Accuracy of High-Resolution Ultrasonography in the Diagnosis of Articular-Sided Partial Thickness Rotator Cuff Tears

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ORIGINAL ARTICLE

Accuracy of high-resolution ultrasonography in the diagnosis of articular-sided partial thickness rotator cuff tears

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None declared

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ABSTRACT

Background The present study aimed to assess the accuracy of high-resolution ultrasonography in the detection of articular-sided partial thickness rotator cuff tears.

Methods Two-hundred and forty-six shoulders of 245 patients underwent ultrasonography and subsequent shoulder arthroscopy. All scans were performed by an experienced specialist musculoskeletal radiologist and arthroscopies were carried out by a single surgeon.

Results Fifty-eight partial thickness tears (of which 56 were articular-sided) were found at arthroscopy. Of the remaining shoulders, 90 had full thickness tears and 98 had intact rotator cuffs. Ultrasonography correctly identified 21 of 56 articular-sided tears as partial thickness tears. It had a sensitivity of 7%, a specificity of 98% and an accuracy of 74% for the diagnosis of articular-sided partial thickness tears. If a full thickness tear was considered as a true positive, the sensitivity increased to 89%, specificity to 98% and accuracy to 96%.

Discussion Ultrasonography is not sufficiently accurate to diagnose articular-sided partial thickness tears. A higher accuracy can be achieved if a full thickness tear is considered a positive finding. Ultrasonography should not be considered a first line investigation for a clinically suspected partial thickness rotator cuff tear. An articular-sided partial thickness rotator cuff tear should be considered in all patients undergoing an arthroscopic rotator cuff procedure.

INTRODUCTION

Ultrasonography (US) is now the modality of choice in most UK hospitals for the diagnosis of rotator cuff disease, although it is questionable whether it can reliably diagnose partial thickness rotator cuff tears (PTRCT). The level of pain and clinical examination are poor indicators of the size of tear [1,2] and cannot be used to reliably differentiate between PTRCTs and full thickness rotator cuff tears (FTRCT) [3]. Magnetic resonance arthrography appears to be the most sensitive (82%) study at present for detecting PTRCTs and was found to be statistically more sensitive and specific than both US and magnetic resonance imaging (MRI) ($p < 0.001$) [4]. There was no statistical difference between US and MRI for the detection of PTRCTs, although the location of the tear was not considered [4]. A disadvantage of magnetic resonance arthrography, however, is that it is an invasive procedure with potential complications [5] and MRI is costly, time-consuming and less readily available. US is a non-invasive dynamic examination that is relatively inexpensive, although it requires expertise and has a significant learning curve.

Although previous studies have compared US findings with arthroscopic assessment, few studies have included large numbers of patients [6–12] with experienced operators performing scans and surgery. Another consideration is that many previous studies have either not differentiated the type of tear diagnosed when reporting the accuracy [1,7,13–17] or have also considered FTRCTs as positive results when analysing the data for the diagnosis of PTRCTs [1,6,12,18–21].

PTRCTs can be categorized using the Snyder [22], Ellman [23] and Habermeyer [24] classifications. Important factors when considering repair are the position, depth and chronicity of the tear as well as the age of the patient. Although there is no clear guidance on what depth of tear should be repaired, there appears to be a consensus that those greater than 50% should be considered [23,25–32]. Articular-sided partial tears (ASPTRCT) are reported to be twice as common as bursal-sided tears [23]. Knowing the depth and position of the tear pre-operatively from imaging will aid surgical planning and ensure the operating time is used most efficiently.

The present study aimed to evaluate the accuracy of high-resolution shoulder US performed by an experienced musculoskeletal radiologist compared to arthroscopy findings specifically focussing on ASPTRCTs and the ability of US to identify the location of the tear.

