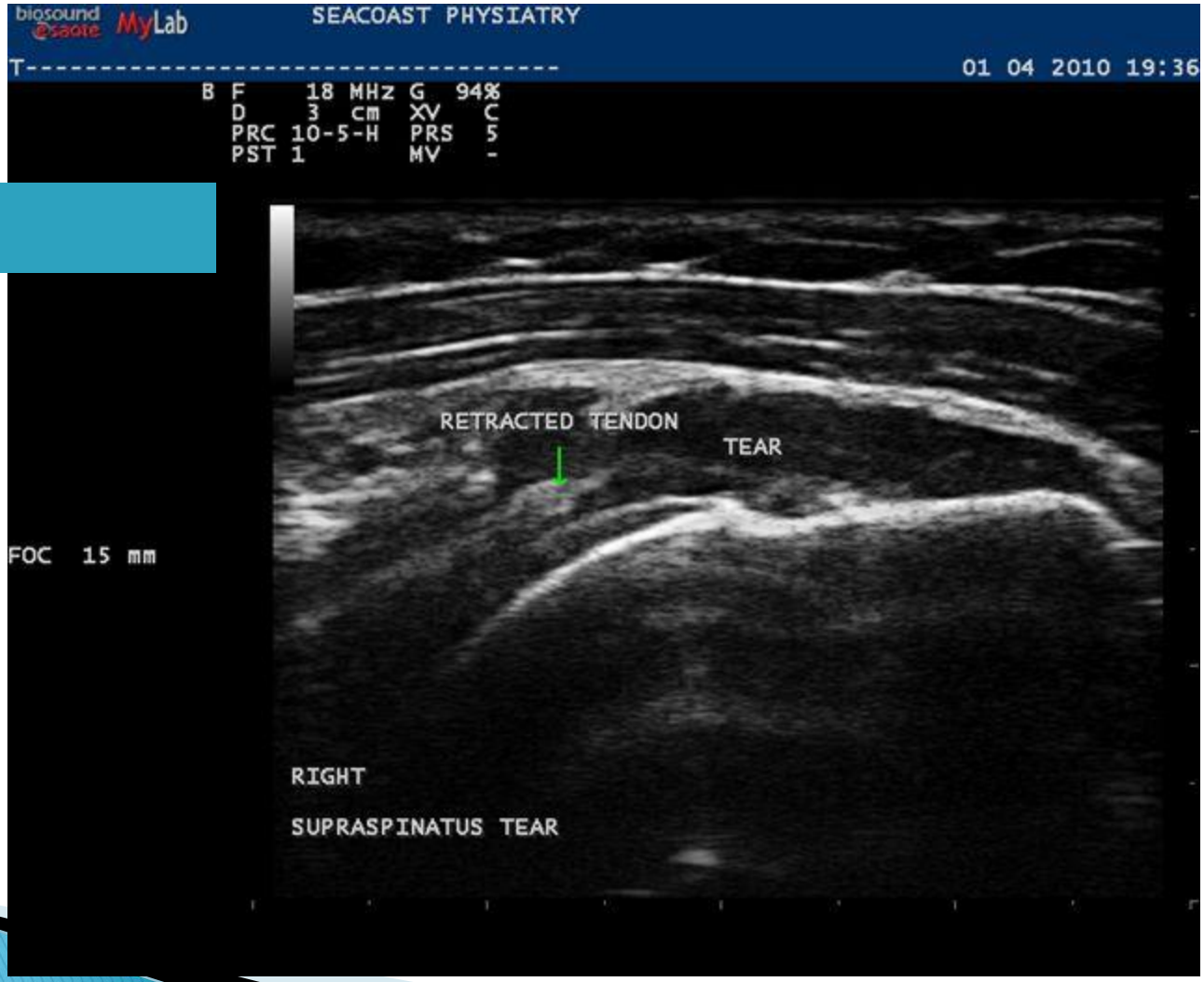
Technical Issues-Anisotropy



Supraspinatus tear



Full Thickness Supraspin Tear

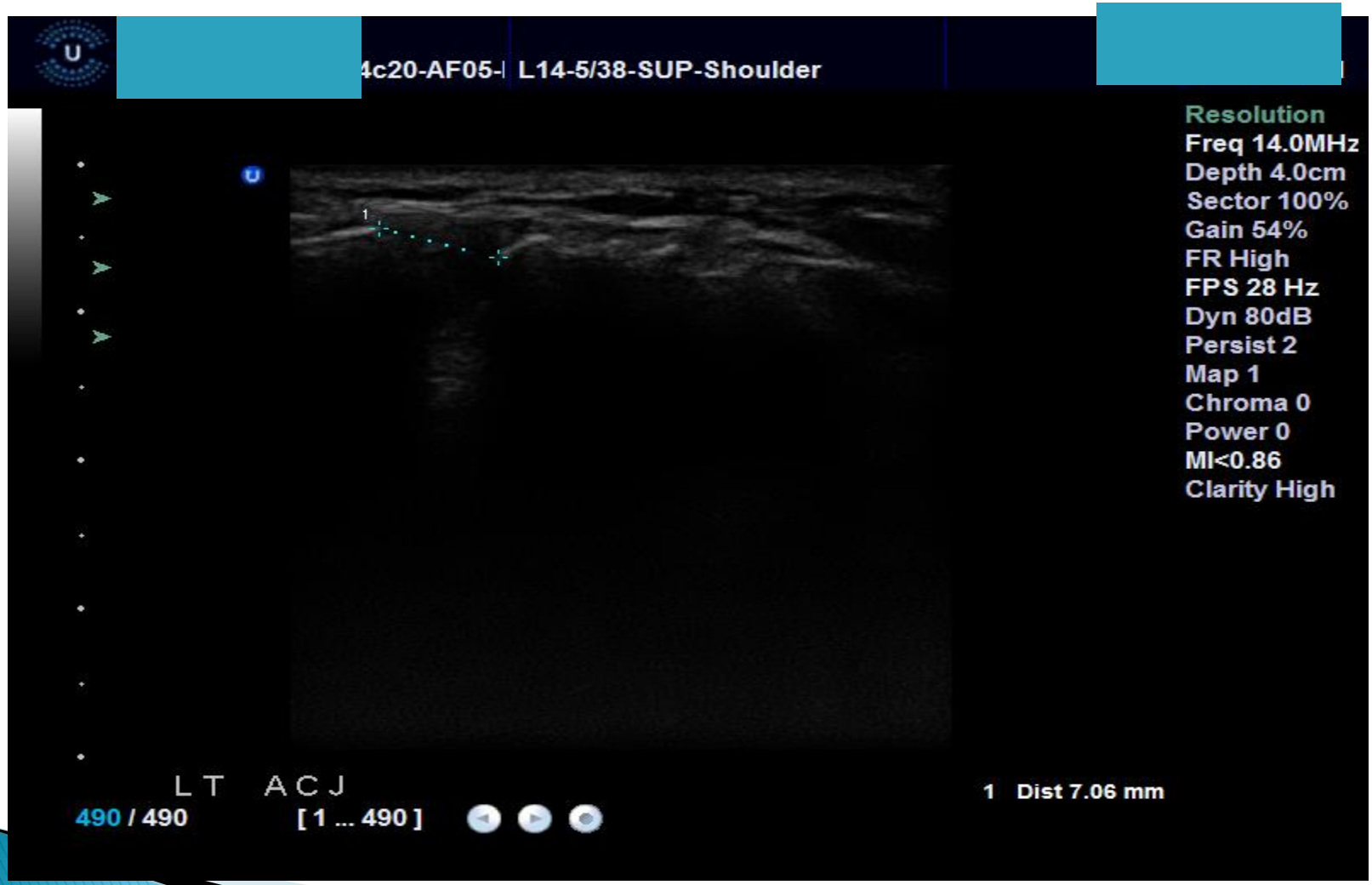


Calcific tendonitis

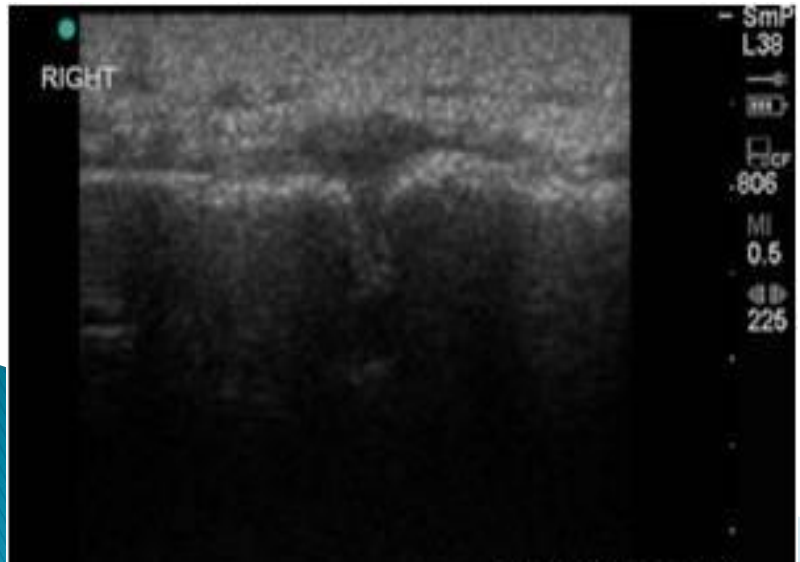
ACJ

- AC joint space is usually <5mm
  - Right and left differ by no more than 2-3 mm
- Coracoclavicular distance usually <11-13 mm
  - Right and left should differ by < 5 mm
- 50% difference in size between the two shoulders is considered significant

