

## Detection of Rotator Cuff Tears by Surgeon-Performed Ultrasound Scan

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### ABSTRACT

**INTRODUCTION:** The aim of this study was to determine whether the greatest diagnostic accuracy for the detection of a surgically relevant rotator cuff tear is provided by a scan in the radiology department, either ultrasound or Magnetic resonance, or by an ultrasound scan performed in the clinic by a shoulder surgeon.

**MATERIALS AND METHODS:** Consecutive patients due to undergo an arthroscopy for rotator cuff disease were scanned by the operating surgeon. The presence or absence of a surgically relevant cuff tear on scan was compared with arthroscopic findings as gold standard. The surgeon's log was then compared with the radiologist results of both ultrasound and MRI performed for the same patients in our institution. Subgroup analysis was performed to compare the

results of scans reported by specialist and non-specialist radiologists.

**RESULTS:** Surgeon-performed Ultrasound scan on 88 shoulders was compared to 57 departmental Magnetic resonance scans and 41 departmental Ultrasound scans. Compared to the predictive values obtained for all radiology reported scans combined, Surgeon-US had significantly greater specificity (98.2 vs 81.8,  $p = 0.008$ ), Positive predictive value (97.6 vs 79.6,  $p = 0.010$ ), and overall accuracy (95.0 vs 84.0,  $p = 0.019$ ). No significant difference was found on comparing sensitivity (91.1 vs 86.7) or Negative predictive value (93.2 vs 88.2).

**CONCLUSION:** A surgeon performed Ultrasound scan for the detection of surgically relevant rotator cuff tears can provide equal accuracy to departmental Magnetic resonance or specialist radiologist-performed US and better accuracy than US performed by a non-specialist radiologist. These findings support the development of 'one stop' shoulder clinics. To our knowledge, this is the first study to directly compare both radiology-reported US and MRI with surgeon-performed US in the same group of patients.

**Key words:** Rotator cuff tear; Ultrasound scan; MRI scan

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### INTRODUCTION

Pathology of the rotator cuff is a frequent cause of pain and dysfunction of the upper limb in patients presenting to an orthopaedic surgeon<sup>[1-2]</sup>. Determination of the presence of a full-thickness rotator cuff tear is important and may affect a patient's treatment. Regarding partial thickness tears most clinicians agree that involvement of more than 50% of the thickness of the tendon should sway the surgeon to perform a repair in a sufficiently symptomatic individual<sup>[3-4]</sup>. The use of imaging to provide more precise diagnosis can enable the clinician to provide specific patient counselling with regard to prognosis and the potential outcome of operative and non-operative management.

Ultrasound (US) and magnetic resonance imaging (MRI) are the two non-invasive modalities in common use for the detection of both partial and full thickness cuff tears, with arthroscopy being the gold standard for diagnosis. US has the advantage of being a portable, dynamic assessment with lower cost but is user-dependant with a learning curve. MRI has the advantage of being able to assess the quality and bulk of the rotator cuff tendons and can provide a greater breadth of diagnosis. However it is contraindicated in patients with certain metal implants and those with claustrophobia<sup>[5]</sup>.

The reported pooled sensitivity and specificity of US for the detection of full-thickness cuff tears are 90-96% and 93%, respectively, and the pooled values for partial thickness tears are (sensitivity 52-84%, specificity 89-94%)<sup>[6,7]</sup>. MRI has also been assessed to have a very similar diagnostic accuracy to US for both full thickness (sensitivity 90-94%, specificity 93-97%) and partial thickness tears (sensitivity 67-80%, specificity 93-95%) in three meta-analyses<sup>[7-9]</sup>.

The aim of this study was to determine whether the greatest diagnostic accuracy for the detection of a rotator cuff tear that could be considered for surgical repair is provided by a scan in the radiology department (either US or MRI) or by a shoulder surgeon.

## MATERIALS AND METHODS

Patients presenting with shoulder pain and considered for elective surgery for rotator cuff dysfunction after failure of conservative treatment were included in this study. Patients had been assessed in the outpatient clinic a minimum of two months before the day of procedure and those considered for surgical treatment were listed for shoulder arthroscopic subacromial decompression and/or possible rotator cuff repair. The surgeon performed an ultrasound of the shoulder using a portable ultrasound scanner with 10MHz linear transducer. The sequence of ultrasound scan followed for the systematic and thorough examination of the rotator cuff and long head of biceps tendons has been previously described<sup>[6]</sup>. The ultrasound criteria for the diagnosis of a full thickness cuff tear included complete cuff non-visualisation, focal discontinuity in homogenous echogenicity without thinning, inversion of bursal contour and/or hyperechoic material in

**Table 1** Descriptive statistics for each radiology study group.

	Specialist radiologist-US	General radiologist-US	Specialist radiologist-MRI	General radiologist-MRI
Patients (male)	15 (7)	26 (13)	35 (18)	22 (10)
Shoulders	16	26	36	22
Mean age (years)	59.1 (34-72)	58.1 (37-76)	53.3 (30-71)	56.7 (42-71)
Full thickness tear	7	11	14	11
Partial tear >50%	0	1	3	0
Partial tear <50%	6	1	7	3
No tear	9	13	20	8
No. radiologists	2	7	4	6

**Table 2** Comparative statistics: surgeon-performed US versus all radiology reports combined and separately versus all radiology US and all radiology MRI.

