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A SONOGRAPHIC CASE REVIEW OF PATHOLOGIES AROUND THE SHOULDER JOINT

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ABSTRACT

The shoulder is one of the most problematic musculoskeletal regions and can generate pain and disability when associated with pathologies of rotator cuff (RC) or non-rotator cuff (NRC) structures. Musculoskeletal ultrasound (US) has become an important diagnostic tool to visualize these entities in a dynamic, real-time and cost-efficient manner compared to other imaging options, such as MRI or arthroscopy.

Ultrasound can confidently identify key findings such as fluid in the anatomical bursae or joint, changes in the symmetry of a torn bursa, and thinning and disruption of rotator cuff tendons.

Our pictorial review showed partial and full tears of the infraspinatus and supraspinatus tendons, impingement, and fluid within the subacromial-subdeltoid bursa, biceps, and calcific tendinopathy among other findings. Our approach is to have a structured way of examining the shoulder joint, in a stable position as well as during a range of dynamic movements. The tendons and structures are interrogated in transverse and longitudinal planes and images are recorded.

The limited experience of many operators in our environment requires that sonographic protocols are standardized, with emphasis on improved training and the use of advanced imaging techniques like elastography and contrast-enhanced ultrasound, to enhance diagnostic capabilities.

Our review has reinforced the importance of Musculoskeletal ultrasound in identifying major changes such as partial and full tears of the infraspinatus and supraspinatus tendons, impingement, and fluid within the subacromial-subdeltoid bursa, biceps, and calcific tendinopathy, among other findings. Furthermore, the use of standardized protocols by an experienced operator would improve diagnostic confidence and yield.

Keywords: rotator cuff, non-rotator cuff, ultrasound, tendon tear, shoulder pathology

Introduction

The shoulder is a very important joint, owing to its mobility and constant use during most physical activities. It is therefore frequently affected by Musculoskeletal disorders, involving both the rotator cuff (RC) and non-rotator cuff structures. These disorders may cause pain and adversely affect the function of the joint. Ultrasound is a ready choice because it is cheap, available, and can demonstrate joint structures in real time. Our article is a pictorial demonstration of rotator cuff tears, biceps tendinopathy, subacromial-subdeltoid (SA-SD) bursitis, calcific tendinopathy, and acromioclavicular (AC) or glenohumeral joint degeneration. Furthermore, it shows the normal anatomy, distinguishes partial from full-thickness tears, and shows fluid collections in the SA-SD bursa and biceps tendon sheath (Zappia et al., 2021). Ultrasound also allows the diagnosis of other pathologies such as tenosynovitis, glenohumeral effusion, suprascapular ganglion cysts, nerve entrapment syndromes, and space-occupying lesions (Chang et al., 2019). The possibility of demonstrating real-time tendon motion, joint stability, and impingement, guides decisions and treatment plans. Considering the challenges of operator and observer dependence, our review emphasizes the standardization of sonographic protocols to improve repeatability and follow-up using ultrasound.

Sonographic techniques

It is important to understand the shoulder anatomy before conducting ultrasound studies.

Our technique involves keeping the patient in a stable and comfortable position. The forearm is placed facing forward and the elbow is flexed up to 65-90-degree. The sonographer accesses the rotator and non-rotator cuff structures from the front or back of the shoulder. A linear probe with an appropriate footprint and high frequency of 7-12 MHz provides the fine resolution required.

All the tendons and muscles are scanned in transverse and longitudinal planes, noting their fibrillar echogenicity and structural continuity. Scan is conducted in a dynamic manner with movement of the shoulder joint in abduction, adduction as well as internal and external rotations can provide insights into the functional range of tendons and help identify abnormalities.

For a complete evaluation, the following structures ought to be examined:

(a) A group of four muscles and tendons - subscapularis, supraspinatus, infraspinatus, and teres minor (rotator cuff structures)

(b). The teres major and the long head of the biceps muscles and tendons non-rotator-cuff structures)

© The various bursa around the shoulder joint (especially the subacromial Subdeltoid bursa)

(d). The outlines and regularity of glenohumeral and acromioclavicular (ACJ) joints.

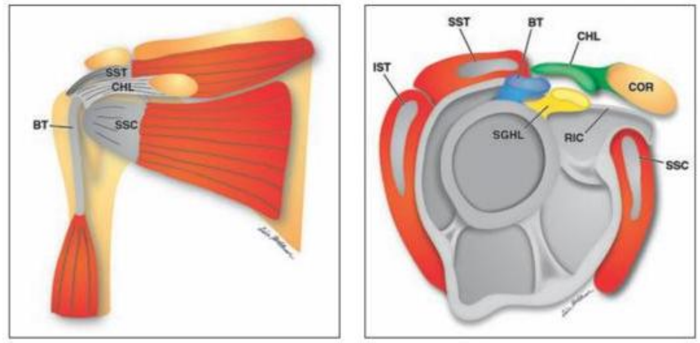

Figure 1: Illustration of normal anatomy. BT: Biceps tendon; SST: Supraspinatus tendon; CHL: Coracohumeral ligament; SSC: subscapularis tendon; IST: Infraspinatus Tendon; RIC: Rotator interval capsule; COR: Coracoid process

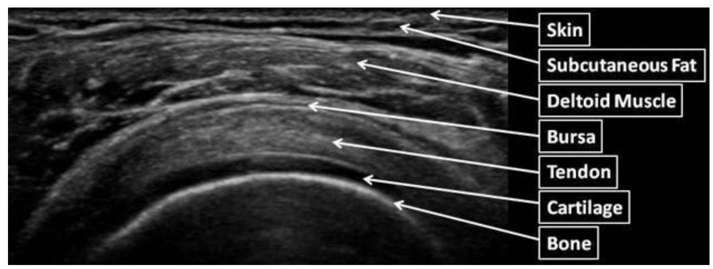

Figure 2: Sonographic illustration of normal anatomy

Methodology and Sonographic Techniques

Patient preparation and Positioning: The patient adopts the best comfortable position, often seated with the arm in 5-10 degrees of abduction and slightly rotated externally to localize the shoulder joint. A warm gel is generously applied to improve the coupling and quality of the image.