MATERIALS AND METHODS

Two-hundred and forty-six shoulders in 245 consecutive patients with shoulder pain who had undergone standardized preoperative US and subsequent arthroscopic assessment between May 2004 and June 2009 were included in the study. There were 128 males and 117 females, with a mean age of 59 years (range 21 years to 83 years). The mean time interval between the US and the arthroscopic examination was 254 days (range 8 days to

Table 1 Results of ultrasonography and arthroscopic assessments

	Arthroscopy					
US	<50% articular	>50% articular	<50% bursal	FT	Intact	Total
Bursal PT	5	0	0	4	4	13
Articular PT	4	0	0	1	2	7
Interstitial PT	12	0	0	1	3	16
FT	20	9	1	82	19	131
Intact	3	3	1	2	70	79
Total	44	12	2	90	98	246

FT, full thickness; PT, partial thickness; US, ultrasonography.

855 days). Surgery was considered in patients with shoulder pain of more than 6 months duration who did not respond to non-operative treatment consisting of physical therapy, nonsteroidal anti-inflammatory medications and at least one subacromial corticosteroid injection.

Ultrasonographic technique

All US examinations were performed by an experienced musculoskeletal radiologist (S.R.). The ATL Ultramark HDI 5000 scanner (Philips 5680 DA Best, The Netherlands) was used for scans performed between May 2004 and July 2006 and the Logiq 9 BT04 (General Electric Healthcare (Chalfont St Giles, Bucks, United Kingdom)) for scans performed between July 2006 and June 2009 with a 5 MHz to 12 MHz linear array probe. The patient was seated on a stool with the radiologist seated facing the patient. All tendons were imaged in the transverse and longitudinal planes. The long head of biceps tendon was imaged first, in the intertubercular groove, with the patient's hand resting on their thigh with the thumb pointing towards the ceiling. The shoulder was then externally rotated and the subscapularis tendon was visualized. Dynamic studies were obtained by alternating between external rotation and a neutral position.

The supraspinatus tendon was then visualized with the patient internally rotating the shoulder. The patient then placed their hand on the opposite shoulder allowing the infraspinatus tendon to be viewed.

A FTRCT was diagnosed when the cuff could not be visualized because of complete avulsion and retraction under the acromion or when there was a focal defect in the cuff created by a variable degree of retraction of the torn tendon ends. A PTRCT was diagnosed when there was a defect on the bursal side of the cuff or a distinct hypo-echoic or mixed hyper-echoic and hypo-echoic defect on the articular side of the cuff.

Surgical technique

All arthroscopic procedures were performed by or under the supervision of a consultant orthopaedic surgeon with the patient in the beach-chair position. Standard posterior, anterior and lateral portals were used. The presence or absence of a FTRCT or of a bursal or articular side PTRCT was recorded. PTRCTs were probed and their depth recorded according to the Ellman classification [23].

All findings from the US and arthroscopic assessment were entered into a database to allow comparison. The sensitivities, specificities, positive predictive and negative predictive values, likelihood ratios and overall accuracy were calculated for the detection of ASPTRCTs with 95% confidence intervals.

RESULTS

Arthroscopic assessment of 246 shoulders revealed 58 PTRCTs (56 ASPTRCTs), 90 FTRCTs and 98 intact rotator cuffs (Table 1). Subacromial decompression was performed in 178 shoulders and combined with acromio-clavicular joint excision in 12 shoulders. Rotator cuff repair was performed in 47 shoulders, capsular release was performed in eight shoulders and arthroscopic stabilization was achieved in one shoulder.

Of the 56 ASPTRCTs, decompression with cuff debridement was performed in 52 shoulders and combined with acromio-clavicular joint excision in three, capsular release in one and stabilization in one shoulder. Cuff repair was performed in two shoulders. These patients had a mean age of 60 years (range 21 years to 83 years).

The analysis for the detection of ASPTRCTs was performed: (i) by considering only those identified as ASPTRCTs as true positives; (ii) by considering all identified PTRCTs (regardless of location on US); and (iii) by considering any tear (PTRCT and FTRCT as seen on US) as a true positive (Table 2).

