

Imaging Modalities for Rotator Cuff and Labro- Ligamentous Complex of Shoulder Joint Evaluation

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ABSTRACT

To compare the positive and negative predictive value of USG and MRI in diagnosis of rotator cuff injuries. To determine the diagnostic accuracy of ultra-sonography (US) compared with magnetic resonance imaging (MRI). To compare the sensitivity and specificity of USG and MRI findings in diagnosis of rotator cuff injuries. To compare the observed ultrasound and magnetic resonance imaging findings with the available arthroscopic or operative findings. Demographic assessment of type of rotator cuff injuries..

Keywords:

Axial skeleton, shoulder, ultrasonography, arthritis and bone tumors

1. Introduction

Structurally and functionally complex of freely moveable areas in the human body due as a connecting link of the upper limb with the axial skeleton, the shoulder joint plays an imperative role in most daily activities, allowing us to position our hands in space. [1] Further, the joint acts as a small fulcrum for a long lever arm, predisposing the rotator cuff to injury, especially from the rapid acceleration and decelerations inherent to most sports and even some activities of daily living. [2] The large humeral head as compared with the glenoid fossa grants shoulder joint mobility at the expense of stability. Due to its greater mobility & unstable configuration it is frequently involved in dislocation & injury. Shoulder anatomy and biomechanics, particularly those of the rotator cuff, endow the gleno humeral joint dynamic and static stability throughout a substantial range of motion. The rotator cuff is composed of supraspinatus, infraspinatus, teres minor and subscapularis musculotendinous complexes. Because of the rotator cuff crucial role, rotator cuff pathology may lead to considerable limitations in daily routine work and leisure/sporting activities. Shoulder pain is the most common musculoskeletal complain after neck and low back pain and can be associated with impairment and marked disabilities. [3-5] As many as 20% of people experience shoulder pain at some stage in life. 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. [6] Differential diagnosis of painful shoulder comprise impingement syndrome, rotator cuff tears, glenohumeral joint instability, capsulitis, acromioclavicular joint pathologies, etc. [6] Shoulder impingement syndrome is the most common disorder among shoulder disorders resulting in functional loss and disability in patients it affects. In patients older than 40 years, the main cause of shoulder pain and / or functional deficit is adhesive capsulitis impingement and or rotator cuff disease. [7,8] The symptoms accompanying shoulder pathologies vary according to the specific site and thus provide important indication of the type of pathology. However, clinical history and physical and examination are rarely sufficient for making a precise diagnosis, radiological examination plays a determining role in diagnosing the various conditions involving shoulder joint. Conventional radiographs are the first line approach to the shoulder, and often they are sufficient for evaluating any traumatic conditions of the joint. It can detect most fractures,

dislocations, calcific tendinitis and other skeletal causes of pain like arthritis and bone tumors. [9,10]

Most of patients the severity of injury acute or chronic, can be determined from a targeted history, focused physical examination & diagnostic imaging. Misdiagnosis or mismanagement of damage to supporting structures of the shoulder may lead to development of degenerative joint disease, chronic shoulder pain range of motion and/or loss of shoulder function. [11] 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. [12] It is very difficult to diagnose the extent of lesion clinically in case of shoulder joint and the decision regarding the line of management to be followed, that is conservative or surgical depends mainly on the extent of lesion. It has been reported that sonography is less accurate for diagnosing partial- thickness tears compared with full thickness tears. [13] 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 transducer. An extensive partial-thickness tear involving greater than 50% of the cuff substance can mimic a full-thickness tear by virtue of its compressibility. [14,15]

2. 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, Puducherry.

