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ORIGINAL RESEARCH

Comparison Between High Resolution Ultrasound And MRI In The Evaluation Of Rotatorcuff Injuries

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Abstract
Introduction: The shoulder joint's stability is largely provided by the rotator cuff muscles and tendons, crucial for dynamic stabilization. Pathologies in these muscles are major causes of shoulder pain and disability. USG and MRI are non-invasive, radiation-free imaging methods with high sensitivity for diagnosing rotator cuff disorders, offering complementary diagnostic insights.
Methodology: Patients presenting with complaints of pain in shoulder joint, restricted movements or clinical suspicion of RC disorders were referred to Radiodiagnosis Department of Muzaffarnagar Medical college. In this study, 30 patients of both genders were studied in age between 20 to 60 years. HRUSG followed by MRI of the affected side shoulder was performed.
Result: In this study, 60% of males and 40% of females were affected, primarily in the 41-50 age group. The supraspinatus tendon was most commonly impacted, with MRI outperforming USG in detecting pathologies. USG showed high specificity and moderate sensitivity and accuracy in identifying rotator cuff tears, particularly full-thickness tears (FTT). However, USG was less effective in detecting infraspinatus and subscapularis tendon issues. Both imaging modalities have limitations, with USG unable to properly evaluate abnormalities of the glenoid labrum, various ligaments, and bones. Tears were associated with subacromial-subdeltoid and Sub coracoid bursitis.
Conclusion: Clinical examination, X-ray, and CT scans offer limited insight into shoulder joint pathologies, particularly for soft tissues like the rotator cuff. HRUSG, being affordable, non-invasive, and real-time, is the first-line diagnostic tool for screening rotator cuff disorders. MRI serves as a problem-solving modality, offering detailed evaluation in complex cases involving glenoid labrum, ligaments, bones, and muscle atrophy, especially when USG results are inconclusive.

Introduction

The upper extremity allows a wide range of motions, including abduction, adduction, flexion, extension, and 360° circumduction, with scapular movements adding further complexity. [1]The shoulder's dynamic stability is primarily maintained by the rotator-cuff (RC), while static stability is provided by the joint capsule, labrum, glenohumeral ligaments, and osseous structures . [2] When RC strength diminishes, glenohumeral joint instability and potential rotator-cuff arthropathy ensue. This joint’s complexity and the limited contact between the humerus and scapula necessitate robust connective tissues for stability and function.[3]

Shoulder disorders rank among the most common joint disabilities globally, with chronic shoulder pain being the second most prevalent musculoskeletal issue after chronic knee pain . RC tears are particularly common in individuals over 40 due to age-related wear and tear.[4] These tears are also prevalent among individuals engaged in repetitive overhead activities, such as athletes .[5] Pain during overhead movements, night pain, and reduced range of motion are typical symptoms of RC disorders, often indicating a tear .[2]

The RC comprises four muscles: supraspinatus, infraspinatus, subscapularis, and teres minor. RC tears, whether partial or full, are widespread, affecting up to 62% of those over 80 years old. Early and accurate diagnosis is crucial to minimize the economic and social impact of shoulder injuries. Misdiagnosis can lead to unnecessary imaging, costly treatments, and prolonged recovery. [6] Differentiating RC tears from other shoulder conditions, such as glenohumeral instability, based on physical examination and history alone is challenging, necessitating diagnostic imaging .[7]

Radiographs are typically the first imaging choice, revealing indirect signs of RC disease, such as acromiohumeral distance reduction, humeral head displacement, and degenerative arthritis . MRI and USG are the primary tools for diagnosing RC injuries, though opinions differ on their accuracy and cost-effectiveness .[8] High-resolution ultrasound (HR-USG) can diagnose both partial-thickness (PTT) and full-thickness tears (FTT), but its effectiveness is limited by operator dependence and difficulty assessing certain structures .[9]

MRI, considered the gold standard for RC assessment, offers high specificity and sensitivity, providing detailed information about tear characteristics and associated conditions .[12] Despite its advantages, MRI has limitations, including cost, accessibility, and patient-related challenges. Given the importance of accurate RC diagnosis and the ongoing debate over the most effective imaging modality [13], this study aims to compare and evaluate the findings of HR-USG and MRI in diagnosing RC injuries.

Methodology

Study Design: This study was designed as a hospital-based observational study.

Study Location: The study was conducted at the Department of Radiodiagnosis & Imaging, Muzaffarnagar Medical College, Muzaffarnagar, Uttar Pradesh.

