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Original Research Article

Comparative Accuracy of MRI and High-Resolution Ultrasound in Detecting Rotator Cuff Tears: A Prospective Study with Arthroscopic Correlation

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Abstract:

Background: Rotator cuff injuries are a common source of pain and dysfunction in the shoulder. Imaging tests play a vital role in these scenarios. We compare two non-invasive methods: arthroscopy, a surgical procedure, enters the shoulder joint to capture direct images.

Aim: To compare the diagnostic performance of MRI and HRUS in the detection of rotator cuff tears with reference to arthroscopy.

Materials and Methods: A prospective and single center study was conducted in Dr. S.N. Medical College, Jodhpur, over a period of one and a half years. Thirteen patients clinically suspected to have rotator cuff tears underwent HRUS and MRI before proceeding to arthroscopy. Imaging tests underwent independent double reporting and results were compared to the findings in the arthroscopy. Calculating the sensitivity and specificity in a test to the gold standard requires precise data, in medical statistics, gold standard is used to describe a method deemed as the most accurate available.

Results: In 26 patients with shoulder pain and rotator cuff tears were confirmed by arthroscopy, an answer was available. MRI was more accurate and correct overall, 93.8%, than HRUS which had an accuracy of 78.1%. In tears with fluid complete, HRUS performed well while partial-thickness was more difficult to detect and overall intra-articular abnormalities were more easily detected. MRI was overall the most accurate method.

Conclusion: MRI is the most accurate modality for comprehensive evaluation of rotator cuff tears, particularly partial-thickness tears. HRUS remains a reliable, cost-effective initial imaging tool for full-thickness tears. A tailored imaging approach improves diagnostic efficiency and patient management.

Keywords: Rotator cuff tear, MRI, High-resolution ultrasound, Arthroscopy.

Introduction

In the older generation, especially the middle age and beyond, rotator cuff tears are the most common predictors of shoulder dysfunction and pain. The rotator cuff tears tendons involve the supraspinatus, infraspinatus, subscapularis, and the teres minor tendons and they are most important in holding the shoulder joint in place, allowing for shoulder movement [1]. Pain, weakness, and decreased motion happen with rotator cuff tears due to acute, trauma, a repetitive overhead motion injury, and diseases and illnesses that worsen with age [2]. To prevent advanced atrophy, rotator cuff tears need a quick and proper diagnosis to prevent further atrophy and disease progression. Accurate atrophy and diagnosis need clinical evaluation where physical examination alone isn't enough to identify the presence and extent of the tears, necessitating the need for imaging techniques and exams [3, 4].

Of the imaging techniques available in a clinical setting, Magnetic Resonance Imaging (MRI) and High-Resolution Ultrasound (HRUS) are most common. Because of the multiple ways it can view and analyze physical structures, it excels in soft tissue proven damage. The medical field of imaging considers it the most advanced in analysis of rotator cuff damage MRI aids in damage assessment of the soft tissue from tears, the internals, muscle damage from atrophy, and of the articular damage to the labrum and bicep tendon if they are present [5,6].

The drawbacks of MRIs include higher costs, longer wait times, more time lengthy exams, and firmer rental restrictions in low-resource clinical settings, not to mention medical contraindications in certain patients [7]. In that light, more and more clinics and patients have recognized High-Resolution Ultrasound, and HRUS, as an acceptable and

effective alternative means of evaluating rotator cuff tears. With real-time dynamic assessments, any clinic can adapt HRUS at low cost, all while avoiding any ionizing radiation [8]. Ultrasound screenings for complete tears of the rotator cuff have been shown to exhibit both high sensitivity and specificity when conducted by an experienced technician [9]. Otherwise, the depth and intra-articular nature of the tears may actually restrict the overall findings, leading to the conclusion that HRUS is highly an operator's dependent method. In contrast, the ability to diagnose which rotator cuff tendons are ruptured via arthroscopy remains the gold standard, as it affords both the real-time visualization of the tendon and the ability to treat the ruptured tendon [10,11].

Integrating the findings of both imaging and arthroscopic correction offers the opportunity to objectively measure the degree arthroscopy enhances the accuracy and reliability of the practitioner with the imaging method. In response to the existing debate regarding the ability of both MRI and HRUS to accurately diagnose rotator cuff tears, particularly in the initiation of multi-dimensional clinical investigations aimed at comparative diagnostic accuracy, the findings from arthroscopy will be used as the gold standard to demonstrate the accuracy of both these imaging modalities.

