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Trans-axillary sonography in the ABER (ABduction and External Rotation) position: a window to the subscapularis, teres major and latissimus dorsi

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Abstract
Shoulder ultrasound is a key tool used by musculoskeletal practitioners to diagnose and treat a variety of upper girdle diseases. While magnetic resonance imaging is the cornerstone of shoulder imaging, sonography is readily available, practical and superior in its ability for dynamic assessment of musculoskeletal pathologies. The subscapularis, teres major and latissimus dorsi muscles are commonly involved in a myriad of pathology including myofascial pain and spasticity. There is scarce literature on the assessment of these muscles for diagnostic and therapeutic purposes. Conventional approaches to shoulder ultrasound have not included a dedicated assessment of the subscapularis muscle due to its inherent anatomical location deep to the scapular blade which blocks sound wave penetration. We describe an approach to visualizing the subscapularis muscle as a short addition to the established shoulder sonography format, which also permits assessment of both the latissimus dorsi and teres major muscles, which are important muscles for shoulder spasticity. The patient is imaged in a semi-recumbent position with the arms elevated above and behind the head in the ABduction and External Rotation (ABER) position. The relative ease of positioning and sonographic access to the musculature coupled with the potential for assessment and intervention makes this approach extremely desirable to the musculoskeletal practitioner looking to diagnose or treat muscle belly pathologies of the subscapularis, teres major or latissimus dorsi.

Keywords Ultrasound · Rotator cuff · Subscapularis · Trans-axillary

Introduction

Shoulder ultrasound is a key tool used to diagnose and treat a variety of upper girdle diseases. While magnetic resonance imaging is the cornerstone of shoulder imaging, sonography is readily available, practical and superior in its ability to dynamically assess musculoskeletal pathology. It is the new recommended standard of care of the guidance of injections for spasticity along with e-stimulation for botulinum toxin, phenol and alcohol, anesthetic blocks and cryoneurolysis [1, 2].

A variety of scanning techniques have been described in the assessment of shoulder pathology. Traditional diagnostic approaches to shoulder sonography include anterior, posterior and superior approaches [3]. The European Society of Skeletal Radiology published a consensus statement on an approach to shoulder sonography to standardize assessment [4]. This includes an assessment of the tendons and muscle bulk of the rotator cuffs namely supraspinatus, infraspinatus and teres minor, periarticular structures and ligaments in a reproducible technique. These techniques however do not allow for ready assessment or targeting of certain integral muscle groups in the shoulder; particularly the latissimus dorsi, subscapularis and teres major which represent

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common injection targets for the treatment of shoulder spasticity [5].

In addition to therapeutic applications, sonography of the shoulder also adds prognostic information. This is especially evident in predicting surgical outcomes for rotator cuff repair [6]. Tear morphology, muscle atrophy and fatty infiltration are evident on ultrasound and impact functional results postoperatively [6–8]. Interestingly, there is scarce literature on the assessment of the subscapularis muscle itself for diagnostic and therapeutic purposes. Partly, conventional approaches to shoulder ultrasound have not included the assessment of the subscapularis muscle due to its inherent anatomical location deep to the scapular blade which blocks acoustic transmission. In our experience, the subscapularis muscle belly along with latissimus dorsi and teres major are readily visible during trans-axillary sonography, which serves as a window for assessment and a range of interventions. In the realm of rehabilitation medicine, intramuscular treatment of these muscles with botulinum toxin and other nerve targeted procedures are increasingly used for the management of hemiplegic shoulder pain, a frequent condition post-stroke that is attributable to spasticity, myofascial pain and complex regional pain syndrome [9].

Spasticity, painful arthroses and painful cuff pathology pose a series of specific challenges for shoulder positioning. Reduced range of motion due to spastic limbs or arthritic glenohumeral joint may alter the ability to place a probe. Spasticity additionally causes alterations in the echogenicity of muscles, wherein upper neuron disorders result in altered echointensity, fatty infiltration or fibrosis, all of which degrade sonographic image quality [10]. Despite these limitations, even in populations with profound spasticity-related muscle changes and limited range of motion, trans-axillary scanning in the arm abducted and externally rotated (ABER) position provides a matchless window to the axillary musculature.

