

EVALUATION OF ROTATOR CUFF INJURIES USING HIGH-FREQUENCY ULTRASONOGRAPHY AND ITS COMPARISON WITH MAGNETIC RESONANCE IMAGING FINDINGS

Mohammad Muzaffar¹, Vinoth Rayar², P. Samai³

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Corresponding Author:
Dr. Vinoth Rayar
Email: vinothrayar84@gmail.com

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¹Assistant Professor, Department of Radiodiagnosis, Srinivasan Medical College and Hospital, Samayapuram, Trichy, India.

²Associate Professor, Department of radiodiagnosis, Srinivasan medical college and hospital, Samayapuram, Trichy, India.

³Assistant Professor, Department of Radiodiagnosis, Srinivasan Medical College and Hospital, Samayapuram, Trichy, India.

Abstract

Background: Shoulder pain is the most common musculoskeletal complaint after neck and lower back pain and can be associated with impairment and marked disabilities. **Objectives:** To compare the sensitivity, specificity, and predictive values of USG and MRI findings in the diagnosis of rotator cuff injuries. Demographic assessment of type of rotator cuff injuries. **Materials and Methods:** This was a comparative cross-sectional study that was conducted at the Department of Radio-diagnosis, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry. The study was approved by the institutional ethics committee, and patients gave written informed consent. A record was maintained in the Department of Radio Diagnosis, Sri Lakshmi Narayana Institute of Medical Sciences, of all cases. This study included 62 patients who presented to the Radiology Department with a clinical history of shoulder pain for evaluating the rotator cuff integrity through the period from 1st Nov 2016 to 31st October 2018 from the Department of Orthopedics. All patients were taken for high-resolution ultrasonography and conventional shoulder MRI in a 1.5 Tesla Siemens MR Scanner. The patients enrolled had undergone shoulder arthroscopy and had confirmed rotator cuff tears. **Results:** There were 42 male and 20 female patients in the study. Age ranged from 19 to 68 years with the mean age 35.38 years. 42 cases with the clinical diagnosis of recurrent dislocation of the shoulder were taken and 20 cases with rotator cuff tear were taken. Out of 42 cases of recurrent dislocation of shoulder 4 had concomitant rotator cuff tear which was not suspected clinically. The average age of patients with recurrent dislocation of the shoulder was 30.61 yrs. For recurrent dislocation of the shoulder, the overall ratio was even more skewed towards males with male to female ratio of 5:2. **Conclusion:** MRI appears to be superior to USG in the detection of partial thickness articular surface tears of the rotator cuff as well as the labro-ligamentous complex of the shoulder joint and should be routinely be done, especially in case of young patients.

INTRODUCTION

Shoulder pain is the most common musculoskeletal complaint after neck and lower back pain and can be associated with impairment and marked disabilities. As many as 20% of people experience shoulder pain at some stage in life.^[1] The first step for a clinician is to determine whether shoulder pain originates from the shoulder region itself or from the cervical region. Several aspects of a patient's history like coexistent neck pain, pain that radiates distally below the elbow,

paresthesia, bilateral shoulder pain, etc. can suggest cervical pathology.^[2,3]

Differential diagnosis of painful shoulder comprises impingement syndrome, rotator cuff tears, glenohumeral joint instability, capsulitis, acromioclavicular joint pathologies, etc. Shoulder impingement syndrome is the most common disorder among shoulder disorders resulting in functional loss and disability in patients it affects.^[4]

Ultrasonography is a good screening modality for detecting rotator cuff tears but it is operator-dependent and is less sensitive for detection of labral pathologies. USG has the advantage of being a rapid

and accurate method of diagnosing rotator cuff bursal abnormalities, including dynamic signs of impingement, calcific deposits, and irregularity of greater tuberosity are other common findings that are clearly identified on USG.^[5]

There is difficulty distinguishing an extensive partial-thickness tear from a full-thickness tear on sonography. The error occurs because of the substantial loss of cuff substance and compressibility of the few remaining fibers with the transducer.