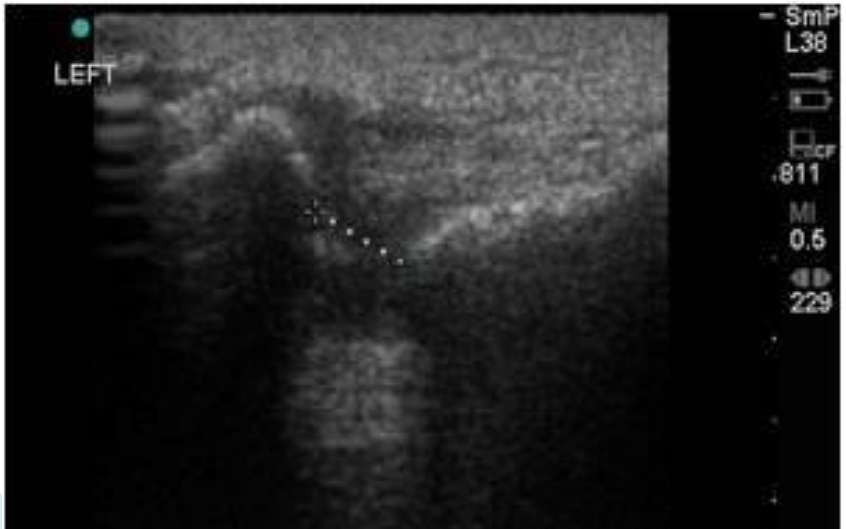
ACJ


4c20-AF05-I L14-5/38-SUP-Shoulder
Resolution
Freq 14.0MHz
Depth 4.0cm
Sector 100%
Gain 54%
FR High
FPS 28 Hz
Dyn 80dB
Persist 2
Map 1
Chroma 0
Power 0
MI<0.86
Clarity High
LT ACJ
490 / 490
[1 ... 490]
1 Dist 7.06 mm

