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Diagnostic Accuracy of Ultrasound in Terms of Sensitivity and Specificity for Detection of Rotator Cuff Tears Keeping MRI as Gold Standard

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ABSTRACT

Background: Rotator cuff tears are a common cause of shoulder pain, significantly affecting mobility and quality of life. Accurate and cost-effective diagnostic methods are essential, particularly in resource-limited settings. While MRI is considered the gold standard, the role of ultrasound in diagnosing rotator cuff tears remains under investigation, with its performance varying across different studies and populations. **Objective:** To determine diagnostic accuracy of ultrasound in terms of sensitivity and specificity for detection of rotator cuff tears keeping MRI as gold standard. **Study Design:** Cross-sectional validation study. **Duration and Place of Study:** The study was conducted from July 2024 to January 2025 at the Department of Radiology, Shaikh Zayed Hospital, Lahore. **Methodology:** A total of 130 patients aged 18–60 years, presenting with suspected rotator cuff tears, were enrolled. Ultrasound was performed using a 10 MHz linear probe, and MRI was conducted on a 1.5T machine. Full- and partial-thickness tears were diagnosed based on established imaging criteria. Metrics such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the overall effectiveness of ultrasound in diagnosis were assessed. **Results:** The mean age of patients was 47.32 ± 7.06 years, with 70% male representation and right-sided tears being more prevalent (73.1%). Ultrasound demonstrated a sensitivity of 94%, specificity of 91%, and diagnostic accuracy of 92%. **Conclusion:** Ultrasound is a reliable, cost-effective diagnostic modality for rotator cuff tears, with accuracy comparable to MRI.

INTRODUCTION

The rotator cuff tear is one of the most frequent reasons for both shoulder pain and dysfunction, particularly in adults and active individuals involved in many overhead repetitive activities.[1] The rotator cuff represents a composite muscle and its four tendons: supraspinatus, infraspinatus, teres minor, and subscapularis, providing the shoulder joint with stability and wide-ranging active motion.[2] Tears related to acute trauma, degenerative changes, or overuse typically present as partial-thickness or full-thickness tears.[3] The main complaints of patients are shoulder pain and weakness, with limitation of movement that severely impairs their quality of life.[4] Early diagnosis with accurate diagnosis is important for effective management and prevention of long-term complications including joint stiffness and irreversible muscle atrophy.[5]

Diagnosis of rotator cuff tears depends on both clinical evaluations and imaging studies.[6] Clinically, the patient's history, symptoms, and physical examination findings are assessed by health-care providers, to which are added tests such as the drop arm test and Hawkins-Kennedy impingement test.[7] These maneuvers provide initial insights, while imaging modalities are necessary for confirmation and to outline tear size and severity.[8] MRI is the gold standard of investigation, given its great detail in the visualization of soft tissues; however, the high cost and unavailability in some settings make access difficult.[9] Other imaging modalities include CT arthrography and ultrasound, the latter of which has gained increased prominence due to its easy availability and low cost in detecting pathology of the rotator cuff.[10] Ultrasound is increasingly used for diagnosing rotator cuff tears and, as such, represents a practical and effective technique in many clinical situations compared to MRI.[11] It provides high-resolution, real-time imaging that allows the clinician to assess tendon integrity, muscle atrophy, and dynamic shoulder movements. Sensitivity and specificity of ultrasound for full-thickness rotator cuff tears are consistently high, ranging between 85–95% and 90–98%, respectively.[12] A meta-analysis found lower but still convincing diagnostic

accuracy across partial-thickness tears.[13] Moreover, the accuracy varies with the sonographer experience-it proves great findings among expert sono-graphers while being at parity with MRI tests. It comes forth bearing restrictions since it has weaknesses in small tear detection or difficult tears.[14] Regardless, ultrasound serves effectively as an extended first-line investigative modality without biological invasion and offers inexpensive availability as well. Nadeem et al., in a study conducted in Pakistan between 2013 and 2016, reported that ultrasound demonstrated a diagnostic accuracy of 90%. The study highlighted sensitivity and specificity rates of 91% and 87%, respectively.[15]

Despite advancements in diagnostic imaging, there remains a need for studies that assess the accuracy and reliability of ultrasound for detecting rotator cuff tears, particularly in resource-limited settings where access to MRI is restricted. By evaluating its sensitivity and specificity, this study aims to establish ultrasound as a cost-effective, non-invasive alternative for diagnosing rotator cuff tears. Such research is crucial to improving early detection, guiding appropriate management, and reducing the burden of shoulder dysfunction on patients, especially in regions with limited healthcare resources.