MRI is a very useful modality for the evaluation of the shoulder because of its multiplanar and thin section capabilities and excellent signal intensity extending through the cancellous bone to reach a cortical surface. rotator cuff tear, degree of tendon retraction, greater tuberosity fractures, gleno-labral and cartilage disruption, and other soft tissue injuries can also be diagnosed by MRI.^[6]

MR Arthrography with intra-articular contrast is performed with gadolinium-based contrast material.^[7] The advantages of capsular distension are twofold firstly; it allows distinction of individual structures by improved soft tissue contrast and physical separation by the intra-articular contrast material. Secondly, it allows analysis of the distribution of contrast material in and around the joint. It is more accurate than standard MR imaging for assessing the capsule labral complex, undersurface of the rotator cuff, glenohumeral ligaments, and rotator cuff interval. Arthroscopy has the dual advantage of being both diagnostic and therapeutic. However, the use of anesthesia and the requirement for hospital stays is an important drawback in the diagnostic utility of arthroscopy.

MATERIALS AND METHODS

This was a comparative cross-sectional study which was conducted at the Department of Radio-diagnosis, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry. The study was approved by the institutional ethics committee, and patients gave written informed consent. A record was maintained in the Department of Radio Diagnosis, Sri Lakshmi Narayana Institute of Medical Sciences, of all cases. This study included 62 patients presented to the Radiology Department of Sri Lakshmi Narayana Institute of Medical Sciences with a clinical history of shoulder pain for evaluating the rotator cuff integrity through the period from 1st Nov 2016 to 31st October 2018 from the Department of Orthopedics. All patients were taken for high-resolution ultrasonography and conventional shoulder MRI in a 1.5 Tesla Siemens MR Scanner. The patients enrolled had undergone shoulder arthroscopy and had confirmed rotator cuff tears.

Inclusion Criteria

Adult patients of either sex with any of the following:

1. History of injury to shoulder.
2. History of recurrent dislocation of the shoulder.

3. Suspected ligamentous, labral, glenohumeral, rotator-cuff, or musculotendinous injuries on clinical examination.
4. X-ray findings suggestive of labor-ligamentous and rotator-cuff or musculotendinous pathologies of the shoulder joint.

Exclusion Criteria

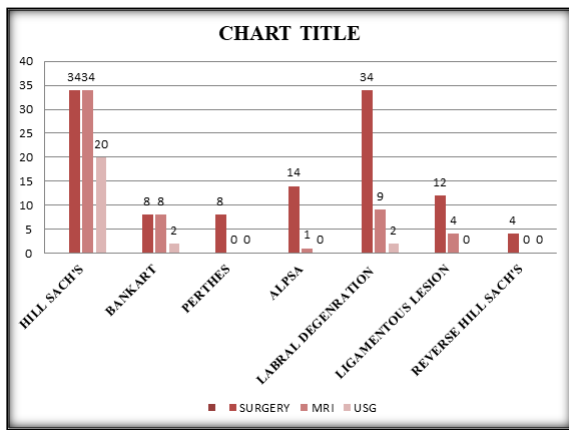
1. Patients who have contraindications to an MR evaluation- patients with pacemakers, claustrophobia, metallic implants.
2. Past history of any operative intervention in the shoulder joint.
3. All the rotator cuff muscles were determined with Sonography and MRI for full-thickness and partial tearing. A comparison between the two methods was done by the McNemar Chi-Square test.

Statistical Analysis

Descriptive statistics (mean, standard deviation, median, range) were provided where appropriate. The empirical distribution of age was reported with mean, standard deviation (SD), and range, with absolute and relative frequencies in the case of categorical variables. Agreement of the scores measured with different methods was evaluated using the Kappa statistic and McNemar-test (Bowker-test in case of more than two categories). In all statistical tests, an effect was considered to be statistically significant if the p-value was 0.05 or less. All data analysis was performed using statistical software (SPSS16.0 Software for Windows).

RESULTS

There were 42 male and 20 female patients in the study. Age ranged from 19 to 68 years with the mean age 35.38 years. 42 cases with the clinical diagnosis of recurrent dislocation of the shoulder were taken and 20 cases with rotator cuff tear were taken. Out of 42 cases of recurrent dislocation of shoulder 4 had concomitant rotator cuff tear which was not suspected clinically. The average age of patients with recurrent dislocation of the shoulder was 30.61 yrs. The average age of patients with rotator cuff tears in the shoulder was 45.4 yrs. 70.9 % of patients (44/62) belonged to the 21-40 years age group. Males were more commonly affected than females (20:11). The overall ratio for rotator cuff tears was the same for males and females (1:1), two patients with recurrent dislocation of the shoulder also had rotator cuff tears. For recurrent dislocation of the shoulder, the overall ratio was even more skewed towards males with male to female ratio of 5:2. The minimum age of affected females was 19 yrs. and that for males was 21 years and both had a history of instability syndrome post-trauma. The maximum age of affected females was 63 yrs. and that for males was 68 yrs., both having rotator cuff tear. Out of 62 patients included in the study, the right side was more commonly involved as compared to the left. (Right: left ratio was 18:13) [Table 1].