Equipment Setup: Ultrasound equipment with high resolution, equipped with both power and Color Doppler settings is ideal for MSK ultrasound. Our equipment is a Logic P9 advanced ultrasound machine, manufactured by GE Health Care, USA. The presence of advanced algorithms such as elastography and Color Doppler features, would improve the confidence level of sonographers. A linear transducer with a high frequency (7-12 MHz range and suitable footprint) is ideal to ensure a high resolution.

Sonographic planes: It is recommended that each structure is interrogated in both transverse and longitudinal planes, for contiguity and to assess the linear fibrillar pattern of muscles and tendons. The joint spaces are examined for irregularities, space narrowing, or fluid collections. Images of each examined structure are taken and stored for documentation. Where necessary, a comparison with the contralateral joint is usually required. Doppler interrogation of lesions and suspicious structures is performed to confirm inflammation.

Dynamic Assessment: This implies that a scan can be performed while actively moving the joints and is a unique advantage of MSK. The patient may be asked to move the affected arm/joint, away and towards the body. In some cases, rotation of the arm inwards and outwards is useful when looking for evidence of tendon impingement.

Discussion and Case Reviews

The shoulder joint has a rather unique anatomy and due to its range of activities, disease processes can easily interfere with joint movement and negatively impact activities of daily living. Our pictorial review has once more documented the salient sonographic features of such conditions, including anterior free edge tears, partial or full-thickness rotator cuff tears, tendon calcifications, and fluid within the biceps tendon sheath or bursae.(Bianchi & Martinoli, 2021; Dinnes et al., 2019).

Rotator Cuff Pathologies

Rotator cuff tears and degeneration

Common pathologies involving the rotator cuff tendons include degenerations or tears and is particularly likely in aged or older adults and individuals with extensive shoulder-related activities. (Dinnes et al., 2020).

The tears may be complete involving the whole tendon or partially involve a segment. The tear can also be at the edges or more commonly in the mid-substance of the tendon. Ultrasound not only allows the location of the tears to be identified, but it is also significant in identifying the extent and types of tears. (Sconfienza et al., 2021). The proper classification above is critical in determining the loss of function and also the type of treatment required. (Teefey et al., 2018).

The figures below describe the various forms of rotator cuff injuries and pathologies.

Anterior Free Edge Tear

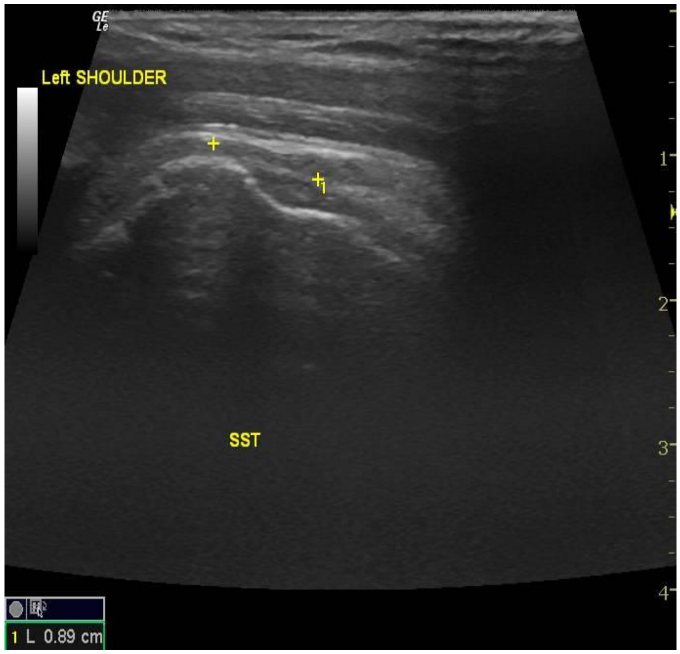

Figure 1 above shows Anterior Free Edge Tear, which is a critical finding

Full Thickness Tear of the supraspinatus tendon (SST)

The differentiation between these types of tears is crucial, as the treatment approach may vary significantly based on the extent and location of the tear (Fukuda et al., 2022).