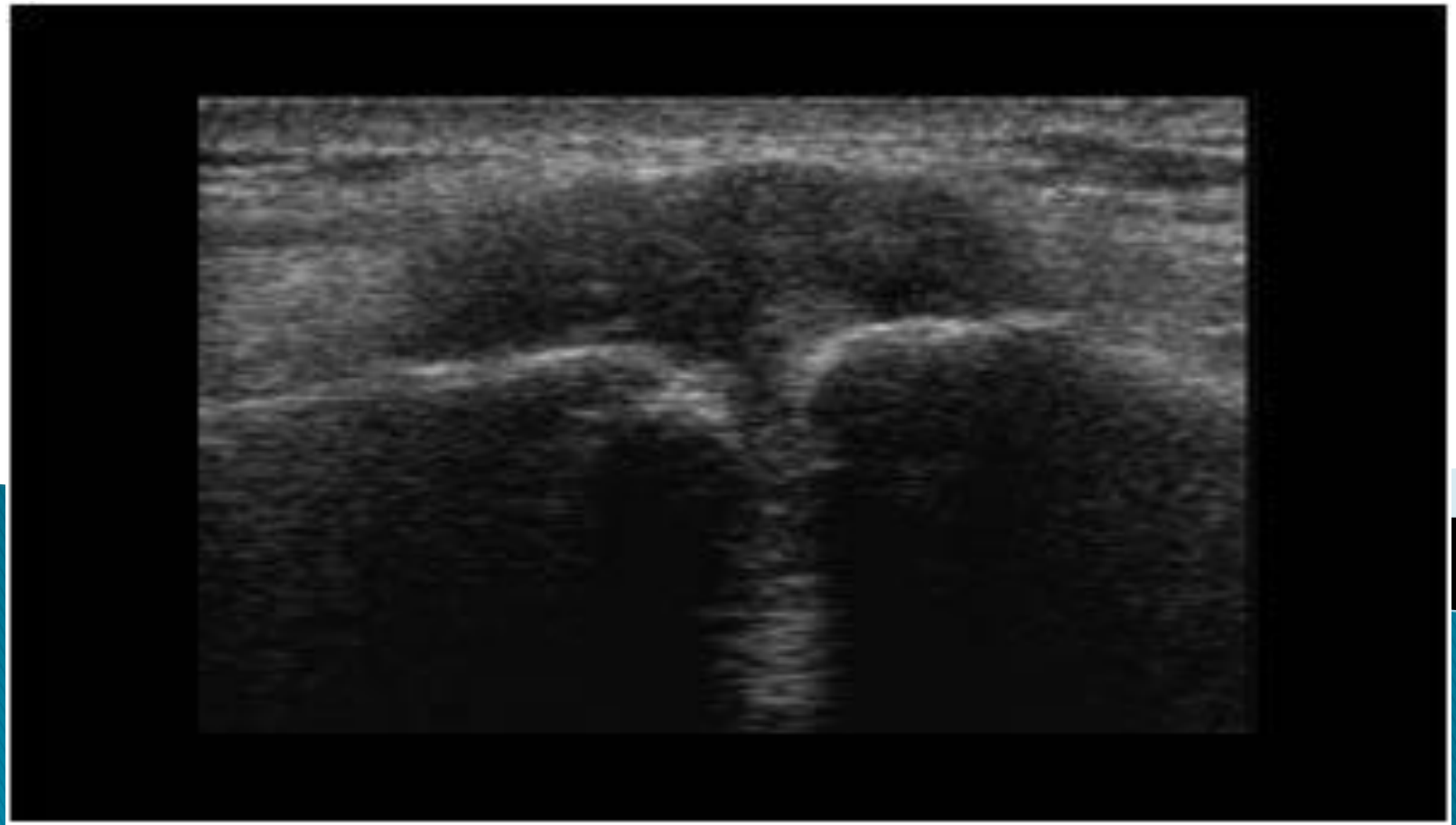
Normal



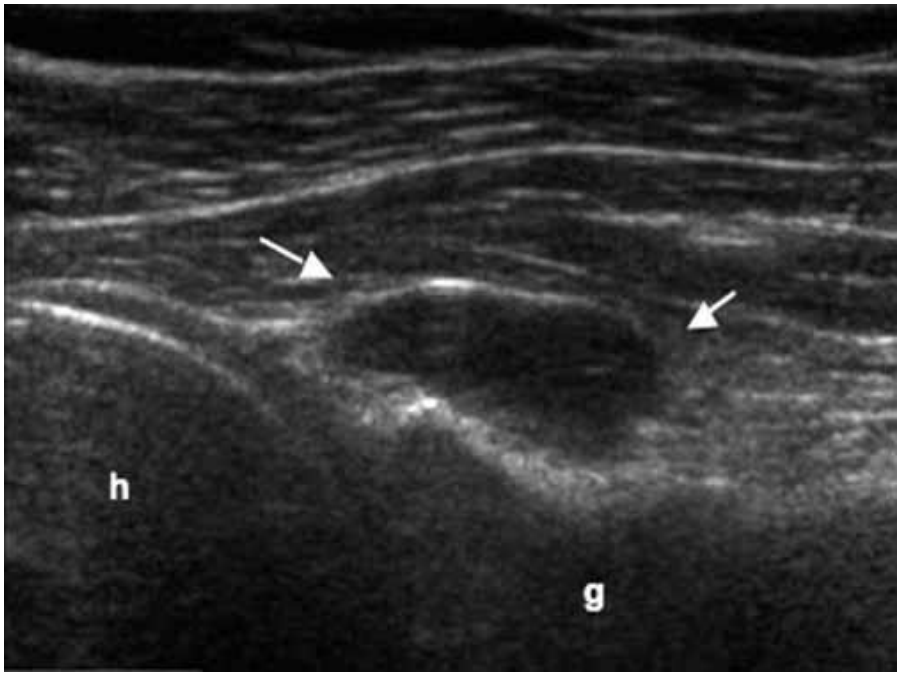
ACJ separation

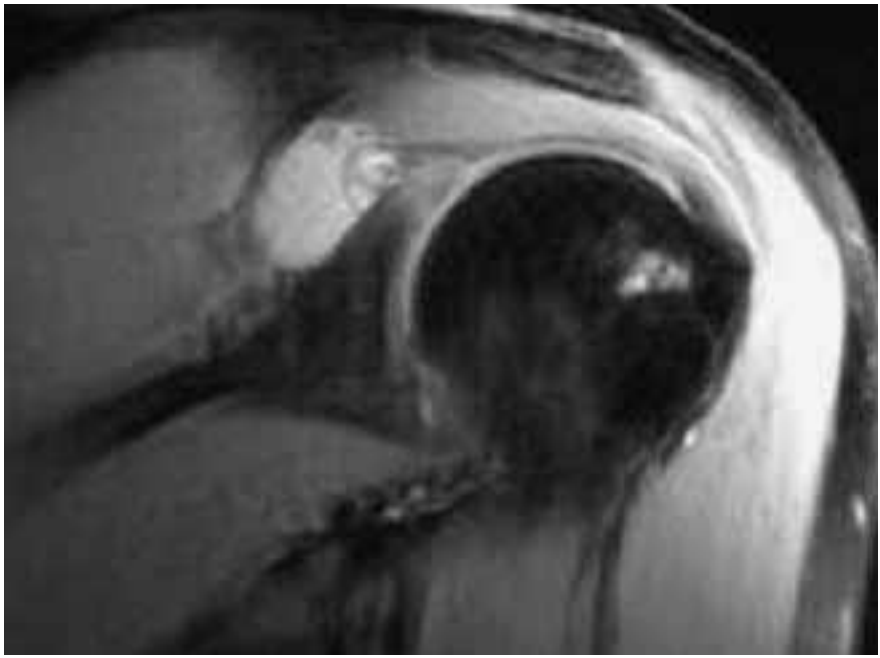


Geyser sign with ACJ effusion

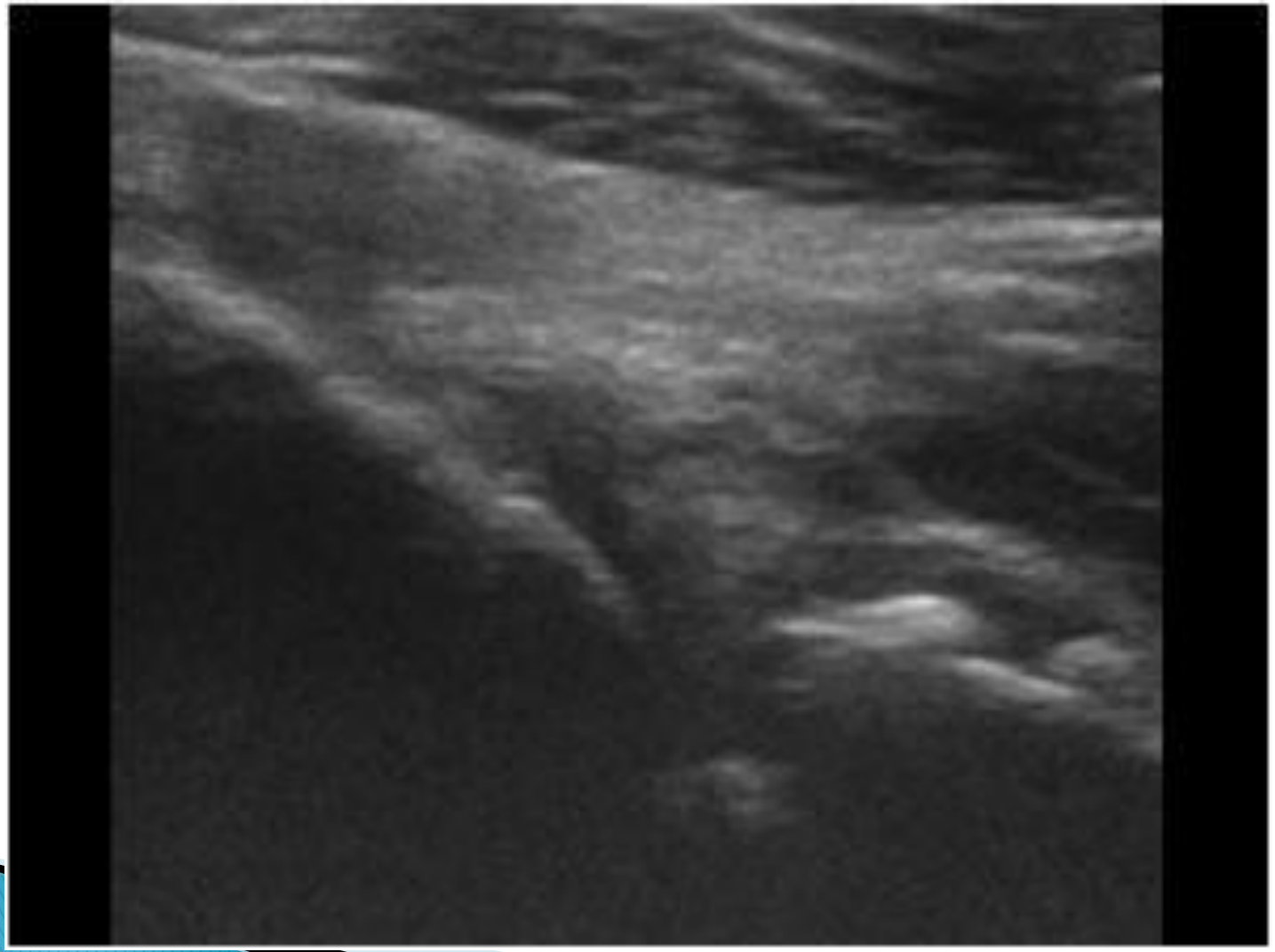


Paralabral Cyst: US/MRI

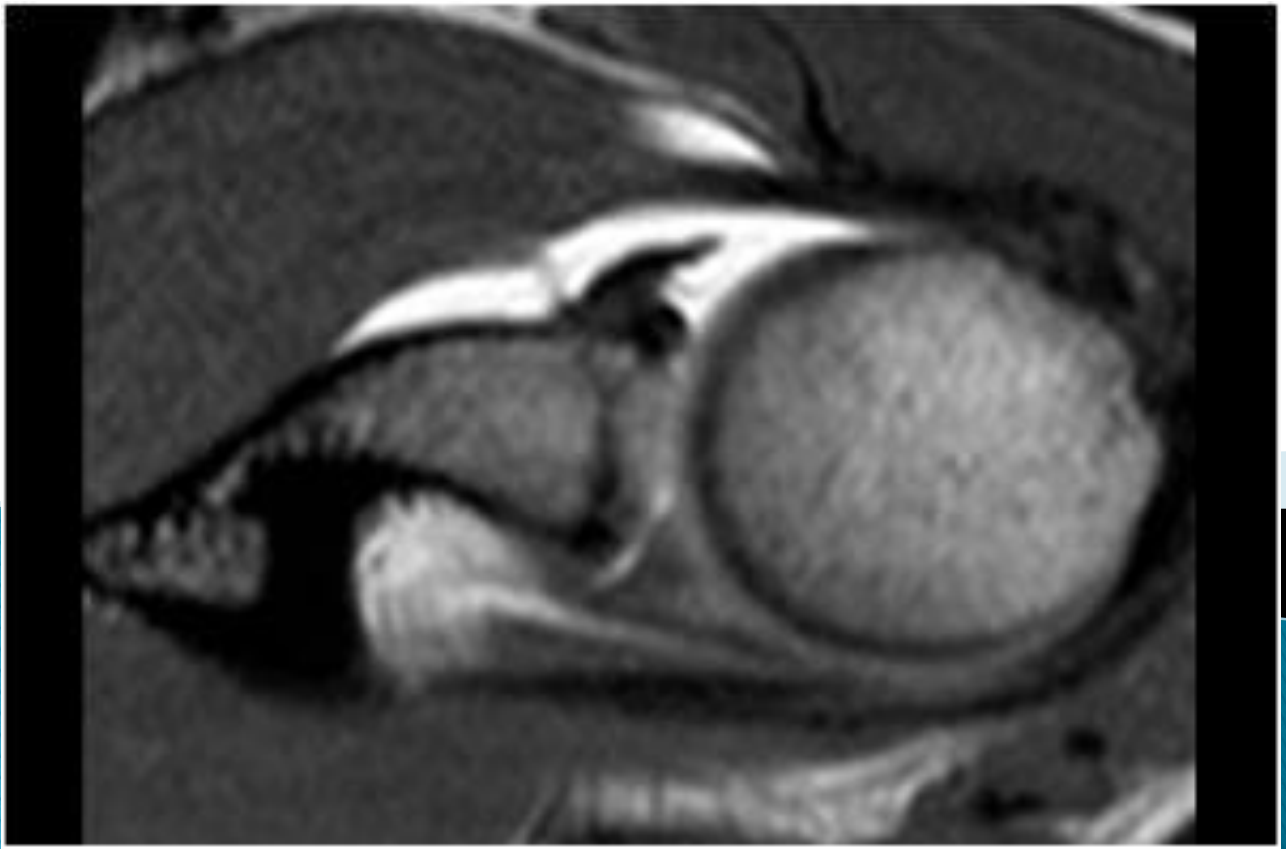




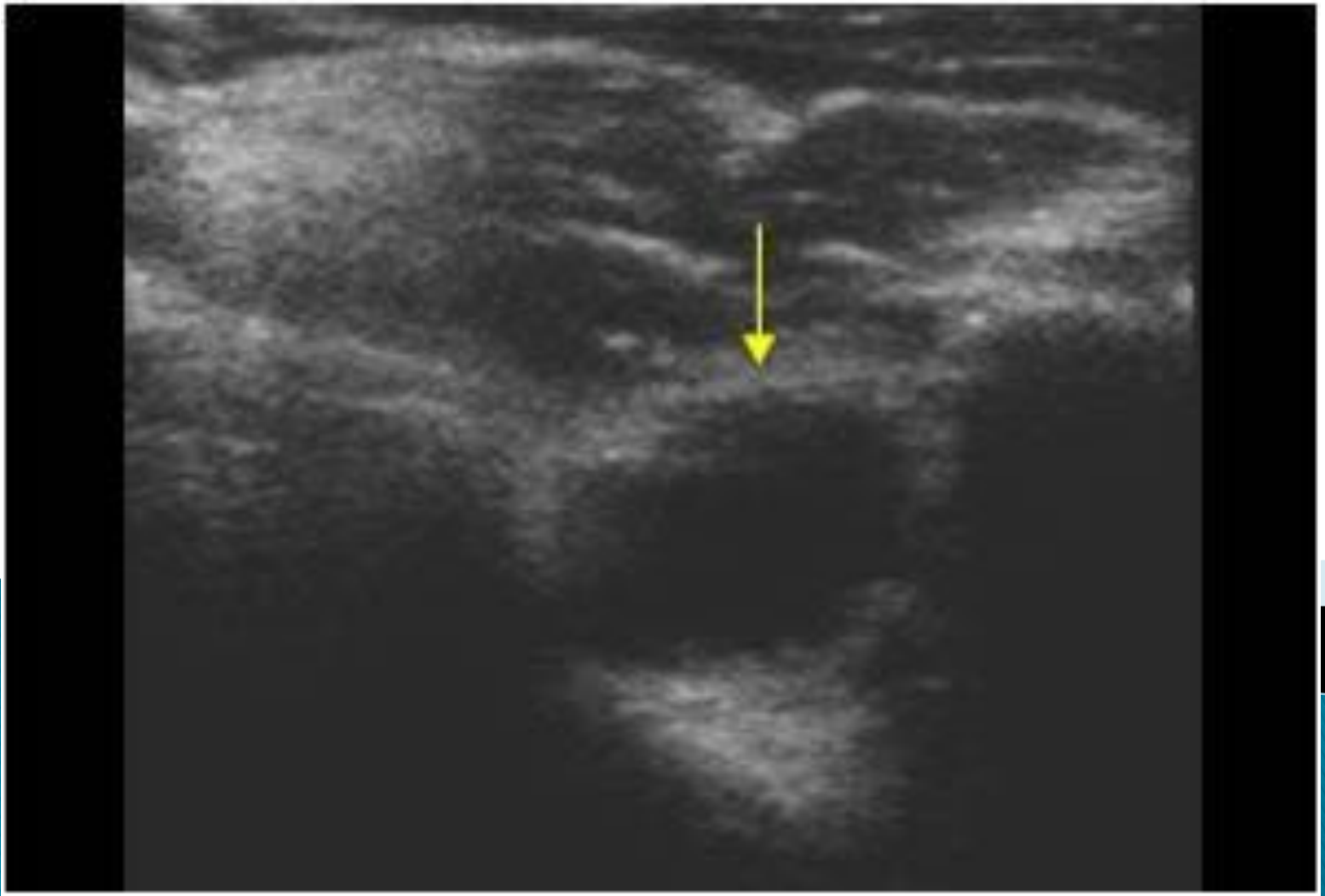
