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ORIGINAL RESEARCH

Correlative study of MRI and ultrasonography in internal derangements of shoulder

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ABSTRACT

Background-Shoulder pain is the third most common cause of joint pain following knee pain and low back pain. The pathological disorders that most frequently affect the shoulder are instability, rotator cuff injury, and impingement. **Aim**: To compare the findings of ultrasound and MRI in the diagnosis of internal derangements of the shoulder. **Objectives:** To study the role of MRI and ultrasound in shoulder joint pathology and to correlate ultrasound findings with MRI findings. **Methods**- This was a cross-sectional study of 55 patients performed in the department of Radio-diagnosis on patients referred from OPD/IPD over eighteen months. Ultrasonography was performed using a Voluson E8 ultrasound scanner using an 11 MHz linear probe, Mindray DC80 ultrasound scanner using an 11MHz linear probe and 5.4 MHz-13.5 MHz linear array probe (hockey stick probe).MRI Scan was performed in Siemens Magnetom Essenza 1.5 tesla machine. The patients were selected randomly and the data was analyzed for sensitivity, specificity, predictive values, and accuracy. **Results**- Out of 55 cases 40 were males and 15 were females. The left side was more involved. MRI was significantly superior to USG in detection of partial thickness tears of rotator cuff tendons. The most commonly involved tendon was supraspinatus, followed by subscapularis. Hill-Sachs lesions, accounting for 50 % of cases, were the most commonly detected lesions in shoulder instability and were clearly demonstrated in both MRI and USG. In our study, USG demonstrated MRI had higher sensitivity compared with USG. **Conclusion**-Ultrasound is a cost-effective option for detecting full-thickness tears of the rotator cuff tendons, MRI is more effective for identifying partial-thickness tears.

Keywords- Supraspinatus, Subscapularis, Ultrasound, MRI.

INTRODUCTION

Shoulder pain is the one of the most common cause of joint pain, following knee pain and lower back pain. The most common pathological disorders that frequently affect the shoulder are instability, rotator cuff injury, and impingement. Rotator cuff injuries account for about 85% of cases; this is the most frequent cause.[1] Biceps tendinopathy and adhesive capsulitis are other frequent conditions. Shoulder injuries are prevalent, making up as much as 20% of all sports-related injuries.[2] The shoulder joint is the most commonly dislocated joint in the body, despite its distinctive form. Apart from dislocations of the shoulder, other frequent injuries are diseases of the rotator cuff tendon, fracture of the humerus and collar bone. [3]Referrals to radiologists for assessment are typical when there is pain involving the shoulder joint, whether or not there is a decreased range of motion. Imaging plays a key role in informing treatment decisions. The most fundamental initial examination needed to evaluate osteoarthritis, bone trauma, and the majority of other arthropathies is still plain film radiography. MRI with the benefits of great soft tissue features, tendon retraction, and extension of the tear to surrounding tissues is now commonly used and regarded as a valid technology for evaluating many causes of shoulder pain.[4]A wide range of musculoskeletal disorders that are best or only visible dynamically that is, during motion, muscle contraction, probe added value of Ultrasonography in Diagnosis of Rotator Cuff Injury Compression, or patient position change can be evaluated with the help of dynamic ultrasonography. Its drawbacks include operator dependence, the need for a consistent scanning technique, and a persistently reported inferior sensitivity and specificity for rotator cuff tear identification as compared to MRI. [5]Numerous investigations have been carried out to ascertain the

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precision of ultrasonography in identifying rotator cuff tears. The results have demonstrated that this method is very accurate in detecting full-thickness tears but somewhat unreliable in detecting partial-thickness tears. [6]Further research was done to evaluate the efficacy of unenhanced MRI against ultrasound in identifying and monitoring rotator cuff injuries.[7]MRI has emerged as the "gold standard" for evaluating overall joint structure and identifying interior derangements that are both subtle and evident.[8]To demonstrate that ultrasonography examination was equally as effective as magnetic resonance imaging (MRI) in the evaluation of shoulder pain, particularly in cases of rotator cuff injuries, our study compared the accuracy of ultrasonography in shoulder joint pathologies with that of MRI performed later on in the same patient.