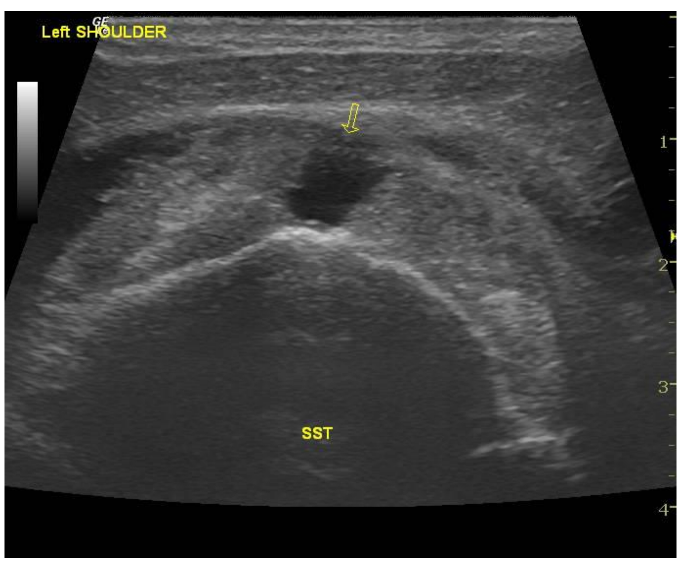

Figure 2A

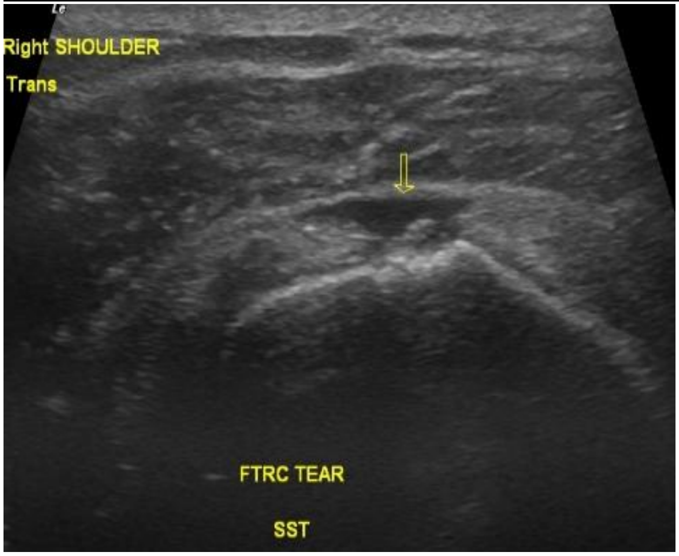

Figure 2B

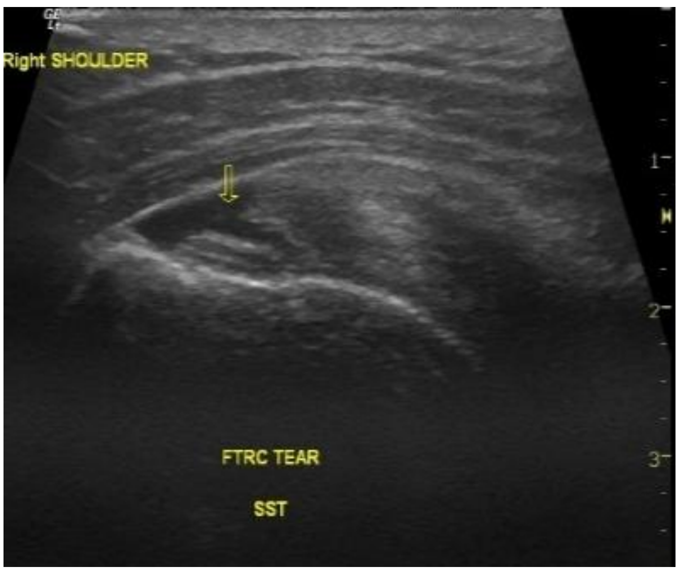

Figure 2C

Tears involving Supraspinatus and Infraspinatus Tendons

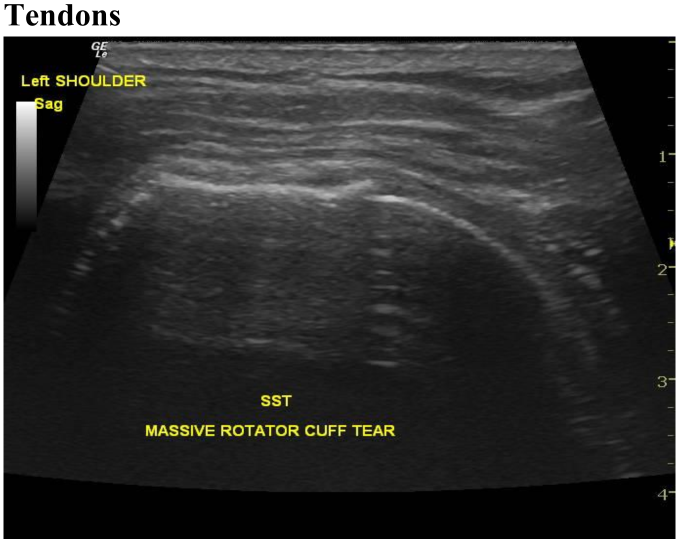

Figure 3A

Figure 3B

Fig 3 (a) and (b) above shows massive tears involving both the Supraspinatus tendon (SST) and infraspinatus tendon (IST)

