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DIAGNOSTIC ACCURACY OF ULTRASOUND IN DETECTING ROTATOR CUFF TEARS KEEPING MRI AS GOLD STANDARD

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Abstract

Introduction: *This study seeks to assess the diagnostic precision of ultrasonography in identifying rotator cuff tears, employing MRI as the reference standard. Considering the extensive application of ultrasound imaging for musculoskeletal evaluation, comprehending its dependability is essential. The results will inform its function in clinical decision-making and screening.*

Objectives: *To determine the diagnostic accuracy of ultrasound in detecting rotator cuff tears keeping MRI as gold standard.*

Subjects & Methods: *The Department of Radiology, PAF Hospital Islamabad, conducted this six-month cross-sectional validation study from 6 October 2024 to 6 April 2025. 185 people were recruited using non-probability consecutive sampling. Patients aged 18–65, independent of gender, with clinical suspicion of rotator cuff injury and symptoms lasting over 15 days were included. Rotator cuff tears are diagnosed by shoulder pain (VAS score >4) and restricted active and passive range of motion. Ultrasonography indicated rotator cuff tears if the cuff was not visible, the tendon was absent or localized, the tendon was discontinuous, and the muscle echogenicity was abnormal. A hyperintense signal in the tendon on T2-weighted, fat-suppressed, or GRE sequences indicated fluid present, indicating a tear. Standard protocol for ultrasound and MRI was followeXd. IBM SPSS 26 software was used for data handling. The sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy of ultrasonography were assessed using a 2x2 contingency table. Stratification was used to manage effect modifiers such age, gender, and symptom duration. Diagnostic accuracy was assessed after stratification with a significance criterion of $p < 0.05$.*

Results. *Ultrasound identified rotator cuff tears in 73.5% of patients, whereas MRI identified tears in 71.9% patients. The results indicates that the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of ultrasound for rotator cuff syndrome are 92.5%, 75.0%, 90.4%, 79.6%, and 87.6%, respectively.*

Conclusions*: Ultrasound has shown to be an accurate, dependable, and easily accessible method for detecting rotator cuff tears in their early stages. Nevertheless, owing to moderate specificity, especially in older, female, and*

chronic cases, MRI is indispensable for validation and comprehensive preoperative planning.

INTRODUCTION

Rotator cuff pathology includes moderate tendinopathy, partial-thickness rips, and total tendon ruptures. Age affects the occurrence and course of many injuries. Studies show that 9.7% of 20-year-olds and older have rotator cuff injuries, with rates rising considerably in elderly populations. Age and unilateral shoulder discomfort dramatically increase contralateral tear risk. Patients without cuff rips average 48.7 years, but those beyond 66 had a 50% chance of bilateral involvement. Although age highly predicts tear presence and kind, it does not predict tear size.

Rotator cuff tear treatment, especially non-surgical, is contentious. The most common adult tendon injury has little high-quality information to guide therapy. Studies show that 30% of persons over 60 and 62% of those over 80 have tears.

Radiography, ultrasonography, and MRI/MR arthrography are essential diagnostic imaging methods. MR arthrography is no better than conventional MRI for rotator cuff assessment, despite its increased cost and invasiveness. Plain radiographs, anteroposterior (AP), genuine AP (Grashey), scapular Y (lateral), and axillary; are usually used for initial examination. The Grashey view identifies chronic big rips' proximal humeral migration by engaging the deltoid. The scapular Y view detects cuff pathology-related acromial spurs, while the axillary view evaluates joint space narrowing and humeral subluxation.

Ultrasound is a popular, cost-effective rotator cuff imaging method. Dynamic assessment and price make it ideal for initial diagnosis. In the realm of orthopedic diagnostics, investigating the diagnostic accuracy of ultrasound in detecting rotator cuff tears, with MRI as the gold standard, holds substantial clinical significance. While MRI has established itself as the reference standard for assessing rotator cuff pathology due to its high sensitivity and detailed soft tissue visualization, ultrasound's real-time and cost-effective nature makes it an attractive alternative.By systematically comparing ultrasound findings with MRI results, this study aims to provide valuable insights into the sensitivity, specificity, and overall accuracy of ultrasound, potentially paving the way for more accessible and efficient diagnostic approaches in the evaluation of rotator cuff tears. Such evidence is pivotal for guiding clinical decision-making and optimizing patient care in orthopedic practices.