Out of 62 cases, 42 patients had a history of recurrent dislocation of the shoulder. Out of 42 patients, 38 patients had a history of anterior instability, 2 cases had posterior instability, and two patients had multi-directional instability. Hill Sach's was the most common lesion, found in 34 out of 42 cases. The labral tear was noted in 9 cases on imaging and 34 cases on surgery. The ligamentous injury was found in 4 cases, with the inferior glen humeral ligament being the most commonly involved (4 cases), and the middle glenohumeral ligament was the next most commonly involved ligament. It was torn from its humeral attachment in 2 cases. ALPSA was detected in 14 out of 42 cases with instability syndrome. Perthes lesion was noted in 8 cases, with 4 of them being bony Bankart and 4 being cartilaginous. Reverse Hill Sach's was seen in 4 cases. Reverse Bankert's lesion was noted in 2 cases.

Most of the cases had a parallel alignment of acromion. Out of 42 cases of recurrent dislocation of the shoulder, 10 had inferolateral tilt and none had low-lying acromion.

Out of 20 cases with a rotator cuff tear, 8 had a parallel alignment of acromion, 6 had inferolateral tilt and 6 had low-lying acromion suggesting a possible correlation between the type of acromion and rotator cuff tear. The average acromion-humeral distance was observed to be lower in patients with rotator cuff tear [Table 2].

As per Table 3, we found that 66.6% of patients with Acromioclavicular joint degeneration had a tear. Only 22 % (12/54) of patients with greater tuberosity pathology had a tear. In the case of 20 patients with rotator cuff tear, 10 patients (50%) had bony changes. Hence these bony changes are an indicator of underlying rotator cuff tear. Greater trochanter fracture, contusion may not be associated with rotator cuff tear [Table 3].

Lesions causing dislocation of the shoulder were higher in MRI as compared to USG [Table 4].

The sensitivity, specificity, and accuracy of MRI with respect to arthroscopy/surgery in full-thickness tears is 100 % [Table 5].

The sensitivity, specificity, and accuracy of USG with respect to arthroscopy/surgery in ligamentous lesions are 0%, 100%, and 80.65% respectively. The sensitivity, specificity, and accuracy of MRI with

respect to arthroscopy/surgery in ligamentous lesions are 33.3%, 100%, and 87.1% respectively [Table 5c]. The sensitivity, specificity, and accuracy of USG with respect to arthroscopy/surgery in Bankart's lesions are 25%, 100%, and 90.32% respectively. The sensitivity, specificity, and accuracy of MRI with respect to arthroscopy/surgery in Bankart's lesions are 81%, 100%, and 100% respectively [Table 5d].

The sensitivity, specificity, and accuracy of USG with respect to arthroscopy/surgery in labral degeneration are 86.6%, 93.7%, and 90.3% respectively. The sensitivity, specificity, and accuracy of MRI with respect to arthroscopy/surgery in labral degeneration are 26.47%, 100%, and 59.68% respectively [Table 5e].

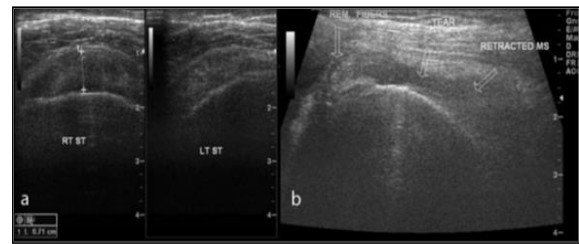


Figure 2: Ultrasound images for the shoulder (a) show the increased thickness of the right supraspinatus muscle compared with the left one which was proved to be tendinosis. (b) Is an ultrasound image for a different patient shows a complete tear of the muscle tendon with retraction and fluid-filled gap