Partial thickness rotator cuff tears

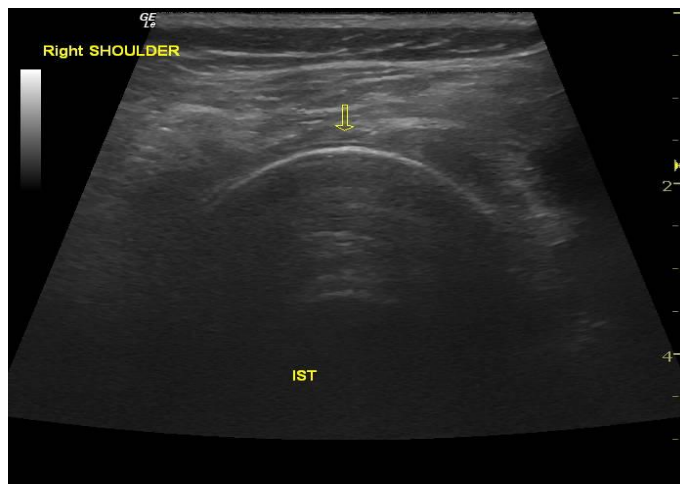

Figure 4A

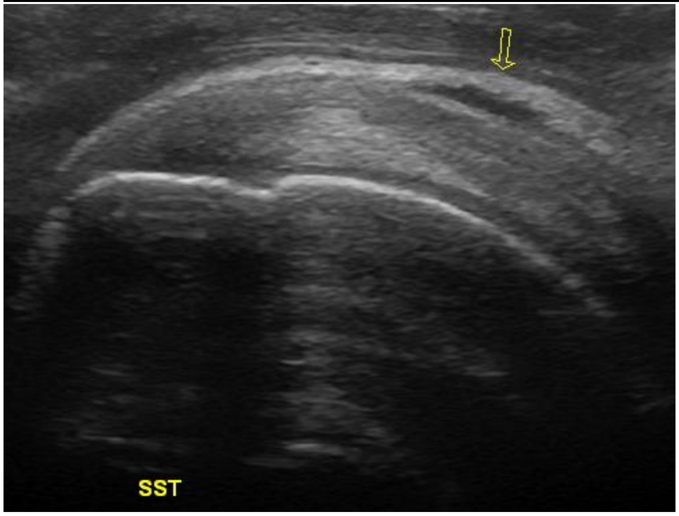

Figure 4B

Mid-substance tear involving the supraspinatus tendon

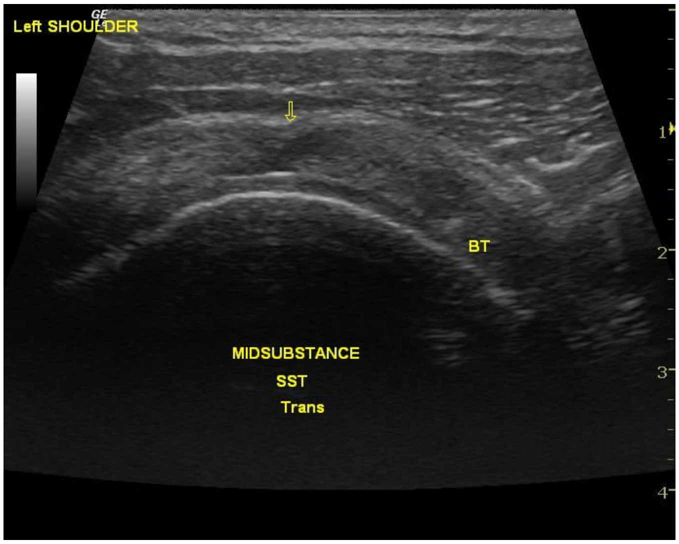

Figure 5A

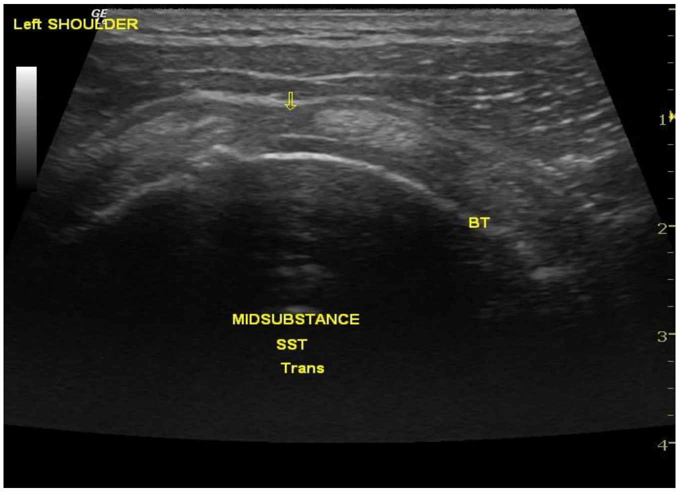

Figure 5B

Forms and locations of calcific tendinopathy

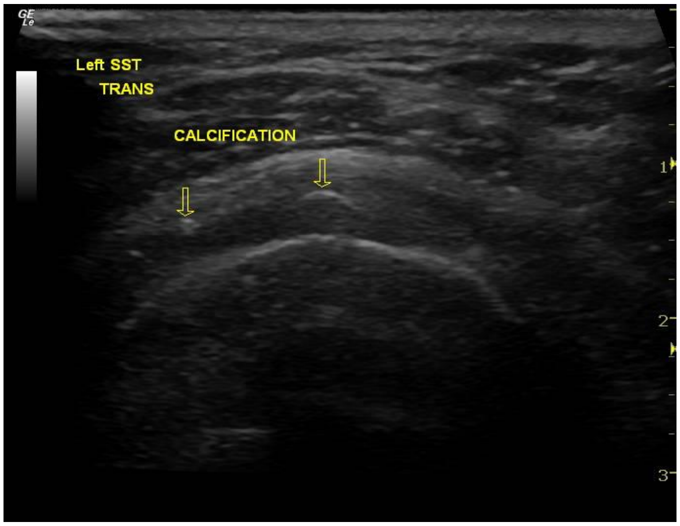

Figure 6A

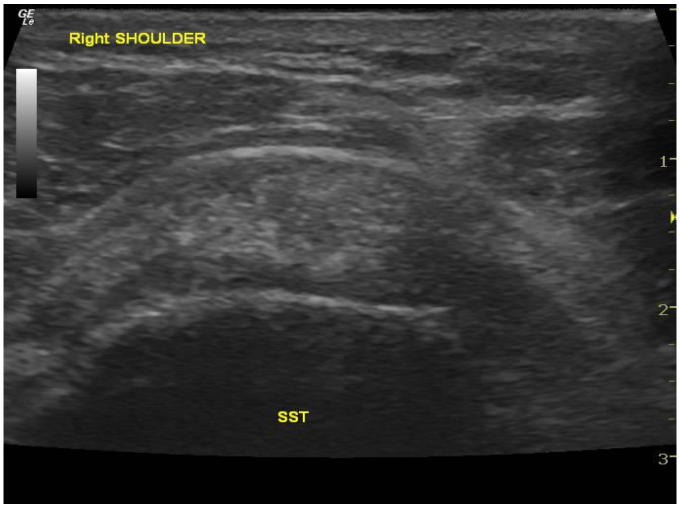

Figure 6B

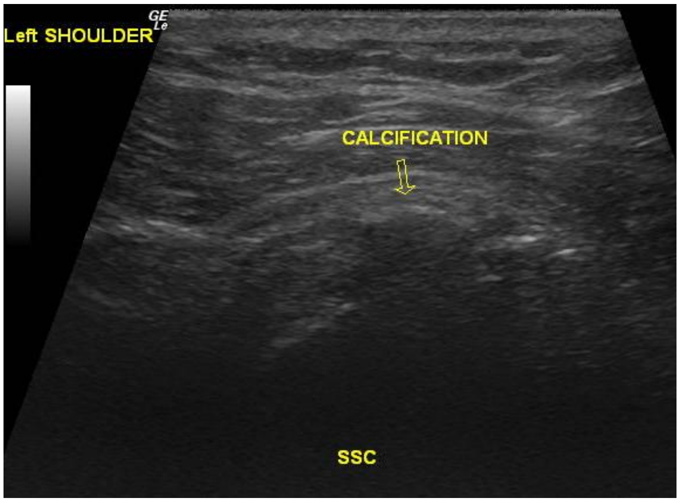

Figure 6C

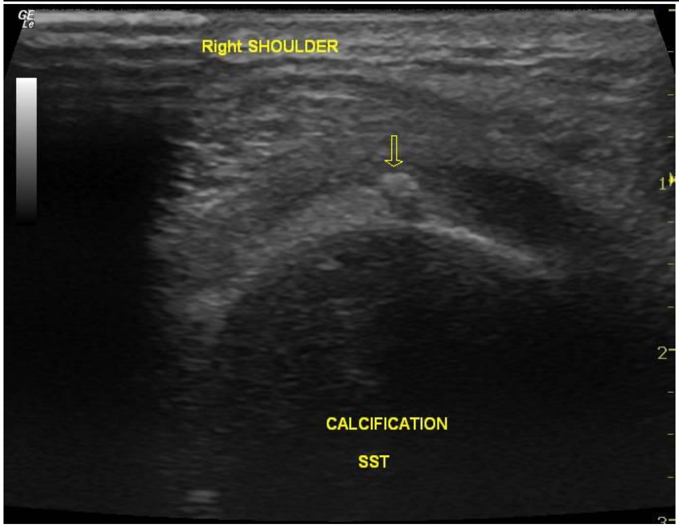

Figure 6D

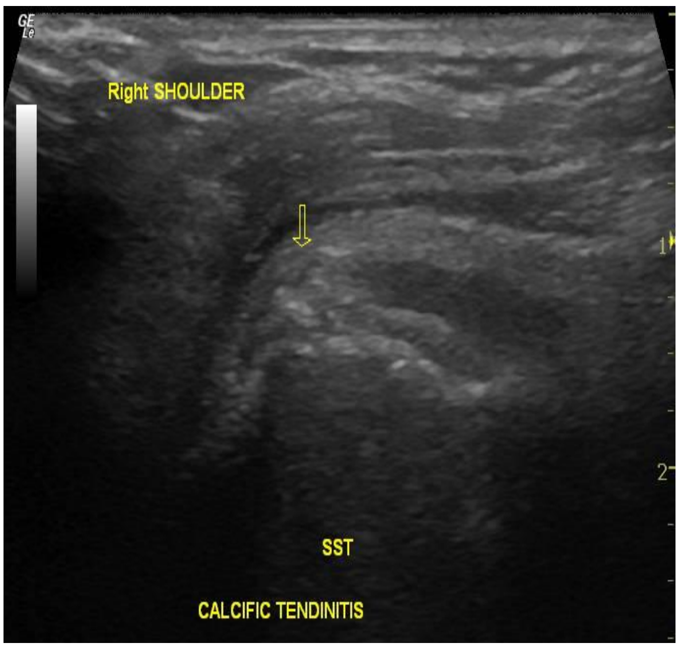

Figure 6E

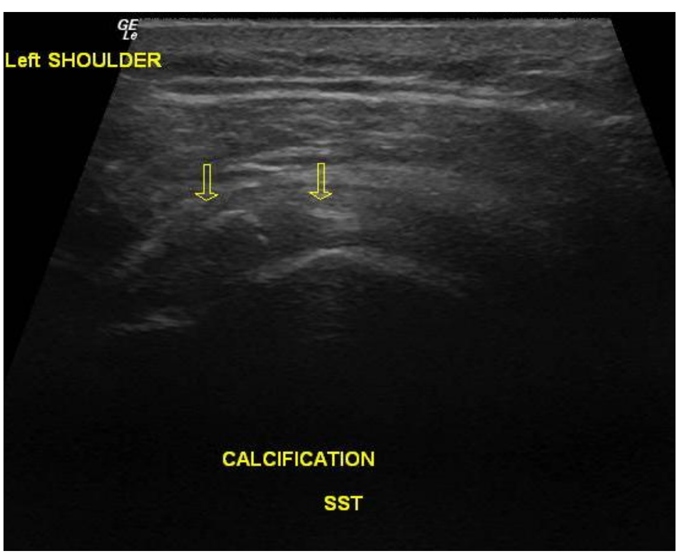

Figure 6F

Complete separation of the tendon as illustrated in Fig 2, is described as full-thickness rotator tear. It is typically a result of long-term degenerative changes that come with age or excessive physical use of the joint, which can create mechanical overload leading to a tear. It is important to make a diagnosis early to ensure healing and treatment. Moreover, decisions regarding the management method will depend on how early the tear is discovered. (Ottenheijm et al., 2020).

(B). Calcific Tendinopathy and Chronic Diffuse Tendinopathy)

Calcification of the supraspinatus tendon was quite common in our case review (fig 6). It results from tiny deposition of calcium hydroxyapatite crystals within the tendons. It appears as an area of echogenic foci, seen within the tendon and may evoke inflammation in the surrounding space causing fluid collection. The latter finding is a pointer to how severe the condition is.

Sometimes, the pattern of changes in the tendon thickness and associated hyper echogenicity may be diffuse because of degeneration, giving rise to chronic tendinopathy. (Louwerens et al., 2020). Calcific tendinopathy can be managed through physical therapy and anti-inflammatory drugs may be necessary if reactive changes occur. Fluid collections will require aspiration under ultrasound guidance. Some authors have reported the use of steroids and platelet-rich plasma (PRP) in non-surgical interventions (Dawson et al., 2021).