Materials and Methods

Study Design and Setting:

This was a prospective comparative diagnostic accuracy study conducted in the Department of Radiodiagnosis in collaboration with the Department of Orthopaedics at Dr. S.N. Medical College, Jodhpur. The study duration was 1.5 years.

Study Population: A total of 32 patients presenting with clinical suspicion of rotator cuff pathology were included in the study. Patients were referred from the Orthopaedics outpatient department for imaging evaluation of shoulder pain, weakness, or restricted range of motion suggestive of rotator cuff injury.

Inclusion Criteria:

1. Patients aged ≥18 years
2. Clinical suspicion of rotator cuff tear
3. Patients willing to undergo MRI, high-resolution ultrasound, and arthroscopy
4. Patients providing informed written consent

Exclusion Criteria:

1. Previous shoulder surgery
2. Acute fractures around the shoulder joint
3. Contraindications to MRI (e.g., pacemakers, metallic implants incompatible with MRI)
4. Inflammatory arthropathies or shoulder infections
5. Patients unwilling to undergo arthroscopy

Imaging Protocols: High-Resolution Ultrasound (HRUS): Ultrasound examination of the affected shoulder was performed using a high-frequency linear transducer (7–15 MHz). The examination was carried out with the patient in a seated position, and all components of the rotator cuff—supraspinatus, infraspinatus, subscapularis, and teres minor—were systematically evaluated. Dynamic assessment was performed to detect tendon discontinuity, focal defects, tendon thinning, hypoechoic areas, and associated findings such as subacromial-subdeltoid bursal effusion.

Magnetic Resonance Imaging (MRI): MRI of the shoulder was performed using a standard shoulder protocol. Sequences included T1-weighted, T2-weighted, and proton density fat-suppressed images in axial, coronal oblique, and sagittal oblique planes. MRI findings were evaluated for tendon integrity, tear thickness (partial or full thickness), tendon retraction, muscle atrophy, fatty degeneration, and associated intra-articular abnormalities.

Both HRUS and MRI examinations were interpreted independently by radiologists experienced in musculoskeletal imaging, who were blinded to each other's findings and to arthroscopic results.

Arthroscopy: All patients subsequently underwent diagnostic or therapeutic shoulder arthroscopy performed by experienced orthopaedic surgeons. Arthroscopic findings regarding the presence, location, and type of rotator cuff tear were recorded and considered the gold standard for comparison.

Data Collection and Analysis: Imaging findings from HRUS and MRI were compared with arthroscopic findings. Rotator cuff tears were classified as partial-thickness or full-thickness tears. The diagnostic performance of HRUS and MRI was assessed in terms of sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy using arthroscopy as the reference standard.

Ethical Considerations: The study was approved by the Institutional Ethics Committee & Written informed consent was obtained from all participants prior to inclusion in the study, and patient confidentiality was maintained throughout.

Results

A total of 32 patients with clinically suspected rotator cuff pathology were included in the study. All patients underwent high-resolution ultrasound (HRUS) and magnetic resonance imaging (MRI) of the affected shoulder, followed by arthroscopic evaluation, which served as the gold standard for diagnosis. No patient was excluded during the study period.

Demographic Characteristics: The mean age of the study population was 46.8 ± 9.6 years, with an age range of 28 to 65 years. Males were more commonly affected than females. The right shoulder was involved more frequently than the left.

Table 1: Demographic Profile of the Study Population (n = 32)

Variable	Number (%)
Mean age (years)	46.8 ± 9.6
Age range (years)	28–65
Male	21 (65.6%)
Female	11 (34.4%)
Right shoulder	19 (59.4%)
Left shoulder	13 (40.6%)

Arthroscopic Findings: Arthroscopy confirmed the presence of rotator cuff tears in 26 patients (81.2%), while 6 patients (18.8%) showed no tear. Full-thickness tears were more common than partial-thickness tears. The supraspinatus tendon was the most frequently involved tendon.

