Evaluation of the symptomatic supraspinatus tendon—a comparison of ultrasound and arthroscopy

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Purpose: A prospective study was undertaken to determine the accuracy of ultrasound compared with arthroscopy in the evaluation of the symptomatic supraspinatus tendon, and to identify whether ultrasound diagnosis was helpful in pre-operative planning.

Methods: A total of 276 consecutive patients with shoulder impingement symptoms underwent ultrasound examination of the supraspinatus tendon. Of these patients, 41 proceeded to open or arthroscopic surgical procedure on clinical grounds, and in this group direct comparison with ultrasound findings was made.

Results: There was full correlation between ultrasound and arthroscopy in the diagnosis of a normal supraspinatus tendon, full-thickness tear, tendinopathy and tendon rupture. There was some discrepancy between the two techniques. Two patients with partial thickness tear on ultrasound had a full thickness tear at arthroscopy. Ultrasound was able to identify intra-substance partial thickness tears in three patients with supraspinatus tendon said to be normal at arthroscopy. Ultrasound helped plan the surgical approach and operative time needed in cases of supraspinatus tendon rupture and full thickness tear.

Conclusion: In this study ultrasound was effective in the evaluation of the symptomatic supraspinatus tendon, and was also able to diagnose intra-tendinous lesions not visible at arthroscopy.

INTRODUCTION

Rotator cuff tears involving the supraspinatus tendon (SST) are commonly seen in clinical practice and are often associated with sub-acromial impingement type pain. Imaging plays an important role in the diagnosis of such lesions, as it is often not possible to clinically differentiate a full-thickness tear (FTT) from a partial thickness tear (PTT) or tendinopathy. Accurate pre-operative diagnosis also helps to plan operative treatment. A variety of modalities have been used to image the rotator cuff, including computerized tomography (CT), magnetic resonance imaging (MRI) and arthrographic techniques.

Ultrasound (US) evaluation of rotator cuff has been shown to be accurate for the diagnosis of rotator cuff tears [1–7]. As a technique it is widely...
available, non-invasive and well tolerated. In this study, we have compared the ability of US to identify and differentiate SST pathologies, when compared with the findings at arthroscopy.

MATERIALS AND METHODS
A total of 276 consecutive patients with clinical supraspinatus impingement syndrome were evaluated by US over a two-year period, from June 1997 to June 1999. Of these, 41 proceeded to arthroscopic decompression, debridement or open repair of the tendon on clinical grounds. In this group, 24 were male, 17 female and the mean age was 57 years (range 34–79).

Two radiologists experienced in shoulder ultrasound performed the US examinations in all patients using a linear array 5–10 MHz transducer, with the shoulder internally rotated to visualize the SST. Clinical data and plain radiographs were available at the time of performing the US examination. Conventional longitudinal and transverse views of the SST were obtained. In our institution, the biceps tendon is routinely scanned as part of a shoulder examination, although these findings were not recorded for the purpose of this study. The other rotator cuff tendons are not routinely examined.

For the purpose of the study, the appearances of the SST on ultrasound were classified into 5 categories (ultrasound and equivalent arthroscopic images are included):

- Normal tendon (Fig. 1a & 1b)
- Tendinopathy (Fig. 2a & 2b)
- Partial thickness tear (Fig. 3)
- Full thickness tear
- Rupture (Fig. 4a & 4b)

Diagnostic criteria for the classification:

- Tendinopathy may be diagnosed if the tendon is seen to be thickened and of patchy and often decreased echogenicity.
- A PTT was diagnosed in the presence of a hypo- or hyperechoic tendon defect, not involving the full thickness of the tendon. This can be an intra-substance partial-thickness tear not involving the tendon surface.
- A FTT was diagnosed if the hypo or hyperechoic tendon defect involved the full thickness of the tendon.

Initially all patients received a course of shoulder physiotherapy and a variable number of sub-acromial steroid injections as first line of management. The decision to proceed to arthroscopy was made on clinical grounds. The indication for surgery was failure of clinical improvement with conservative measures within one year of the onset of symptoms. The surgeon knew the US diagnosis prior to surgery and accordingly, the pre-operative planning was made. All patients underwent shoulder joint arthroscopy and bursoscopy. All
patients underwent an arthroscopic subacromial decompression or rotator cuff debridement. Those patients with a full thickness tear or tendon rupture were treated with an open repair following arthroscopic decompression. In this group, pre-operative sonographic diagnosis helped plan the surgical procedure and allocation of appropriate theatre time.

A single surgeon performed all the operations. The average time to surgery from the time of US was 6 months. The state of the SST was noted at the time of surgery and comparison was then made with the US findings.

RESULTS

The results are summarized in Table 1. It can be seen that there is a discrepancy between the US and arthroscopic findings in five patients in the PTT group. In three of these patients where US diagnosed intra-substance partial tear, arthroscopy was normal. Two patients with PTTs at ultrasound had FTTs at the time of surgery.

DISCUSSION

Rotator cuff disorders are commonly associated with impingement syndrome, which can result from outlet and non-outlet factors. Outlet factors such as the shape and slope of the acromion and prominence of the acromio-clavicular joint are common causes of impingement. Non-outlet factors are less frequently seen and include prominence of the greater tuberosity, loss of humeral head depressors, loss of gleno-humeral fulcrum, lesions of the acromion and thickened sub-acromial bursa or cuff [8]. The rotator cuff may impinge against the coraco-acromial arch leading to a microtraumatic process, giving rise to tears commonly affecting the supraspinatus tendon [9]. Infraspinatus, subscapularis, and teres minor tendons are much less commonly involved [10, 11]. Tears can range from partial or intra-substance tears to complete

Figure 2 (a) Longitudinal US of a right SST, which is thickened and of diffusely abnormal echotexture containing multiple poorly defined hypoechoic foci. The appearances are consistent with tendinopathy. (b) Bursoscopic image showing irregular and frayed appearance on the bursal surface of the SST consistent with tendinopathy (arrow).