This study included 62 patients presented to the Radiology Department of Sri Lakshmi Narayana Institute of Medical Sciences with clinical history of shoulder pain for evaluating the rotator cuff integrity through the period from 1st Nov 2016 to 31st October 2018 from Department of Orthopedics. All patients were taken for high resolution ultrasonography and conventional shoulder MRI in 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: History of injury to shoulder. History of recurrent dislocation of shoulder. Suspected ligamentous, labral, glenohumeral, rotator-cuff or musculotendinous injuries on clinical examination

Exclusion criteria

Patients who have contraindications to an MR evaluation- patients with pacemakers, claustrophobia, metallic implants. Past history of any operative intervention in the shoulder joint. Ultrasonography was done using a high frequency linear transducer on ULTRASONIX Expert Ultrasound machine with 6-10 MHz linear-array transducer using musculoskeletal settings with the following technique. X-ray findings suggestive of labro-ligamentous & rotator-cuff or musculotendinous pathologies of shoulder joint and Magnetic Resonance Imaging, [MRI] was performed using Siemens 1.5 Tesla MR system using flex coil. Examinations were done with the

shoulder in external rotation as this anatomic position optimally orients the supraspinatus tendon parallel and perpendicular to the oblique coronal and oblique sagittal.

Patient was seated on a chair in front of ultrasound machine and arm fully exposed from neck to elbow with free mobility of the arm. The probe is held between the thumb, index and middle fingers with the little finger extended to rest on the patient. Sequential examination of the muscles was done. The long head of the biceps is used as the landmark in the rotator cuff examination by US. Then scanning of the subscapularis followed by the supraspinatus then the infraspinatus and teres minor muscles were performed.

Statistical Analysis

All the rotator cuff muscles were determined with Sonography and MRI for full-thickness and partial tearing. Comparison between two methods was done by McNemar Chi-Square test.

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 case of categorical variables. Agreement of the scores measured with different methods was evaluated using 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. To evaluate the sensitivity and specificity of the USG for detection of any supraspinatus, infraspinatus or subscapularis tendon damage we pooled full-thickness-tears and partial-thickness-tears to one entity. To compare the classification of supraspinatus, infraspinatus and subscapularis tendons in US and MRI to intraoperative findings we also pooled full-thickness and partial-thickness tears into one entity. To calculate the sensitivity and specificity of USG for the detection of long biceps pathologies we pooled tendovaginitis, dislocation and ruptures. All data analysis was performed using statistical software (SPSS16.0 Software for windows).

3. Results And Discussion

Age And Sex Distribution Of Patients

Table 1: Age and Sex distribution of patients

Age	Male	Female	Total
<20 years	0	2	2
21-30 years	18	2	20
31-40 years	14	10	24
41-50 years	4	6	10
51-60 years	0	0	0
61-70 years	4	2	6
>70 years	0	0	0
Total	40	22	62

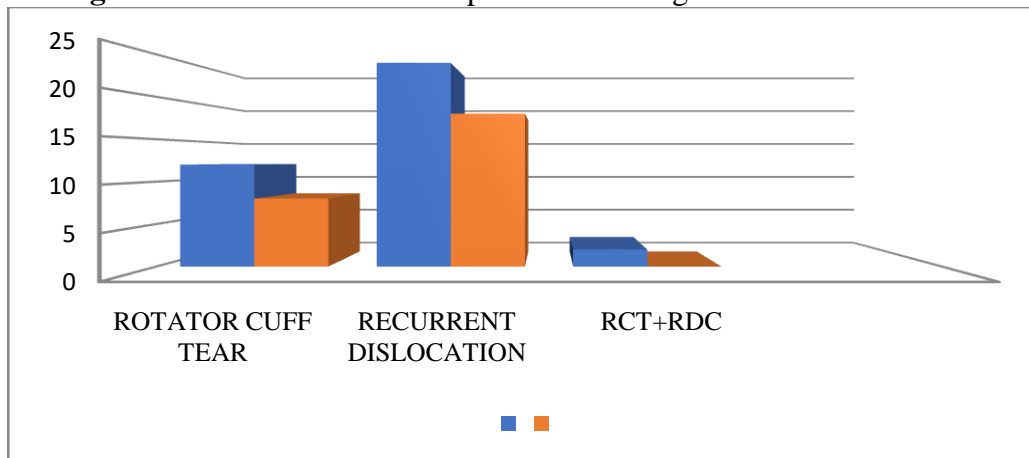
There were 42 male and 20 female patients in the study. Age ranged from 19 to 68 years with the mean age 35.38 years. 42 cases with clinical diagnosis of recurrent dislocation of shoulder were taken and 20 cases with rotator cuff tear were taken. Out of 42 cases of recurrent dislocation of shoulder 4 had concomitant rotator cuff tear which was not suspected clinically. The average age