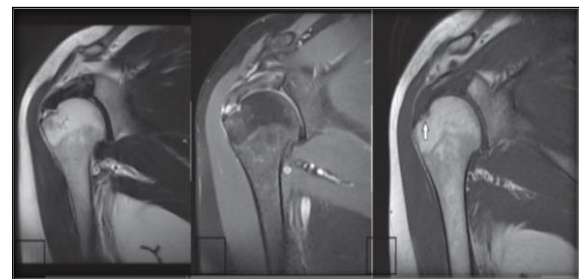


Figure 3: MRI coronal T2 (a), PD with fat suppression (b), and T1 (c) WI revealed a full-thickness tear of the supraspinatus tendon near its humeral attachment with fluid signal seen in the gapping area which measures about 6 mm (comparable to the US)

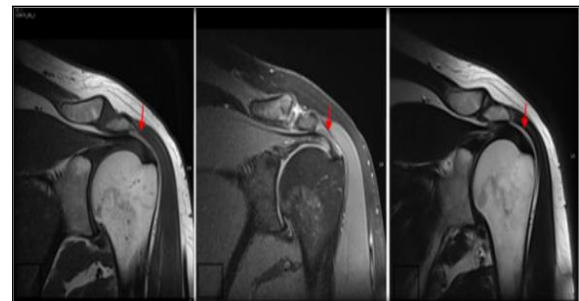


Figure 4: MRI coronal T1 (a), PD with fat suppression (b), and T2 (c) WI showing abnormal intermediate signal of the supraspinatus tendon in all pulse sequences with no disruption of its continuity (red arrows) denoting tendinopathy. Associated osteoarthritic changes of the acromioclavicular joint are noted

Table 1: Acromial alignment on MRI

Acromial Alignment	No. of Patients	Percentage
Parallel	40	64.5%
Inferolateral	16	25.8%
Low Lying	6	9.67%

Table 3: Bony changes detected on MRI and association with rotator cuff tears

Bony Changes of Humours	Number of patients	Associated with rotator cuff	%
Acromioclavicular Joint Degeneration	6	4	66.6
Greater tuberosity irregularity/contusion/fracture/Hill sashes/Bankart fracture	54	12	22.2

Table 4 (a): Comparison of findings by USG & MRI in rotator cuff tears patients

Tear	USG	MRI	Arthroscopy/ Surgical Findings
Full Thickness	8	8	8
Partial Thickness	8	12	18

Table 4 (b) Comparison of findings by USG & MRI in recurrent dislocation of the shoulder

Lesion	USG	MRI	Arthroscopy/Surgical Correlation
Hill Sach's	20	34	34
Bony Bankart	2	4	4
Cartilagenous Bankart	0	4	4
LABRAL TEAR/DEGENERATION	2	9	34
Ligamentous Lesion	0	4	12
ALPSA	0	1	14
Perthe's	0	0	12
Reverse Hill Sach's	0	4	4
Reverse Bankart	0	2	2

Table 5: Comparison of MRI and USG Findings with Arthroscopic/ Surgical MRI Findings in Full Thickness Rotator Cuff Tear

		Arthroscopy/Surgery		
		Positive	Negative	
MRI	Positive	8	0	8
	Negative	0	54	54
		8	54	62

(b) USG & MRI in Partial Thickness Tear

	USG	MRI
Sensitivity	44.4	66.7
Specificity	100	100
Accuracy	83.87	90.32

(c) USG & MRI in Ligamentous Lesions

	USG	MRI
Sensitivity	0	33.3
Specificity	100	100
Accuracy	80.65	87.1

(d) USG & MRI in Bankart's Lesion

	USG	MRI
Sensitivity	25	100
Specificity	100	100
Accuracy	90.32	100

(e) USG & MRI Findings in Labral Degeneration

	USG	MRI
Sensitivity	5.88	26.47
Specificity	100	100
Accuracy	48.39	59.68

DISCUSSION

There were 42 male and 20 female patients in the study. Age ranged from 19 to 68 years with the mean age 35.38 years. These were present in over 50% of

the dominant shoulder in the seventh decade and in 80 % of subjects over 80 years of age in a study conducted by Milgrom C et al,^[8] A high correlation between the onset of rotator cuff tears increasing age has also been reported by Fehringner EV et al,^[9] and

Yamamoto et al,^[10] in their studies which correlates with our findings.

Males were more commonly affected than females overall. (20:11) In a study conducted by Zacchilli MA et al,^[11] on the epidemiology of shoulder dislocation the male incidence rate was 34.90 per 100,000 person-years with an incidence rate ratio of 2.64 relative to the female incidence rate. It was found that 71.8% of the dislocations were in males. Stratified by decade, the maximum incidence rate (47.8) occurred in those between the ages of twenty and twenty-nine years.