Posterior Labral Tear



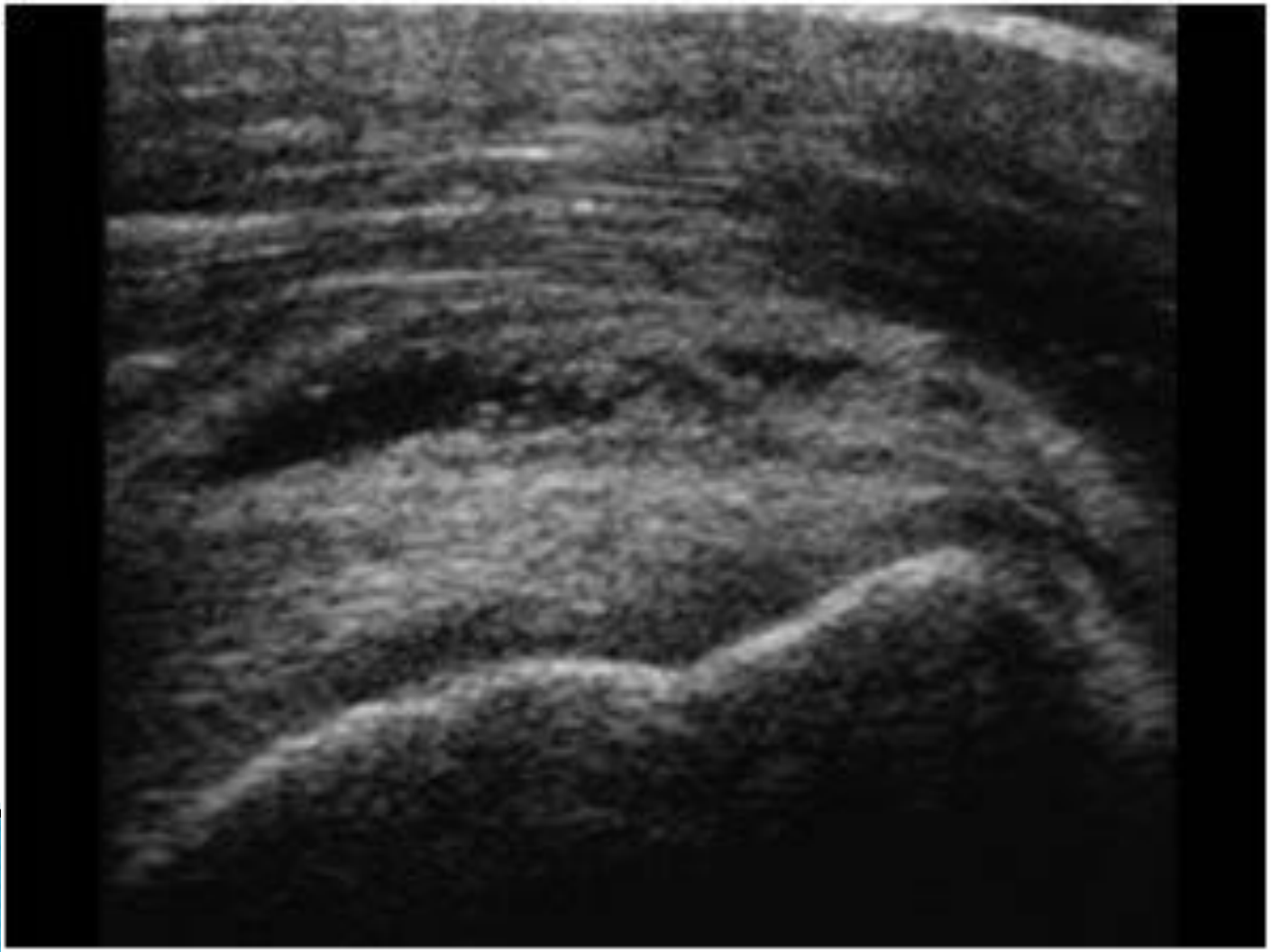
Posterior Labral tear on MRI



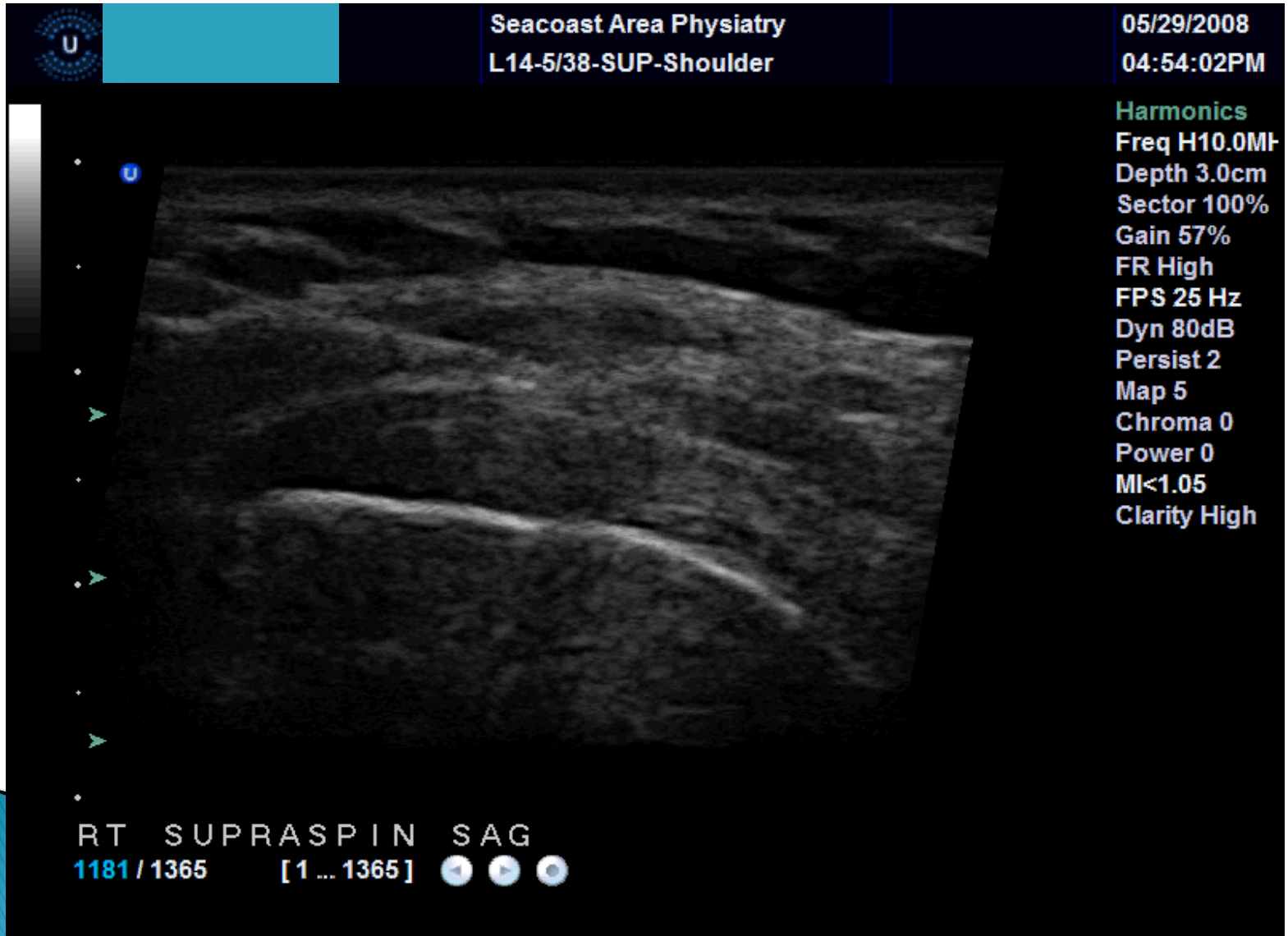
Spinoglenoid notch cyst with posterior ganglion cyst



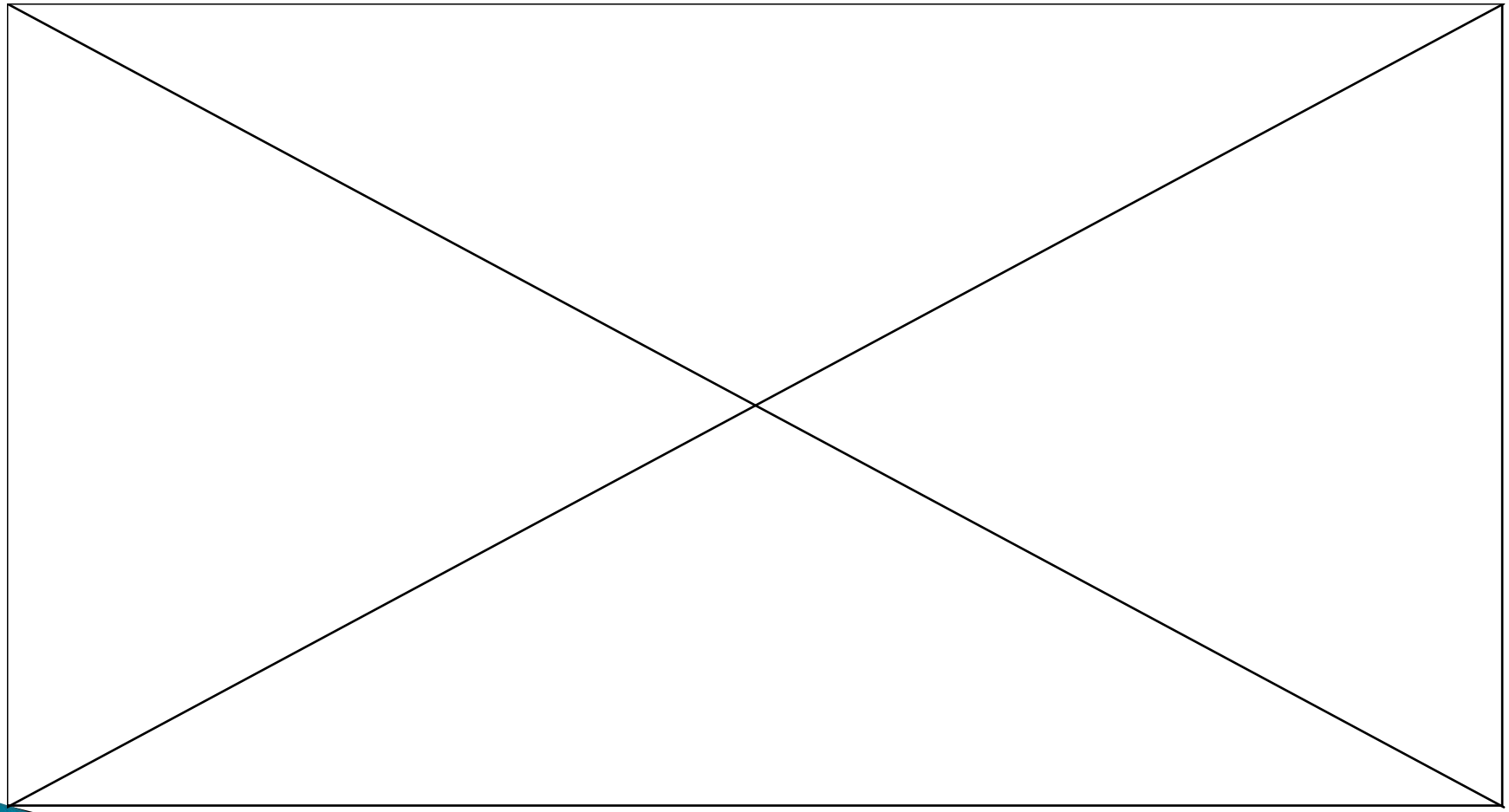
Subdeltoid bursitis



Subdeltoid Bursal Injection



Dynamic Impingement



Interventional Uses

- Guided injections-steroid, anesthetics, viscous injections, PRP
- Aspiration/ injections of cysts
- Calcific tendinitis- irrigation
- Percutaneous tenotomy (McShane, “Sonographically Guided Percutaneous Needle Tenotomy for Treatment of Common Extensor Tendinosis in the Elbow” J Ultrasound Med 25:1281-89, 2006)

Is my injection going where I want it to go?