Study Population: The study population included all outpatient department (OPD) and inpatient department (IPD) patients presenting with symptoms of shoulder pain and restricted movements who were referred to the Department of Radiodiagnosis for high-resolution ultrasonography (HR-USG) and magnetic resonance imaging (MRI).

Duration of Study: The study spanned a total duration of 18 months, with 12 months dedicated to data collection and 6 months to data analysis.

Sample Size: A total of 30 patients were included in the study. The sample size was determined based on the number of cases that presented to the Department of Radiodiagnosis for HR-USG and MRI for shoulder pain and restricted movements over the past three years. All eligible OPD and IPD patients exhibiting symptoms of shoulder pain and restricted shoulder movements were included in the study.

Inclusion and Exclusion Criteria

The study included patients presenting with shoulder pain and restricted movements, those clinically suspected of having rotator cuff (RC) injuries, and known cases of RC injuries. Patients were excluded if they were post-operative cases, unwilling to participate, had a history of claustrophobia, or had contraindications to MRI, such as aneurysmal clips, cardiac pacemakers, or metallic implants incompatible with MRI.

Study Methodology: Patients suspected of having RC injuries were assessed using both HR-USG and MRI, with diagnoses based on clinical and radiological findings. Informed consent was obtained from all patients prior to diagnostic procedures. A comprehensive clinical history was recorded for each patient. MRI scans were performed with patients in the supine position using a Siemens MagnetomEssenza 1.5 Tesla machine, while HR-USG was conducted using the SAMSUNG H-60 machine.

Statistical Analysis: Data collected during the study were compiled in an Excel spreadsheet and subsequently analyzed using SPSS software (Version 20). Categorical variables were analyzed using the Chi-square test, while percentages and proportions were calculated for qualitative data. Quantitative data were expressed using mean and standard deviation. The level of statistical significance was set at $p < 0.05$. The study's power was set at 80%, with a confidence interval of 95%.

Result

The study assessed the accuracy and effectiveness of high-resolution ultrasonography (HR-USG) compared to magnetic resonance imaging (MRI) in diagnosing rotator cuff (RC) tendon pathologies in a sample of 30 patients presenting with shoulder pain and restricted movements. The gender distribution among the patients was 60% male and 40% female, with the majority of patients falling within the 41-50 year age group. The most commonly affected shoulder was the right shoulder (76.7%). USG and MRI Findings In evaluating the RC tendons, USG identified the supraspinatus tendon as the most frequently injured, with 19 out of 30 patients (63.3%) showing abnormalities. Specifically, USG detected tendinopathy in 2 patients (6.66%), partial-thickness tear (PTT) in 9 patients (30%), and full-thickness tear (FTT) in 8 patients (26.66%). MRI findings corroborated the presence of FTT in the same 8

patients but identified a higher number of tendinopathy (4 patients, 13.33%) and PTT (14 patients, 46.66%). MRI also detected an interstitial tear in one patient, which USG had not identified.

For the infraspinatus tendon, USG reported a nearly normal profile in 96.7% of patients, with only one case of tendinopathy (3.33%) detected. In contrast, MRI findings showed abnormalities in 8 patients (26.6%), including tendinopathy in 7 patients (23.33%) and a PTT in 1 patient (3.33%). The subscapularis tendon displayed similar disparities, with USG identifying abnormalities in 16.7% of patients and MRI in 50%. MRI was more sensitive, detecting tendinopathy in 12 patients (40%), a PTT in 2 patients (6.66%), and an interstitial tear in 1 patient, all of which were not detected by USG.

Sensitivity and Specificity of USG

The sensitivity and specificity of USG for detecting RC pathologies varied among the tendons. For the supraspinatus tendon, USG demonstrated a sensitivity of 70.37% and a specificity of 100%, with a positive predictive value (PPV) of 100% and an accuracy of 73.33% (p-value ≤0.03). However, for the infraspinatus tendon, USG's sensitivity was notably lower at 12.5%, although specificity remained high at 100%, with an accuracy of 76.67% (p-value ≤0.26). The subscapularis tendon results revealed a sensitivity of 33.33% and a specificity of 93.33%, with a PPV of 83.33% and an accuracy of 63.33% (p-value ≤0.28).

Correlation Between USG and MRI

The study found that MRI was generally more sensitive than USG in detecting RC pathologies, particularly for partial-thickness tears and tendinopathy. Despite this, USG demonstrated high specificity, particularly for the supraspinatus and infraspinatus tendons, indicating that when USG does detect pathology, it is likely to be accurate. The findings suggest that while USG is a valuable tool for initial screening due to its affordability and non-invasive nature, MRI remains the gold standard for detailed assessment and diagnosis of RC injuries, particularly in cases where USG findings are inconclusive.

