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Diagnostic difficulties in the radiological assessment of subscapularis tears

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ABSTRACT

Background: Radiological evaluation of rotator cuff tears are sensitive and specific. Accuracy may be low in diagnosing subscapularis tears.
Materials and methods: We retrospectively reviewed shoulder arthroscopies performed by two surgeons over 45 months. We reviewed patients who had subscapularis repairs and their preoperative imaging.
Result: 286 cases had imaging (193 MRIs, 93 USS) with 77 subscapularis repairs. MRI suggested 31 tears, arthroscopy confirmed 16 (30% sensitivity, 89% specificity). USS suggested 6 tears, arthroscopy confirmed 4 (13% Sensitivity, 97% specificity).
Discussion: Results demonstrated low accuracy for preoperative radiological subscapularis tear assessment. This has logistical, diagnostic and implications on treatment.

1. Introduction

Rotator cuff tears are a common presenting pathology to the orthopaedic surgeon. As part of the investigation of the painful shoulder MRI and USS is widely used in the diagnosis of a rotator cuff tear. Whilst work relating to the accuracy of MRI and USS in the diagnosis of rotator cuff tears has been performed this is mostly relating to tears of the supero-posterior cuff. The accuracy of MRI has variable levels of sensitivity ranging from 0.41 to 1.0 and specificity ranging from 0.79 to 1.0.[1]

USS has been shown to be as effective in detecting[2] and quantifying[3] cuff tears. The prevalence of subscapularis tendon tears has not been widely studied, as the vast majority of the literature relates to supraspinatus tears.[4,5] Subscapularis tendon tear recognition and repair are critically important in the restoration of the normal anatomy with a view to optimising functional outcome.[6] The subscapularis muscle is the largest and only anterior rotator cuff muscle[7] and its repair is necessary to balance the force couple of the posterior rotator cuff.[8,9] The upper portion of the subscapularis where the tears tend to originate is particularly important because this is the part of the insertion that is broadest superiorly[10] and acts as the anterior attachment of the rotator cable.[9] It has also been shown that if these tears extend into the supraspinatus tendon, upper subscapularis tendon repair reduces the stress on the adjacent supraspinatus repair.[11] Subscapularis tears are increasingly being recognised to be present in approximately 30% of shoulder procedures and 50% of rotator cuff repairs.[15]

In the treatment of subacromial pain it is important to be able to accurately diagnose rotator cuff tears because whilst the initial management of the patient may well still be conservative, the presence of a cuff tear may lead the treating surgeon to offer surgery earlier if the patient is younger and higher demand. In addition to this an accurate pre-operative picture as to what pathology will be encountered when embarking on shoulder surgery is also important because it allows the operating surgeon to plan contingencies and organise theatre resources.

Most UK hospitals offer a musculoskeletal radiology service that includes ultrasound and MRI of the shoulder and, indeed, many orthopaedic surgeons perform in-office surgeon lead ultrasound scanning. It is the authors' anecdotal experience that although the literature supports excellent accuracy of ultrasound and MRI in the diagnosis and assessment of supraspinatus tears, that perhaps this is not the case for subscapularis tears.[4,5]

The aim of the present study was to assess the accuracy of imaging modalities in the pre-operative diagnosis of subscapularis rotator cuff tears.

2. Material and methods

We identified patients retrospectively during a 4-year period beginning in January 2013. The hospital computer system and operative diaries were searched to identify all patients who had undergone a shoulder arthroscopy ± procedure (excluding stabilisation). Operative notes were reviewed. (At the time of surgery, it is routine practice in our unit not only to document the type and size of tear, but also to take intra-operative photographs that are stored in the patient's notes). This

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list was then cross referenced with the PACS database and the outpatient clinic notes to identify all those who had an ultrasound scan or MRI of their shoulder prior to the arthroscopy.

The MRI and CT scans in the present study were all performed by trained (musculoskeletal interest) consultant radiologists in our hospital department using a standardised protocol and equipment. The MRI scans were using a 1.5 T scanner. Ultrasound scans were performed by ultrasound sonographers and Consultant Surgeons in clinic using a standardised protocol and equipment. Shoulder arthroscopy was performed by one of two shoulder surgeons (the senior author and his colleague). The recorded operative findings were then compared with radiological findings. All of the recorded procedures included arthroscopic subacromial decompression.