of patients with recurrent dislocation of shoulder was 30.61 yrs. The average age of patients with rotator cuff tear of shoulder was 45.4 yrs. 70.9 % of patients (44/62) belonged to the 21-40 years age group. 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. Total 62 cases were included in the study out of which 42 cases had clinical diagnosis of recurrent dislocation of shoulder and 20 cases had suspected rotator cuff tear. 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 shoulder was 30.61 years. [16-19] The average age of patients with rotator cuff tear of shoulder was 45.4 yrs. 70.9% of patients (44/62) belonged to the 21-40 years' age group. The most common age group for patients with rotator cuff tear was 41-50 years and that for recurrent dislocation of shoulder was 21-30 yrs. The minimum age of affected female was 19 years and that for male was 21 yrs and both had history of instability syndrome after trauma. The maximum age of affected female was 63 years and that for male was 68 years, both having rotator cuff tear. The prevalence of partial- or full- thickness tears increased markedly after 50 years of age. These were present in over 50% of dominant shoulder in the seventh decade and in 80 % of subjects over 80 years of age in a study conducted by Milgrom et al⁸⁹ A high correlation between the onset of rotator cuff tears increasing age has also been reported by Fehring et al⁹⁰ and Yamamoto et al⁹¹ in their studies which correlates with our findings. [20]

Males were more commonly affected than females overall. (20:11) For recurrent dislocation of shoulder overall ratio was even more skewed towards males with male: female ratio of 5:2. The ratio for rotator cuff tear was same for males and females (1:1) and two patients with recurrent dislocation of shoulder also had rotator cuff tear. In a study conducted by Zacchilli MA et al, on 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. [21,22] 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; A young age and male sex are risk factors for shoulder dislocation which correlated well with our study.

Out of 62 patients included in the study, right side was more commonly involved as compared to left. (Right: left ratio was 18:13) In case of recurrent dislocation of shoulder, the ratio was 4:3 and in case of rotator cuff tear it was 3:2.

Figure: 1 Chart-distribution of patient according to side of involvement



Out of 62 cases, 42 patients had history of recurrent dislocation of shoulder. Out of 42 patients 38 patients had 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. Labral tear was noted in 9 cases on imaging and 34 cases on surgery. Ligamentous injury was found in 4 cases, with inferior glen humeral ligament being most commonly involve (4 cases), and middle glen humeral 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.