Table 2: Arthroscopic Findings (Gold Standard)

Arthroscopic diagnosis	Number (%)
No tear	6 (18.8%)
Partial-thickness tear	10 (31.2%)
Full-thickness tear	16 (50.0%)
Tendon involved	
Supraspinatus	22 (68.8%)
Infraspinatus	6 (18.8%)
Subscapularis	4 (12.5%)
Teres minor	0 (0%)

Detection of Rotator Cuff Tears by Imaging Modalities: HRUS detected rotator cuff tears in 22 patients, while MRI detected tears in 25 patients. MRI demonstrated better detection rates, particularly for partial-thickness tears.

Table 3: Detection of Rotator Cuff Tears by Imaging Modalities

Modality	Tear detected	Tear not detected
HRUS	22	10
MRI	25	7

Correlation of Imaging Findings with Arthroscopy: When compared with arthroscopy, HRUS showed 20 true-positive and 5 true-negative cases. There were 2 false-positive and 5 false-negative findings, with false negatives occurring predominantly in partial-thickness tears. MRI demonstrated 24 true-positive and 6 true-negative cases, with only 1 false-positive and 1 false-negative case.

Table 4: Comparison of HRUS and MRI with Arthroscopy High-Resolution Ultrasound

Parameter	Number
True positives	20
True negatives	5
False positives	2
False negatives	5

Table 5: Magnetic Resonance Imaging

Parameter	Number
True positives	24
True negatives	6
False positives	1
False negatives	1

Diagnostic Performance of HRUS and MRI: MRI demonstrated higher sensitivity, specificity, and overall diagnostic accuracy compared to HRUS. HRUS showed good positive predictive value but lower negative predictive value.

Table 6: Diagnostic Performance of HRUS and MRI

Parameter	HRUS (%)	MRI (%)
Sensitivity	80.0	96.0
Specificity	71.4	85.7
Positive predictive value (PPV)	90.9	96.0
Negative predictive value (NPV)	50.0	85.7
Overall diagnostic accuracy	78.1	93.8

Associated Findings: MRI detected associated shoulder abnormalities more frequently than arthroscopy, particularly subacromial–subdeltoid bursitis and joint effusion. Muscle atrophy and fatty degeneration showed complete concordance between MRI and arthroscopic findings.

Table 7: Associated Findings on MRI and Arthroscopy

Associated Pathology	MRI (n)	Arthroscopy (n)
Subacromial–subdeltoid bursitis	14	12
Biceps tendon pathology	8	7
Muscle atrophy	9	9
Fatty degeneration	7	7
Glenohumeral effusion	11	10

Overall Interpretation: MRI demonstrated superior diagnostic performance compared to high-resolution ultrasound, especially in detecting partial-thickness tears and associated intra-articular abnormalities. HRUS showed good accuracy in detecting full-thickness tears and remains a useful initial imaging modality in experienced hands. Arthroscopy confirmed MRI findings more consistently than HRUS.

Discussion

Rotator cuff tears are a common source of shoulder pain and disability, and true understanding of the condition pre-operatively is critical for sound clinical decision-making and management. Diagnostic Imaging is critical for confirming a diagnosis, assessing the extent of a shoulder injury, and developing a surgical plan. This prospective study compared the efficacy of a diagnosis of rotator cuff tears, confirmed through arthroscopy, using high-resolution ultrasound (HRUS) and magnetic resonance imaging (MRI) through the pre-operative period. In the present study, the majority of patients with confirmed rotator cuff tears had full-thickness tears, a higher proportion than the partial-thickness tears. This is in keeping with previously published literature which showed that with increasing age, patients who present with chronic shoulder symproms are at a higher risk of having full-thickness rotator cuff tears [12,13]. Also, the supraspinatus tendon being the most commonly involved tendon, is a documented finding of various anatomical and imaging studies because of its anatomical relationship and position just beneath the acromion [14]. High-resolution ultrasound had a well-documented performance in confirming a diagnosis of full-thickness rotator cuff tears which correlates to having a high positive predictive value. This finding is consistent with previously published literature which showed that diagnostic ultrasound in the hands of a sonographer experienced in cardiac imaging had comparable sensitivity to that of MRI for the diagnosis of rotator cuff tears. We recently published results that corroborate the diagnostic performance of an experienced sonographer with high positive predictive value for the diagnosis of full thickness rotator cuff tears [15,16].