Discussion

The subscapularis muscle is the largest and strongest muscle of the rotator cuff muscles [11]. The subscapularis arises from a broad attachment of the subscapular fossa along the anterior surface of the scapular blade and attaches at the lesser tubercle with additional fibres blending with the anterior glenohumeral capsule. It is innervated by the upper and lower subscapular nerves and functions to internally rotate and adduct the humerus. Clinically, the lift-off test as described by Gerber and Krushell is employed to assess subscapularis function [12]. Tears involving the subscapularis are frequently secondary to degeneration and impingement [13]. Tendinitis of the subscapularis is commonly seen in overuse from repetitive throwing or overhead movements [14]. In upper motor neuron syndromes, it is implicated in adduction and internal rotation. On sonography, the tendon insertion characteristically appears as a multipennate structure. Routinely, the standard shoulder examination focuses on the tendinous pathology of subscapularis without emphasis on subscapularis muscle bulk. Cross-sectional imaging with computed tomography or magnetic resonance is employed for a complete assessment of the subscapularis and shoulder joint as a whole. Frequently, an ABER-positioned sequence (ABduction and External Rotation) in magnetic resonance imaging is employed to delineate glenohumeral joint pathologies under a stressed view [15]. ABER positioning entails 90 degrees abduction at the shoulder and flexion at the elbow which recreates the position of maximal tension in which the tendon of subscapularis is normally susceptible to injuries in throwing-related sports athletes [16].

The latissimus dorsi tendon extends from the T7-L5 spinous processes, thoracolumbar fascia, iliac crest, lowermost ribs and the inferior angle of the scapula. It inserts onto the floor of the intertubercular groove along the anterior upper humerus and is supplied by the thoracodorsal nerve [17]. The teres major originates from the posterior surface of the inferior border of the scapular blade and inserts onto the medial lip of the intertubercular groove, being supplied by the lower subscapular nerve. The latissimus dorsi and teres major tendons are typically inseparable (conjoined) in imaging, although anatomical dissection studies typically demonstrate some degree of tendinous separation in the majority of patients [18–20].

Shoulder sonography is normally performed in a seated position generally. Scanning typically commences with the shoulder in internal rotation with the elbow flexed and hand supinated to assess the tendon of the long head of the biceps. Subsequently, the subscapularis tendon is assessed with the adducted shoulder in external rotation in both transverse and sagittal planes. Following this, the supraspinatus tendon is assessed with the shoulder in extension and elbow flexed. The infraspinatus and teres minor is evaluated with the hand on the opposite shoulder. Lastly, the muscle bulk of supraspinatus, infraspinatus and teres minor are determined with fanning ultrasound above and below the spine of the scapula. Typically no mention is made of the subscapularis muscle bulk on shoulder sonography. While the subscapularis is a deep structure in a neutral shoulder position, scapulothoracic biometrical studies have demonstrated dynamic positions in which the subscapularis is the most superficial and thus readily imaged [21].

We describe an approach to visualising the subscapularis muscle as a short addition to the established shoulder sonography format, which also permits assessment of both the latissimus dorsi and teres major muscles, as these are desired targets for the management of the spastic shoulder (although the latter two muscles are less frequently targeted in shoulder

Fig. 1 Real time demonstration of sonography with shoulder in the ABER position (ABduction and External Rotation). ABER positioning entails 90 degrees abduction at the shoulder and flexion at the elbow which recreates the best position for maximal visualisation of the subscapularis

assessment). The patient is imaged in a semi-recumbent position with the arms elevated above and behind the head in the ABER position (Fig. 1). This position naturally abducts and externally rotates the shoulder joint bringing subscapularis to a superficial position for assessment (Figs. 2, 3, 4, 5, 6). As combined shoulder pathology from a mixture of cuff pathology and arthrosis frequently co-exist, it is prudent that the patient is supported in an inclining bed with arm supports used for further comfort and stability. Spastic patients may need assistance to help with this position due to hypertonicity and paresis, and the arm is abducted as much as possible. Placing the patient palm up under their head may also facilitate stable positioning in non-spastic patients. In our experience, this ABER trans-axillary approach is well tolerated even in patients with glenohumeral arthropathy, rotator cuff pathology, hemiplegic shoulder pain and spasticity. Axillary fold hair seldom impedes image quality, and as