Table 1: Demographic and Clinical Characteristics of Patients

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Female	12	40.0
	Male	18	60.0
Age Group (years)	10-20	2	6.7
	21-30	6	20.0
	31-40	7	23.3
	41-50	9	30.0
	51-60	5	16.6
	>60	1	3.3
Affected Shoulder Side	Right	23	76.7
	Left	7	23.3
Duration of Symptoms	<1 month	13	43.33
	1-3 months	8	26.67
	3 months to < 1 year	8	26.67
	>1 year	1	3.33

Table 2: USG and MRI Findings of Rotator Cuff Tendon Pathologies

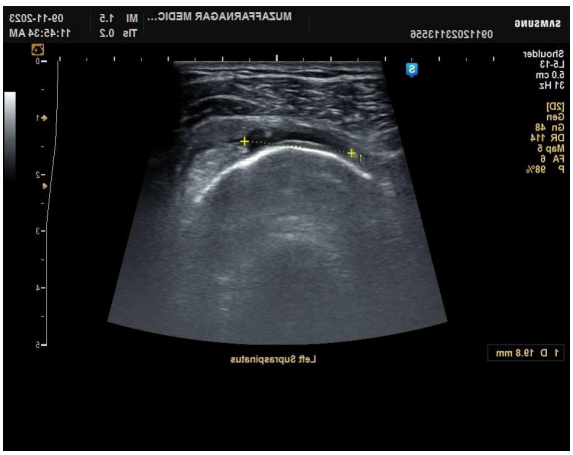
Affected Tendon	No Pathology (USG/MRI)	Tendinopathy (USG/MRI)	Partial-Thickness Tear (PTT) (USG/MRI)	Interstitial Tear (IT) (USG/MRI)	Full-Thickness Tear (FTT) (USG/MRI)	Total (n)
Supraspinatus	11 / 3	2 / 4	9 / 14	0 / 1	8 / 8	30
Infraspinatus	29 / 22	1 / 7	0 / 1	0 / 0	0 / 0	30
Subscapularis	25 / 15	5 / 12	0 / 2	0 / 1	0 / 0	30

Table 3: Pathological Correlations Between USG and MRI Findings

Affected Tendon	Imaging Modality	Normal n (%)	Tendinopathy n (%)	Interstitial Tear (IT) n (%)	Partial-Thickness Tear (PTT) n (%)	Full-Thickness Tear (FTT) n (%)
Supraspinatus	USG	11 (36.66%)	2 (6.66%)	0 (0.0%)	9 (30%)	8 (26.66%)
	MRI	3 (10%)	4 (13.33%)	1 (3.33%)	14 (46.66%)	8 (26.66%)
Infraspinatus	USG	29 (96.66%)	1 (3.33%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	MRI	22 (73.33%)	7 (23.33%)	0 (0.0%)	1 (3.33%)	0 (0.0%)
Subscapularis	USG	25 (83.33%)	5 (16.66%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	MRI	15 (50%)	12 (40%)	1 (3.33%)	2 (6.66%)	0 (0.0%)

Table 4: Sensitivity, Specificity, and Predictive Values of USG for Rotator Cuff Tendon Disorders

Tendon	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	p-Value
Supraspinatus	70.37%	100.00%	100.00%	27.27%	73.33%	0.03*
Infraspinatus	12.50%	100.00%	100.00%	75.86%	76.67%	0.26
Subscapularis	33.33%	93.33%	83.33%	58.33%	63.33%	0.28



USG image of full thickness tear in the Left Supraspinatus tendon along with retraction of torn end.

MRI image of full thickness tear in the Left Supraspinatus tendon along with retraction of torn end in the same patient.

Discussion

Rotator-cuff (RC) disorder is a significant cause of shoulder pain, ranking as the third most common musculoskeletal ailment after neck and low back pain. The etiology of RC damage is complex, involving both external and internal factors. Various techniques are used to evaluate shoulder pain, including physical exams, plain X-rays, arthrography, USG, CT scans, and MRI. Although arthrography was traditionally used for diagnosing RC injuries, it is invasive and carries several health risks. Consequently, HR-USG and MRI are now the recommended imaging techniques for assessing potential RC tears, each with its own advantages and disadvantages. This study was conducted to evaluate and compare the diagnostic efficacy of HR-USG and MRI in assessing RC injuries.