3. Results

A total of 77 subscapularis rotator cuff repairs were performed from 304 shoulder arthroscopies of which only 15 (19%) were picked up on pre-operative radiological investigations. The 304 procedures were performed on 294 patients. 3 patients were excluded, 1 due to incomplete hospital notes, 1 was a revision procedure and 1 patient had a shoulder hemiarthroplasty in situ. 204 right, and 100 left shoulders were operated on. Mean age was 59.1 (29–86) over the time period from January 2013 to October 2016.

286 patients had pre-operative imaging available for review. 193 patients had been investigated with MRI and 93 with ultrasound. Of the patients investigated with ultrasound 79 cases had been performed formally in the radiology department, 63 by the Consultant Radiologist and 16 by a trained sonographer. 14 scans were performed “in-office” by the Orthopaedic Consultant in clinic. 31 subscapularis tears were suspected on MRI, of which 16 were seen at arthroscopy and 13 went on to be repaired. Of the 162 cases where no tear was suspected, 38 were found to have a tear at surgery of which 32 were repaired. This gave MRI a sensitivity of 29.6% (95% CI 18–43.6%), a specificity of 89.2% (95% CI 82.8–93.8%). Positive predictive value for MRI was 51.6% (95% CI 36.2–66.7%) and negative predictive value was 76.5% (95% CI 73.1–79.7%). MRI was accurate at picking up subscapularis tears in 73% of the cases.

Ultrasound identified 6 subscapularis tears, of which 4 were seen at operation and 2 subsequently repaired. USS has a sensitivity of 12.5% (95% CI 3.5–29%), specificity of 96.7% (95% CI 88.7–99.6%). Positive predictive value for USS was 66.7% (95% CI 27.9–21.2%) and negative predictive value was 67.8%. Ultrasound was accurate at picking up subscapularis tears in 68% of the cases.

A comparison of the MRI and ultrasound sensitivity and specificity for investigation of Subscapularis, Supraspinatus and the Long Head of Biceps are shown in Tables 1 and 2. Concomitant repair of supraspinatus and subscapularis occurred in 44 cases. The remaining arthroscopic procedures performed are shown in Table 3.

It has been previously shown that there is a high prevalence (90%) of supraspinatus tears associated with subscapularis tears.[5] In our series we found a relatively small number of cases (17.3%) that required concomitant repair of supraspinatus alongside subscapularis.

Table 1
Data for MRI investigations.

	Subscapularis	Supraspinatus	Long Head of Biceps
MRI Total Number	193	193	193
Actual Tear	54	168	20
No Tear	139	25	173
True Positives	16	145	9
True Negatives	124	14	170
False Positives	15	11	3
False Negatives	38	23	11
Sensitivity	29.6% (18–43.6%)	86.3% (80.2–91.1%)	45% (23.1–68.5%)
Specificity	89.2% (82.8–93.8%)	56% (34.9–75.6%)	98.3% (95–99.6%)
PPV	51.6% (36.2–66.6%)	93% (89.4–95.4%)	75% (46.9–91.1%)
NPV	76.5% (73.1–79.7%)	37.8% (26.7–50.5%)	93.9% (91.2–95.8%)
Accuracy	73%	82%	93%

Table 2
Data for USS investigations.

	Subscapularis	Supraspinatus	Long Head of Biceps
USS Total Number	93	93	93
Actual Tear	32	87	6
No Tear	61	6	87
True Positives	4	71	4
True Negatives	59	2	86
False Positives	2	4	1
False Negatives	28	16	2
Sensitivity	12.5% (3.5–29%)	81.6% (71.9–89.1%)	66.7% (22.3–95.7%)
Specificity	96.7% (88.7–99.6%)	33.3% (4.3–77.7%)	98.8% (93.8–100%)
PPV	66.7% (27.9–91.2%)	94.7% (90.9–96.9%)	80% (34.5–96.8%)
NPV	67.8% (64.7–70.8%)	11.1% (3.6–29.6%)	97.7% (93.3–99.3%)
Accuracy	68%	78%	97%

Table 3
Additional arthroscopic procedures.