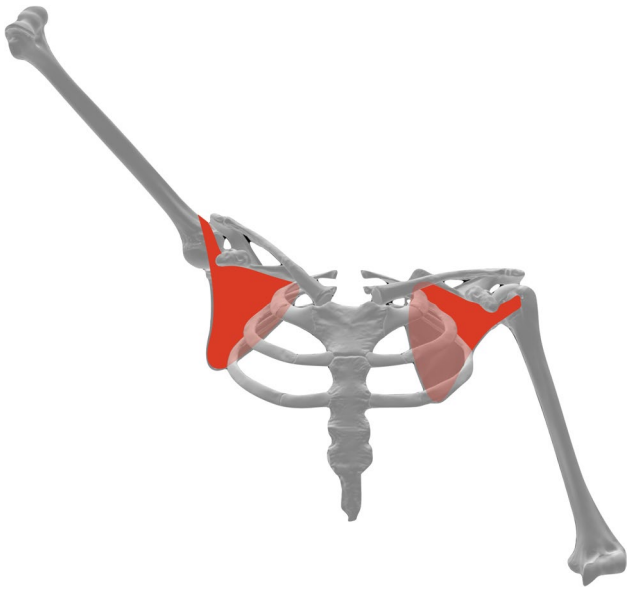

Fig. 2 3D surface rendered reconstruction with left arm down and right arm in ABER position viewed anteroposteriorly. In the arms down/neutral position (left), the subscapularis muscle belly is almost entirely obscured by the chest wall. In the ABER position (right), the subscapularis is exposed to transaxillary insonation for both diagnostic and therapeutic access

such we do not recommend preprocedural shaving. Human hair size is significantly smaller than ultrasonic wavelength thus limiting the scattering effect [22]. Interventions through a trans-axillary approach are also generally safe to perform; the axillary nerve is readily seen and avoided, originating from the posterior cord of the brachial plexus coursing anterior to the superior aspect of the subscapularis and inferior to the coracoid process where it exits posteriorly through the quadrangular space. The axillary artery and vein are also elevated cranially, well above the muscle bellies (Figs. 7, 8, 9).

Conclusion

Trans-axillary sonography in the ABER position is neither well-established in practice nor extensively published in the literature. The relative ease of positioning and sonographic access to the musculature coupled with the potential for assessment and intervention makes this approach extremely desirable to the musculoskeletal practitioner looking to diagnose or treat muscle belly pathologies of the subscapularis, teres major or latissimus dorsi.

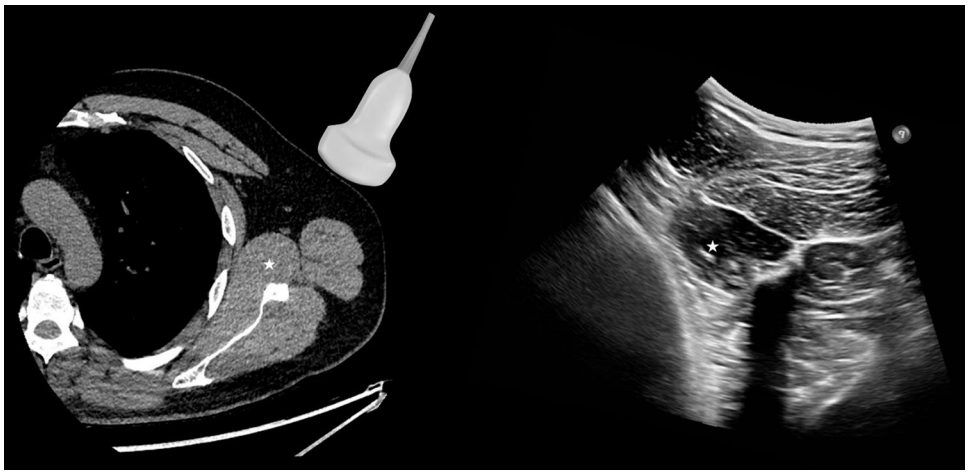

Fig. 3 CT and US correlation of shoulder musculature in the ABER position (*denoting the position of subscapularis anterolaterally instead of the posteroinferior location in neutral position)