- Confirmed by fluoroscopy, knee injections were intraarticular in 71% using a anterolateral portal, 75% anteromedial and 93% through a lateral midpatellar portal. Jackson, “Accuracy of Needle Placement into the Intra-Articular Space of the Knee” JBJS 84:1522-27, 2002

Subacromial Injections

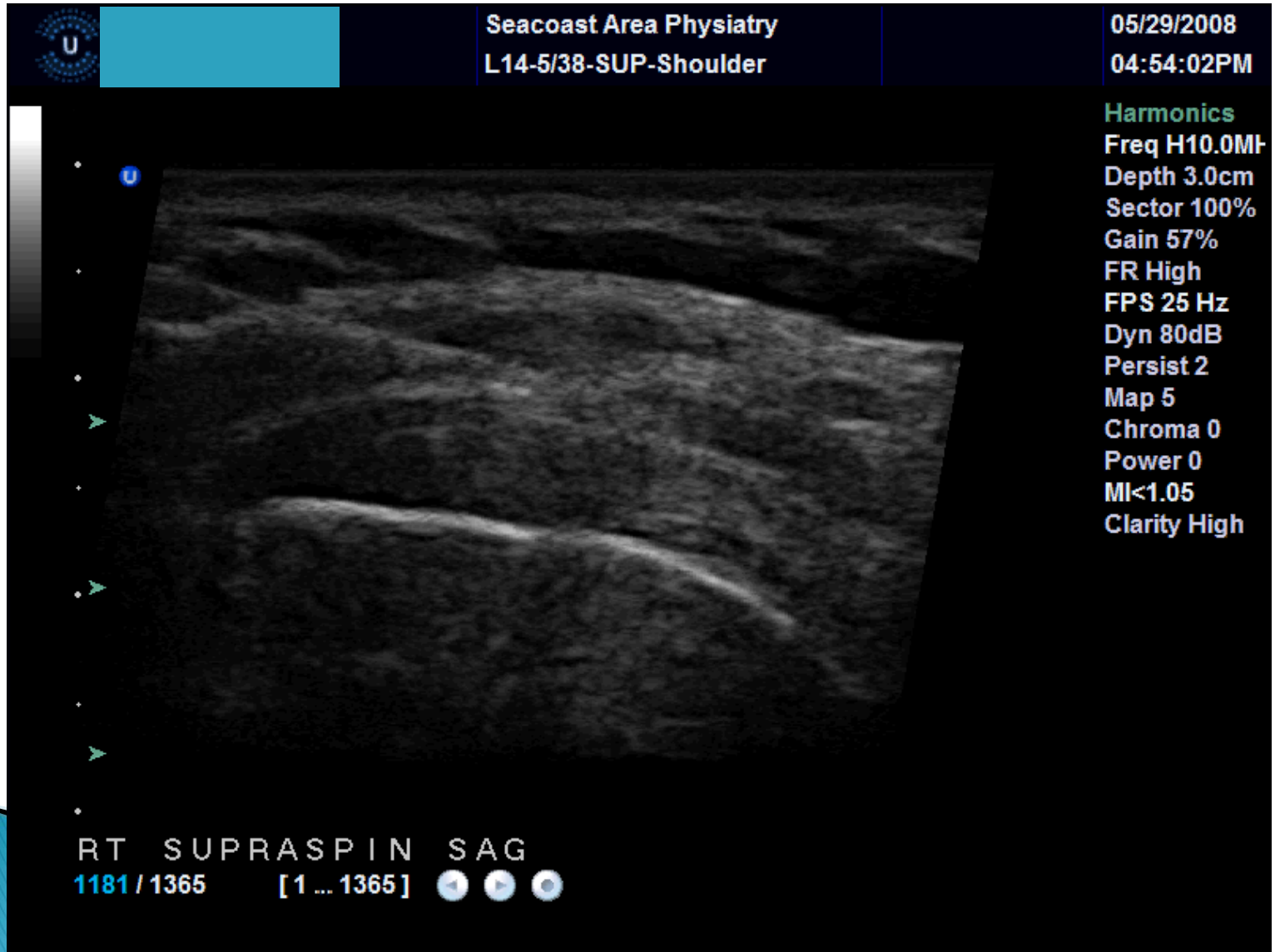
Approximately 30% of injections miss subacromial bursa (Eustace 1993, Yamakado 2002, Henkus 2006, Sethi 2006)

Naredo et al (2004) Randomized cohort of 41 patient blind vs US guided subacromial steroid injection. VAS ($p=0.001$) & SFA($p=0.012$) significantly better in US guided group

US guided shoulder injections for subacromial bursitis

- US guided injection technique can result in significant improvement in shoulder abduction ROM one week after injection vs. the blind technique

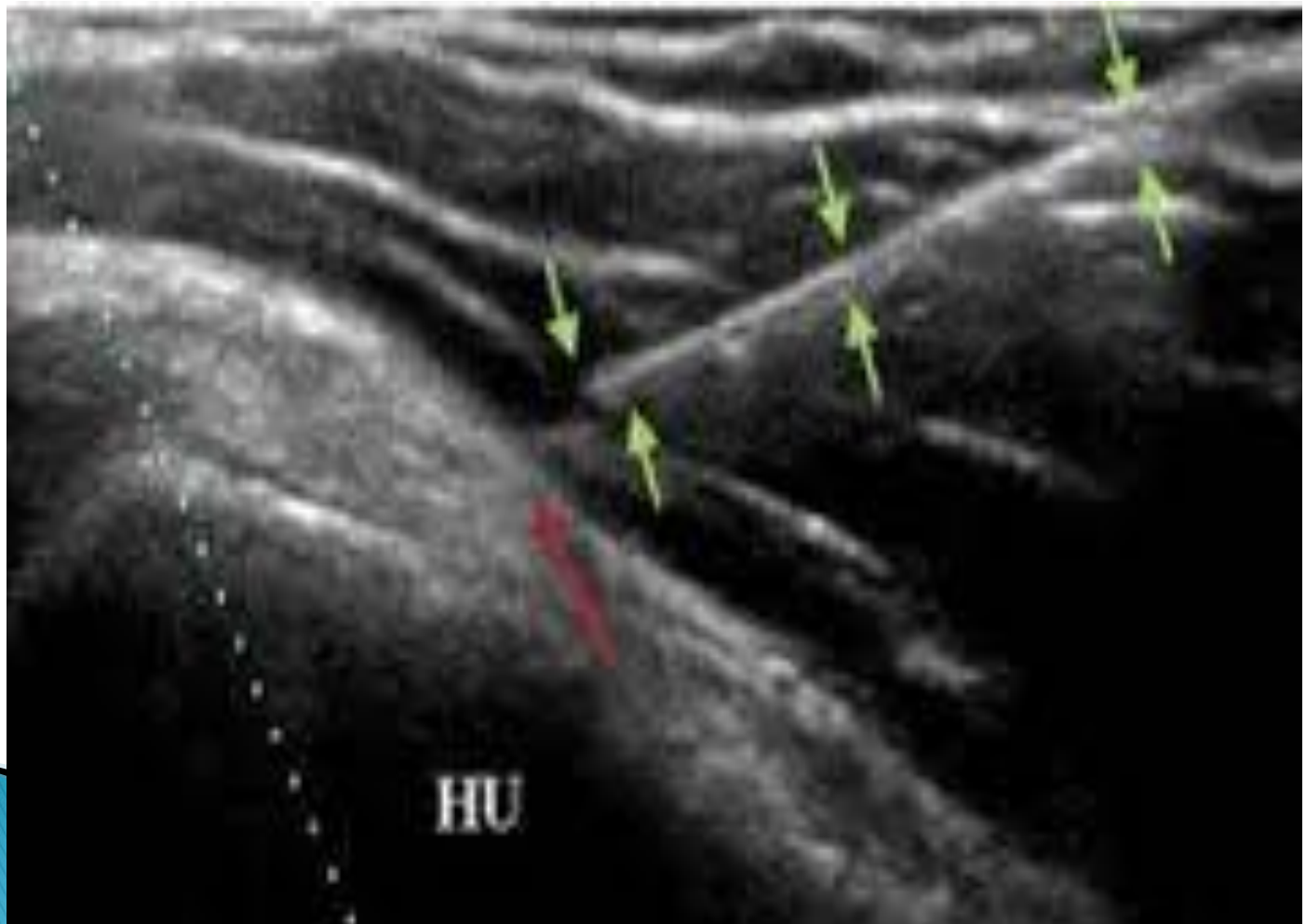
Chen, Am J PM&R, vol 85:1:2006


Seacoast Area Physiatry
L14-5/38-SUP-Shoulder
05/29/2008
04:54:02PM
Harmonics
Freq H10.0MH
Depth 3.0cm
Sector 100%
Gain 57%
FR High
FPS 25 Hz
Dyn 80dB
Persist 2
Map 5
Chroma 0
Power 0
MI<1.05
Clarity High
RT SUPRASPIN SAG
1181 / 1365
[1 ... 1365]

