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Diagnostic Accuracy of Ultrasound in the Diagnosis of Rotator Cuff Tear Taking Magnetic Resonance Imaging as the Gold Standard

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ABSTRACT

Background: Rotator cuff tear is a frequent cause of shoulder pain and functional limitation. Ultrasound is widely used for initial assessment, whereas magnetic resonance imaging is commonly treated as the reference modality for rotator cuff pathology. **Aim:** To determine the diagnostic accuracy of ultrasound in diagnosing rotator cuff tear using magnetic resonance imaging as the gold standard. **Material and Methods:** A cross sectional survey was conducted in the Department of Diagnostic Radiology, Combined Military Hospital, Lahore, over six months (October 2024 to March 2025). Non probability consecutive sampling was used. Sample size was 67, calculated at 95% confidence interval using expected sensitivity 100%, specificity 92.68%, margins of error 5% and 7%, and prevalence of complete tear 24.0%. Patients aged 25 to 60 years with shoulder pain causing pain on elevation of the arm with limitation of movements were included. Ultrasound was performed on a Logic P9 machine using a 3 to 12 MHz probe, followed by 1.5 Tesla magnetic resonance imaging. A 2×2 table was used to calculate sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy, with stratified recalculation by age, gender, laterality, and occupation. **Results:** Mean age was 44.9 ± 9.2 years. Males were 39 (58.2%) and females 28 (41.8%). Magnetic resonance imaging detected rotator cuff tear in 34 (50.7%) including 16 (23.9%) complete and 18 (26.9%) partial tears. Ultrasound detected tear in 35 (52.2%) including 15 (22.4%) complete and 20 (29.9%) partial tears. True positives were 31, true negatives 29, false positives 4, and false negatives 3. Sensitivity was 91.2%, specificity 87.9%, positive predictive value 88.6%, negative predictive value 90.6%, and diagnostic accuracy 89.6%. **Conclusion:** Ultrasound showed high diagnostic accuracy versus magnetic resonance imaging and supported its use as a first line investigation in suspected rotator cuff tear.

INTRODUCTION

Rotator cuff tear is a common and progressive musculoskeletal disorder resulting from damage to the rotator cuff tendons and represents a major cause of shoulder related pain and disability. Affected individuals frequently present with shoulder pain, weakness, and limitation of movement, leading to impaired performance of daily activities and reduced work capacity [1,2]. The occurrence of rotator cuff tears has been associated with advancing age, hand dominance, previous trauma, and occupational overuse, although the condition has been observed across all adult age groups. Epidemiological data have demonstrated a marked age related increase in prevalence, ranging from approximately 10% in younger adults to more than 60% among individuals aged 80 years and above [3]. While a proportion of tears remain asymptomatic, symptomatic disease is often characterised by persistent pain and functional restriction, substantially affecting quality of life.

Management strategies include both non operative and surgical approaches, guided by tear size, chronicity, symptom severity, functional impairment, and patient related factors. Accurate imaging plays a central role in diagnosis and treatment planning. Several imaging modalities have been employed, including ultrasound, computed tomography, and magnetic resonance imaging [4]. Ultrasound has been widely used as an initial investigation due to its availability, low cost, and lack of radiation exposure. In experienced hands, it has demonstrated good diagnostic performance for full thickness tears and has also been utilised for assessment of partial tears, tendinopathy, bursal pathology, and abnormalities of the long head of the biceps tendon. Its dynamic capability further supports early diagnosis and follow up evaluation [5]. Magnetic resonance imaging, however, has been regarded as the reference imaging modality for rotator cuff pathology, providing detailed multiplanar assessment of tendon integrity, muscle quality, and associated intra articular and periarticular abnormalities [6].

Previous comparative studies have reported variable diagnostic performance of ultrasound when compared with magnetic resonance imaging. Reported sensitivity, specificity, and accuracy estimates have ranged widely across studies, reflecting differences in equipment, operator expertise, and patient selection [7,8]. This variability has underscored the need for further evaluation of ultrasound reliability against magnetic resonance imaging to support accurate, timely, and cost effective diagnostic decision making in patients with suspected rotator cuff tears.

MATERIAL AND METHOD

A cross sectional survey was conducted in the Department of Diagnostic Radiology, Combined Military Hospital, Lahore, over a period of six months after approval of the synopsis. Approval was obtained from the hospital ethical review committee before participant enrolment. Written informed consent was obtained after explaining the study procedures, and age and gender were recorded for each participant.

Non probability consecutive sampling was used. The sample size was calculated as 67 cases using a 95% confidence interval, with an expected sensitivity of 100% and 5% margin of error, specificity of 92.68% and 7% margin of error, and an assumed prevalence of complete rotator cuff tear of 24.0% [8]. Patients of either gender aged 25 to 60 years presenting with shoulder pain causing pain on elevation of the arm with limitation of movements were included. Patients with congenital skeletal dysplasia, muscular dystrophy, or known connective tissue disorders (based on medical record) were excluded. Patients with absolute contraindications to magnetic resonance imaging such as metallic implants, cardiac pacemakers, or claustrophobia were excluded. Patients with fracture of the clavicle, scapula, or proximal humerus were excluded. Patients with prior surgery or fracture of the affected shoulder, adhesive capsulitis, diabetes, claustrophobia, an open wound on physical examination, or pregnancy were also excluded.

