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ORIGINAL ARTICLE

Sonographic evaluation of rotator cuff muscles injuries keeping MRI shoulder as gold standard.

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ABSTRACT… Objective: To evaluate the diagnostic performance of ultrasonography (USG) compared to magnetic resonance imaging (MRI) in diagnosing rotator cuff muscles injuries. **Study Design:** Cross-sectional, Validation study. **Setting:** Department of Radiology, Combined Military Hospital (CMH), Gujranwala, Pakistan. **Period:** April 2023 to September 2024. **Methods:** A total of 91 patients aged 18 to 75 years, referred for imaging due to clinical suspicion of rotator cuff muscle injury were analyzed. All patients underwent shoulder USG, as well as MRI within a two-week interval, and findings were compared. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of USG were calculated using MRI findings as the reference standard. Concordance between USG and MRI findings was assessed using Cohen's kappa coefficient (κ). A p-value < 0.05 was considered significant. **Results:** Among the 91 patients, 48 (52.7%) were female. The mean age was 48.85 ± 14.85 years. USG analyzing full-thickness rotator cuff tears demonstrated sensitivity, specificity, PPV, NPV, and diagnostic accuracy of 68.4%, 97.2%, 86.7%, 92.1%, and 91.2%, respectively, with substantial agreement ($\kappa=0.712$, $p<0.001$). For partial-thickness rotator cuff tears, USG showed sensitivity, specificity, PPV, NPV, and diagnostic accuracy of 89.7%, 90.3%, 81.3%, 94.9%, 90.1%, respectively, with substantial agreement ($\kappa=0.778$; $p<0.001$).USG detecting rotator cuff tendinopathy, yielding a sensitivity, specificity, PPV, NPV, and diagnostic accuracy of 96.2%, 96.9%, 92.6%, 98.4%, 96.7%, respectively, with very substantial agreement ($\kappa=0.920$; $p<0.001$). **Conclusion:** This study demonstrated high-resolution ultrasound as a reliable and effective modality for diagnosing rotator cuff muscle injuries.

Key words: Magnetic Resonance Imaging, Radiology, Rotator Cuff, Tendinopathy, Ultrasonography.

INTRODUCTION

Rotator cuff muscle injuries (RCMIs) are one of the leading causes of shoulder pain and disability, especially among middle-aged and elderly populations, athletes, and those performing repetitive overhead activity.[1] RCMIs account for approximately 30-70% of all shoulder pain complaints in adults.[2,3] Data have shown that "partial-thickness rotator cuff tears (PTRCTs)" or "full-thickness rotator cuff tears (FTRCTs)" are present in over 40% of people over the age of 60.[4,5]

"Magnetic resonance imaging (MRI)" is considered the gold standard due to its excellent soft tissue resolution.[6] High cost related to MRI, limited availability, and longer scan times, especially in resource-constrained settings like Pakistan. Ultrasound (USG) is increasingly being used as a 1st line modality because of the affordability, availability, and non-invasive nature.[7] USG allows dynamic assessment and comparison with the contralateral side in real time, making it an attractive tool in evaluating RCMIs.[8] International studies report that USG has a sensitivity of 84-96% and specificity of 90–98% for FTRCTs, depending on the operator's expertise. In clinical settings, timely and accurate diagnosis of these injuries is crucial for determining appropriate treatment plans, whether conservative or surgical.

USG is an affordable, non-invasive, and widely available modality that allows dynamic assessment of the shoulder. The diagnostic performance of USG is operator-dependent and remains underutilized in many clinical settings.

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This study was therefore undertaken to evaluate the diagnostic utility of USG compared to MRI in detecting RCMIs, aiming to determine whether USG can serve as a reliable initial imaging tool, particularly in settings with limited access to advanced imaging technologies like MRI. This study aimed to evaluate the diagnostic performance of USG compared to MRI in diagnosing RCMIs.