In this study, 30 patients were evaluated using both USG and MRI. A slight male predominance was observed, with males comprising 60% of the study population, which aligns with the findings of Zhang et al. (14). Dineshram Vijayan (15) also reported fewer female patients affected compared to males. However, Samira Saraya (16) reported a higher prevalence of RC disorders among females (67.5%) than males (32.5%). The participants' ages ranged from 20 to 60 years, with the majority (30%) falling within the 41-50 years age group. The mean age was 47.08 years for females and 35.44 years for males, comparable to the findings of Selvaraj S et al. (17). Other studies, such as those by Shrestha MS et al. (18) and Tempelhof et al. (49), have also shown that RC tears are more frequent in the 4th and 5th decades of life, with degenerative changes in RC tendons increasing with age. Ozaki et al. (19) similarly reported these findings.This study found that 76.7% of patients had right shoulder involvement, a result consistent with the findings of Bouaziz et al. (20), who noted a higher frequency of right shoulder involvement (68%) compared to the left shoulder (32%). In terms of symptom duration, 43.33% of patients reported symptoms lasting less than one month, with most patients seeking medical attention within the first three months, likely due to the significant impact of shoulder pain on daily activities. The most frequently affected tendon was the supraspinatus, with a prevalence of 90%, followed by the subscapularis (50%) and infraspinatus (26.66%). These findings align with the studies by Rakesh Vijayvargiya (21) and Matthieu J et al. (22), which also reported high involvement of the supraspinatus tendon. Zlatkin and colleagues (23) noted that full-thickness and complete tears are more common in the supraspinatus tendon.Interestingly, none of the patients in this study had involvement of the teres minor tendon, consistent with the findings of Gilles et al. (24), who observed teres minor abnormalities in only 0.8% of 2436 shoulder examinations. Among those with tears, 70.37% had partial-thickness tears (PTT) and 29.62% had full-thickness tears (FTT), correlating with the findings of Aggarwal J et al. (25), who reported similar distributions. When comparing USG to MRI findings, USG identified 2 out of 4 tendinopathies correctly identified by MRI in the supraspinatus tendon. For the 14 PTTs found by MRI, USG identified 9. MRI also identified 1 interstitial tear, which USG missed, but both modalities correctly identified 8 FTTs. USG demonstrated a sensitivity of 70.37%, specificity of 100%, PPV of 100%, NPV of 27.27%, and an accuracy of 73.33% for supraspinatus tendon pathologies, with a statistically significant p-value (<0.03). These findings align with Selvaraj S et al. (5), although Brandt et al. (26) reported lower specificity, and De Jesus et al. (27) found no significant differences between the modalities. For the infraspinatus tendon, USG identified 1 tendinopathy out of 7 correctly identified by MRI, but it missed 1 PTT detected by MRI. USG showed a sensitivity of 12.50%, specificity of 100%, PPV of 100%, and an accuracy of 76.67%, which is in line with the findings of Jaganathan AP et al. (28). However, Fischer et al. (29) reported higher accuracy rates. In the subscapularis tendon, USG identified 5 tendinopathies out of 12 detected by MRI and missed 1 interstitial tear and 2 PTTs identified by MRI. USG demonstrated a sensitivity of 33.3%, specificity of 93.3%, PPV of 83.3%, NPV of 58.3%, and accuracy of 63.3%, with a p-value <0.28. These findings are comparable to those of Narasimhan et al. (30), who also reported lower sensitivity for USG in detecting subscapularis tendon tears. Overall, USG was found to have good specificity, sensitivity, and accuracy for detecting RC tendon tears, especially FTTs, with findings comparable to studies by Read et al. (31), Teefey et al. (32), and Niti More (33). However, MRI proved superior in detecting tendinopathies, PTTs, and providing detailed evaluations of tear sites and sizes.

Conclusion

Rotator cuff (RC) disorders are among the most common causes of shoulder pain, with presentations ranging from asymptomatic to severe functional impairment. Prompt and accurate diagnosis is crucial to ensure effective treatment and quick recovery. While clinical examinations provide limited insight, imaging modalities like high-resolution ultrasonography (HR-USG) and magnetic resonance imaging (MRI) are essential for thorough evaluation. MRI offers comprehensive assessment, but HR-USG demonstrates comparable specificity, sensitivity, and accuracy, making it a reliable, cost-effective, and non-invasive first-line diagnostic tool. However, due to limitations such as inter-observer variability and reduced effectiveness in detecting certain pathologies, MRI remains the preferred modality for detailed and complex assessments. This study underscores the complementary roles of HR-USG and MRI in diagnosing RC injuries, advocating for HR-USG in initial evaluations and MRI for comprehensive characterization.