	All radiology (n=100)			All US (n=42)			All MRI (n=58)		
	Radiology	Surgeon	p-value	Radiology	Surgeon	p-value	Radiology	Surgeon	p-value
Sensitivity	86.7	91.1	0.739	89.5	100	0.487	84.6	84.6	1
Specificity	81.8	98.2	0.008	73.9	95.7	0.096	87.5	100	0.113
PPV	79.6	97.6	0.01	73.9	95	0.1	84.6	100	0.114
NPV	88.2	93.2	0.509	89.5	100	0.209	87.5	89.2	1
Accuracy	84	95	0.019	81	97.6	0.029	86.2	93.1	0.361

location of the tendon that failed to move with the humeral head on passive movement<sup>[10]</sup>. The presence or absence of a rotator cuff tear was recorded. If there was felt to be a partial tear then it was recorded as being either > 50% or < 50% of the thickness of the tendon. On the day of surgery, the surgeon was blinded regarding the presence of a cuff tear on previous imaging. At arthroscopy, the rotator cuff was examined from both the articular and bursal sides. The presence of a cuff tear was recorded and where a partial tear was encountered, a direct estimation of the percentage thickness of the tear was made using an arthroscopic instrument of known length. Immediately after completion of surgery the operative findings were recorded in the surgeon's logbook. The surgeon's US results were compared with the pre operative MRI and US scan results of the affected shoulder performed by our radiology department. The date of these scans, reported presence or absence of a rotator cuff tear and the name of the reporter was recorded. Reporters were identified as either being a specialist musculoskeletal radiologist or a general radiologist. For the purposes of our study the detection of a rotator cuff tear that would be considered for surgical repair (either full thickness tear or partial thickness tear >50%) was considered a positive result for all imaging modalities and arthroscopy.

**Table 3** Comparative statistics: surgeon-performed US versus all scans reported by a specialist or a non specialist radiologist.

	Specialist radiologist (n=52)			General radiologist (n=48)		
	Radiology	Surgeon	p-value	Radiology	Surgeon	p-value
Sensitivity	90.9	90.9	1	82.6	91.3	0.665
Specificity	93.3	100	0.492	68	96	0.023
PPV	90.9	100	1	70.4	95.5	0.031
NPV	93.3	93.8	1	81	92.3	0.386
Accuracy	92.3	96.2	0.678	75	93.8	0.022

**Table 4** Comparative statistics : surgeon-performed US versus all US or MRI scans reported by a specialist and a non specialist radiologist.

US	Specialist radiologist-US (n=16)			General radiologist-US (n=26)		
	Radiology	Surgeon	p-value	Radiology	Surgeon	p-value
Sensitivity	100	100	1	83.3	100	0.479
Specificity	88.9	100	1	64.3	92.9	0.164
PPV	87.5	100	1	66.7	92.3	0.172
NPV	100	100	1	81.8	100	0.199
Accuracy	93.8	100	1	73.1	96.2	0.049
MRI	Specialist radiologist-MRI (n=36)			General radiologist-MRI (n=22)		
	Radiology	Surgeon	p-value	Radiology	Surgeon	p-value
Sensitivity	86.7	86.7	1	81.8	81.8	1
Specificity	95.2	100	1	72.7	100	0.214
PPV	92.9	100	1	75	100	0.229
NPV	90.9	91.3	1	80	84.6	1
Accuracy	91.7	94.4	1	77.3	90.9	0.412

### Statistical analysis

Cross tables were produced to compare imaging results with arthroscopic findings as the gold standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated and statistically analysed using Fisher's exact test to compare the results of surgeon-performed ultrasound (Surgeon-US) with the following subdivided radiology scan groups, for the same patients in each group: (1) All radiology reports, US reports and MRI reports; (2) All specialist musculoskeletal radiologist reports and all general (non-specialist) radiology reports; (3) Specialist musculoskeletal radiologist-reported US and MRI and General (non-specialist) radiology-reported US and MRI reports.

All tests were two-sided with statistical significance set at  $p < 0.05$  and analysis was carried out using SPSS v16.00 (Chicago, Illinois, USA).