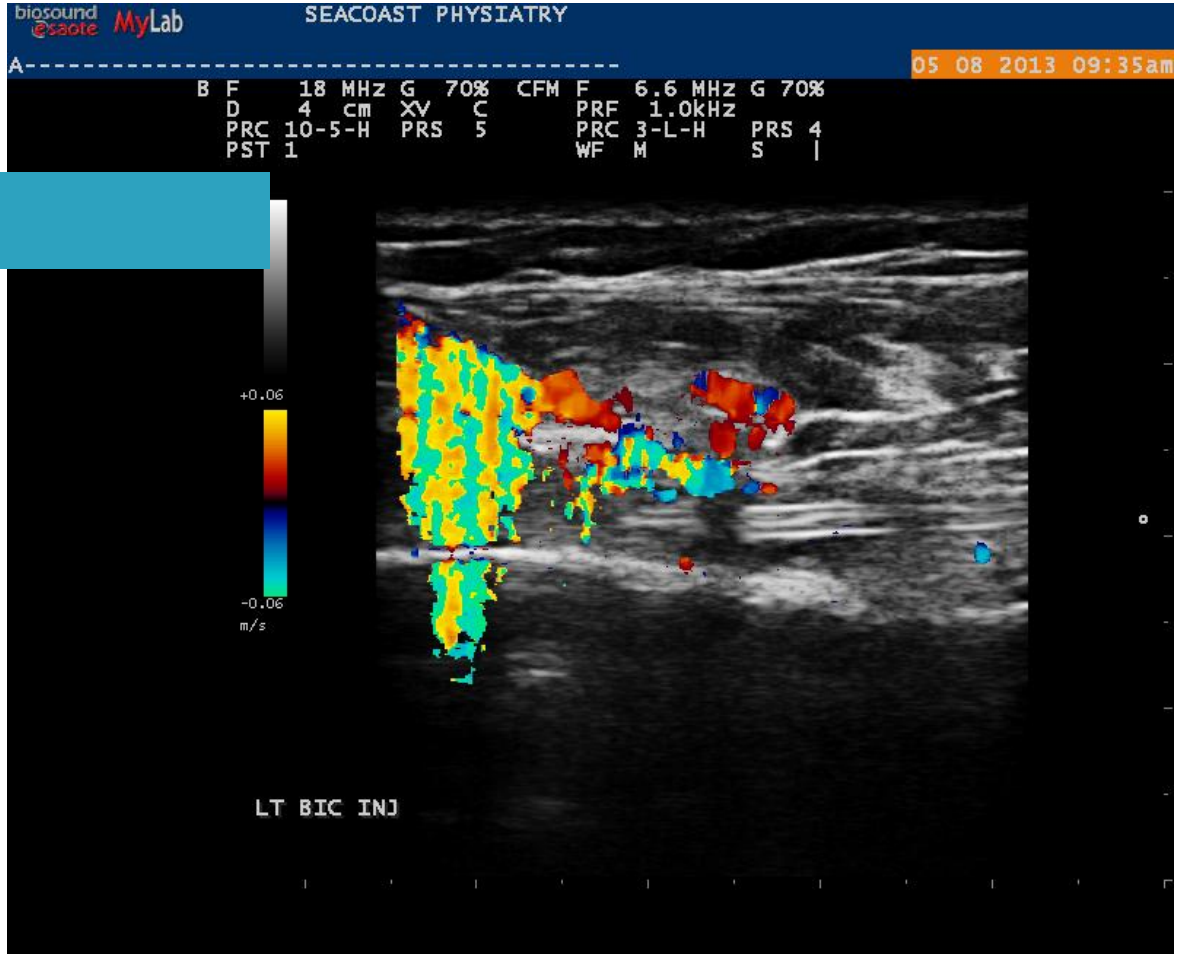
Advantages of MSK US for injections

- Possibility of identifying vascular structures, nerves and tendons and avoiding them
- Insures that injectate is delivered to the proper location

Biceps tendon sheath injection



Biceps injection



Mean Echo Intensity (Pillen, Muscle Ultrasound in Neuromuscular Disorders, Muscle and Nerve, June 2008).

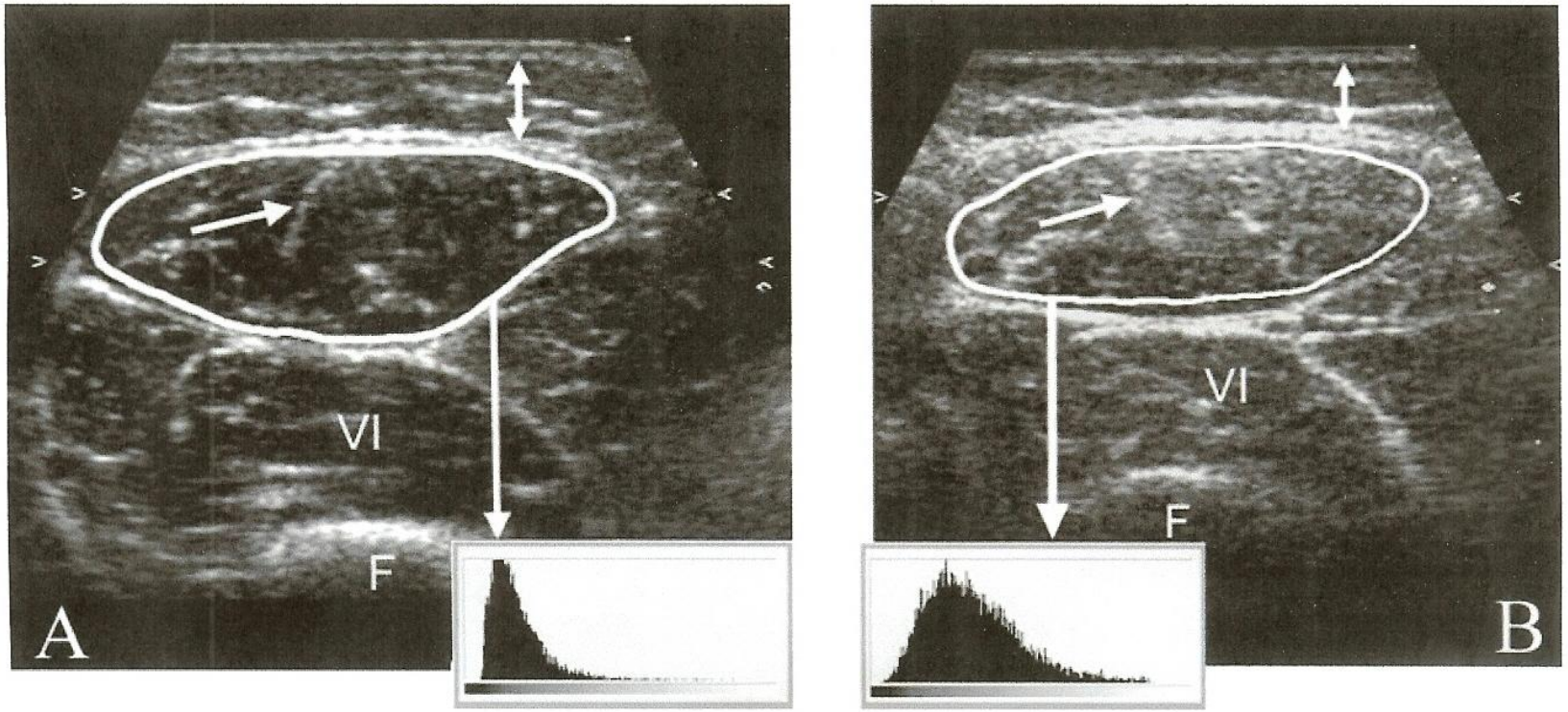


FIGURE 6. Transverse ultrasound image of a normal left quadriceps muscle **(A)** and of a patient with Duchenne muscular dystrophy (DMD) **(B)**. Both are 3.5 years of age. The rectus femoris muscle is encircled. The mean echo intensity is measured for this region, as shown in the histograms below (scale: black = 0; white = 255). The rectus femoris of the DMD patient has increased muscle echo intensity, with the corresponding histogram being displaced to the right. Note the fine granular pattern of echo intensity, homogeneously spread among the muscle with attenuation of the ultrasound beam; that is, the echo intensity in deeper areas of the muscle is decreased compared to the superficial areas. Fascia within the muscle, such as the central fascia in the anterior part of the rectus femoris (single arrow), are more difficult to recognize in the DMD patient. VM, vastus medialis; VL, vastus lateralis; VI, vastus intermedius; F, femur; double arrow, subcutaneous tissue. The quadriceps muscle was measured halfway along the line from the anterosuperior iliac spine to

Ultrasound evaluation of nerves

- Numerous studies published on the utility of MSK US in evaluating peripheral nerves and plexi
- Appear echogenic, well-seen internal structure similar to tendons but slightly less orderly arrangement, less anisotrophy
- Cartwright, “Cross Sectional Area Reference Values for Nerve Ultrasonography” Muscle and Nerve 37:5:566-71, 2008

Assessment of soft tissue masses

- Excellent for differentiating: cystic, solid, fluid, calcific, foreign body, vessel, inflammation
- Never diagnose soft tissue masses on US in the office, always consider MRI or US guided biopsy
- Additional data may be obtained with contrast enhanced US which is being researched currently
- Lipomas-poorly defined with infiltrative appearance-MRI is better but US is sufficient to do a guided biopsy (Fornage, "The Case for Ultrasound of Muscles and Tendons", Seminars in Musculoskeletal Radiology, 4:4:375-91, 2000)
- Hemangiomas-MRI superior (Fornage)
- Tumors (sarcomas)-color doppler, confirm with MRI

Platelet Growth Factor Overview

Platelet Derived Growth Factor (PDGF)

- Released by the activated platelets.
- Powerful chemoattractant.