NON-ROTATOR CUFF PATHOLOGIES

Joint movement is sustained by the biomechanics of the acromioclavicular (AC) and glenohumeral joints and support from the tendon attaching the long biceps muscle. The structures that form the non-rotator cuff can be affected by disease of the tendon, joint degeneration, or inflammation of the bursae. (Beggs, 2021). Sonographic findings in biceps tendinopathy include abnormal thickening, reduced echogenicity, and fluid within the tendon sheath (Smith et al., 2022). The subacromial bursae are commonly inflamed and may be identified due to fluid collections. (Zhao et al., 2019). In elderly patients, osteoarthritic changes may show noticeable changes such as irregular bone margins, reduced joint space and the presence of bony spurs (osteophytes)

Subacromial-subdeltoid (SA-SD) bursal pathology

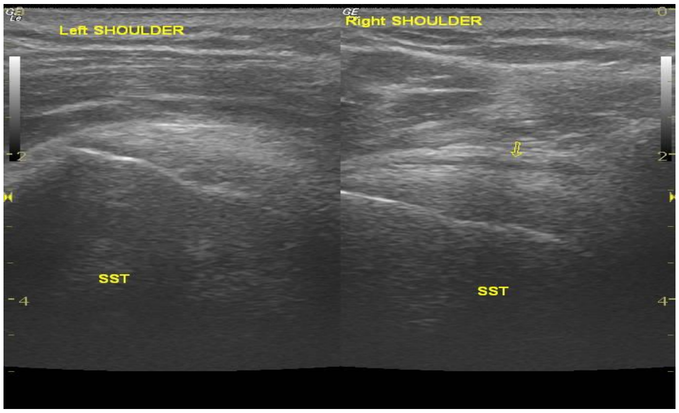

Figure 7A (SST: supraspinatus tendon)

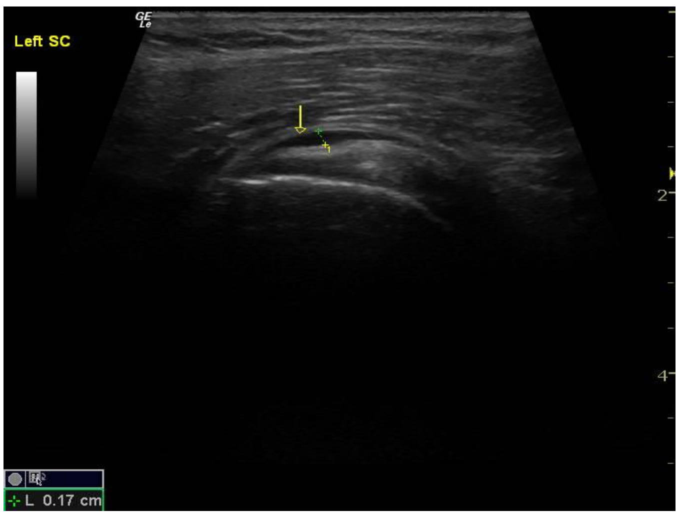

Figure 7B: SA-SD thickening and bursal fluid

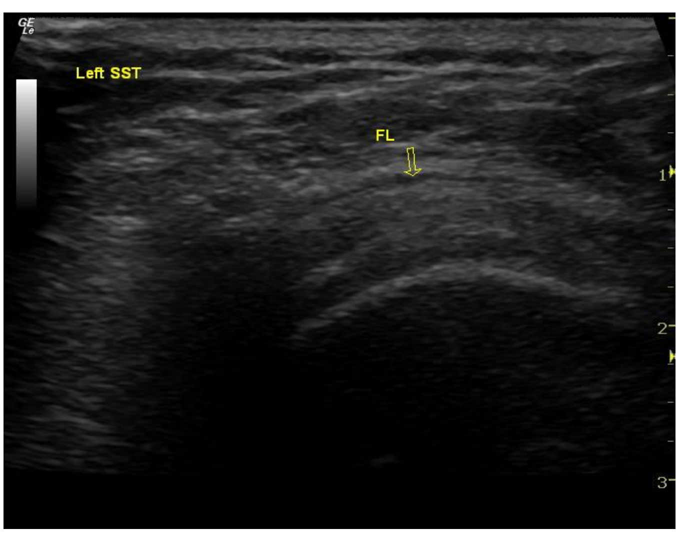

Figure 7C: SA-SD bursal fluid (impingement)

Subacromial-Subdeltoid (SA-SD) Bursal Pathology (Fig 7)

Impingement occurs when the tendon rubs the adjacent bones and is a consequence of continuous inflammation following joint movements, trauma or aging.

The subacromial-subdeltoid bursa is important in ensuring that friction is reduced and may often be the point of impingement. Inflammation and irritation cause the thickening of the s bursa and the accumulation of small amounts of fluid, both of which are visible during ultrasound evaluation (Lambers et al., 2020).

Our review, also indicated unusual concavity of the subdeltoid bursal concavity, following rotator cuff tears. When seen in conjunction with irregularities of the humeral head surface, the changes in the bursa will guide the treatment plan aimed at correcting the structural abnormalities and relieving the symptoms of pain and debilitation (Park et al., 2021).