Figure 3 Longitudinal US of a left SST, which contains a focal hypoechoic intra-tendinous lesion (callipers) not involving the bursal or articular aspects. This is consistent with an intra-substance partial tear and was not visualized at arthroscopy.
rupture of the tendon. They can involve the bursal, articular or both surfaces.

Accurate diagnosis is necessary to plan the management of rotator cuff tears. Surgical treatment is advocated if conservative measures fail. In our unit, the gleno-humeral joint and the subacromial space are initially assessed arthroscopically and either a subacromial decompression or open tendon repair performed depending on type of cuff lesion. Most surgeons prefer to treat SST tendinopathy, intra-substance tear and PTT by arthroscopic sub-acromial decompression to control impingement, with or without debridement of the tendon. Some authors prefer to convert a PTT to FTT and repair the tendon directly [12]. Open surgery is carried out for FTT, if the tendon is thought to be repairable without tension. Accurate pre-operative diagnosis helps plan the surgical approach and allows allocation of appropriate theatre time.

Shoulder arthrography is a useful diagnostic procedure and can reliably detect full-thickness tears and, at times, partial thickness tears on the inferior (joint) surface of the cuff [13–15]. It cannot detect intra-substance tears, tendinopathy or partial-thickness tears affecting the bursal surface of the cuff. Diagnostic accuracy is increased with CT or MR arthrography. Arthrography however is an invasive procedure and is associated with complications [13, 14].

Noninvasive imaging techniques for the evaluation of rotator cuff pathology have considerably improved over the past decade. Plain radiographic findings include narrowing of the acromio-humeral space, decalcification of the greater tuberosity and reversal of the normal convexity of the inferior surface of the acromion, but these appearances are not specific in the diagnosis of rotator cuff tears [16]. MR imaging of the shoulder has been found to be accurate in diagnosing FTTs, but the results are variable with PTTs [1, 17, 18]. MR examination has advantages over plain arthrography or US in that the former technique provides information of the whole rotator cuff, the glenohumeral and acromio-clavicular joints. It also gives information about the presence of significant fatty degeneration of the rotator cuff muscles, which may preclude a major rotator cuff tear repair. It has been shown in some early studies the limitations of the clinical utility of MR due to the frequent occurrence of ‘abnormal’

<table>
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<th>US findings</th>
<th>Correlation at arthroscopy</th>
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<td>Normal</td>
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<td>Tendinopathy</td>
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<td>7</td>
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<td>Rupture</td>
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<td>TOTAL</td>
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**Figure 4** (a) Longitudinal US demonstrates rupture of right SST with distal tendon remnant demonstrated (arrow). The proximal tendon has retracted out of field of view. (b) Arthroscopic image of a ruptured SST with retraction. The retracted segment is held with forceps (arrow).
signal in the rotator cuff in asymptomatic individuals [19]. However, in a recent study by Wright et al., it was suggested that either fast spin echo inversion recovery (FSEIR) images or fast-spin echo (FSE) fat-saturated images with TE greater than 66 be used to facilitate the differentiation of fluid signal from intermediate increased signal intensity in rotator cuff imaging in order to refine the normal variability of the rotator cuff’s signal [20]. The cost factor and limited availability mean that MRI is not the first line of investigation in many centres.

Ultrasound as a technique is attractive. It is safe, widely available and well tolerated. Since Seltzer et al. described the sonographic appearances of tears of the rotator cuff in 1979; there have been several other studies supporting the usefulness of this investigation [21]. It has been shown that operator skills and equipment specifications play an important role in obtaining accurate sonographic results [22]. US has been found to be accurate in diagnosing FTTs, but not reliable in detecting PTTs [5–7]. Dynamic US studies have also been performed to diagnose sub-acromial impingement [6, 7]. Sonographic changes in the biceps tendon, which accompany a lesion of the cuff, are well understood [5]. Some authors have described direct correlation between the diameter of the biceps tendon and the extent of tears [5, 23]. Ultrasound can reliably detect biceps tendon abnormalities including dislocation, rupture, and tendinitis.

Our results showed that US was very accurate in diagnosing the normal tendon, tendinopathy, FTTs and ruptures of the SST. However only two out of seven cases in the PTT group were correlated at surgery. Three of these patients had a focal intra-substance tear diagnosed at US, but the supraspinatus tendon appeared normal at arthroscopy. Intra-substance tears are often not visible at arthroscopy but are readily diagnosed by ultrasound. The diagnosis of intra-substance tears is important, as they may be responsible for continuing symptoms following normal arthroscopy. In the remaining two patients said to have PTT at US, FTT was found at surgery. It is likely that during 6 months from the time of US to surgery, the PTT may have progressed to FTT.

CONCLUSION

Our study demonstrated that US is effective in evaluating the symptomatic SST. Ultrasound is accurate in identifying the normal tendon, tendinopathy, FTT and SST rupture and is also able to diagnose intra-substance tears of the SST not visualized during arthroscopy. US is a useful method of pre-operative assessment in symptomatic SST to plan the operative approach and for allocation of theatre time.

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REFERENCES