METHODS

This cross-sectional, validation study was conducted at the Department of Radiology, Combined Military Hospital (CMH), Gujranwala, Pakistan, during April 2023 to September 2024. Ethical approval was obtained from the "Institutional Ethical Committee" (ERB NO. 26-2023, dated: 22-02-2023). Using online sample size calculator OpenEPI, a sample size of 91 was calculated taking the expected sensitivity of USG in diagnosing FTRCTs as 93.7% taking MRI findings as the reference[10], with 95% confidence level and 5% margin of error. Non-probability, consecutive sampling technique was adopted. Inclusion criteria were patients of any gender, aged 18 to 75 years, referred for imaging due to clinical suspicion of RCMI, based on symptoms such as shoulder pain, weakness, or limited range of motion. Informed and written consents were obtained from all patients. Patients with a history of recent shoulder trauma (within the past six weeks), prior shoulder surgery, or congenital shoulder abnormalities were excluded. Patients with known inflammatory arthritis, malignancies involving the shoulder region, or incomplete imaging data were also excluded.

All enrolled patients underwent shoulder USG, as well as MRI within a two-week interval to avoid changes in pathology between studies. USG examinations were performed by an experienced radiologist. Standard sonographic criteria were used to assess rotator cuff integrity, including evaluation for tendon thickness, echotexture, continuity, and the presence of fluid-filled gaps or retraction. FTRCT was labeled as complete discontinuity of tendon fibers with/without retraction and fluid accumulation. PTRCT was described as a focal hypoechoic or anechoic defect involving either the bursal or articular surface without complete disruption. Tendinopathy was labeled when there was heterogeneous echotexture and increased tendon thickness without fiber discontinuity. MRI examinations were performed using a dedicated shoulder coil. Standard imaging sequences were employing for MRI. Interpretation of MRI was carried out by a separate senior radiologist who was blinded to the USG findings. A FTRCT on MRI was defined as a complete discontinuity of tendon fibers with or without tendon retraction and associated fluid signal intensity on T2-weighted images. The PTRCTs were identified as focal hyperintense signals in the tendon substance on fluid-sensitive sequences without complete fiber disruption. Tendinopathy was diagnosed based on thickened tendons with intermediate T1 and T2 signal changes and lack of full-thickness disruption. All findings from both imaging modalities were recorded in structured data sheets and subsequently compared.

Statistical analysis was performed using "IBM-SPSS Statistics, version 26.0". Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of USG were calculated using MRI findings as the reference standard. Concordance between USG and MRI findings was assessed using Cohen's kappa coefficient (K). "Receiver operating characteristic (ROC) curve" analysis was performed to determine "area under the curve (AUC)" with 95% confidence interval (CI). A p-value < 0.05 was considered significant.

RESULTS

Among the 91 patients, 48 (52.7%) were female. The mean age was 48.85±14.85 years, while there were 56 (61.5%) patients who were aged between 46-75 years. The most frequently reported presenting symptom was limited range of motion, noted in 64 patients (70.3%), followed by weakness in 58 (63.7%), and pain 56 (61.5%), as shown in Table-I.

Charactristics		Frequency (%)
Gender	Male	43 (47.3%)
	Female	48 (52.7%)
Age groups	18-45	35 (38.5%)
	46-75	56 (61.5%)
Frequency of presenting symptoms	Limited range of motion	64 (70.3%)
	Weakness	58 (63.7%)
	Pain	56 (61.5%)

Table-I. Characteristics of patients (n=91)

USG demonstrated good diagnostic performance for detecting FTRCTs when compared with MRI, with a sensitivity of 68.4%, specificity of 97.2%, PPV of 86.7%, NPV of 92.1%, and overall diagnostic accuracy of 91.2% (κ=0.712, p<0.001). For PTRCTs, USG showed higher diagnostic performance, with a sensitivity of 89.7%, specificity of 90.3%, PPV of 81.3%, NPV of 94.9%, and diagnostic accuracy of 90.1%. Substantial agreement with MRI was observed (κ=0.778; p<0.001).USG detecting rotator cuff tendinopathy yielded a sensitivity of 96.2%, specificity of 96.9%, PPV of 92.6%, NPV of 98.4%, and diagnostic accuracy of 96.7% (κ=0.920; p<0.001). Details about the diagnostic evaluation of RCMIs with USG keeping MRI findings as gold standard are shown in Table-II.