MATERIAL AND METHOD

The patients referred to the department of radio-diagnosis at the Pacific Institute of Medical Sciences, Umarda, Udaipur, with clinically suspected shoulder pathologies were offered to participate in the study.

Sample size: 55

The sample size (n) is calculated according to the formula: n =z2 *p* (1- p) / e2

Inclusion Criteria

1. The patients with clinically suspected shoulder joint pathologies.
2. Trauma cases were also included.

Exclusion Criteria

1. Claustrophobia, or anxiety disorder exacerbated by MRI. Patients who were not willing to give consent.
2. Patients with pacemakers, MR-incompatible metallic implants, or aneurysmal clips were excluded from MRI.

Material

Study Design: Cross-Sectional Study

Source of Data

This study was performed in the department of radiology of Pacific Institute of Medical Sciences, Udaipur on patients referred from OPD and IPD over a period of eighteen months from November 2022 to April 2024. Consent was obtained from the subjects included in the study. Ethical committee clearance was obtained.

MRI imaging was performed in Siemens Magnetom Essenza 1.5 Tesla machine using a shoulder coil, and the relevant sequences were selected as required:

1. Coronal obliqueT1W/proton density-weighted (PDW)sequence.
2. Coronal oblique fat-suppressed(FS)PDW /T2–W sequence.
3. Sagittal obliqueT2W&PDW sequence (with or without fat suppression).
4. Axial T2-W &PDW (with or without fat suppression) Field of view: 14–16 cm, slice thickness: 2-3 mm, and matrix: 512 x 512.

Ultrasonography was performed using a Voluson E8 ultrasound scanner using an 11 MHz linear probe, a Mindray DC 80 ultrasound scanner using an 11 MHz linear probe, a 5.4 MHz–13.5 MHz linear array probe (hockey stick probe), and a convex transducer (2 to 5 MHz) whenever required. Transverse images of the long head of the biceps were captured with the patient's arm and forearm resting on the thigh, and the palm supinated. A 90-degree rotation of the transducer allowed for a longitudinal view of the biceps. Additionally, transverse imaging of the subscapularis tendon and the supraspinatus was performed. Longitudinal and transverse scans were conducted to evaluate the rotator cuff tendons and the posterior labrum.

Statistical Analysis

Descriptive statistical methods were applied in the present study.

For rotator cuff tears of various types, 2 x 2 contingency tables were made for each to numerate the true and false positive and negative results of both USG and MRI.

The validity measures for each test for each type of tears were calculated.

Sensitivity=a/(a+c) Specificity = d / (b +d)
PPV=a/(a+b)
NPV = d / (c + d)
Diagnostic accuracy = (a+d) /N

The difference in validity of USG and MRI was considered significant if p value is less than 0.05.

RESULTS

In our study males were most commonly affected (72.7%) and left shoulder was more commonly involved (51%). Pain was the most common symptom (72.7%) observed in patients. In our study, a major cause of shoulder derangement was degenerative (27%), followed by traumatic (20%), and then impingement (23.6%). There were 36 patients with primary rotator cuff pathologies, 16 with instability, and 3 patients with miscellaneous disorders. MRI also identified SLAP tears in 18 patients detecting all SLAP lesions. Of these, SLAP1 tears were most commonly seen in12cases (66.6%).

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Table 1: Frequency of various etiology

Category	Frequency	Percentage
Degenerative	27	49.10%
Traumatic	17	20%
Impingement	6	23.60%
Occupational/Sports	3	5.45%
Infective	2	1.82%
TOTAL	**55**	**100%**

In our study, the major cause of shoulder derangement was degenerative (27%), followed by traumatic (20%), and then impingement (23.6%). Other causes were sports injuries (5.5 %) and infective (3.6 %).