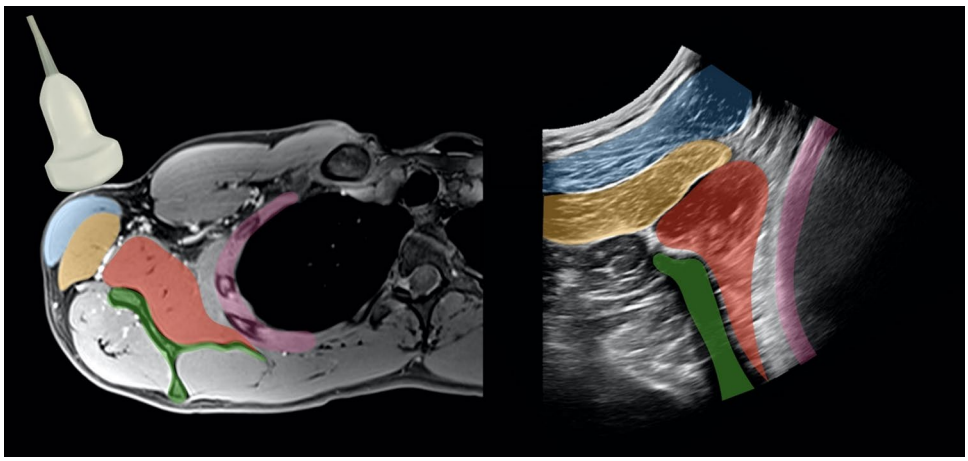

Fig. 4 MRI and US correlation of the shoulder musculature in the ABER position (blue—latissimus dorsi, orange—teres major, red—subscapularis, green—scapular blade, pink—chest wall)

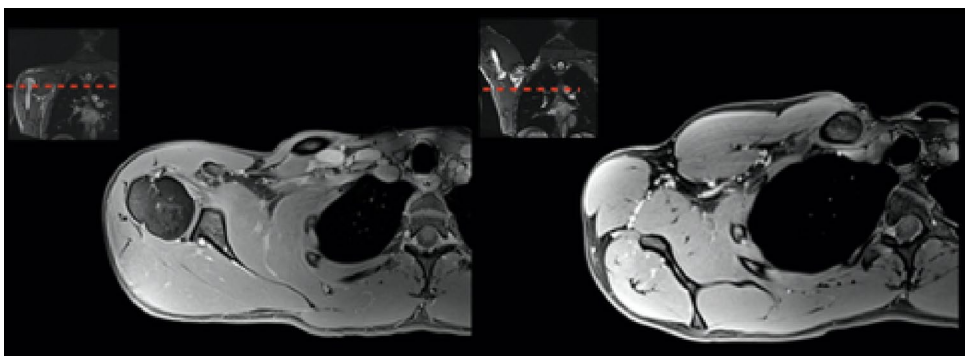

Fig. 5 Axial MRI T1FS demonstrating position of the shoulder musculature in neutral and ABER position. Note the increased visibility/exposure of subscapularis in the dynamic position (Dotted red line on localizer demonstrating trans-axillary landmark used for sonography)

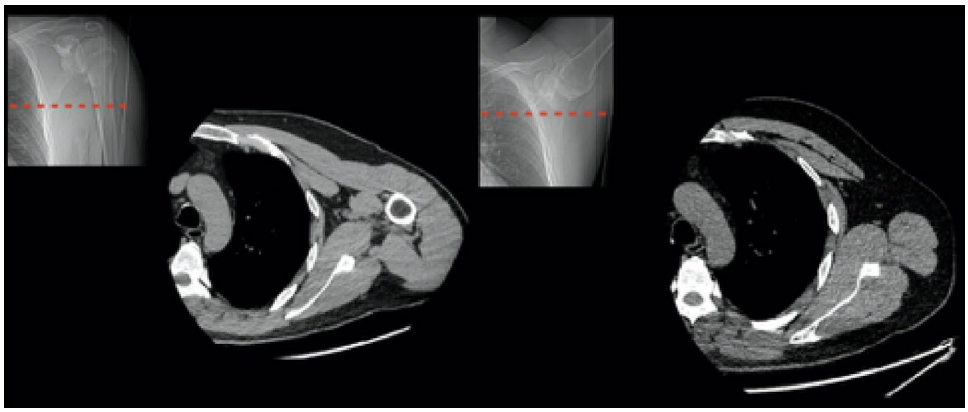

Fig. 6 Axial CT demonstrating position of the shoulder musculature in neutral and ABER position. Note the increased visibility/exposure of subscapularis in the dynamic position (Dotted red line on scout demonstrating trans-axillary landmark used for sonography)