According to ROC curve, the AUC for USG in identifying FTRCTs was 0.828 (95% CI, 0.698–0.958; p<0.001), as shown in Figure-1.

According to ROC curve, the AUC for USG in identifying PTRCTs was 0.900 (95% CI, 0.823–0.977; p<0.001), as shown in Figure-2.

According to ROC curve, the AUC for USG in identifying tendinopathy was 0.965 (95% CI, 0.916–1.00; p<0.001), as shown in Figure-3.

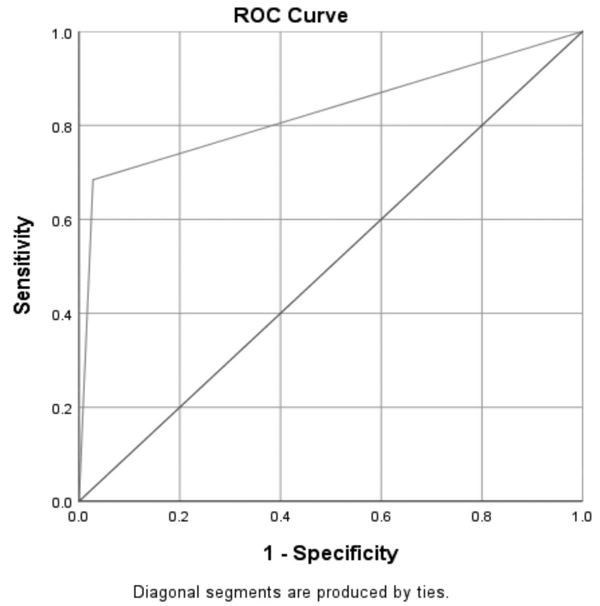

Figure-1. ROC curve analysis for diagnostic utility of ultrasound in identifying full-thickness tears

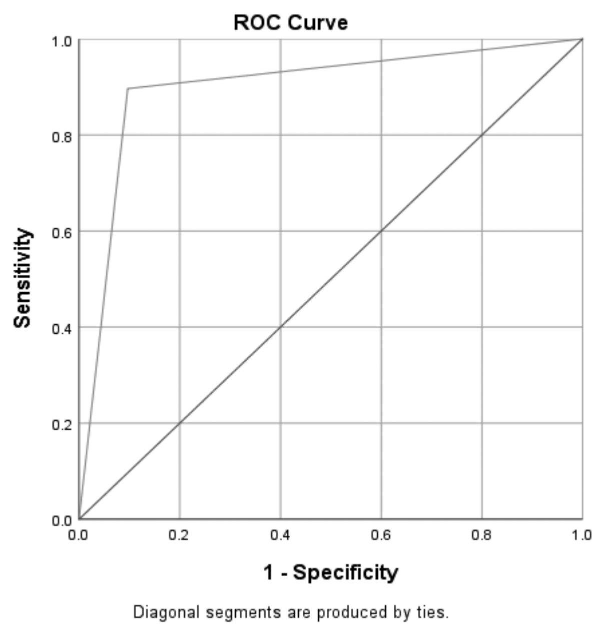

Figure-2. ROC curve analysis for diagnostic utility of ultrasound in identifying partial-thickness tears

Diagnosis	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	Cohen's Kappa Coefficient	P-Value
Full-thickness trear	68.4%	97.2%	86.7%	92.1%	91.2%	0.712	<0.001
Partial-thickness tear	89.7%	90.3%	81.3%	94.9%	90.1%	0.778	<0.001
Tendinopathy	96.2%	96.9%	92.6%	98.4%	96.7%	0.920	<0.001

Table-II. Diagnostic evaluation of rotator cuff muscles injuries with ultrasound keeping MRI findings as gold standard