MATERIALS AND METHODS

This cross-sectional validation study was performed at the Department of Radiology, PAF Hospital Islamabad, over a six-month period from 6 October 2024 to 6 April 2025. A sample size of 185 individuals was determined utilizing the WHO sample size calculator, predicated on a sensitivity of 88%, specificity of 89%, and a prevalence of 22.2%, with a 95% confidence interval and 10% precision (Naqvi and Hensley). Patients were recruited by a non-probability consecutive sampling method. The inclusion criteria were individuals aged 18 to 65 years, regardless of gender, exhibiting clinical suspicion of rotator cuff injuries, with symptoms lasting over 15 days. Patients were excluded if they had a history of prior shoulder surgery or fracture, adhesive capsulitis, claustrophobia, or were pregnant. The clinical diagnosis of a rotator cuff tear is characterized by shoulder pain (VAS score >4) and restricted active and passive range of motion, specifically forward flexion of less than 100°, external rotation at the side between 0° and 20°, and internal rotation below the thoracic vertebral level. A rotator cuff tear on ultrasonography was identified if the following criteria were met: non-visualization of the cuff, localized or focal absence of the tendon, tendon discontinuity, and aberrant muscle echogenicity. MRI data were deemed positive for a tear if a hyperintense signal was observed within the tendon on T2-weighted, fat-suppressed, or GRE sequences, indicative of fluid presence. Upon acquiring informed consent, demographic information including age, gender, and duration of symptoms was documented. All ultrasound examinations were conducted utilizing a high-

frequency linear transducer. An MRI of the shoulder was conducted in different planes utilizing standard sequences, which included coronal oblique proton density, T1 and T2-weighted images with fat suppression, sagittal oblique T2-weighted, and axial T2-weighted sequences. Data was processed via IBM SPSS version 26. The mean and standard deviation were computed for quantitative data. Frequencies and percentages were computed for qualitative factors. Diagnostic criteria such as sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy of ultrasonography were determined via a 2×2 contingency table, with MRI serving as the reference standard. Effect modifiers, including age, gender, and symptom duration, were managed via stratification, and the post-stratification diagnostic accuracy was evaluated with a significance threshold of $p < 0.05$.

RESULTS

This study comprised a total of 185 patients. The mean age of the individuals was 48.48 ± 8.78 years, and the average duration of symptoms was 30.06 ± 8.49 days. Among 185 cases, 129 (69.7%) were male. The age distribution by gender is illustrated in Table 1. Patients were additionally classified into several groups based on age and symptom duration, which is graphically depicted in figures 1 and 2.

Ultrasound (USG) identified rotator cuff tears in 136 patients (73.5%), whereas MRI identified tears in 133 patients (71.9%) (table 2). Among the 133 patients with MRI-confirmed rotator cuff injuries, 123 (92.5%) also tested positive on ultrasound. In contrast, of the 52 individuals without a rotator cuff tears on MRI, 39 (75.0%) were accurately classified as negative on ultrasound. The results indicates that the sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy of ultrasound for rotator cuff syndrome are 92.5%, 75.0%, 90.4%, 79.6%, and 87.6%, respectively (table 3).

Ultrasound exhibited higher specificity in males while maintaining equivalent sensitivity across both genders. The 45–60 years group exhibited the highest specificity, although sensitivity remained uniformly higher across all age demographics. Ultrasound exhibited marginally superior outcomes in patients with shortened illness duration. Table 4 presents a comprehensive stratification analysis for study confounders.

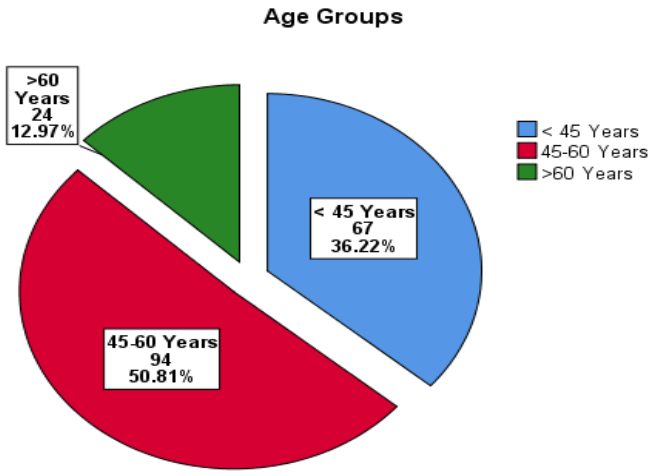

Figure 1: Distribution of patients in different age groups (n=185)