METHODOLOGY

This validation study, designed as a cross-sectional analysis, took place between July 2024 and January 2025 in the Radiology Department of Shaikh Zayed Hospital, Lahore. The research included 130 participants, aged 18 to 60 years, of both sexes, suspected of rotator cuff tears, selected through non-probability consecutive sampling. The sample size was calculated with a 95% confidence level, using estimated sensitivity and specificity values of 91% and 87%,[15] an anticipated prevalence of 50%,[16] and a 7% margin of error for sensitivity and 9% for specificity. Initial demographic information, such as the patient's name, age, gender, symptom duration, body mass index (BMI), and the side of involvement (left or right shoulder), was recorded. Patients presenting with shoulder pain, stiffness, limited daily activity, or a history of trauma were included, while those with metallic stents, fixators, old cardiac pacing devices, or tendinopathies secondary to autoimmune diseases, such as rheumatoid arthritis, were excluded. A radiologist with over five years of experience performed both ultrasound and MRI assessments to ensure consistency and minimize inter-observer variability.

Ultrasound assessments were performed using a GE LOGIQ S7 expert ultrasound machine with a 10 MHz linear probe. Full-thickness tears were diagnosed when a hypoechoic area spanning from the articular to the bursal surface or measuring more than 2.5 cm was observed in both coronal and sagittal planes. Partial-thickness tears were identified as hypoechoic foci confined to either the bursal or articular surface or measuring less than 2.5 cm. MRI evaluations were conducted using a 1.5T MRI (Signa HDxt, GE Medical Systems) with multiplanar multiecho T1-weighted, fat saturation, and PD sequences. Partial-thickness tears were diagnosed based on focal increased signal intensity or fibrous discontinuity visible on T1W, PDW, and T2W sequences, appearing as bright as fluid on T2W. Complete tears were recognized when a distinct gap spanned from the bursal layer to the articular surface, often containing fluid or granulation tissue. The performance measures, including sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy, were derived through a 2x2 contingency matrix, referencing MRI as the gold standard. Statistical processing was carried out with SPSS version 27.0, and findings were categorized based on age, gender, and the location of the tear for detailed analysis.

RESULTS

The study reported that the mean age of patients was 47.32 ± 7.06 years, indicating that middle-aged individuals were predominantly affected. The mean BMI was 25.70 ± 1.92 kg/m², reflecting a population within the normal to overweight range. The average duration of symptoms was 5.92 ± 2.93 months, suggesting a moderate delay in seeking medical care, as shown in Table 1.

Table 1

Mean ± SD for Patients Categorized by Age, BMI and Duration of Symptoms

	Demographics	Mean±SD
1	Age (years)	47.323±7.06
2	BMI (Kg/m^2)	25.704±1.92
3	Duration of symptoms (months)	5.915±2.93

Gender distribution revealed that 70% of the patients were male and 30% female, highlighting a higher prevalence in males. Additionally, tears were more common on the right side, accounting for 73.1%, compared to 26.9% on the left side, as shown in Table 2.

Table 2

Distribution and Proportion of Patients by Gender and Site of Tear

Gender / Site of tear	No. of Patients	%age
Male	91	70%
Female	39	30%
Right	95	73.1%
Left	35	26.9%

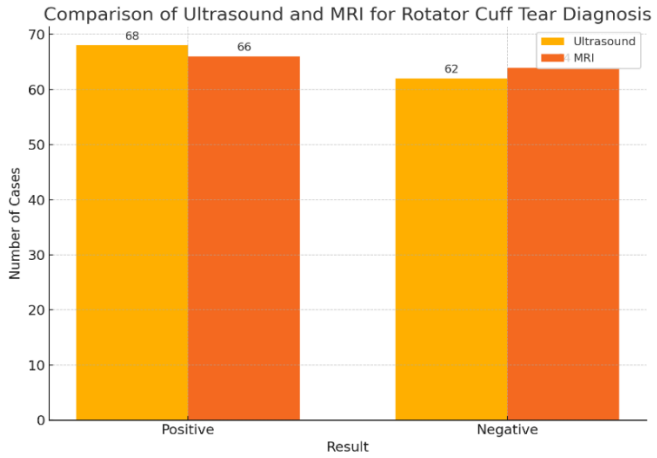
The diagnostic results for rotator cuff tears showed that ultrasound identified tears in 52.3% of cases, while MRI diagnosed 50.8%, demonstrating a comparable performance between the two modalities, as shown in Table 3.

Table 3

Overall Results of Ultrasound and MRI in Diagnosis of Rotator Cuff Tear

Rotator cuff tear	Ultrasound	MRI
Positive	68 (52.3%)	66 (50.8%)
Negative	62 (47.7%)	64 (49.2%)
Total	130 (100%)	130 (100%)

Figure 1



When comparing ultrasound to MRI, the analysis revealed a chi-square value of 93.14 with a statistically significant p-value of 0.000, underscoring the strong diagnostic agreement between these imaging techniques, as shown in Table 4.