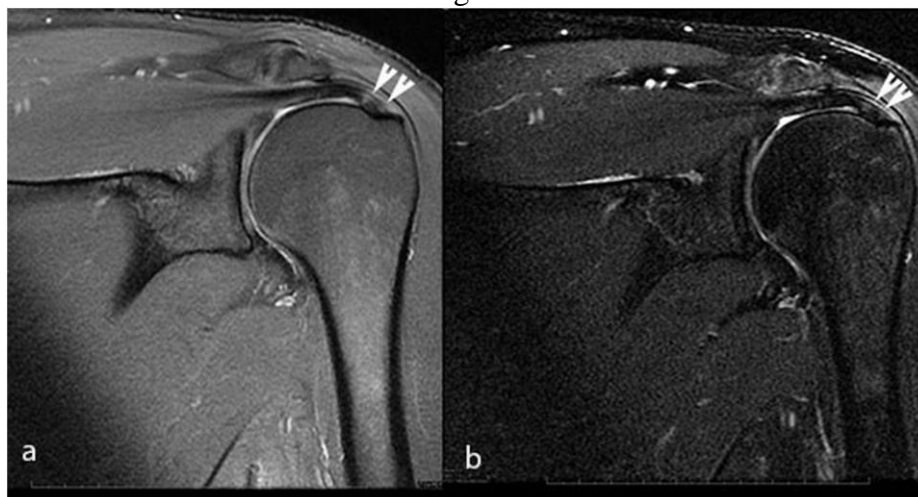
Spectrum Of Injured Structures

Figure: 2 Shows The Recurrent Dislocation Of Shoulder



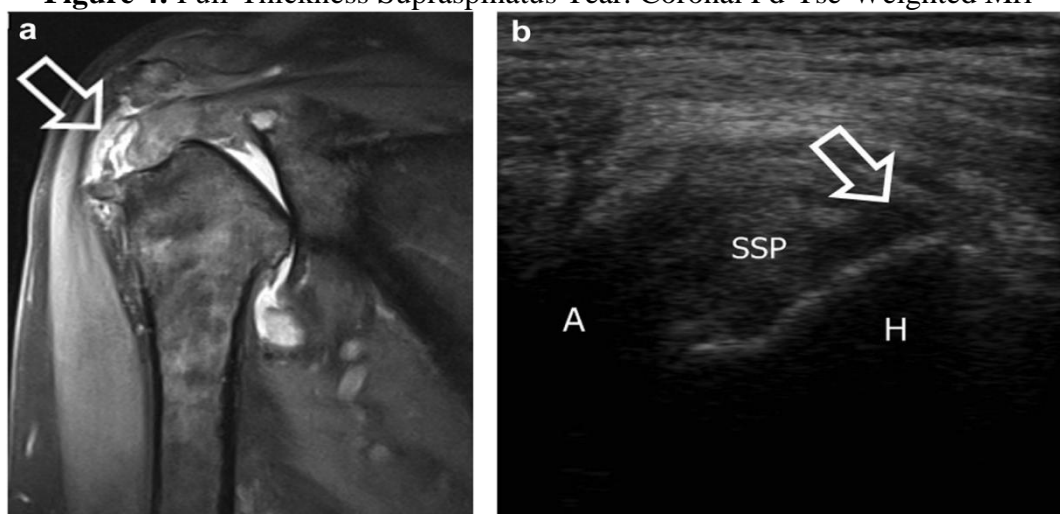
MRI coronal T2 (a), PD with fat suppression (b) and T1 (c) WI revealed a full thickness tear of the supraspinatus tendon near its humeral attachment with fluid signal seen in the gapping area which measures about 6 mm (comparable to the US).

Figure: 3 Findings By Mri And Surgery In Patients With Recurrent Dislocation Of Shoulder, Pd-Tse-Weighted Mri.



Coronal PD fat sat (a) and STIR (b) images for the shoulder show abnormal hyperintense signal (arrowheads) at the distal part of the supraspinatus tendon that was proved to be tendinosis. Out of total 62 patients had clinical suspicion of rotator cuff tear, 24 patients had rotator cuff tear, out of them 8 patients had full thickness tear and 16 had partial thickness tear. [23] Supraspinatus was the most commonly involved muscle and was involved in all the 24 cases. Out of 24 cases, full thickness tear was seen in 4 cases and partial thickness tear in 16 cases. Infraspinatus was the second most commonly involved muscle, showing tear in 6 cases. 2 of the cases showed full thickness tear and rest of them had partial thickness tear. Subscapularis tear was not observed in any of the cases. (most likely due to less number of cases). [24-27] In patients with anterior dislocation was the most common type of dislocation seen in 38/42 cases. One patient had multi directional instability and one patient had posterior dislocation.

Figure 4: Full-Thickness Supraspinatus Tear. Coronal Pd-Tse-Weighted Mri



plane (a) and transverse US image (b). The arrow points out the rupture, hyperintense in the MRI and hypoechoic in the US. A ¼ Acromion; H ¼ Humerus; SSP = Supraspinatus tendon.

XRAY

An AP view of the shoulder was performed in all the cases. Assessment for signs of rotator cuff pathology like degenerative changes (cystic and sclerotic) at greater tubercle (GT) or undersurface of acromion or lesser tuberosity was done in patients with rotator cuff pathology (20 patients). Acromion-clavicular joint degeneration was also assessed. [13,27]

In patients of instability syndromes X ray was assessed for evidence of Hill Sachs lesion or Bony Bankart's lesion.

Table 2: X-ray findings in patients with rotator cuff pathology

XRAY CHANGES	N	%
GT IRREGULARITY	8/62	12.9
LT IRREGULARITY	2/62	3.22

AC JOINT DEGENERATION	4/62	6.45
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Greater tubercle irregularity was found to be fairly common (40%) in patients presenting with symptoms of rotator cuff pathology.

