The clinical utility of ultrasonography for rotator cuff disease, shoulder impingement syndrome and subacromial bursitis

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The lifetime prevalence of shoulder pain is identical to that of neck pain at 66%,[1,2] ranking only behind the prevalence of low back pain (84%).[3] Periarticular shoulder disorders are the most common cause of shoulder pain encountered by general practitioners and musculoskeletal specialists.[4] Our decision to focus on rotator cuff disease (RCD), shoulder impingement syndrome (SIS) and subacromial bursitis (SAB) is based on the frequency with which these diagnoses appear in ultrasonography reports. Accurate clinical diagnosis of these disorders is often challenging.

Clinical history

Because RCD, SIS and SAB all have gradual or sudden onset of symptoms, affect the shoulder and/or lateral upper arm and cause painful or restricted shoulder movement, diagnosis based on the clinical history alone is unreliable. Diagnosis may be further confounded by the coexistence of different shoulder disorders, lack of consensus on diagnostic criteria, case definition and even nomenclature,[5-8] and failure to establish what the patient means by "shoulder pain". For example, patients frequently refer to the upper border of the trapezius and the scapula as their "shoulder";[7] pain here has different diagnoses from pain localised to the shoulder or lateral upper arm. If the clinician overlooks this and proceeds to shoulder ultrasonography, which has more than 50% chance of finding an abnormality in an asymptomatic shoulder,[9,10] there is a risk of a type 2 diagnostic error (ie, diagnosis of a condition which either does not exist or which is not the cause of the patient's symptoms).

Clinical examination

Traditional clinical teaching, such as that pioneered by the English orthopaedic surgeon James Cyriax, focused on eliciting pain on active, passive and resisted shoulder movements to determine the site of the shoulder lesion.[11,12] Such differentiation has been considered important in facilitating effective treatment.[12,13] Although Cyriax described subacromial impingement of the rotator cuff, he never conceptualised this as a distinct syndrome with specific clinical tests. For detecting SIS, the clinician has an array of eponymous clinical tests designed to maximise or expose encroachment on the rotator cuff and subacromial bursa.[8,14,15] The reliability of these tests depends on their sensitivity (ie, ability to detect the disorder when present) and specificity (ie, ability to avoid or minimise misdiagnosis when the disorder is absent). A systematic review that examined diagnostic clinical tests was unable to establish conclusive evidence of reliability[16] so that, unsurprisingly, clinical studies have shown poor to moderate agreement and reproducibility between examiners.[5,17-19] One study which did find good agreement, between two experienced physiotherapists,[20] has been criticised because of the small number of cases and the paucity of medical information.[5,19]

ABSTRACT

- Periarticular shoulder disorders are common in clinical practice, and diagnosis is often difficult.
- Medicare statistics indicate that between 2001 and 2006 the use of diagnostic shoulder ultrasonography increased significantly.
- Rotator cuff disease, shoulder impingement syndrome and subacromial bursitis are among the most common diagnoses reported on shoulder ultrasonography.
- Shoulder ultrasonography is useful in the diagnosis of full thickness tears, but its utility for other rotator cuff disorders, shoulder impingement syndrome and subacromial bursitis is less well established.

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Shoulder ultrasonography in Australia

The poor to moderate reliability and reproducibility of clinical tests for periarticular shoulder disorders[5,16-19] may explain why Australian clinicians have turned increasingly to shoulder ultrasonography[21] for diagnostic help. At issue is whether the reliability and reproducibility of shoulder ultrasonography makes it a more dependable diagnostic option than clinical examination. The appeal of ultrasonography lies in its safety, speed of operation, wide availability, relatively low cost and non-invasiveness.