Table 2: Diagnosis in 36patients with rotator cuff pathology

Tear thickness or tendinopathy	Frequency	USG	MRI
Supraspinatus Tendinopathy	6	6	6
Supraspinatus Full Thickness Tear	8	6	8
Supraspinatus Partial Thickness Articular Surface Tear	15	10	15
Supraspinatus Partial Thickness Bursal Tear	7	6	7
Supraspinatus Partial Thickness Intrasubstance Tear	2	1	2
Subscapularis Tendinopathy	4	4	4
Subscapularis Full Thickness Tear	7	5	7
Subscapularis Partial Thickness Articular Surface Tear	3	2	3
Infraspinatus Partial Thickness Articular Surface Tear	3	2	3
Biceps Tendinosis	3	3	3
SLAP Tear	13	0	13
Infraspinatus Tendinopathy	1	1	1

In our study, MRI and USG accurately diagnosed supraspinatus, subscapularis and infraspinatus tendinopathy. The most common diagnosis in this study was a partial thickness supraspinatus tear observed in 24 patients (66.6%) most commonly involving articular surface followed by full thickness tears of supraspinatus (22 %) and subscapularis (19.4 %). Additionally, associated SLAP tear in 13 and biceps tendinosis in 3 cases while infraspinatus involvement accounted for only 4 cases.USG was 73% sensitive for full thickness tears and 69.2% sensitive for partial thickness tears.

Table 3: Diagnosis in 16patients with instability

Diagnosis	Frequency	USG	MRI
Hill-Sachs Lesion	8	5	8
Bony Bankart Lesion	2	1	2
Soft Tissue Bankart Lesion	3	0	3
Supraspinatus Tendinopathy	2	2	2
Supraspinatus Full-Thickness Tear	4	3	4
Supraspinatus Partial-Thickness Articular Surface Tear	2	2	2
Supraspinatus Partial-Thickness Bursal Tear	2	1	2
Subscapularis Partial-Thickness Articular Surface Tear	4	2	4
Infraspinatus Partial-Thickness Articular Surface Tear	1	1	1
ALPSA	2	0	2
Bone Marrow Edema	13	0	13
SLAP Tear	5	0	5

Among the 16 patients presenting with instability the most common abnormality identified was the Hill-Sach's lesion, found in 8 cases (50%), followed by Bankart's lesion, which was present in 5 cases (31.2 %). USG was 54.2% sensitive and 100% specific. p value= 0.001.

Absolute detection and quantification of miscellaneous pathologies

Among three patients with miscellaneous disorders, two cases (66.6%) were diagnosed with infective arthritis, while the remaining patient was diagnosed with giant cell tumor (GCT) of the clavicle.In addition, other MRI findings included adhesive capsulitis in 5 patients, AC joint arthropathy in 13 patients, and paralabral cysts identified in 2 of them. Joint effusion was seen in (85.4%) cases.

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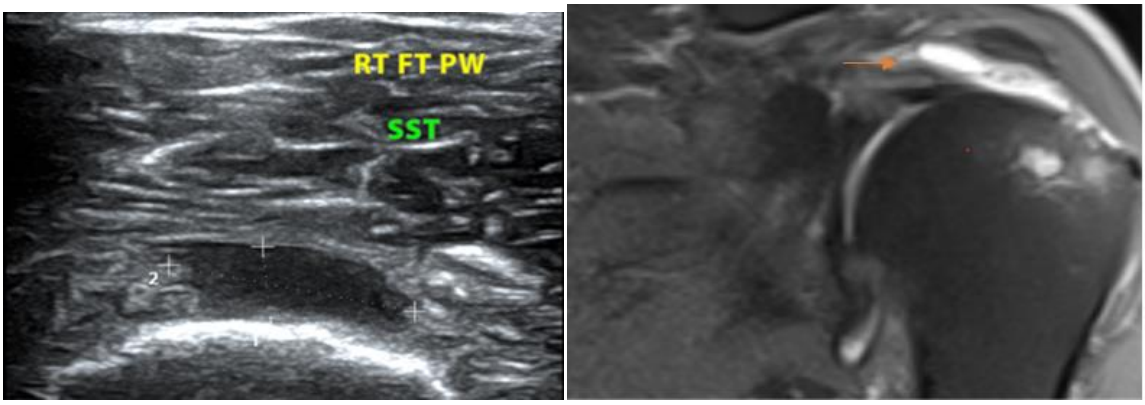