Table 4

Comparison of Ultrasound Versus MRI in Diagnosis of Rotator Cuff Tear

Ultrasound	MRI		Total
	Positive	Negative	
Positive	62 (TP)	6 (FP)	68
Negative	4 (FN)	58 (TN)	62
Total	66	64	130

Chi square = 93.14

P value = 0.000

Key:

TP = True positive

FP = False positive

FN = False negative

TN = True negative

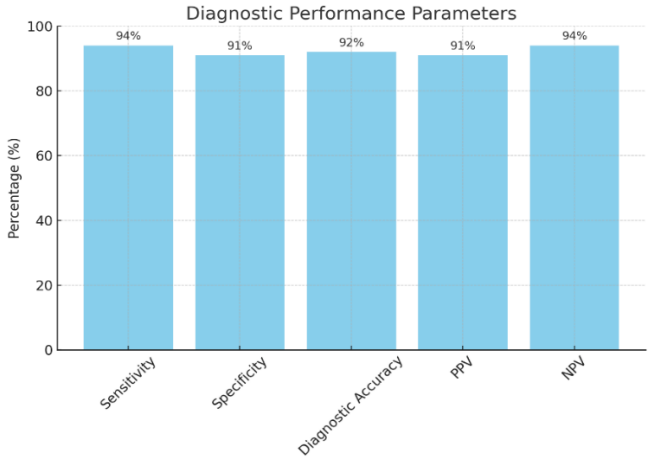
Ultrasound demonstrated high reliability in diagnosing rotator cuff tears, with sensitivity at 94%, specificity at 91%, overall accuracy at 92%, a positive predictive value (PPV) of 91%, and a negative predictive value (NPV) of 94%, as shown in Table 5.

Table 5

Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of Ultrasound for Diagnosis of Rotator Cuff Tear

Diagnostic Parameter	Result
Sensitivity	94%
Specificity	91%
Diagnostic Accuracy	92%
PPV	91%
NPV	94%

Figure 2



Stratified analysis provided further insights. For patients aged 18–40 years, sensitivity was 95%, specificity 86%, and diagnostic accuracy 92%, suggesting excellent diagnostic performance in younger patients. For those over 40 years, sensitivity was 94%, specificity 91%, and diagnostic accuracy 92%, showing consistent reliability in older age groups. In males, ultrasound demonstrated a sensitivity of 94%, specificity of 96%, and diagnostic accuracy of 95%, reflecting high precision. In females, however, sensitivity dropped to 0%, with specificity and accuracy at 87%, indicating diagnostic challenges in this group. Regarding the site of the tear, right-sided tears showed a sensitivity of 94%, specificity 97%, and diagnostic accuracy of 95%, highlighting superior diagnostic capability, whereas left-sided tears had 0% sensitivity, 86% specificity, and 86% accuracy, revealing limitations in detecting left-sided tears, as shown in Table 6.

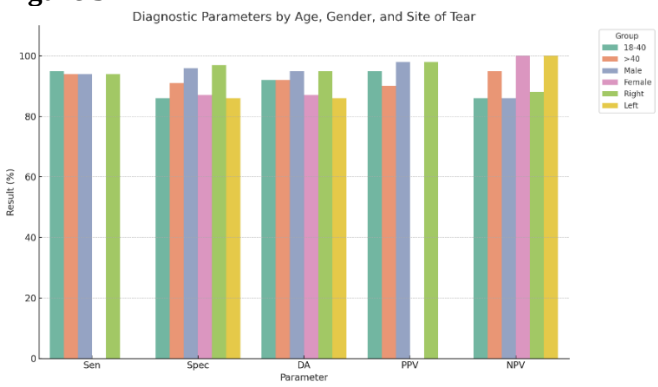
Table 6

Stratified Analysis of Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of Ultrasound for Diagnosis of Rotator Cuff Tear with Age, Gender and Site of Tear

Variables	Groups	Diagnostic Parameter	Result
Age (years)	18-40	Sen	95%
		Spec	86%
		DA	92%
		PPV	95%
		NPV	86%
	>40	Sen	94%
		Spec	91%
		DA	92%
		PPV	90%
		NPV	95%
Gender	Male	Sen	94%
		Spec	96%
		DA	95%
		PPV	98%
		NPV	86%
	Female	Sen	0%
		Spec	87%
		DA	87%
		PPV	0%
		NPV	100%

Site of tear	Right	Sen	94%
		Spec	97%
		DA	95%
		PPV	98%
		NPV	88%
	Left	Sen	0%
		Spec	86%
		DA	86%
		PPV	0%
		NPV	100%

Figure 3



DISCUSSION

This study highlights the strong effectiveness of ultrasound as a diagnostic tool for rotator cuff tears, with sensitivity at 94%, specificity at 91%, accuracy at 92%, a positive predictive value (PPV) of 91%, and a negative predictive value (NPV) of 94%. Its performance was particularly notable for right-sided tears, achieving a sensitivity of 94%, specificity of 97%, and accuracy of 95%. Among patients aged 18–40 years, ultrasound demonstrated a sensitivity of 95%, specificity of 86%, and accuracy of 92%, while for those over 40, sensitivity remained at 94%, with specificity and accuracy at 91% and 92%, respectively.