Between 2000 and 2006, use of diagnostic ultrasound and ultrasound-guided shoulder injections increased in Australia (Box 1).[21] The Medicare item number for ultrasound-guided shoulder injections includes other regions of the body, so its exact cost is unknown. The Medicare reimbursement for this procedure is $129.95, whereas for a blind intrasynovial injection (item number 50124) it is $22.25.[21] A 2004 review found no evidence that imaging-guided subacromial bursal injections improved long-term outcomes,[22] while a randomised study found that blind injections into the subacromial bursa by an experienced orthopaedic surgeon or by an experienced musculoskeletal radiologist were as accurate as ultrasound-guided injections.[23]

Shoulder ultrasonography — reliability

Rotator cuff disease

The tendons of the supraspinatus, infraspinatus, teres minor and subscapularis merge to form the rotator cuff of the shoulder. Degenerative RCD is the most common cause of shoulder pain and most often involves the supraspinatus.[4,24] Its vulnerability to intrinsic degeneration has been attributed to relative avascularity,[25] but its vascularity is no different from that of the infraspinatus,[26] which suggests that factors that aggravate ischaemia (eg, increased intramuscular pressure associated with working with the arms highly elevated[27] or rotator cuff impingement[28]) contribute to or

1 Medicare statistics for ultrasonography[21]

Period	No. of services	Total rebates to providers ($)
Diagnostic shoulder ultrasonography (MBS item no. 55808)		
2000–2001	104 252	8 831 943
2005–2006	219 924	20 627 499
All imaging-guided injections (MBS item no. 55850)		
2000–2001	3504	406 155
2005–2006	26 522	3 435 070

MBS = Medicare Benefits Schedule. ◆

accelerate the degenerative process. The spectrum of RCD extends from tendinitis to partial or full thickness rotator cuff tears with or without calcification.[24]

Data indicate that ultrasonography is reliable in the diagnosis of full thickness rotator cuff tears, but less reliable in the detection of partial thickness tears. Its reliability in the diagnosis of non-calcific tendinitis is unknown because of a lack of comparative surgical data.[16,29,30]

Ultrasound-detected rotator cuff tears are often clinically important but tears are also frequently found in asymptomatic shoulders;[9,31] it has been suggested that they be regarded as "normal degenerative attrition not necessarily causing pain or functional impairment".[31] Clearly, it is as important to detect a tear as to determine its clinical significance. Unfortunately, neither ultrasonography nor magnetic resonance imaging (MRI) can discriminate between symptomatic and asymptomatic tears.[32,33]

Shoulder impingement syndrome

The most common type of SIS is external or outlet impingement due to anatomical narrowing of the humero–acromial space, leading to compression of the rotator cuff and overlying subacromial bursa when the arm is abducted in a position of partial flexion. Common causes of anatomical narrowing include subacromial osteophytes or anatomical variants of the acromion. Less common types of SIS are non-outlet impingement, in which glenohumeral instability allows proximal translocation of the humeral head, narrowing the humero–acromial space and compressing the rotator cuff, and internal impingement in which the infraspinatus is impinged upon, often in throwing sports.[34]

There are few publications on the reliability of ultrasonography for the diagnosis of SIS. An early study relied on changes in the subacromial bursa, in particular bursal fluid.[35] However, Schmidt et al identified fluid in the subacromial bursa in 85% of asymptomatic shoulders,[36] and neither experienced radiologists[37] nor musculoskeletal ultrasound experts could agree[38] when assessing the subacromial bursa — a matter of concern given the importance of bursal changes in the assessment of SIS.[37]

Read and Perko used bunching of the subacromial bursa as the criterion to diagnose SIS, noting that the bunching was "largely indicative of mechanical compression by the overlying coracoacromial arch".[30] They qualified this by noting a "number of difficulties with the dynamic ultrasound diagnosis of impingement" largely relating to operational issues, including "observer variation" and "diagnostic criteria". Of concern to them was their observation that signs of impingement on ultrasound "were frequently found on the contralateral side where symptoms were absent or minimal".