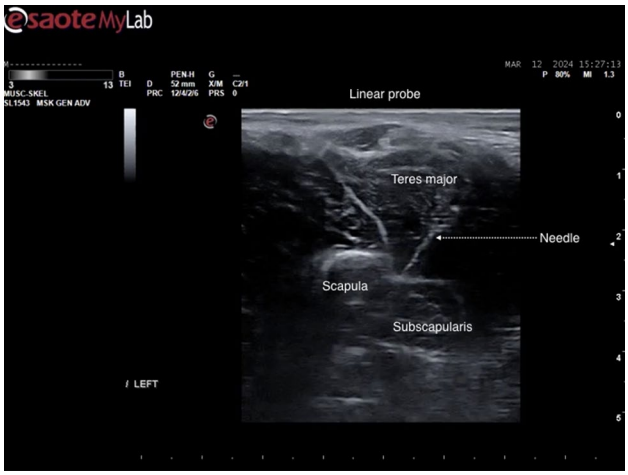

Fig. 7 Ultrasound using a low frequency linear transducer with patient in the ABER position allowing complete visualisation and safe access for needle placement during cryoneurolysis of the subscapularis (labelled)

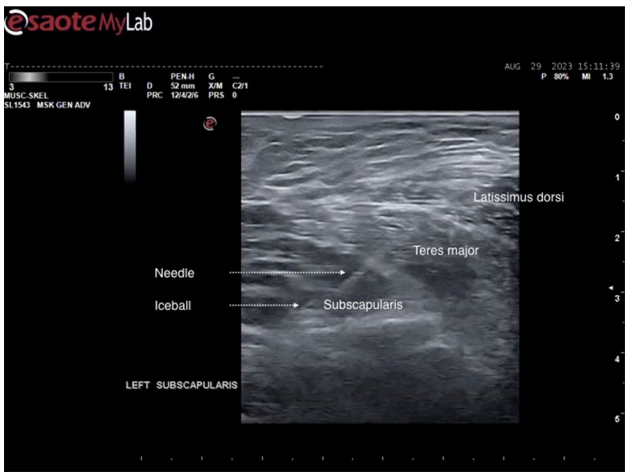

Fig. 8 Ultrasound demonstrating iceball formation during cryoneurolysis of the subscapularis (labelled). Also visualised are lattisimus dorsi and teres major muscles allowing for combined treatment with a single needle pass if clinically required

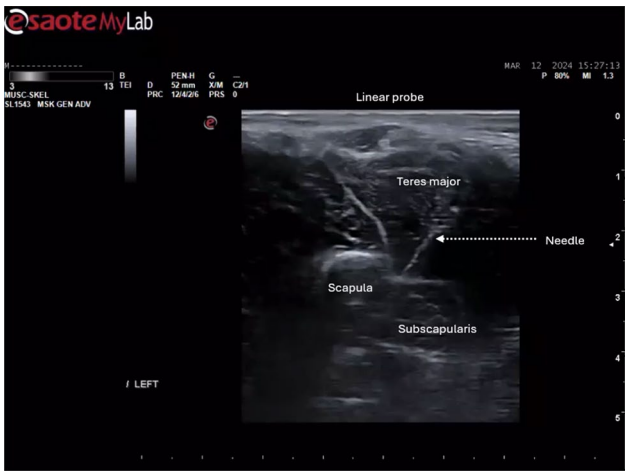

Fig. 9 Real time ultrasonography demonstrating cryoneurolysis of the subscapularis using the ABER approach

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40477-024-00924-6.

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Data availability Not applicable.

Declarations

Conflict of interest Logeswaran Selvarajah, Mark Cresswell and Timothy Murray have no conflict of interest. Paul Winston and Romain David have received educational grants from Ipesen, Abbvie, Merz and Pacira Biosciences.

Informed consent Informed consent was obtained for images described in this report.

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