Sidharthan Selvaraj et al.[17] evaluated the diagnostic accuracy of ultrasound (USG) versus MRI for rotator cuff injuries in a study of 50 patients, reporting a sensitivity of 93% and specificity of 97% for supraspinatus tears and lower sensitivity (74%) and specificity (86%) for subscapularis tears. These results align closely with our findings, where USG demonstrated an overall sensitivity of 94% and specificity of 91%, with stratified analyses revealing higher sensitivity and specificity for right-sided tears (94% and 97%, respectively). However, our study highlighted challenges in diagnosing left-sided tears, with sensitivity dropping to 0%, which was not addressed in Selvaraj's study. Rana Dilawaiz Nadeem et al.[15] assessed high-resolution ultrasonography (HRUS) for diagnosing rotator cuff tears in 92 patients, finding 91% sensitivity, 87% specificity, and an overall accuracy of 90.2%. These findings are comparable to our study, where USG achieved an accuracy of 92%. Both studies emphasize USG's utility as a reliable diagnostic tool, but our study provides additional stratified insights, particularly regarding the impact of age and gender on diagnostic performance. For example, in our study, diagnostic accuracy in males (95%) exceeded that in females (87%), a factor not explored in Nadeem's research. João Alberto Yazigi Junior et al.[18] conducted a prospective diagnostic accuracy study, reporting USG sensitivity of 36.3% and specificity of 91.7% for supraspinatus tears. While the specificity aligns with our findings, the significantly lower sensitivity contrasts sharply with the 94% sensitivity reported in our study. This discrepancy might be attributed to operator dependency and the clinical context, as Yazigi noted limitations in detecting partial-thickness tears, which were not separately analyzed in our study. Ali S. Farooqi et al.[13] systematically reviewed 23 studies involving 2054 shoulders, reporting median diagnostic accuracies of 93% for full-thickness supraspinatus tears and 81% for partial-thickness tears. These results align with our study's overall accuracy of 92% and stratified performance metrics. However, Farooqi emphasized the role of operator expertise, highlighting variability based on training, which is consistent with our study's observation of diagnostic challenges in females, potentially indicating operator dependency for specific subgroups. Abhinav Gupta et al.[19] examined the diagnostic accuracy of USG in 50 patients, finding sensitivities of 84% for tendinosis, 78.1% for partial-thickness tears, and 100% for full-thickness tears, with specificities ranging from 87.5% to 94.4%.[19] While these results demonstrate strong diagnostic capabilities, our study reported higher overall sensitivity (94%) and specificity (91%), particularly for younger patients (sensitivity 95%, specificity 86%), highlighting consistent performance across diverse age groups. Additionally, our findings regarding right-sided tears' superior diagnostic accuracy (95%) provide further nuance not addressed by Gupta.

Kelechi R. Okoroha et al.[20] highlighted the diagnostic performance of ultrasound, with sensitivity ranging from 74% to 98% and specificity between 93% and 100% for full-thickness tears. These results align with the findings of this study, which demonstrated a sensitivity of 94% and specificity of 91%, showing excellent accuracy for right-sided tears. However, this study revealed notable challenges in diagnosing left-sided tears and female patients, issues not addressed in Okoroha's review.[20]

Several limitations should be acknowledged. First, the relatively small sample size of 130 patients may restrict the broader applicability of the findings. Additionally, the single-center nature of the study could introduce selection bias and limit its relevance to diverse clinical environments or patient populations. Additionally, the study relied on operator-dependent ultrasound imaging, which may affect reproducibility and diagnostic consistency across different practitioners. Stratified analyses revealed significant variability in diagnostic

performance among subgroups, particularly in females and for left-sided tears, suggesting that further research with larger, more diverse cohorts is needed to confirm these findings and address these limitations.

CONCLUSION

Our study has concluded that ultrasound is a reliable and cost-effective diagnostic tool for rotator cuff tears, with performance comparable to MRI. It demonstrates consistent accuracy across age groups and genders, particularly for right-sided tears, though challenges remain in diagnosing left-sided tears and female patients. These findings support its use as an accessible and efficient modality for initial evaluation and management of rotator cuff injuries.

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***Authors Contribution**

Dr. Nawal Naseem: Led the study's design and conceptual framework, drafted the preliminary version of the manuscript, and supervised the collection of data from the hospital.

Dr. Saulat Sarfraz: Significantly enhanced the manuscript's quality, contributed to the study's foundational design, and played a key role in data analysis and interpretation.

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