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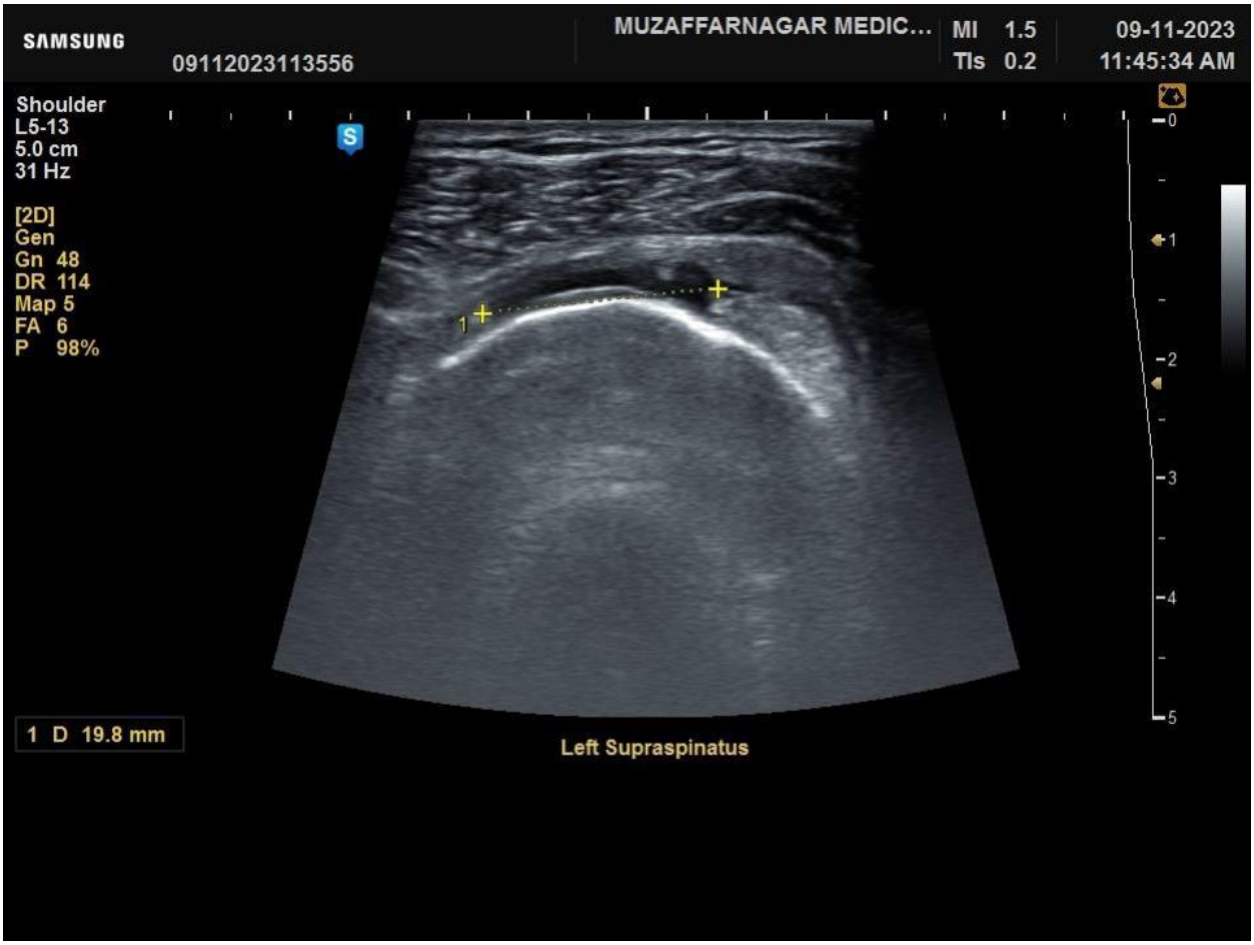

Image: 1.1: USG image of FTT in the Left Supraspinatus tendon along with retraction of torn
end.

Image: 1.2: MRI image of FTT in the Left Supraspinatus tendon along with retraction of torn end in the same patient.

Image 2.1: USG image of PTT in the Right Supraspinatus tendon.

Image 2.2: Coronal MRI image of PTT in Right Supraspinatus tendon in same patient.