Acromial Alignment On Mri:

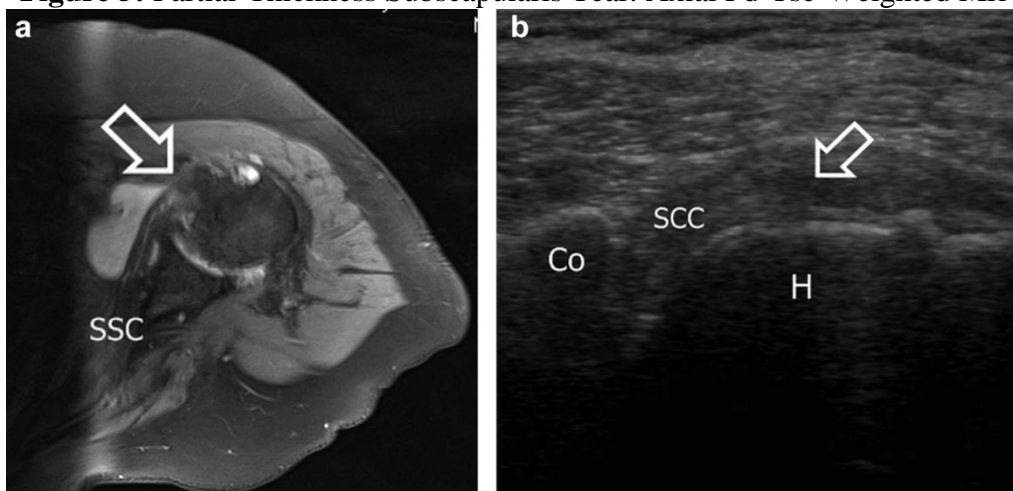
Most of the cases had parallel alignment of acromion. Out of 42 cases of recurrent dislocation of shoulder, 10 had inferolateral tilt and none had low lying acromion.

Table 3: Acromial Alignment On MRI

ACROMIAL ALIGAMENT	NO. OF PATIENTS	PRECENTAGE
Parallel	40	64.5%
Inferolateral	16	25.8%
Low lying	6	9.67%

Out of 20 cases with rotator cuff tear, 8 had parallel alignment of acromion, 6 had inferolateral tilt and 6 had low lying acromion suggesting a possible co relation between the type of acromion and rotator cuff tear.

Figure 5: Partial-Thickness Subscapularis Tear. Axial Pd-Tse-Weighted Mri



plane (a) and transverse US image (b). The arrows show the focal defect with a thinned-out tendon. Co ¼ Coracoid; H ¼ Humerus, ISP ¼ Infraspinatus tendon, S ¼ Scapula; SSC ¼ Subscapularis tendon.

Acromio Humeral Distance & Rotator Cuff Tear:

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 in concordance with the study by Saupeet al who found that a >7mm acromion- humeral distance in their study was associated with 90% of the rotator cuff tears. Our study showed that type I and type II acromion (90.3%) is the most

common which is consistent with the findings in general population. [28] And also that Type II and III are more likely to be associated with tears and impingement. 16/42 patients (25.8%) showed inferolateral alignment of acromion with respect to clavicle Inferolateral alignment showed higher incidence of rotator cuff tear. In a study on 91 patients with rotator cuff tears Hirano et al also found that there was little correlation between acromion type and presence of tear. However, they reported a significantly higher number of type III acromion (39%) in patients with rotator cuff tear. In our study we found that overall type ii and iii acromion (50%) were associated with rotator cuff pathology more frequently (6/12 patients with rotator cuff tear). [29]

4. Conclusion

MRI is very sensitive for detection of full thickness tears of rotator cuff but it lacks sensitivity in case of partial thickness tears of 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. Ultrasound and MRI are comparable in both sensitivity and specificity. Since USG is less expensive and more easily available, it could be considered as the screening method when rotator cuff integrity is the main question, and when well-trained radiologists and high resolution equipment are available.

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Ethical approval: The study was approved by the Institutional Ethics Committee

Conflict Of Interest

The authors declare no conflict of interest.

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