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Diagnostic Accuracy and Agreement between Magnetic Resonance Imaging and Ultrasound Finding for the Diagnosis of Rotator Cuff Tears

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ABSTRACT

Objective: To determine the diagnostic accuracy and agreement between ultrasound and magnetic resonance (MR) imaging in determining rotator cuff tears.

Study Design: Cross-sectional study.

Place and Duration of the Study: Armed Forces Institute of Radiology and Imaging, Pak Emirates Military Hospital, Rawalpindi Pakistan, from Jul 2018 to Jan 2019.

Methodology: Patients of either gender with a traumatic shoulder injury duration of less than 15 days were consecutively included. Rotator cuff tear on ultrasonography was diagnosed on the presence of a hypoechoic discontinuity in the tendon and accentuation of cartilage shadow, giving a 'double cortex' view while on MRI, the hyper-intense signal area within the tendon on T2W, fat-suppressed and GRE sequences, corresponding to fluid signal seen.

Results: Of 88 patients, the mean age was 54.022±5.19 years. Ultrasound diagnosed rotator cuff tears in 42(47.7%) patients, and MRI diagnosed rotator cuff tears in 44(50.0%) patients. Diagnostic accuracy of ultrasound taking MR imaging as the gold standard showed sensitivity as 81.82%, specificity as 77.27%, negative predicted value as 78.26%, positive predicted value as 80.95%, and overall diagnostic accuracy as 79.55%. A moderate agreement was found between ultrasound and MRI findings (*p*-value=0.591).

Conclusion: The findings of the current study showed significant moderate agreement between ultrasound and MR imaging in the determination of rotator-cuff tears.

Keywords: Rotator cuff tears, Ultrasound, MRI, Agreement.

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INTRODUCTION

Rotator cuff disease is the most common cause of shoulder symptoms.[1] In addition, it is expected that more than half of the general population by the age of 70 years experienced a full or partial-thickness rotator cuff tear, irrespective of the presentation.[2] For effective treatment strategies to be devised, it is critical that the physician has a clear diagnosis and assessment of the severity of the tear via imaging, as a clinical examination on its own has limited use.[3]

Ultrasound and Magnetic Resonance (MR) imaging are the two main diagnostic imaging modalities.[4] There are many advantages to using ultrasound to visualize the shoulder area, including being widely available, inexpensive and noninvasive. However, as previous studies have shown, there is variability and inconsistency in the reporting of diagnostic sensitivities and specificities of ultrasound.[5,6]

MR imaging is rapidly becoming a more commonly used tool for evaluating rotator cuff tears. MR imaging has often been declared the gold standard for rotator cuff imaging.[7] In contrast to ultrasounds, MR imaging is considered to have a customarily high baseline diagnostic yield to rule out this particular pathology.[8] MR imaging provides a detailed look at soft tissue and information about the thickness, shape & dimensions of the tear, along with tendon retraction.[9]

In various international studies, MR imaging is reported to have high diagnostic accuracy for determining full and partial-thickness tears of the rotator cuff.[10] A thorough literature search has revealed that this topic should be addressed in Pakistan. Therefore, this motivated us to conduct a study to determine the accuracy and agreement of ultrasound compared to the gold standard, MR imaging, for determining rotator-cuff tears in our cohort.

METHODOLOGY

This cross-sectional study was carried out at Armed Forces Institute of Radiology and Imaging, Pak Emirates Military Hospital Rawalpindi, from July 2018 to Jan 2019. Institutional approval was obtained prior conducting the study (Certificate number: 006). Moreover, informed consent was signed by all participants

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of the study after explaining the pros and cons of the study. The sample size was estimated taking expected agreement between Ultrasound and MR imaging as 85%,[7] in the determination of rotator cuff tear.

Inclusion Criteria: Patients of either gender with aged 45-70 years, having traumatic shoulder injury with a duration of less than 15 days were included in the study.