Bursal fluid

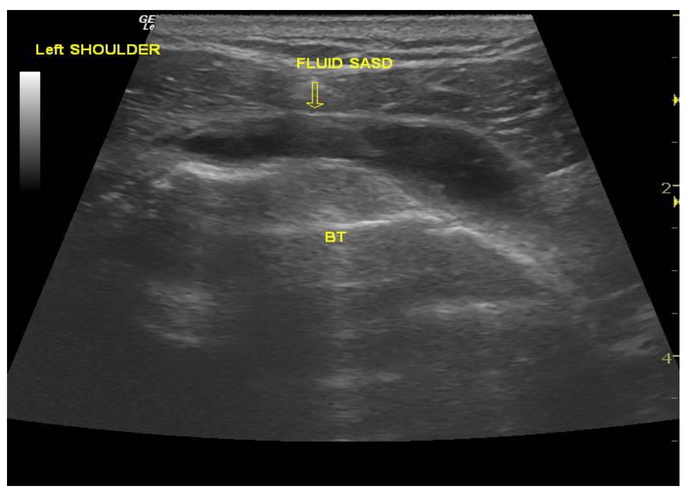

Figure 8A

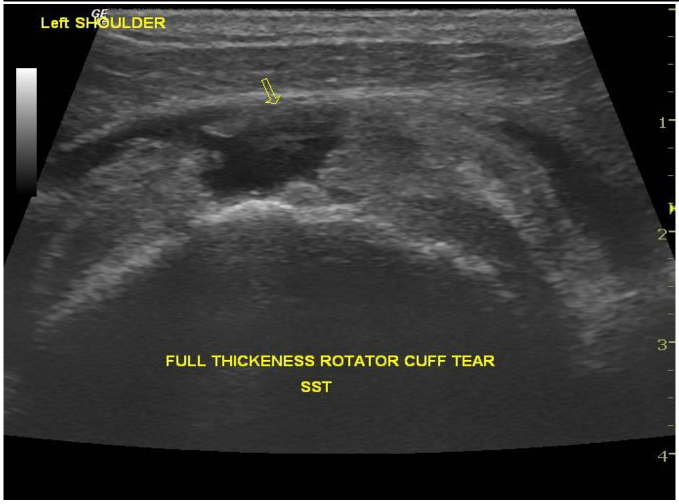

Figure 8B

Fig 8 (A and B) shows bursal fluid outlining margin of tears

Long head of biceps tendon tear

Like the rotator cuff muscles, injuries of the Biceps tendon may also cause pain and loss of function of the adjacent shoulder due to limited mobility. Such injuries may be due to trauma or degeneration and may be recognized due to the presence of effusion within the biceps tendon sheath.

This finding is an indication of tenosynovitis or maybe the only pointer to an associated rotator cuff pathology. Ultrasound is invaluable in determining the position and integrity of the biceps tendon as well as treatment planning following injury (MacMahon et al., 2020).

A combination of a biceps tendon disease and tears involving the rotator cuff is an indication for comprehensive intervention. When contemplated, surgical interventions such as tenodesis are preferable. (Noyes et al., 2021).