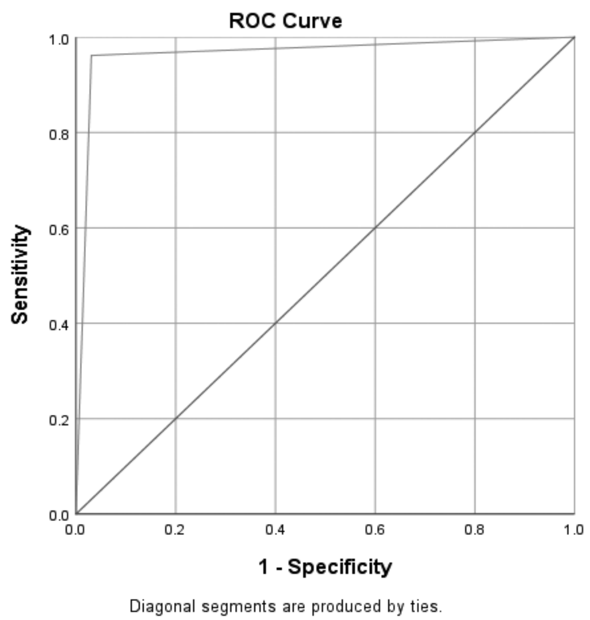

Figure-3. ROC curve analysis for diagnostic utility of ultrasound in identifying tendinopathy

DISCUSSION

This study demonstrated that SG, when compared with MRI, performed well as a diagnostic tool for evaluating RCMIs. Khan et al.[11], stated that USG showed a sensitivity of 83.3% and specificity of 96.4% for FTRCTs, closely aligning with the specificity observed in the current study (97.2%), although sensitivity in the present study was slightly lower (68.4%). The lower sensitivity may reflect operator-related variability or differences in tear size distribution. For PTRCTs, Khan et al.[11], reported a sensitivity of 65.22% and specificity of 88.24%, which were both lower than those reported here (89.7% and 90.3%, respectively), indicating a potentially better diagnostic performance in the present setting, possibly due to equipment resolution or greater operator expertise. Nunna et al.[12], in a study conducted in Central India, also evaluated USG versus MRI and found near-perfect agreement for complete tears and moderate agreement for PTRCTs. Their findings emphasized that although USG is less sensitive for PTRCTs, it performs very well in detecting complete tears, a conclusion that corresponds with the high specificity and PPV seen for FTRCTs in the present data. Selvaraj et al.[13], reported diagnostic accuracy of USG in detecting supraspinatus tears to be 93% with a specificity of 97%, which is nearly identical to the specificity seen in this study, supporting the robustness of USG for evaluating supraspinatus integrity.

Mourad et al.[14], reported very high sensitivity (96.6%) and specificity (100%) of USG for RCMIs, showing 98.3% diagnostic accuracy, which is relatively higher than what this study revealed, likely due to smaller sample size (n=30) or selection bias favoring more obvious tears. Naganna et al.[15], reported 100% sensitivity and 96.4% specificity for FTRCTs, but significantly lower sensitivity (58.3%) for PTRCTs, reinforcing the established notion that FTRCTs are easier to identify via USG, while PTRCTs are more prone to underdiagnosis. Farooqi et al.[16], analyzing over 2000 shoulders found that USG had a higher median accuracy (0.93) for FTRCTs compared to PTRCTs (0.81). The present study findings, particularly the AUC values and diagnostic accuracy across all three categories of pathology, are in agreement with these summary statistics. This consistency affirms that USG can approach MRI in diagnostic performance under ideal conditions, particularly when performed by experienced radiologists.[17,18]

The present study's findings have critical clinical implications. The diagnostic accuracy of USG across all categories, especially tendinopathy and PTRCTs, supports its role as an important imaging modality in these patients.[19,20] Given its cost-effectiveness, portability, and ability to perform dynamic assessments in real-time, USG is particularly suited to resource limited settings, where access to MRI may be limited due to financial or logistical constraints. The high NPV for all three pathologies implies that a negative USG scan could reliably rule out clinically significant pathology in many cases, thereby reducing unnecessary referrals for MRI. The findings of this study may influence imaging protocols and clinical decision-making pathways, particularly where resources are constrained.

