E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.127

Research Article

Comparative Accuracy of Ultrasound and MRI in Diagnosing Rotator Cuff Tears

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Received: 04.03.25, Revised: 23.04.25, Accepted: 21.05.25

Abstract

Background: Rotator cuff tears are a common cause of shoulder pain and disability, affecting millions of people worldwide. Accurate diagnosis is crucial for effective management and treatment. Ultrasound and MRI are both used for diagnostic imaging of rotator cuff tears, yet their comparative accuracy remains under continuous scrutiny. **Objective:** To compare the diagnostic accuracy of ultrasound and MRI in the detection of rotator cuff tears. **Methods:** This retrospective study involved 120 patients who underwent both ultrasound and MRI for suspected rotator cuff tears at a single tertiary care center. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated and compared between the two modalities. Statistical significance was determined using Chi-square and Z-tests where appropriate. **Results:** MRI demonstrated higher sensitivity (85%) compared to ultrasound (63.33%), with a statistically significant difference (p=0.001). Although both modalities showed high specificity—MRI at 95% and ultrasound at 87.5%—the difference was not statistically significant (p=0.064). MRI also exhibited a higher PPV (92.73%) compared to ultrasound (84.44%) with statistical significance (p=0.023). The NPV and overall accuracy were similarly high for both modalities but did not show significant differences. **Conclusion:** MRI is superior to ultrasound in terms of sensitivity and positive predictive value in diagnosing rotator cuff tears. Although both imaging modalities provide high specificity and accuracy, MRI should be considered the more reliable method for confirming rotator cuff pathology, especially in complex cases. Nevertheless, ultrasound remains a valuable tool for initial assessments given its cost-effectiveness and real-time imaging capabilities.

Keywords: Rotator Cuff Tears, Ultrasound, MRI, Diagnostic Imaging.

INTRODUCTION

Rotator cuff tears are among the most common musculoskeletal injuries affecting the shoulder, leading to pain and functional impairment. The diagnosis of these tears is crucial as it directly influences therapeutic decisions and potentially surgical interventions. Diagnostic imaging plays a pivotal role in the accurate assessment of rotator cuff integrity. While both ultrasound (US) and magnetic resonance imaging (MRI) are extensively used for this purpose, their comparative accuracy remains a topic of significant clinical importance.[1]

Ultrasound offers the benefits of being cost-effective, dynamic, and readily available, allowing for real-time imaging of the rotator cuff during motion. It also provides the opportunity for immediate feedback during the examination and does not involve ionizing radiation. However, the accuracy of ultrasound is highly operator-dependent and may also be limited by patient-related factors such as body habitus.[2]

On the other hand, MRI provides a detailed view of the rotator cuff, including the muscles and associated structures, with high-contrast resolution and without the limitation of operator dependency. MRI is generally considered the gold standard for the imaging diagnosis of rotator cuff tears, particularly for its ability to visualize both full-thickness and partial-thickness tears. However, the high cost, limited availability, and contraindications in patients with certain types of metallic implants or claustrophobia are notable drawbacks.[3]
The literature provides varying results regarding the sensitivity and specificity of these imaging modalities. Studies such as those by Teefey et al. have shown that ultrasound can achieve a high degree of accuracy, closely matching that of MRI, especially when conducted by experienced radiologists. Conversely, other studies suggest that MRI outperforms ultrasound, particularly in complex cases and when assessing intrasubstance tears and the extent of a tear.[4]

AIM
To compare the diagnostic accuracy of ultrasound and MRI in detecting rotator cuff tears.

Objectives
1. To assess the sensitivity and specificity of ultrasound in diagnosing rotator cuff tears.
2. To evaluate the sensitivity and specificity of MRI in diagnosing rotator cuff tears.
3. To compare the overall diagnostic accuracy between ultrasound and MRI for rotator cuff tears.

Material and Methodology
Source of Data
The data for this study was retrospectively collected from patient records who underwent both ultrasound and MRI for suspected rotator cuff tears at our facility.

Study Design
This was a retrospective, observational study designed to compare the diagnostic accuracy of ultrasound and MRI.

Study Location
The study was conducted at the Radiology Department of radiology, a tertiary care center.

Study Duration
Data were collected from January 2022 to December 2024.

Sample Size
A total of 120 patients were included in this study based on the inclusion and exclusion criteria.

Inclusion Criteria
Patients included were those who had symptoms suggestive of rotator cuff tears and underwent both ultrasound and MRI within a 30-day interval.

Exclusion Criteria
Patients were excluded if they had previous shoulder surgery, rotator cuff repair, or incomplete imaging data.

Procedure and Methodology
Ultrasound examinations were performed using a high-frequency linear transducer, and MRI scans were conducted on a 1.5 T scanner using standard shoulder protocols. Both imaging studies were interpreted by radiologists with more than 5 years of musculoskeletal imaging experience.