Transforming Growth Factor – Beta (TGF-β)

- Plays a major role in matrix formation and healing.

Vascular Endothelial Growth Factor (VEGF)

- Stimulates endothelial growth and angiogenesis

Fibroblast Growth Factor (FGF)

- Family of growth factors involved in angiogenesis, wound healing

Epidermal Growth Factor (EGF)

- Linked to angiogenesis and collagen deposition at wound sites.
- Shown to stimulate wound repair in fibroblasts and epithelial cells.

Insulin-life Growth Factor – 1 (IGF-1)

- Cellular recruitment
- Orchestrator of cellular proliferation

Procedure

PRP

- Made from anticoagulated blood
- Citrate is added to whole blood to inhibit the clotting cascade, then it is centrifuged
- Process first involves separating the red and white blood cells from the plasma and platelets
- Second centrifugation produces the PRP which then needs to be clotted to allow for platelet activation and the release of growth factors

Sports Medicine Applications

Efficacy in Surgery:

Everts 2008- Exogenous Application of Platelet-Leukocyte Gel during Open Subacromial Decompression Contributes to Improved Patient Outcomes

- Magellan Based
- Open Subacromial Decompression in 20 pts w/ P-gel & 20 w/o
- The tip of the p-gel application device was placed in the subacromial space before closing the deltoid layer & sub-q tissue. Before skin closure, 10ml was applied intracapsular, device was removed & 3ml of p-gel was sprayed over sub-q tissue.
- Pts w/ P-gel had less pain, improved ROM, performed more ADLs & recovered faster.

Multicenter, retrospective review- US guided PRP for tendinopathy

- Mautner ets als did 180 US guided PRP injections for tendinopathy refractory to conventional treatments with symptoms a median of 18 months.
- 82% reported moderate (>50%) to complete improvement in symptoms. Injection sites were lateral epicondyle, achilles, and patellar tendons, rtc tendons, hamstring, gluteus medius, and medial humeral epicondyles. 60% received 1 injection, 30% received 2 injections and 10% received 3 or more injections (PMR Feb 2013:5:169-75)

Athletes who have gone public with PRP use

Rotator Cuff Repair

- Randelli evaluated 14 patients who had arthroscopic RTC repairs augmented with intraoperative application of autologous PRP in combination with an autologous thrombin component after repair.
- Conclusions: VAS, UCLA scores, and Constant scores all significantly improved at each time interval compared to presurgery scores. (No control group and no radiographic or ultrasound follow up to assess for tendon healing)

50 yo female s/p rtc repair 6 months prior, acute onset of pain. Anterior aspect of left supraspinatus 5/2013

Transverse view of left supraspinatus

Doppler left supraspinatus sagittal-note the inflammation

PRP injection 6/5/13

Post PRP 8/29/13

Post PRP 9/9/13

Post PRP protocol

- It is important to emphasize that NSAIDs and aspirin should not be used for post injection pain control as these medications will inhibit the necessary inflammatory phase. (An exception is the use of low-dose aspirin for cardiovascular conditions.)
- Clearly explain to the patient that he/she may have significant pain for up to 3 weeks, although the pain usually improves after a few days.

Post PRP protocol

- While patients may keep the injected part relatively immobilized for comfort for the first 2 days, early gentle ROM activity is encouraged. Acetaminophen, tramadol, or opioid analgesics may be used during the first few days as needed. The use of ice is generally discouraged, though not absolutely prohibited.

Post PRP protocol

- Physical therapy or guided home exercise is encouraged starting at the 3-6 week point, with emphasis on ROM and lower load resistance or weight training.
- Resistance/weight training should emphasize the eccentric or “negative” aspect of the exercise, and should use lower weights with higher repetitions (15-20 reps).

Post PRP rehabilitation protocol

http://www.uwhealth.org/files/uwhealth/docs/sportsmed/sports_med_PRP.pdf

Contraindications to PRP

- **Absolute contraindications**
- Platelet dysfunction syndrome
- Critical thrombocytopenia
- Hemodynamic instability
- Septicemia

Relative contraindications to PRP

- Consistent use of NSAIDs within 48 hours of procedure
- Corticosteroid injection at treatment site or systemic use of corticosteroids
- Tobacco use
- Recent fever or illness
- Cancer- especially hematopoietic or bone
- HGB < 10 g/dl
- Platelet count < 105/ul
- Any other condition that interferes with healing response (poorly controlled diabetes, nutritionally compromised, etc)

Questions for the future

- Rigorous, randomized controlled studies needed.
- Insurance coverage?
- Since PRP contains growth factors such as IGF-1 and mechano growth factor, some amateur and professional athletes under the rules of antidoping agencies, are prohibited from using PRP intramuscularly

Anti Doping agencies-note these agencies do not have jurisdiction over US professional athletes-thus PRP is not banned by professional leagues

- In 2009, the World Antidoping Agency met and determined that PRP will be prohibited when given via the intramuscular route, but local injections at a site of injury at other routes will require a declaration of use in compliance with the International Standard for Therapeutic Use Exemptions
- In 2009, the US Antidoping Agency issued an athlete's advisory that a PRP injection is equivalent to an injection of growth factors and an athlete needs a TUE if a a medical professional determines it is necessary

MSK Certification/Accreditation?

- The lack of defined training standards and educational oversight, combined with the dramatic increase in the utilization of MSK US by non-radiologists, has resulted in the Centers for Medicare and Medicaid Services (CMS) and other third party payers increasingly scrutinizing who is performing MSK US, and what type of training is received
- Certification is Individual (through ARDMS)
- Accreditation is for the Practice (through AIUM)

Eligibility for Practice Accreditationmerican Institute for Ultrasound Medicine

- Complete a residency or fellowship with MSK training and at least 100 completed studies
- OR document subsequent involvement in the supervision and/or performance, interpretation, and reporting of 100 diagnostic MSK ultrasound examinations within the previous 36 months, plus 30 CME hours credits specific to MSK ultrasound, including at least one ultrasound course that provided hands-on training in MSK applications
- Case Study submission

Maintenance of AIUM practice accreditation

- Perform at least 50 MSK US studies per year
- 10 hours of CME every 3 years
- Case study submissions

American Registry for Diagnostic Medical Sonography (ARDMS) is an independent, not-for-profit organization founded in 1975

- Individual practitioner MSK US Certification

Individual MSK US ARDMS Certification–leads to RMSK certificate

- Active Certification or License in a Health Field
- Performed and/or authorized diagnosis of a minimum of 150 MSK ultrasound studies within the preceding 36 months (case log)
- No more than 5% (8 cases) of the 150 case log requirement can be labeled as therapeutic (injection or aspiration)
- Minimum of 30 MSK ultrasound specific CMEs
- 200 question examination

Practice Certification-AIUM

- Excellent practice guidelines on how to perform an MSK US Examination:

  http://www.aium.org/resources/guidelines/musculoskeletal.pdf

MSK US Free CMEs

- American Institute of Ultrasound in Medicine (AIUM) (Members)
- eRADIMAGING (Members)
- International Center for Postgraduate Medical Education (ICPME)
- myCME
- SDMS (Members)
- Sono World

MSK US CMEs for a fee

http://www.ardms.org/registrant_resources/cme_general_information/cme_general_information

Obstacles to MSK US use (Survey of American Rheumatologists in 2008, n=570 respondents)

- Operator/reader variability vs. other imaging modalities
- Initial cost of purchasing equipment (15-30k)
- Fear of inadequate reimbursement for labor intensity
- Lack of support for training
- Doubt about its utility and impact on patient care

(Samuels Bull NYU Hosp Joint Disease, 2010;68(4):292-8)

Avg. US reimbursement for procedure codes

- 76881 US Extrem Complete:$143.98
- 76882 US Extrem Limited: $55.31
- 76942 US guidance for needle placement-aspiration/injection/biopsy: $76.38
- 20600 Arthrocentesis, aspiration and or injections: small joint or bursa: $61.72
- 20605 Arthrocentesis : intermediate joint or bursa: $70.61
- 20610 Arthrocentesis: large joint or bursa:$75.90

Conclusion: more research is needed to validate the expanding roles of MSK US.

Demo?

Thank You