4/24 (16.6%) patients with rotator cuff tears had on history of pain, one of them had a history of recurrent dislocation and presented with instability, and another patient was 68 years old with restricted movement. In a similar study, Fehringer et al found full-thickness RC tears in 22 % of asymptomatic patients >65 years.^[9] In younger asymptomatic adults, the prevalence of tears is expected to be lower: 5% and 11% in the fourth and fifth decades.^[8]

7.05 mm was the average acromion-humeral distance in patients' rotator cuff pathology, which was lower than the overall average of 7.5mm which is in concordance with the study by Saupeet al,^[12] who found that a >7mm acromion-humeral distance in their study was associated with 90% of the rotator cuff tears.

In a study on 91 patients with rotator cuff tears Hirano,^[13] et al also found that there was little correlation between acromion type and the presence of tear. However, they reported a significantly higher number of type III acromion (39%) in patients with rotator cuff tear.

We found that 75 % of patients with greater tubercle irregularity had a tear which indicates a high specificity for finding a greater tubercle irregularity for diagnosing a rotator cuff tear. This finding was also corroborated by Kaneko,^[14] et al in 1995 who found that GT irregularity as a marker for tear using routine X-rays was 78% sensitive and 98% specific.

Out of a total of 62 patients, 20 patients had clinical suspicion of rotator cuff tear, 24 patients had rotator cuff tear on MRI, out of them 8 patients had full thickness tear and 16 patients had partial thickness tear. 4 patients with recurrent dislocation of the shoulder had concomitant partial thickness rotator cuff tear which was detected on MRI. In patients with rotator cuff lesions, 8 cases of full-thickness tears were diagnosed on USG as well as MRI. 12 out of a total 18 cases of partial thickness tears were diagnosed on MRI and 8 cases were diagnosed on USG. 12 out of the 18 cases were articular surface tears. 2 cases was intra-substance partial thickness tear; 4 cases were bursal surface partial thickness tear. It correlated well with the findings of Itoi E et al,^[5] who found that partial articular surface tears occur more frequently than partial bursal surface or intra-substance tears.

On MRI all the tears were detected on the T2 W Fat Saturated sequences with some of the large tears apparent on proton density images as well. T2 W

sequences with fat saturations were also the most sensitive for the diagnosis of effusion in the joint or bursae. However anatomical details were less well visualized on T2W images with fat saturation. These are in correlation with the study by Renius,^[16] et al. They studied the utility of T2W and T2W fat sat images in diagnosing rotator cuff tears in 49 surgically proven patients and found a sensitivity of 80% non-fat sat vs 100% for fat sat T2W images in full thickness tears and sensitivity of 15% vs 35 % in partial thickness tears.

The sensitivity, specificity, and accuracy of USG for the detection of partial thickness rotator cuff tear was 44.4%, 100%, and 83.87% and that for MRI was 66.7%, 100%, and 90.32% which is similar to those found in various studies. The sensitivity, specificity, and accuracy of both USG and MRI for the detection of full-thickness rotator cuff tear was 100 % which is a bit higher as compared to studies may be because of less number of cases included in our study.

CONCLUSION

MRI plays a significant role in evaluating the stage and prognosis of RC disease: tear size tendon retraction, and the extent of muscle atrophy, each of which negatively impacts the functional outcome. MRI is very sensitive for the detection of full-thickness tears of the rotator cuff but it lacks sensitivity in case of partial thickness tears of the rotator cuff, especially the articular surface partial thickness tears.

The detection of partial thickness tear is important because partial thickness tear of the anterior supraspinatus fiber increases the strain upon the remaining supraspinatus fibers and intact infraspinatus tendon, leading to tear propagation and potentially impacting the decision to operate sooner as opposed to waiting. Also, the increased waiting times lead to increased fatty degeneration of the rotator cuff muscle which correlates negatively with post-surgical functional outcome.

Hence early detection of partial thickness tear may improve the functional outcome in the post-surgery period. There is a high incidence of various labro-ligamentous injuries in patients with instability syndrome and the functional outcome of the patient significantly improves after surgery. Therefore, I would like to conclude that MRI appears to be superior to USG in the detection of partial thickness articular surface tears of the rotator cuff as well as the labro-ligamentous complex of the shoulder joint, and should be routinely done, especially in case of young patients.

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