Several factors may account for the high diagnostic performance observed in this study. The study utilized a standardized imaging protocol with high-frequency linear transducers and was conducted by experienced radiologists, reducing inter-operator variability. The MRI interpretation was blinded and conducted independently to avoid bias. The inclusion criteria ensured a clinically relevant population, all presenting with shoulder symptoms and undergoing both imaging modalities within a two-week window to avoid temporal changes in pathology. The study did not include arthroscopy as a reference standard, which is considered the most definitive diagnostic tool for RCMI. Although, MRI is widely accepted as the gold standard, minor pathologies or early tendinopathy might still be underestimated. The study excluded patients with prior surgery, acute trauma, or inflammatory arthritis, which could be relevant subpopulations in broader clinical practice.

CONCLUSION
This study demonstrated high-resolution USG as a reliable and effective modality for diagnosing RCMIs. In resource-limited settings such as Pakistan, incorporating musculoskeletal USG into the diagnostic algorithm for shoulder pain can enhance access to timely care, reduce healthcare costs, and streamline patient management. Continued efforts are needed to ensure training, standardization of imaging protocols, and access to quality USG equipment to maximize the diagnostic potential of this modality.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

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REFERENCES
1. Akhtar A, Richards J, Monga P. **The biomechanics of the rotator cuff in health and disease - A narrative review.** J Clin Orthop Trauma. 2021; 18:150-56. doi: 10.1016/j.jcot.2021.04.019.
2. Zhao J, Zeng L, Liang G, Luo M, Yang W, Liu J, et al. **Risk factors for symptomatic rotator cuff tears: A retrospective case-control study.** Front Med (Lausanne). 2024; 10:1321939. doi: 10.3389/fmed.2023.1321939
3. Millett PJ, Horan MP, Maland KE, Hawkins RJ. **Long-term survivorship and outcomes after surgical repair of full-thickness rotator cuff tears.** J Shoulder Elbow Surg. 2011; 20(4):591-7. doi: 10.1016/j.jse.2010.11.019
4. Lawrence RL, Moutzouros V, Bey MJ. **Asymptomatic rotator cuff tears.** JBJS Rev. 2019; 7(6):e9. doi: 10.2106/JBJS.RVW.18.00149
5. Yamamoto A, Takagishi K, Osawa T, Yanagawa T, Nakajima D, Shitara H, et al. **Prevalence and risk factors of a rotator cuff tear in the general population.** J Shoulder Elbow Surg. 2010; 19(1):116-20. doi: 10.1016/j.jse.2009.04.006
6. Duy HN, Tam NT, Khanh HD, Thi NV, Minh Duc N. **Diagnostic performance of magnetic resonance imaging in discriminating benign and malignant soft tissue tumors.** Int J Gen Med. 2023; 16:1383-91. doi: 10.2147/IJGM.S408962
7. Teichgräber U, Ingwersen M, Ehlers C, Mentzel HJ, Redies C, Stallmach A, et al. **Integration of ultrasonography training into undergraduate medical education: catch up with professional needs.** Insights Imaging. 2022; 13(1):150. doi: 10.1186/s13244-022-01296-3
8. Madhavi P, Patil P. **Diagnostic accuracy of USG and MRI for the detection of rotator cuff injury.** Cureus. 2024; 16(8):e68199. doi: 10.7759/cureus.68199
9. Sambandam SN, Khanna V, Gul A, Mounasamy V. **Rotator cuff tears: An evidence based approach.** World J Orthop. 2015 Dec 18; 6(11):902-18. doi: 10.5312/wjo.v6.i11.902
10. Aminzadeh B, Najafi S, Moradi A, Abbasi B, Farrokh D, Emadzadeh M. **Evaluation of diagnostic precision of ultrasound for rotator cuff disorders in patients with shoulder pain.** Arch Bone Jt Surg. 2020; 8(6):689-95. doi: 10.22038/abjs.2020.42894.2166
11. Khan Z, Khanduri S, Rohit, Ansari D, Mulani M, Habib A, et al. **Ultrasound evaluation of rotator cuff injuries & their correlation with magnetic resonance imaging.** Int J Pharmaceut Clin Res. 2024; 16(9):679-86. Available from: https://impactfactor.org/PDF/IJPCR/16/IJPCR,Vol16,Issue9,Article112.pdf
12. Nunna B, Parihar P, Nagtode P, Bora N, Shetty ND, Dhabalia R. **A study of high-resolution ultrasound and magnetic resonance imaging findings in shoulder joint pain at a Tertiary Care Hospital in Central India.** Cureus. 2024; 16(8):e66518. doi: 10.7759/cureus.66518