Fig 1: Ultrasound image and MRI PDFS coronal images showing full thickness tear with retraction of supraspinatus tendon (→)

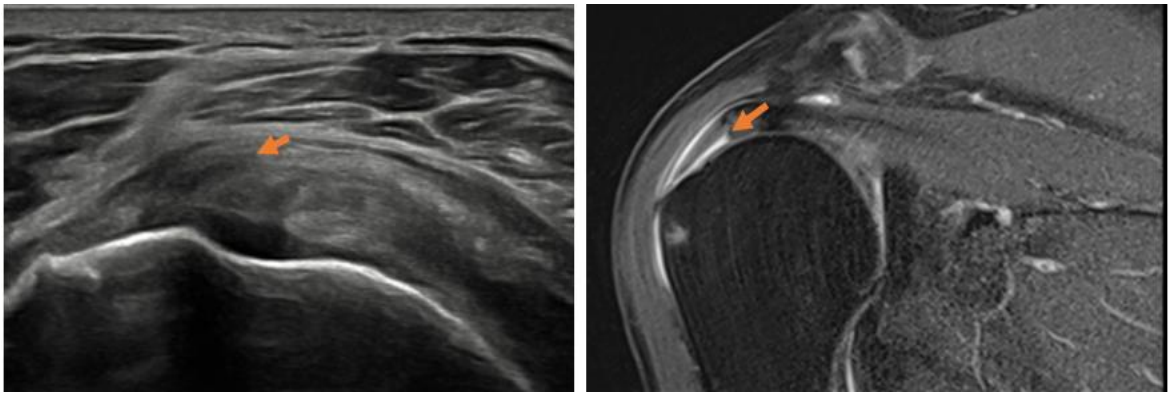

Fig 2: Ultrasound and MRI PDFS coronal images showing partial thickness tear of supraspinatus tendon (→)

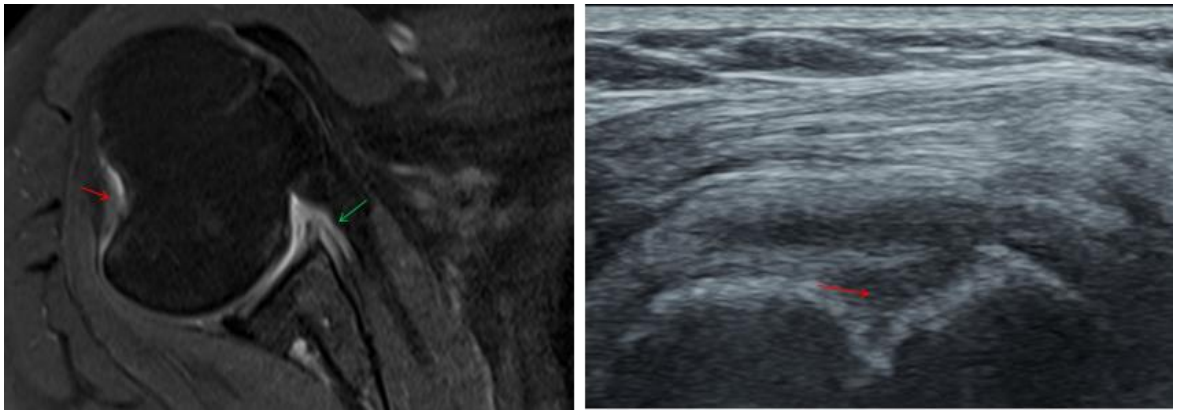

Fig 3: MRI PDFS axial and ultrasound images showing Hill sac (→) and Bankart lesion (→)

DISCUSSION

The shoulder joint is recognized as the most complex joint in the body, susceptible to damage due to its inherent structural instability and extensive range of motion. Pathologies affecting the rotator cuff tendons, labrum, and supporting ligaments lead to substantial morbidity and disability. MRI stands as superior for diagnosing rotator cuff injuries, offering non-invasive, multiplanar imaging with excellent soft tissue resolution and no ionizing radiation[9]. Ultrasound serves as an initial, cost-effective, and readily accessible imaging modality for evaluating rotator cuff pathologies.[10] In this study, both USG and MRI have made substantial contributions to diagnosing various shoulder pathologies across all categories, reflecting their complementary roles in clinical practice.