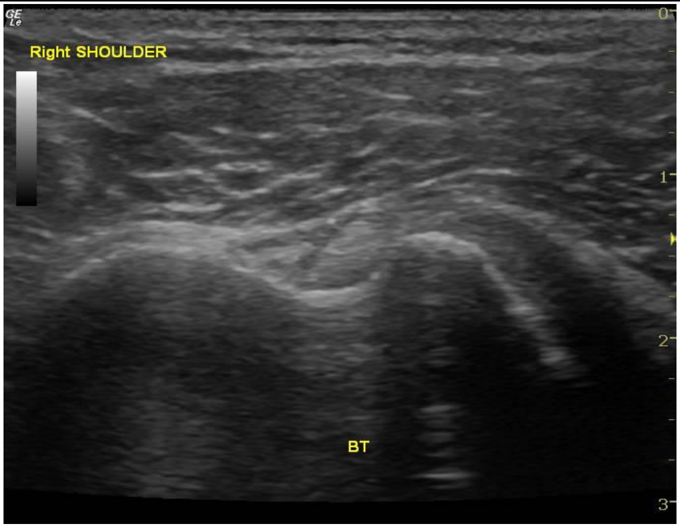

Figure 9A

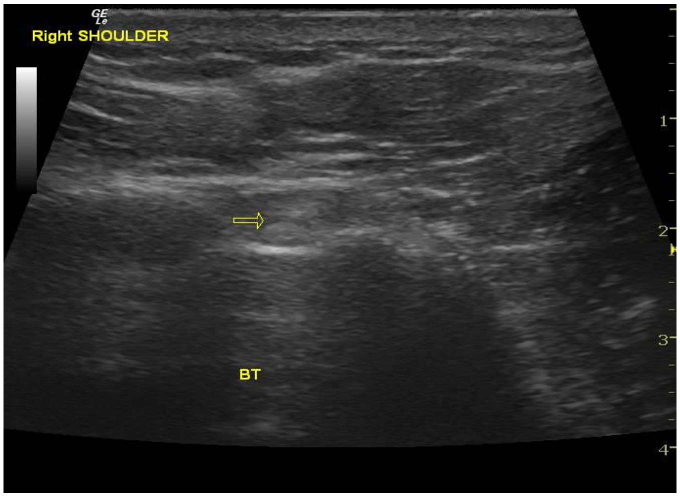

Figure 9B

Biceps tendon Sheath effusions

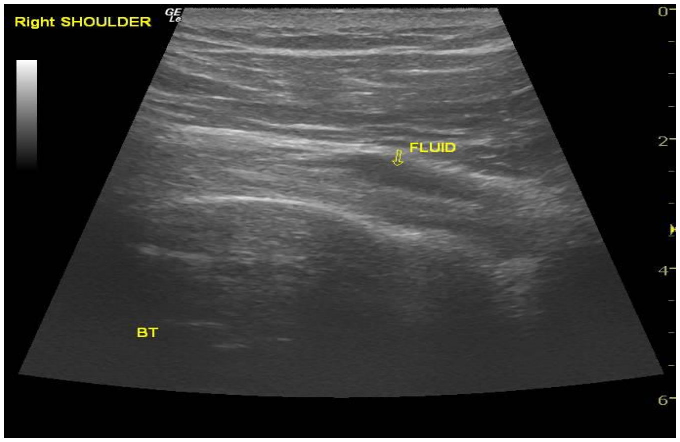

Figure 10A

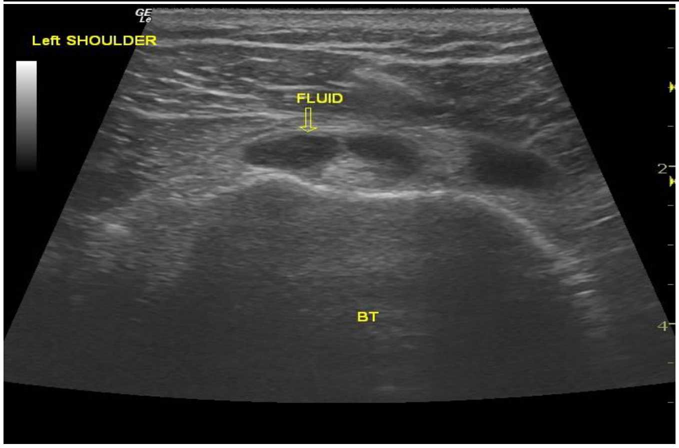

Figure 10B

Fig 10A and 10B shows Biceps tendon sheath effusion

Subdeltoid bursal concavity suggesting a tear

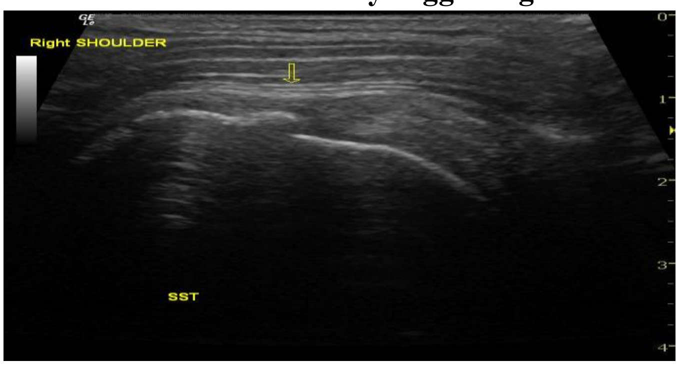

Fig 11: Subdeltoid bursal concavity suggesting a tear

Thickness of Rotator cuff as a sign of pathology

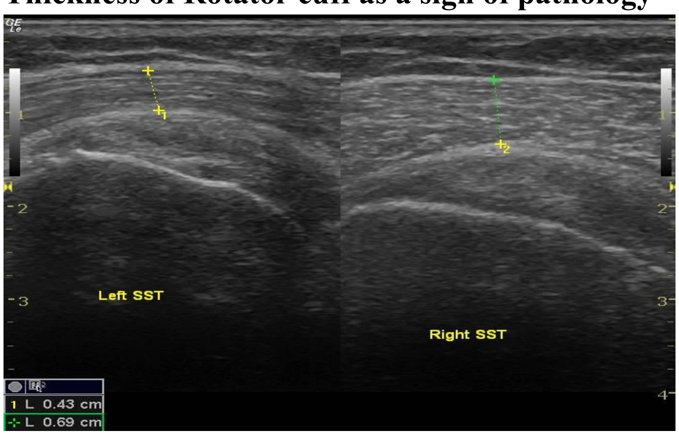

Figure 12: Difference in cuff thickness

Muscle pathology

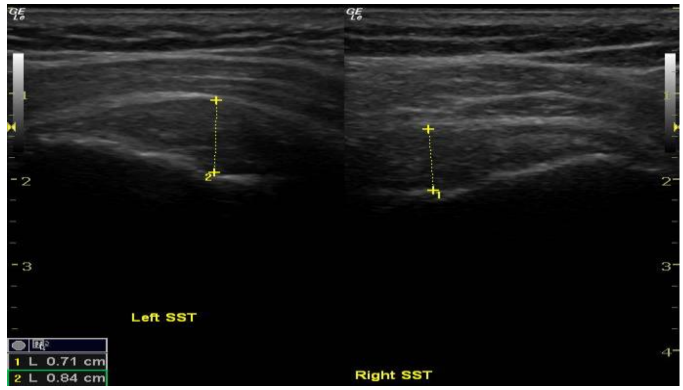

Fig 13: Deltoid muscle atrophy

Degenerative bone disease

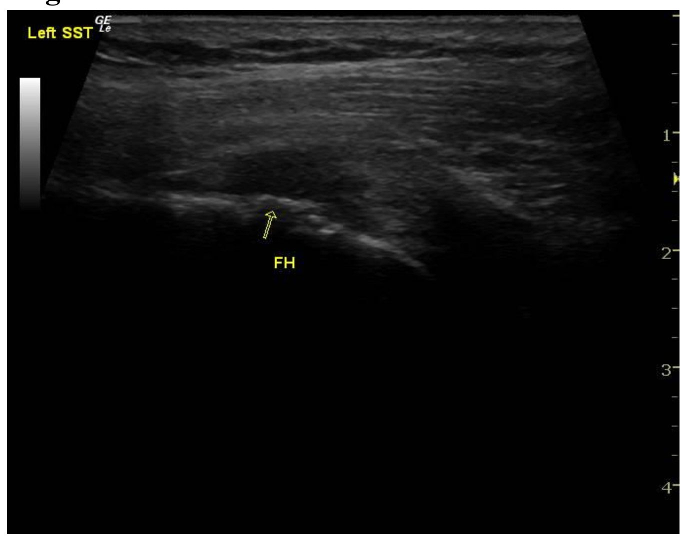

Fig 14: Irregularity of humeral head surface (degenerative)

The pictorial review continues to emphasize the role of ultrasound as a reliable tool in the diagnosis of shoulder pathologies and evaluation of its biomechanics. It has the unique advantage of demonstrating soft tissue structures in a non-invasive and dynamic manner. The absence of radiation and low cost means that ultrasound can be conveniently used for follow-up management. (Sconfienza et al., 2021).

To improve diagnostic yield and outcomes, the sonographer must be skilled and experienced in musculoskeletal ultrasound and should demonstrate a good knowledge of the complex anatomy of both rotator and non-rotator cuff structures. A simplified and standardized protocol for the ultrasound evaluation of shoulder pathologies is required in our environment to reduce the long learning curve. This would improve the reproducibility and reliability of results irrespective of the clinical setting. This is in line with the recommendations of other authors (Beggs et al., 2021). This study advocated continuous medical education and training in musculoskeletal ultrasound, especially for those who evaluate and manage shoulder pathologies (Klauser & Tagliafico, 2020).

Conclusion

Ultrasound of the shoulder, using high-resolution equipment can diagnose a wide spectrum of conditions involving both rotator and non-rotator cuff structures. Although MRI has superior resolutions particularly for deeper structures of the joint, ultrasound provides a real-time, cost-effective alternative. It is hoped that further training and education will aid a seamless integration of ultrasound into routine orthopedic practice in our environment.

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