More recently, dynamic shoulder ultrasonography was used for diagnosis of SIS on the basis of pooling of fluid in the lateral aspect of the subacromial bursa, or surface changes in the bursa or rotator cuff (ie, bunching) as the greater tuberosity of the humeral head passed under the acromion.[39] The numbers were small, with only 13 patients and 26 shoulders examined. The investigators undermined their own diagnostic criteria by diagnosing SIS in four patients who reported pain on shoulder movement but who had no ultrasonographic evidence of impingement (ie, no pooling of fluid in the bursa or bunching). Seven were found to have osseous impingement between the humeral head and the undersurface of the acromion and only three fulfilled criteria for soft tissue SIS. Three of the clinically asymptomatic shoulders were found to have impingement.

Data on the reliability of shoulder ultrasonography for the diagnosis of SIS are not compelling. This may in part explain why the Australian Medicare Benefits Schedule (MBS) (effective 1 November 2006) excluded suspected SIS as a clinical indicator for shoulder or upper arm ultrasonography for which a Medicare benefit is payable.

Subacromial bursitis

The subacromial–subdeltoid bursa is contiguous in 95% of individuals. Its physiological function is to protect the rotator cuff from wear by dissipating friction and allowing free motion between the rotator cuff and the overlying acromion and deltoid.

The term "bursitis" appears frequently in radiology reports of shoulder ultrasonography, implying a specific diagnostic entity, but the published literature contains no suitable definition of SAB on ultrasound.[37] By tacit consensus, the term "bursitis" appears to have become a descriptor for bursae judged by the radiologist to contain excessive fluid or bursae with synovial or fibrotic thickening. Yet abnormal amounts of fluid in the subacromial bursa may result from its communication with the glenohumeral joint via a tear in the rotator cuff,[40] or from bursal impingement with an intact rotator cuff. Thickening of the subacromial bursa may result from chronic bursal impingement or may potentially be physiological, reflecting the protective function of the bursa in upper limb athletics and in occupations involved in prolonged and forceful upper limb activities.[27,41] In none of these situations does the appellation "bursitis" appear to be justifiable, either from a pathological or therapeutic standpoint. Furthermore, as rotator cuff tears are paralleled by changes in the subacromial bursa,[42] asymptomatic "bursitis" may be as highly prevalent as asymptomatic rotator cuff tears.[31,38] Data suggest that this is the case. Naranjo et al identified so-called SAB in 29% of asymptomatic shoulders,[10] while an MRI study identified changes consistent with SAB in 100% of asymptomatic patients who had undergone rotator cuff repair.[43] The absence of changes indicative of a true inflammatory bursitis on histopathological examination in patients with RCD, SIS and calcific tendinitis prompted one group to suggest that the term "bursitis" be abandoned in favour of "local bursal reaction".[44] However, primary bursal disease is a very real entity. It may be acute, as in crystal synovitis (usually due to the deposition of calcium hydroxyapatite crystals), or it may be infective. It may also be chronic, as in polymyalgia rheumatica, rheumatoid arthritis and other chronic inflammatory arthropathies.

The lack of agreement in assessment of the subacromial bursa[37,38] and the high incidence of "bursitis" in asymptomatic individuals[10,38,42,43] suggest that circumspection is warranted in interpreting SAB on ultrasonography.

Shoulder ultrasonography — reproducibility

Reproducibility of a diagnostic test implies agreement between different examiners (ie, interexaminer agreement) and consistency of findings when the test is repeated by the same examiner (intra-examiner agreement). Reproducibility depends on the reliability (sensitivity and specificity) of the diagnostic test, the experience of the examiner[37,45] and consensus on diagnostic criteria and nomenclature.[6,7,45,46]

In 2001, the EULAR (European League Against Rheumatism) Working Group for Musculoskeletal Ultrasound published technical guidelines in an effort to standardise scanning methods.[45] This might have been expected to reduce interscanner differences in the acquired image, thus reducing interpretive differences. Yet, 4 years later, a prospective study by radiologists remained critical of the lack of standardisation of certain sonography procedures and noted "a lack of consensus in the radiology literature as to what appearances are normal and abnormal".[37] In 2006, investigators from the EULAR Working Group, in a study of interobserver reliability, found difficulty in reaching a consensus on "bursitis versus normality" and reported that enlarged bursae were "commonly detected with high resolution ultrasonography machines in normal subjects".[38] They considered that the paucity of studies on the "validity, reliability and sensitivity to change" had largely contributed to the perception of ultrasonography being the most operator-dependent imaging technique.[38] It is sobering that despite ultrasonography being in clinical use for more than 30 years, standard reference values were published for the first time only in 2004.[36]