In our study involving 55 patients, the majority fell within the 51 to 60-year age group. The mean age of patients presenting with shoulder pathology was 47.27years, with a standard deviation of 14.64years. There was a predominance of males in our study. Pain was the most prevalent symptom, observed in 72.7% of patients. The distribution of affected sides was nearly equal between right and left shoulders, with the left side involved in slightly more cases (50.9%).

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Other causes were sports injuries (5.5 %) and infective (3.6 %).

Etiology-In our study, a major cause of shoulder derangement was degenerative (27%), followed by traumatic (20%), and then impingement (23.6%).

Rotator cuff pathologies

65.4 % of the total patients studied in our series had primary rotator cuff pathology. The most common involved tendon was a partial thickness supraspinatus tear observed in 24 patients (66.6%) most commonly involving articular surface followed by full thickness tears of supraspinatus (22 %) and subscapularis (19.4 %).

Both USG and MRI had significant contributions in diagnosing changes of tendinosis, partial and full thickness tears.

Full thickness tear-There was no significant difference in sensitivity between USG and MRI in the detection of full thickness rotator cuff tears. USG demonstrated slightly less sensitivity as compared to MRI. Both USG and MRI showed high specificity in the detection of full-thickness rotator cuff tears.

Partial thickness tears: In diagnosing partial thickness tears overall, there was statistically significant difference in the sensitivity of USG as compared to MRI. MRI is a better modality to detect partial thickness tears compared to USG.

Acromial morphology was classified according to the shape and configuration of the inferior surface into three types. Type I– curved, concave inferiorly; type II – flat and type III – flat with anteroinferior hook. In our study, the most common Acromial morphology was type II(60%),followed by type I(23.6%), and type III (16.4%)were seen.

INSTABILITY

Hill-Sach's Lesion: The most frequently observed lesion in patients with either a single dislocation or recurrent dislocations is the Hill-Sach's lesion, identified in 8 out of 16 cases (50 %). MRI successfully detected this lesion in all patients, while ultrasound identified it in only 5.

Antero-Inferior Gleno-Labro-Ligamentous and Periosteal Lesions: Ultrasound faces significant limitations in assessing antero-inferior labral ligamentous complex injuries in patients with instability. In contrast, MRI provides clear visualization of both normal and torn labrum, glenohumeral ligaments, and any ruptured or avulsed anterior glenoid periosteum. Among the antero-inferior injuries, the most common was the Bankart lesion, observed in 5 cases, 1 of which had an associated glenoid fracture.

Role of USG in miscellaneous pathologies: In our study, ultrasound (USG) played pivotal role in diagnosing all three cases evaluated: septic arthritis, Tubercular arthritis, and a giant cell tumor(GCT) of the clavicle which was subsequently confirmed by MRI.

CONCLUSION

MRI serves as a versatile investigative tool for comprehensively assessing all internal shoulder derangements, offering excellent soft tissue contrast and multi- planar imaging capabilities. Ultrasonography (USG), being cost-effective, proves comparable to MRI in detecting full-thickness tears of rotator cuff tendons. However, MRI excels over USG in identifying partial-thickness tears of rotator cuff tendons. MRI demonstrates high sensitivity in evaluating shoulder instability, making it an efficient diagnostic tool for this condition. Ultrasonography has expanded its clinical applications beyond rotator cuff evaluation to include detecting Hill-Sachs lesions, bony Bankart lesions and synovial thickening, biceps tendinosis, and calcifications of rotator cuff tendons. Nevertheless, it has limitations in evaluating labral and cartilaginous lesions. MRI has demonstrated superiority in accurately assessing the location and extent of tears. Additionally, it excels in detecting pathologies unrelated to the rotator cuff, such as subacromial-subdeltoid effusion, subcoracoid effusion, paralabral cyst, adhesive capsulitis and AC joint arthropathy.

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