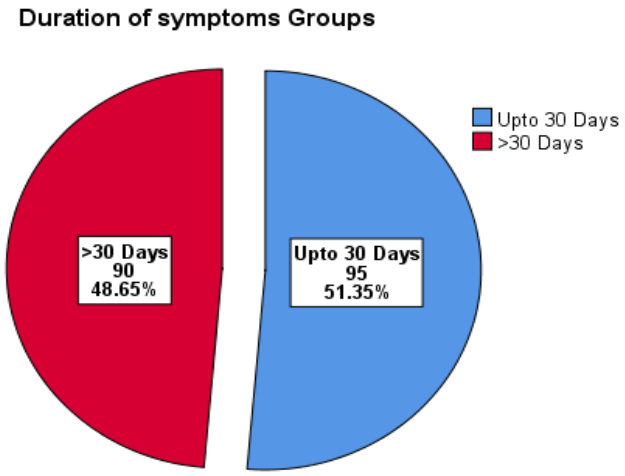

Figure 2: Distribution of patients in different groups on the basis of duration of symptoms (n=185)

Table 1: Demographic Profile of the study Population (age and gender distribution)

GENDER	FREQUENCY	PERCENTAGE	MEAN AGE ± SD (YEARS)
Males	129	69.7	48.53 ± 8.66
Females	56	30.3	48.36 ± 9.15
Total	185	100.0	48.48 ± 8.78

Table 2: Overall results of ultrasonography and MRI findings for the diagnosis of in detecting rotator cuff tears

Rotator Cuff Tears	Ultrasound Findings	MRI Findings
Positive	136 (73.5%)	133 (71.9%)
Negative	49 (26.5%)	52 (28.1%)
Total	185 (100%)	185 (100%)

Table 3: Diagnostic accuracy of ultrasonography for diagnosis of rotator cuff tears keeping MRI findings as gold standard

Rotator Cuff Tears on Ultrasonography	Rotator Cuff Tears on MRI		
	POSITIVE	NEGATIVE	TOTAL
POSITIVE	123 (66.5%) (True Positives)	13 (7.0%) (False Positives)	136 (73.5%)
NEGATIVE	10 (5.4%) (False Negatives)	39 (21.1%) (True Negatives)	49 (26.5%)
Total	133 (71.9%)	52 (28.1%)	185 (100.0%)

Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
92.5	75.0	87.6	90.4	79.6

PPV: Positive Predictive Value, NPV: Negative Predictive Value

Table 4: Diagnostic accuracy of ultrasonography for diagnosis of rotator cuff tears keeping MRI findings as gold standard (stratification analysis for study confounders)

Study Confounders	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Gender					
Male	93.8%	81.8%	93.8%	81.8%	90.7%
Female	89.2%	63.2%	82.5%	75.0%	80.4%
Age Groups					
<45 Years	92.3%	66.7%	90.6%	71.4%	86.6%
45-60 Years	92.4%	85.7%	93.8%	82.8%	90.4%
>60 Years	93.3%	55.6%	77.8%	83.3%	79.2%
Duration of Symptoms					
Upto 30 Days	94.3%	76.0%	91.7%	82.6%	89.5%
>30 Days	90.5%	74.1%	89.1%	76.9%	85.6%

PPV: Positive Predictive Value, NPV: Negative Predictive Value.

DISCUSSION

Findings of our study indicated that ultrasound is a highly sensitivity diagnostic modality for identifying rotator cuff tears relative to MRI, the gold standard, although with intermediate specificity (75.0%) and an overall accuracy of 87.6%. These findings correspond with recent studies, while highlighting clinically significant differences among demographic and clinical subgroups that require thorough examination. The higher sensitivity indicates that ultrasound is highly effective for excluding rotator cuff pathologies, rendering it an optimal first-line imaging technique, particularly in resource-limited environments. The intermediate specificity suggests limitations in verifying tears, possibly due to difficulties in distinguishing partial-thickness tears or tendinosis from full-thickness tears during ultrasound assessment. This diagnostic performance feature reflects current meta-analyses and emphasizes the ongoing significance of MRI for conclusive diagnosis in circumstances where surgical intervention is contemplated. ,

Our findings align with several global and local studies that have shown the superior diagnostic efficacy of ultrasound in evaluating rotator cuff injuries. In a comprehensive study by Rutten et al., ultrasound (USG) identified 95% of full-thickness and 89% of partial-thickness tears, closely aligning with MRI results, showing no statistically significant difference (p=0.15), thereby confirming the equivalent diagnostic efficacy of both techniques for rotator cuff assessment. Soundararajan et al. documented a sensitivity of 76.92% and specificity of 85.71% for ultrasound, which, although marginally lower than our results, underscored the efficacy of high-resolution ultrasound in standard evaluations, particularly in identifying supraspinatus and subscapularis involvement. Rana et al. similarly reported a sensitivity of 91%, specificity of 87%, and a positive predictive value of 95% for ultrasound compared to MRI, closely matching with our findings and further validating the role of ultrasound in clinical decision-making.