Procedure Performed	Number
Sub-Acromial Decompression	292
Acromioclavicular Joint Excision	181
Biceps Tenotomy	142
Rotator Cuff Repair (Supra/Infraspinatus)	254
Subscapularis Repair	77
Concomitant Supra/Infraspinatus repair + Subscapularis Repair	44

4. Discussion

In our Hospital we had a poor detection rate pre-operatively for subscapularis tears. This has implications for the diagnostic process and decision making relating to the potential operative management of patients who have often failed non-surgical management of shoulder impingement symptoms in whom a missed tear may cause significant symptoms and impact on shoulder function. Intra-operative discovery of subscapularis tears pose operative challenges with regards to available equipment, surgeon skill mix and list planning.

The sensitivity of both MRI and USS was very low, but ultrasound in particular was poor at excluding subscapularis tears. In this age of healthcare rationing and budget cuts, increasing pressure is being used to limit access to MRI and offer cheaper alternatives – i.e. USS. Perhaps it would be wiser to retain an index of clinical suspicion for subscapularis tears and order MRI more frequently, although the authors accept that this is also not hugely sensitive.

The difficulty in radiological and intra-operative diagnosis of subscapularis tears may relate to the way it tends to tear with > 90% starting on the articular, cephalad aspect of the tendon insertion.[12,13] The radiological diagnosis of these tears involves the differentiation of where the torn subscapularis tendon edge is situated and where the rotator interval starts. It has been found in previous research that preoperative MRI scans of the shoulder do not reliably predict subscapularis tendon tears, unless the tears extend at least half the

cephalad-to-caudal distance of the tendon, whereas smaller tears are usually missed.[6] Although retracted subscapularis tears can be appreciated on transverse images on MRI arthrography, without Indirect signs of subscapularis tear including contrast medium leakage or abnormalities in the course of the long head of biceps such as medial subluxation, partial tears are more difficult to appreciate.[14]

The importance of upper portion of subscapularis tendon tears are becoming increasingly recognised[15] which may in turn influence the pre-operative surgical planning. It is the experience of the authors that unless there is a large retracted tear of subscapularis or associated abnormalities in the course of the long head of biceps, pre-operative radiological diagnosis is very difficult. As pre-operative diagnosis of partial tears is difficult, and subscapularis tears are often missed as the lesser tuberosity is difficult to visualise,[15] we feel that every effort should be made to visualise the subscapularis footprint. In some situations a 70° arthroscope may be helpful in visualising the lesser tuberosity as described by Denard et al.[15]

Although retrospective, this study identified the pre-operative radiological investigation for all patients that underwent subscapularis repair over a four year period. This does introduce some selection bias because there may have been a significant cohort of patients whom had a scan suggesting subscapularis pathology but then whose symptoms resolved or did not want surgery. However, if we are to evaluate the accuracy of pre-operative radiological investigations using surgery as a gold standard, then this selection bias is inevitable. The difficulty in appreciating partial tears of the subscapularis tendon as it inserts on the lesser tuberosity versus minor fraying of the tendon which might not warrant formal repair may have also introduced and over-reporting bias. The time taken from pre-operative radiological investigation to surgery was not assessed, so there may have been sufficient time for tears to develop or progress during that interim period. In this study we have not graded the subscapularis tears which would be useful in determining how they correlate with pre-operative imaging.

5. Conclusion

We conclude that, whilst the literature supports that MRI and USS can have a high sensitivity and specificity in picking up rotator cuff tears, radiological diagnostic accuracy for subscapularis tears is poor.

We would recommend a regular combined radiology/shoulder surgery multidisciplinary team meeting in the department not only to feedback the intra-operative findings, but also as a useful learning tool for both specialities, and as a forum for the discussion of more complex cases. The increasing use of 3 T MRI scanners may improve the ability to appreciate partial subscapularis tears, and scanners that allow abduction, external rotation (ABER) positioning may play a role in the diagnosis of partial thickness, articular sided rotator cuff pathology.[16]

Conflict of interest

The authors declare that there are no conflict of interest.

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