Table 2 Accuracy of ultrasonography for articular-sided partial tears

	Articular-sided PT	PT	PT and FT
Sensitivity	0.07 (0.03–0.11)	0.37 (0.30–0.41)	0.89 (0.83–0.92)
Specificity	0.98 (0.97–0.99)	0.98 (0.96–0.99)	0.98 (0.96–0.99)
PPV	0.57 (0.25–0.84)	0.86 (0.71–0.96)	0.94 (0.87–0.98)
NPV	0.75 (0.74–0.76)	0.82 (0.79–0.83)	0.96 (0.94–0.97)
PLHR	3.76 (0.96–14.79)	19.75 (6.79–60.70)	47.02 (19.50–126.45)
NLHR	0.95 (0.90–1.00)	0.64 (0.59–0.73)	0.11 (0.08–0.18)
Accuracy	0.74 (0.72–0.76)	0.82 (0.78–0.84)	0.96 (0.92–0.98)

FT, full thickness; NLHR, negative likelihood ratio; NPV, negative predictive value; PLHR, positive likelihood ratio; PPV, positive predictive value; PT, partial thickness.

DISCUSSION

The present study involved US scans being performed by a specialist trained musculoskeletal radiologist with surgery performed by a consultant orthopaedic surgeon in a large consecutive series of patients. The findings obtained demonstrate that high-resolution shoulder US can be used in the clinically suspected PTRCT. It has the ability to rule in ASPTRCTs, but has a very poor sensitivity. However, if an ASPTRCT is seen after US, the odds of diagnosing it are 3.8-fold greater.

Previous studies within the literature comparing US findings with arthroscopy have produced a variety of results, reporting a sensitivity of 0.46 to 0.97 and specificity of 0.84 to 0.97 for the detection of PTRCTs [3,8,9,33,34]. The interpretation of results for the detection of PTRCTs within the literature requires caution because many studies have either not differentiated the type of tear diagnosed or have included FTRCTs as true positives when analysing the data [1,6,12,18–21]. This is demonstrated clearly within the present study. If FTRCTs are considered as a 'true positive' then the sensitivity and specificity is significantly increased.

The main misdiagnosis by US appears to be the over-diagnosis of FTRCTs (52% of ASPTRCTs) and the diagnosis of interstitial tears (21% of ASPTRCTs), as well as difficulty in delineating between bursal and articular-sided tears. A previous study of the reasons for potential diagnostic errors in shoulder US highlighted the limitations of the test, which include difficulty in distinguishing large bursal-side PTRCTs from FTRCTs and occasionally from severe bursitis and tendinopathy [35]. An interstitial tear was not diagnosed at arthroscopy in the present study and reflects the difficulty in identifying such tears surgically. Seventy-five percent (12 out of 16 patients) of the interstitial tears diagnosed on US had an ASPTRCT at the time of surgery. These factors are likely to have accounted in some part for the poor sensitivity.

Twenty-two percent (six out of 27 patients) of PTRCTs diagnosed at US were found to have a FTRCT by the time arthroscopy was carried out. Progression to FTRCTs with non-operative treatment has been demonstrated in approximately one-fifth of patients at 1 year, with a further one-third increasing in size [36].

Although the false-positive and false-negative diagnostic rate for PTRCTs within this series did not affect the surgical approach [37] or result in any unnecessary surgical procedures, it did have an impact upon service delivery. Six patients had a longer procedure than anticipated and 49 patients had a shorter procedure than was anticipated, affecting operating theatre time allocation.

A limitation of the the present study is that it only included patients who underwent both US and arthroscopy, with the disease state therefore not confirmed in all patients undergoing ultrasonography. However, this is a limitation of all such studies. Other limitations include the scans being performed by a single operator as well as the difficulty of accurate measurement of the PTRCTs at arthroscopy.

In conclusion, high-resolution US is a valuable non-invasive tool in the evaluation of rotator cuff pathology in patients with shoulder pain with consideration for surgical intervention. However, it is not useful in identifying the position of a PTRCT and should not be considered as the first form of imaging for patients who are clinically suspected of having a PTRCT and are candidates for a potential repair. An ASPTRCT diagnosed after US is highly likely to be present at arthroscopy. Also, an ASPTRCT should be considered in any symptomatic patient who requires further intervention and is listed for an arthroscopic procedure, regardless of the ultrasound findings.

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