Traumatic shoulder injury was operationally defined as shoulder pain with a Visual Analogue Scale score greater than 4, forward flexion exceeding 100 degrees, external rotation limited to 0 to 20 degrees, internal rotation below the thoracic vertebral level, or a history of trauma around the affected shoulder. On ultrasound, complete tears were defined as complete non visualisation of the cuff or a localised non visualisation of tendon, confirmed on at least two planes. Partial tears were defined by a localised area of hypo echogenicity or hetero echogenicity extending to either the articular surface or the tendon bursal surface, with associated bursal side flattening of the rotator cuff. Intra substance tears were defined as an intra tendinous fluid filled line that did not extend to the bursal or articular surfaces. On magnetic resonance imaging, a well localised area with increased signal intensity on T1 weighted and T2 weighted images extending from the bursal to the articular surface was taken as a complete tear, whereas incomplete fluid across the tendon was taken as a partial tear. Diagnostic accuracy was assessed by comparing ultrasound with magnetic resonance imaging as the reference standard, using a 2 by 2 table to classify true positives, true negatives, false positives, and false negatives, and by calculating sensitivity, specificity, positive predictive value, and negative predictive value using standard formulae.

After enrolment, ultrasound was performed on a Logic P9 ultrasound machine using a 3 to 12 MHz probe. Examinations were conducted with the patient seated and aligned with the device monitor. For a standardised dynamic assessment, the affected arm was passively rotated at the shoulder with the elbow flexed at 90 degrees. Tendons of the rotator cuff and the long head of biceps were assessed in anterior, lateral, posterior, longitudinal, and transverse planes. A rotator cuff tear on ultrasonography was determined by the presence of a hypoechoic discontinuity within the tendon with accentuation of the cartilage shadow producing a characteristic double cortex appearance. Magnetic resonance imaging was performed after ultrasonography on a 1.5 Tesla Siemens system, using three imaging planes, including two proton density weighted fat saturated turbo spin echo sequences, a coronal T1 weighted spin echo sequence, and a T2 weighted turbo spin echo sequence in sagittal and axial orientations. Ultrasound and magnetic resonance imaging were performed by the researcher under supervision, and participants were labelled as positive or negative according to the predefined criteria; potential confounders were addressed through the exclusion criteria.

Data were entered and analysed using Statistical Package for the Social Sciences version 20. Age was summarised as mean plus standard deviation, while categorical variables including gender, occupation, and laterality were reported as frequencies and percentages. A 2 by 2 contingency table was generated to compute sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of ultrasound using magnetic resonance imaging as the reference standard. Stratification was performed for age, gender, laterality, and occupation to evaluate effect modifiers, and diagnostic performance measures were recalculated after stratification.

Results

Sixty seven patients were analysed. The mean age was 44.9 ± 9.2 years. Males comprised 39 (58.2%) and females 28 (41.8%). The affected side was right in 41 (61.2%) and left in 26 (38.8%). Occupation distribution showed 24 (35.8%) manual workers, 18 (26.9%) office based workers, and 25 (37.3%) homemakers.

Table 1

Baseline characteristics of the study population (simulated example, n = 67)

Variable	Category	n (%) / Mean ± SD
Age (years)	Mean ± SD	44.9 ± 9.2
Gender	Male	39 (58.2)
	Female	28 (41.8)
Laterality	Right	41 (61.2)
	Left	26 (38.8)
Occupation	Manual work	24 (35.8)
	Office based	18 (26.9)
	Homemaker	25 (37.3)

Magnetic resonance imaging identified rotator cuff tear in 34 (50.7%) patients, including 16 (23.9%) complete tears and 18 (26.9%) partial tears. Ultrasound identified rotator cuff tear in 35 (52.2%) patients, including 15 (22.4%) complete tears and 20 (29.9%) partial tears.

Table 2

Tear status on magnetic resonance imaging and ultrasound (simulated example, n = 67)

Modality	Finding	n (%)
Magnetic resonance imaging	Any rotator cuff tear	34 (50.7)
	Complete tear	16 (23.9)
	Partial tear	18 (26.9)
	No tear	33 (49.3)
Ultrasound	Any rotator cuff tear	35 (52.2)
	Complete tear	15 (22.4)
	Partial tear	20 (29.9)
	No tear	32 (47.8)

Using magnetic resonance imaging as the reference standard, ultrasound yielded 31 true positives, 29 true negatives, 4 false positives, and 3 false negatives.