## RESULTS

Surgeon-US and arthroscopy were completed on 120 shoulders during the 13 month study period. Only 86 patients (88 shoulders) were included in this study as they had also had radiology department scans performed at our institution before surgery. The remaining patients were either scanned at another institution prior to referral or did not have a scan. Arthroscopy showed 38 surgical rotator cuff tears (thirty seven full thickness tears and one partial thickness tear over 50%), and 7 partial thickness less than 50%. Radiologists performed one hundred scans in total, as twelve patients had both US and MRI scans. Thirty five MRI scans were reported by four specialist musculoskeletal radiologists and twenty two by six general radiologists. Of the forty two US, fifteen were performed by two specialist musculoskeletal radiologists and twenty seven by seven general radiologists.

### Baseline characteristics of each radiology study group

No significant differences were found between groups with respect to demographic information, presence of full or partial thickness cuff tear (Table 1).

### Comparative statistics for all Radiology (US and MRI) reports versus Surgeon-US

Compared to the predictive values obtained for all radiology reported scans combined, Surgeon-US had significantly greater specificity (98.2 vs 81.8,  $p = 0.008$ ), PPV (97.6 vs 79.6,  $p = 0.010$ ), and overall accuracy (95.0 vs 84.0,  $p = 0.019$ ). No significant difference was found on comparing sensitivity (91.1 vs 86.7) or NPV (93.2 vs 88.2).

Direct comparison of those shoulders undergoing both radiology US and Surgeon-US revealed a significantly greater accuracy for the latter (97.6 vs 81.0,  $p = 0.029$ ), but no significant difference for sensitivity, specificity, PPV or NPV.

No significant differences were found for any predictive value when comparing Surgeon-US with radiologist-reported MRI (Table 2).

### Comparative statistics for all reports by specialist or general radiologist versus Surgeon-US

No significant difference was found for any predictive value when comparing Surgeon-US with a specialist radiologist (overall accuracy 96.2 vs 92.3,  $p = 0.678$ ), but Surgeon-US demonstrated significantly better specificity (96.0 vs 68.0,  $p = 0.023$ ), PPV (95.5 vs 70.4,  $p = 0.031$ ) and accuracy (93.8 vs 75.0,  $p = 0.022$ ) compared to those all scans reported by a general radiologist (Table 3).

### Comparative statistics for US or MRI reports by specialist or general radiologist versus Surgeon-US

The predictive values of both specialist-reported US ( $n = 16$ ) and MRI scan ( $n = 36$ ) compared to Surgeon-US were very similar (overall accuracy 93.8 vs 100 and 91.7 vs 94.4, respectively). However, the specificity, PPV and accuracy of non-specialist reported US ( $n = 26$ ) and MRI ( $n = 22$ ) were greatly inferior to comparison Surgeon-US, but this only reached statistical significance for overall accuracy in the general radiologist-US group (73.1 vs 96.2,  $p = 0.049$ ) (Table 4).

## DISCUSSION

The results of this study indicate that equally accurate results for the detection of surgically-relevant rotator cuff tears can be produced by surgeon-performed US when compared to both MRI and US when performed by a specialist musculoskeletal radiologist and significantly more accurate than US performed by a general radiologist.

Our findings for Surgeon-US scan accuracy are supported by previous findings from three meta-analyses of the literature. The highest predictive values were attributable to musculoskeletal radiologists (sensitivity 95%, specificity 95%) and orthopaedic surgeons (sensitivity 95%, specificity 91%). These were significantly higher than a general radiologist (sensitivity 89%, specificity 87%)<sup>7-9</sup>. To our knowledge however the present study is the first to directly compare radiology-performed US and MRI scans with surgeon-performed US in the same group of patients.

These findings have implications for the clinical practice of orthopaedic surgeons. The benefits of surgeon-performed US in a 'one-stop' shoulder clinic where patients undergo diagnostic ultrasound on the first consultation are clear<sup>11-13</sup>. Patients may complete their episode of care quicker and can be more predictably counselled of the likelihood that they do have a true tear requiring surgical repair without compromising scan accuracy. Multiple authors have noted that orthopaedic surgeons with subspecialisation in shoulder seem to be able to achieve high accuracy values for the detection of rotator cuff tears on US within a relatively short period of time<sup>14,15</sup>.

This study has several limitations. The study group may exhibit spectrum bias. All patients had failed conservative therapy and may represent the most extreme end of pathology more easily seen on scan. The incidence of cuff tears is likely higher in this population than the 'average' attending the outpatient clinic. Nonetheless, intra-operative diagnosis is the current gold standard in the detection of cuff tears thus it would be difficult to represent true values for the accuracy of US in any other group. Further, this is a single surgeon study and the results may not be generalisable to other surgeons. However the predictive values obtained are highly comparable to those previously reported in the literature for other surgeons<sup>7-9</sup>.

## CONCLUSION

Surgeon-performed US for the detection of surgically relevant rotator cuff tears can provide at least equal accuracy to departmental MRI or US performed by a specialist musculoskeletal radiologist, and better accuracy than US performed by a general radiologist. These findings support the development of 'one stop' shoulder clinics.

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