Our stratified findings by gender, age, and illness duration enhance the existing research.

Our study revealed a greater diagnosis accuracy in males (90.7%) compared to females (80.4%). This may pertain to anatomical or operator-related variances during ultrasound exams. Prior research has not uniformly investigated stratified accuracy discrepancies; nevertheless, Naqvi et al. highlighted the significance of operator expertise in ultrasound interpretation, noting an accuracy of 88% for ultrasound versus 89% for MRI.

Naseem et al. (2025) similarly demonstrated that ultrasound (USG) exhibits exceptional sensitivity (94%) and specificity (91%), indicating that in some contexts, USG may approximate the diagnostic accuracy of MRI.

Our maximum accuracy for age was observed in the 45–60 years age group (90.4%), perhaps due to excellent visibility and a reduction in confounding degenerative alterations. Conversely, diagnostic performance diminished in individuals over 60 years (accuracy: 79.2%), presumably due to more intricate age-related alterations, a conclusion corroborated by the Cochrane review by Lenza et al., which indicated significant variability and heterogeneity in sensitivity and specificity across different age groups and patient demographics.

The duration of symptoms also affected diagnostic values. Patients exhibiting symptoms for ≤30 days demonstrated superior sensitivity (94.3%) and accuracy (89.5%) relative to those with prolonged symptom durations (sensitivity 90.5%, accuracy 85.6%). Acute inflammation and distinct soft tissue planes in the early stages of the disease likely enhance sonographic visibility. Kaveti et al. similarly proposed that ultrasonography (USG) is superior in assessing full-thickness and acute rips, particularly in the supraspinatus, with a near-perfect correlation for specific tear types (κ=0.94). The precision of ultrasound enhances with the operator's experience. Iossifidis et al. revealed that orthopedic surgeons could attain exceptional diagnostic performance, with sensitivity and specificity increasing from 86% to 95% and 92% to 98%, respectively, following sufficient training. This underscores the efficacy of USG as a dependable front-line instrument when analyzed by seasoned doctors.

Ultimately, various investigations, including those conducted by Elmorsy et al. and Apostolopoulos et al., determined that although ultrasonography (USG) may exhibit marginally lower sensitivity than magnetic resonance imaging (MRI) for partial-thickness tears, its cost-effectiveness, portability, and capacity to provide dynamic assessments warrant its designation as the primary diagnostic tool.

The findings are reinforced by several methodological features, including the prospective research design, blinded radiological evaluations, and sequential patient recruitment, which reduced selection bias. Nevertheless, specific limitations must be recognized, including the study's single-center design, which may influence generalizability, and the absence of assessment of inter-observer variability in ultrasound interpretation. The study also failed to evaluate partial-thickness tears independently, which are recognized as a problem in ultrasonography diagnosis and may have influenced the identified limitations in specificity. Future research paths must encompass multicenter validation studies, evaluations of the cost-effectiveness of ultrasound-first diagnostic protocols, and investigations into how tear features (size, chronicity, and location) affect the diagnostic efficacy of ultrasound.

This study offers compelling evidence that ultrasonography is an effective first-line imaging technique for rotator cuff disease, especially due to its high sensitivity and accessibility. Clinicians must be aware of its limits, particularly in some patient subgroups when diagnostic confidence may diminish. These findings support a nuanced, patient-specific strategy for shoulder imaging, wherein ultrasound functions as an effective screening modality, but MRI maintains a crucial role in definitive diagnosis, especially for surgery planning or in complex diagnostic scenarios. The results highlight the necessity of combining clinical judgment with imaging results and taking into account individual patient characteristics when determining diagnostic approaches for suspected rotator cuff tears.

CONCLUSIONS

Our research, consistent with current literature, validates that ultrasonography is an efficient primary method for detecting rotator cuff tears (RCT) owing to its superior sensitivity, accessibility, and cost-efficiency. Nonetheless, its moderate specificity, especially in elderly patients, females, and chronic cases, requires careful application, with MRI designated for

confirmation diagnosis. With an overall accuracy around 88%, ultrasound should be regarded as a dependable, economical, and accessible alternative to MRI, especially for preliminary screening. Nonetheless, MRI is essential for thorough evaluation and preoperative strategizing in intricate or ambiguous situations. Future study should concentrate on standardizing ultrasound methods and assessing the influence of operator proficiency to reduce diagnostic variability.

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