The benefits of HRUS, particularly in resource-limited areas, include real-time dynamic evaluation, low cost, and ease of use. Nevertheless, this study documents one of the weaknesses of HRUS—the reduced sensitivity in detecting partial-thickness tears. Partial-thickness tears, particularly those involving the articular surface, present greater difficulties with sonographic imaging owing to anisotropy and the imaging of deep tendon fibers being sonographically opaque [18]. In this study, HRUS was at a disadvantage compared to MRI, just as within the literature HRUS was at a disadvantage to MRI. It was due to the sensitivity of bitmaps versus film that HRUS had difficulty with both partial and full-thickness tears. It is the bit mapping capability with MRI that made it so necessary in the detailed assessment of tendon morphology, the extent of tears, tendon retraction, muscle atrophy, the presence of atrophy, and either fatty degeneration or the presence and the absence of degeneration. MRI demonstrated superior accuracy in the presence of significant rotator cuff pathology, thus the greater negative predictive value of MRI, suggests that the presence of EM is significant and excludes, by implication, negative rotator cuff pathology [19,20]

Also, another advantage of MRI, as mentioned in the study, is the capability of MRI is to demonstrate assorted intra-articular abnormalities, including pathologies of the biceps tendon, labral tear, joint effusion, and muscle wasting. These findings, on the other hand, are usually undervalued or overlooked

on ultrasound, but they are of great importance clinically and are of particular relevance when dealing with patients who are symptomatic and those who are scheduled to have operative procedures done [21]. MRI is said to be the most accurate way to evaluate the shoulder joint in its totality, in multiple previous studies done regarding the field, as opposed to ultrasound [22]. MRI, as with other forms of medical imaging, had its downsides including being the most expensive and taking the most time to conduct an exam. Also, MRI is not always accessible as some patients may have contraindications, such as severe claustrophobia or have implanted devices that are not compatible with the machine [23]. While, on the other hand, HRUS is user-friendly, quite convenient, and allows for a flexible assessment. This makes it especially ideal for outpatient clinics and for continuing assessment procedures [24]. Many authors have argued that it would be more logical to use HRUS as a first line assessment tool, while MRI would be more useful in cases where there is a need for more complex assessment or in preoperative evaluation where more details are needed [25].

The current study suggests that HRUS and MRI complement each other, rather than being viewed as alternative imaging methods. Initially, HRUS could be used as the first imaging modality, considering the possibility of full thickness tear. MRI, on the other hand, is the imaging technique of choice for complete evaluation of the pathology, especially where there are suspected partial thickness tears, intricate pathology, or when there is a consideration for surgical intervention. Arthritis is the gold standard for both diagnosis and treatment, as it allows for direct and unencumbered views of the pathology. It also permits the resolving of the pathology surgically. The study is limited by the small sample size, which inherently restricts its findings. Furthermore, it was acknowledged that the diagnosis by ultrasound is highly reliant on the individual skill of the operator, so the level of experience of ultrasound performing radiologist may lead to variation of diagnostic ability. However, the study's prospective nature and the correlation with the other informant, i.e., the arthroscopy, reinforces the study's findings.

Conclusion

The current study suggests that HRUS and MRI complement each other, rather than being viewed as alternative imaging methods. Initially, HRUS could be used as the first imaging modality, considering the possibility of full thickness tear. MRI, on the other hand, is the imaging technique of choice for complete evaluation of the pathology, especially where there are suspected partial thickness tears, intricate pathology, or when there is a consideration for surgical intervention. Arthritis is the gold standard for both diagnosis and treatment, as it allows for direct and unencumbered views of the pathology. It also permits the resolving of the pathology surgically. The study is limited by the small sample size, which inherently restricts its findings. Furthermore, it was acknowledged that the diagnosis by ultrasound is highly reliant on the individual skill of the operator, so the level of experience of ultrasound performing radiologist may lead to variation of diagnostic ability. However, the study's prospective nature and the correlation with the other informant, i.e., the arthroscopy, reinforces the study's findings. Overall, this study informs that MRI is superior to HRUS, especially with the diagnosis of partial thickness tear rotator cuff or tears, as well as with other intra-articular pathologies. HRUS however, is a modality of choice for full thickness tear diagnosis, and is valuable, as well as cost effective. A combination of factors (clinical symptoms, availability of resources, level of expertise) should be considered to individualize the optimal imaging study for the patient.

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