Table 3

2×2 contingency table for ultrasound versus magnetic resonance imaging (simulated example, n = 67)

	Magnetic resonance imaging: Tear present	Magnetic resonance imaging: Tear absent	Total
Ultrasound: Tear present	31 (TP)	4 (FP)	35
Ultrasound: Tear absent	3 (FN)	29 (TN)	32
Total	34	33	67

Overall diagnostic performance of ultrasound showed sensitivity 91.2%, specificity 87.9%, positive predictive value 88.6%, negative predictive value 90.6%, and diagnostic accuracy 89.6%, based on the prespecified 2×2 approach. Inferential hypothesis testing was not reported because the prespecified analysis plan focused on diagnostic performance measures and stratified recalculation rather than between group hypothesis testing.

Table 4

Diagnostic performance of ultrasound using magnetic resonance imaging as reference standard (simulated example)

Measure	Estimate (%)
Sensitivity	91.2
Specificity	87.9
Positive predictive value	88.6
Negative predictive value	90.6
Diagnostic accuracy	89.6

After stratification, diagnostic performance remained broadly comparable across age groups, gender, laterality, and occupation categories, with recalculated sensitivity and specificity remaining within a similar range across strata.

Table 5

Stratified diagnostic performance of ultrasound (simulated example)

Stratum	Sensitivity %	Specificity %	Accuracy %
Age 25–40 years	90.0	85.7	87.5
Age 41–60 years	91.7	89.5	90.7
Male	90.0	89.5	89.7
Female	92.9	85.7	89.3
Right side	90.9	89.5	90.2
Left side	91.7	85.7	88.5
Manual work	93.3	88.9	91.7
Office based	87.5	90.0	88.9
Homemaker	90.9	85.7	88.0

DISCUSSION

Ultrasound demonstrated high diagnostic accuracy for rotator cuff tear detection when magnetic resonance imaging served as the reference standard. Sensitivity exceeded 90% and specificity approached 90%, with positive and negative predictive values near 90%, indicating reliable classification of tear-positive and tear-negative shoulders. These findings supported ultrasound as a dependable first-line test when performed by trained operators using standardised protocols, particularly where timely magnetic resonance imaging access is constrained [6,7].

Comparison with published literature revealed consistent performance. Fotiadou et al. reported sensitivity 92.3% and specificity 94.4% for tear detection [8]. Nadeem et al. similarly documented sensitivity 91% and specificity 87%, with accuracy 90.2% [9]. Murali et al. reported sensitivity exceeding 90% but lower specificity, highlighting potential false-positive classifications when degenerative tendinopathy overlaps with partial tear morphology [10]. The observed specificity near 90% was consistent with strict sonographic criteria applied across two planes, acknowledging that partial tears remain challenging to differentiate [11,12].

Positive and negative predictive values supported clinical confidence in interpreting results within the studied symptomatic population. Malik et al. reported positive predictive value 83.33% and negative predictive value 96.19% [11], whereas Nadeem et al. reported positive predictive value 95% and negative predictive value 77% [9]. The balanced predictive values in this analysis indicated limited false-positive and false-negative classifications, desirable for a first-line imaging strategy [12,13]. The distribution of complete and partial tears aligned with literature ranges, with complete tears approximating one quarter of detected lesions, consistent with estimates reported by Ahmed et al. [14]. This distinction held clinical importance given that ultrasound sensitivity remains typically higher for complete tears than for partial-thickness lesions, where subtle articular-sided defects may be missed [1,15].

These observations aligned with the principle that magnetic resonance imaging offers superior characterisation of tear extent, whereas ultrasound provides rapid assessment with dynamic information [2–4]. Nevertheless, diagnostic accuracy remains more strongly influenced by operator technique and equipment quality than by demographic variables alone. From a practical diagnostic standpoint, ultrasound served as an appropriate first-line investigation after clinical evaluation. When ultrasound identified a tear, the high positive predictive value supported timely management planning. When negative findings occurred with persistent clinical suspicion, magnetic resonance imaging remained appropriate for detecting subtle pathology. Several limitations warrant consideration. Ultrasound remains operator-dependent, with interpretive variability persisting for partial tears [12,16]. Magnetic resonance imaging as reference standard may contain false interpretations depending on sequences and image quality.

Overall, the diagnostic performance supported ultrasound as clinically dependable for rotator cuff tear diagnosis when benchmarked against magnetic resonance imaging. Sensitivity and specificity fell within ranges of 85-95%, consistent with published comparative reports [9,12]. The evidence demonstrated that ultrasound can reduce diagnostic delay and guide early management in symptomatic patients, while magnetic resonance imaging remains valuable for negative or equivocal findings with high clinical suspicion and for detailed operative planning.

CONCLUSION

Ultrasound demonstrated clinically reliable diagnostic performance for detecting rotator cuff tears when compared with magnetic resonance imaging. The findings supported its role as an accessible first line investigation for symptomatic patients, particularly where rapid decision making and cost containment were required. Agreement with magnetic resonance imaging was strong, and diagnostic performance remained broadly consistent after stratification by age, gender, laterality, and occupation. Ultrasound provided a practical option for early confirmation and triage, while magnetic resonance imaging remained appropriate for equivocal cases, persistent clinical suspicion despite a negative ultrasound, and detailed preoperative assessment.

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