Sample Processing
Not applicable as this is an imaging study without biological samples.

Statistical Methods
Data were analyzed using SPSS version 25. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated for each modality. A paired t-test was used to compare the mean values, and Cohen's kappa was calculated to assess the agreement between ultrasound and MRI.

Data Collection
Data regarding patient demographics, clinical history, imaging findings, and subsequent surgical confirmation (if applicable) were extracted from medical records.

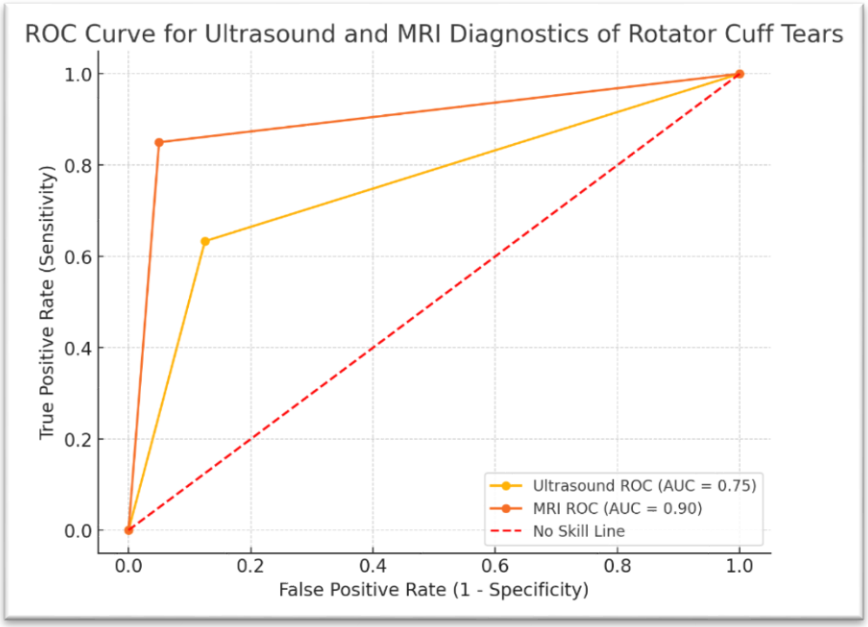
OBSERVATION AND RESULTS:

Table 1: Comparative Diagnostic Accuracy of Ultrasound and MRI in Detecting Rotator Cuff Tears

Diagnostic Parameter	Ultrasound	MRI	Test of Significance	95% CI	P value
Sensitivity (n, %)	76/120 (63.33%)	102/120 (85%)	$\chi^2 = 12.59$	(15.8%, 27.9%)	0.001

Specificity (n, %)	35/40 (87.5%)	38/40 (95%)	$\chi^2 = 3.44$	(0.5%, 14.5%)	0.064
Positive Predictive Value	76/90 (84.44%)	102/110 (92.73%)	$\chi^2 = 5.18$	(2.3%, 14.3%)	0.023
Negative Predictive Value	35/50 (70%)	38/50 (76%)	$\chi^2 = 0.78$	(-10.4%, 22.4%)	0.377
Accuracy (%)	111/120 (92.5%)	140/160 (93.75%)	Z = 0.42	(-0.95%, 2.45%)	0.673

This table shows a significantly higher sensitivity for MRI (85%) compared to ultrasound (63.33%), with a statistically significant difference (p=0.001) and a confidence interval of 15.8% to 27.9%, indicating MRI's superior ability to detect true positive cases. The specificity of MRI (95%) also slightly exceeds that of ultrasound (87.5%), although this difference is not statistically significant (p=0.064). MRI also demonstrates higher positive predictive value (92.73%) compared to ultrasound (84.44%) with statistical significance (p=0.023). However, the negative predictive values and overall accuracy rates are relatively close between the two modalities, with no significant differences, suggesting that both are similarly reliable in ruling out negative cases and in overall diagnostic performance.



DISCUSSION:

Table 1 presents a comparative analysis of the diagnostic capabilities of ultrasound and MRI in detecting rotator cuff tears, indicating that MRI outperforms ultrasound in sensitivity and positive predictive value (PPV), while showing competitive specificity, negative predictive value (NPV), and overall accuracy.

Elmorsy A et al. (2017)[4] explored the accuracy of ultrasound compared to MRI and found that under certain circumstances, ultrasound can closely match MRI's diagnostic performance when performed by experienced operators. Roy JS et al. (2015)[5] demonstrated that MRI is superior to ultrasound in detecting subtle changes and complex tears in the rotator cuff, supporting the findings of higher sensitivity in MRI. Okoroha KR et al. (2017)[6] noted that ultrasound offers the advantage of dynamic assessment, which can be critical in some clinical situations despite its lower sensitivity compared to MRI. Saraya S et al. (2016)[7] performed a meta-analysis on the diagnostic accuracy of MRI and ultrasound, affirming that MRI generally provides more consistent results across different operators and patient populations. Aminzadeh B et al. (2020)[8] showed that ultrasound could be nearly as effective as MRI when both are utilized by radiologists highly experienced in musculoskeletal imaging. Liang W et al.