Indications for shoulder ultrasound

Because of the high incidence of abnormalities detectable by shoulder ultrasonography in asymptomatic patients,[9,10,29,31,38] this technique is best employed for patients complaining of shoulder or lateral upper arm pain, particularly if pain is localised to these regions on clinical examination. This should reduce the risk of an incorrect diagnosis of a periarticular shoulder disorder in patients with nonspecific shoulder region pain, which is often localised to the trapezius or scapular regions and which is six times more common than rotator cuff disorder.[47] Although neither the clinical examination nor ultrasonography is a perfect diagnostic instrument for shoulder pain, this is no reason to eschew either, but nor should there be an expectation that the sum of two imperfect instruments enhances diagnostic accuracy.[18] Indeed, the high number of false positives in shoulder ultrasonography in asymptomatic patients[9,10,29,31,38] suggests the opposite may be true.

Scepticism about the utility of clinical examination is not entirely justified. Studies have shown at least moderate inter-examiner agreement for RCD and SIS,[15,19] the most common causes of shoulder pain. A systematic review suggested that clinical examination by specialists could rule out the presence of a rotator cuff tear,[16] and both clinical and ultrasound studies suggest that inter-examiner reproducibility can be improved with training.[5,19,38,45,46,48]

On the available evidence, shoulder ultrasonography is best viewed as an adjunctive imaging modality in the diagnosis of shoulder pain rather than a stand-alone investigation. It has been suggested that shoulder ultrasound might be at its most valuable where the clinician is able to interpret the images in the setting of the clinical history and physical examination, "enabling ultrasound to become the physician's extended finger".[45] In the real world this ideal situation is unlikely to eventuate unless the clinician is also a proficient ultrasonographer. In a government-subsidised, fee-for-service medical system such as operates in Australia, the issue of propriety might arise if the requestor of a service became its financial beneficiary.

Clinical diagnosis might be enhanced if there were agreement on ultrasound diagnostic criteria for shoulder disorders and better standardisation of radiology reports. In view of the Australian MBS exclusion of SIS from clinical indicators attracting a benefit in shoulder ultrasonography, it seems reasonable for radiologists to provide comment and clarification when the diagnosis of SIS is made, to explain the implications of a diagnosis of SAB, and in view of the many ultrasound-detectable abnormalities in asymptomatic individuals,[9,10,29,31,38] to emphasise to clinicians the need for clinical correlation, whatever diagnosis is provided.

Conclusion

Shoulder ultrasonography is reliable in the diagnosis of full thickness tears but less reliable in the detection of partial thickness tears.[16,29,30] The reliability of shoulder ultrasound in the diagnosis of SIS has not been clearly established. The validity of the diagnosis of SAB is problematic because of the lack of a suitable ultrasound definition of SAB,[37] and because the "diagnosis" may not reflect a specific entity requiring specific treatment.[44]

Clinicians need diagnostic certainty to optimise management. A reported ultrasound abnormality enables the clinician to fulfil the doctor's half of the bargain in the doctor–patient relationship, by delivering a diagnosis with the promise of treatment. The patient can be mollified and may even be satisfied. If the patient is also a claimant or litigant, the injury claim can seemingly be validated by an objectively verifiable abnormality on imaging. That all of this has the potential to reinforce and thereby perpetuate referral behaviour is consistent with the rise in requests for shoulder ultrasonography in Australia between 2000 and 2006.[21] Yet on the available evidence, shoulder ultrasonography, like all other imaging modalities, is rarely able to deliver the diagnostic certainty for which clinicians yearn.

Competing interests

None identified.

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