13. Selvaraj S, Sen KK, Das SK, Murthy N, Patil V, Hiremath R. **Diagnostic accuracy of ultrasound vs. MRI inevaluation of rotator cuff injuries.** Int J Radiol Diagnost Imag. 2019; 2(2):92-95. doi: 10.33545/26644436.2019.v2.i2b.45

14. Mourad MZA, Mohamed MI, Elagamy AR, Mohamed SM. **Role of Ultrasonography in Evaluation of Rotator Cuff Muscle Injury.** Sohag Med J. 2019; 23(3):176-85. Available from: https://smj.journals.ekb.eg/article_57237_0caab9aa08f82711acfa387d11cdb8c5.pdf

15. Naganna HP, Rangaswamy SM, Jaganathan, Puttaraju NC, Lingaiah RKN, Nagarajegowda PH. **Study of rotator cuff disorders by ultrasound with magnetic resonance imaging correlation.** Int J Contemp Med Surg Radiol. 2018; 3(1):70-75.

16. Farooqi AS, Lee A, Novikov D, Kelly AM, Li X, Kelly JD 4th, et al. **Diagnostic accuracy of ultrasonography for rotator cuff tears: A systematic review and meta-analysis.** Orthop J Sports Med. 2021; 9(10):23259671211035106. doi: 10.1177/23259671211035106

17. Mamoun HAEA, Fahim YM, Mohamad MT. **Comparative study of Ultrasound and MRI in diagnosis and assessment of shoulder impingement syndrome.** Al-Azhar Int Med J. 2022; 3(3):25159-164. doi: 10.21608/aimj.2022.105037.1652

18. Toh Y. **Ultrasound versus magnetic resonance imaging as first-line imaging strategies for rotator cuff pathologies: A comprehensive analysis of clinical practices, economic efficiency, and future perspectives.** Cureus. 2024; 16(4):e59231. doi: 10.7759/cureus.59231

19. Okoroha KR, Fidai MS, Tramer JS, Davis KD, Kolowich PA. **Diagnostic accuracy of ultrasound for rotator cuff tears.** Ultrasonography. 2019; 38(3):215-20. doi: 10.14366/usg.18058

20. Henderson RE, Walker BF, Young KJ. **The accuracy of diagnostic ultrasound imaging for musculoskeletal soft tissue pathology of the extremities: A comprehensive review of the literature.** Chiropr Man Therap. 2015; 23:31. doi: 10.1186/s12998-015-0076-5

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1	**Sikandar Abbas:** Data collection, drafting, responsible for data approved for publication.
2	**Nadeem Ibrahim:** Concept, design, critical revisions, approved for publication.
3	**Amer Hayat Haider:** Literature review, data analysis, proof reading, approved for publication.
4	**Noorulain:** Literature review, data analysis, proof reading, approved for publication.
5	**Nooriya Gohar:** Literature review, data synthesis, proof reading, approved for publication.
6	**Izza Shahid:** Literature review, data synthesis, proof reading, approved for publication.