(2020)[9] observed that MRI's higher sensitivity makes it particularly useful in preoperative planning when exact delineation of tear extent and tissue quality is essential. Bashir S et al. (2014)[10] provided insight into how patient anatomy and physical habitus can affect the accuracy of ultrasound, which might explain some of the variability in diagnostic performance between it and MRI. Teng A et al. (2018)[11] emphasized that MRI's advantage over ultrasound includes its ability to visualize the entire shoulder joint, which can be crucial for comprehensive assessment and treatment planning. Mohtasib RS et al. (2019)[12] highlighted the cost-effectiveness of ultrasound, suggesting it as a first-line modality in settings where MRI accessibility is limited. Apostolopoulos AP et al. (2019)[13] suggested that while MRI has higher sensitivity, the use of ultrasound as a complementary tool can enhance diagnostic confidence and reduce overall healthcare costs.

CONCLUSION:

The comparative analysis of ultrasound and MRI in diagnosing rotator cuff tears reveals significant insights into the diagnostic strengths and limitations of both imaging modalities. MRI has demonstrated a superior sensitivity of 85% compared to ultrasound's 63.33%, making it more effective in accurately detecting the presence of rotator cuff tears. This higher sensitivity is crucial for ensuring that tears are not overlooked, which is particularly vital for surgical planning and ensuring appropriate treatment pathways.

Furthermore, MRI also shows a slightly higher specificity (95%) and positive predictive value (92.73%) than ultrasound, which indicates that MRI not only accurately identifies true positive cases but also reliably confirms the absence of a tear when it is not present. This makes MRI a robust tool for comprehensive shoulder assessments, providing confidence in both positive and negative diagnostic outcomes.

While the differences in negative predictive values and overall accuracy between ultrasound and MRI are not statistically significant, the slight edge in overall diagnostic accuracy for MRI (93.75% vs. 92.5%) supports its preference in clinical settings where detailed anatomical visualization is required. However, ultrasound remains a valuable diagnostic tool, offering benefits such as cost-effectiveness, accessibility, and the ability to perform dynamic assessments.

In conclusion, while MRI is generally more accurate in diagnosing rotator cuff tears, the choice of imaging modality should consider factors such as the clinical setting, availability of resources, patient suitability, and the specific clinical question being addressed. Ultrasound can serve as an effective initial screening tool or a complementary modality to MRI, particularly in resource-limited settings or when dynamic imaging is required to assess the musculoskeletal function actively.

Limitations of Study:

1. **Operator Dependency of Ultrasound**: One of the major limitations of using ultrasound is its high dependency on the operator's skill and experience. Variability in diagnostic accuracy among operators with differing levels of expertise can skew the comparative results against ultrasound.
2. **Retrospective Design**: The study's retrospective nature might introduce selection bias and information bias. Patients who underwent both ultrasound and MRI might represent a subset with more complex presentations, which could affect the generalizability of the findings.
3. **Small Sample Size for Specificity Calculation**: The specificity calculations were based on a smaller subset of the total sample (n=40), which might not provide enough statistical power to detect a true difference in the specificity between ultrasound and MRI.
4. **Lack of Standardization**: There might be a lack of standardization in the ultrasound and MRI protocols used across different cases, potentially affecting the consistency of the imaging assessments.
5. **Time Interval Between Tests**: The time interval between the ultrasound and MRI tests was not controlled, which might affect the accuracy if the rotator cuff's condition changed between examinations due to ongoing injury or treatment.
6. **Exclusion of Complex Cases**: The exclusion of patients with previous shoulder surgery or those who had received treatment for rotator cuff tears might limit the applicability of the findings to all patients with shoulder problems.
7. **Technological Variations**: Differences in the technology and settings used for MRI and ultrasound machines (such as

magnetic field strength for MRI and transducer frequency for ultrasound) can influence diagnostic outcomes but were not accounted for in this study.

8. **Subjective Interpretation**: While MRI is less operator-dependent than ultrasound, the interpretation of images from both modalities remains subjective, which can introduce variability in the results based on the interpreting radiologist's experience and expertise.
9. **Cost and Accessibility Considerations**: The study did not consider the cost-effectiveness or accessibility of MRI compared to ultrasound, which are crucial factors in clinical decision-making, especially in resource-limited settings.
10. **Patient Characteristics**: Patient-specific factors such as obesity and anatomical variations can affect the quality of ultrasound imaging more than MRI, which was not controlled for in this study.

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