Exclusion Criteria: Patients with a history of prior surgery or fracture of the affected shoulder, adhesive capsulitis, diabetes, the patient having history of claustrophobia, an open wound on physical examination and pregnancy were excluded from the study

Non-probability consecutive sampling technique was employed. The traumatic shoulder injury was defined as patient with shoulder pain VAS (Visual Analogue Scale) >4, forward flexion of more than 100°, external rotation "0 to 20" degree, internal rotation below the thoracic vertebral level, or trauma history around affected shoulder.[11]

The consultant Radiologist performed the sonographic examination. Ultrasound examination was performed using high frequency "10-MHz" linear transducer. Ultrasound examination was performed putting patients in sitting position in line of sight of device monitor. Performing the standardized examination dynamic ultrasound, the patient's affected arm was passively rotated in the shoulder with the elbow flexed at 90. The tendons of the rotator cuff and the long biceps were assessed on anterior planes, lateral planes, posterior planes, longitudinal planes, and transverse planes. Rotator cuff tear on ultrasonography was determined if ultrasound of the shoulder shows a hypoechoic discontinuity in tendon and accentuation of cartilage shadow, giving a 'double cortex' view.[12]

MR imaging was performed using the "3 T whole-body system". Three imaging planes, including two protons density-weighted fat-saturated turbo spin echo sequences, a coronal T1-weighted spin echo sequence and a T2-weighted TSE sequence in sagittal and axial orientation, were evaluated. Rotator cuff tear on MRI was diagnosed based on the presence of hyperintense signal area within the tendon on T2WI, fat-suppressed and GRE sequences corresponding to the fluid signal.

SPSS-25.0 was used for the data analysis. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency (n) and percentages (%). Kappa statistics were used. The *p*-value was calculated to check the strength of agreement between Ultrasound and MR imaging in determining rotator cuff tear.

RESULTS

Of 88 patients, the mean age was 54.02±5.19 years (minimum 45 maximum 70 years). The n & % according to gender were male (72.7%) and female (27.3%). The mean BMI was 25.69±1.67Kg/m^2, and the mean duration of complaints was 5.75±2.00 days.

Percentage and frequency of patients on Ultrasound and Magnetic Resonance Imaging in diagnosis of rotator Cuff tear were (n=88). Out of which, ultrasound diagnosed rotator cuff tears in 42(47.7%) patients, and MRI diagnosed rotator cuff tears in 44(50%) patients (Table-I). A moderate agreement was found between ultrasound and MRI findings in the diagnosis of rotator cuff tear (*p*-value=0.591) (Table-II)

Table-I: Frequency Distribution of Ultrasound and Magnetic Resonance Imaging in the Diagnosis of Rotator Cuff Tear (n=88)

Rotator Cuff tear	Ultrasound	Magnetic Resonance Imaging
Positive	42(47.7%)	44(50.0 %)
Negative	46(52.3 %)	44(50.0%)
Total	88(100 %)	88(100 %)

Table-II: Agreement between Ultrasound and Magnetic Resonance Imaging in Diagnosis of Rotator Cuff Tear (n=88)

Rotator Cuff tear		MRI		*p*-value
		Positive (n=44)	Negative (n=44)	
Ultrasound	Positive (n=42)	34(80.9%)	8(19.1%)	0.591
	Negative (n=46)	10(21.7%)	36(78.3%)	

Diagnostic accuracy of ultrasound taking MRI as the gold standard showed sensitivity at 81.82%, specificity of 77.27%, a negative predicted value of 78.26%, a positive predicted value of 80.95%, and overall diagnostic accuracy at 79.55% (Table-III).

Table-III: Diagnostic Parameters for Ultrasound in the Diagnosis of Rotator Cuff Tear (n=88)

Diagnostic Parameters	Values
Sensitivity= True Positive/(True Positive+False Negative)	Sensitivity= 36/(36+8) =36/44 = 81.82%
Specificity= True Negative/(True Negative+False Positive)	Specificity= 34/(34+10) = 34/44 = 77.27 %
Positive Predictive Value= True Positive/(True Positive+False Positive)	Positive Predictive Value= 36/(36+10) =36/46 = 78.26 %
Negative Predictive Value= True Negative/(True Negative+False Negative)	Negative Predictive Value= 34/(34+8) =34/42 = 80.95 %
Diagnostic Accuracy=(True Positive+True Negative)/All Patients	Diagnostic Accuracy= (36+34)/88= 70/88 =79.54 %

DISCUSSION

This study was conducted to assess the agreement of a cost-effective and easily available diagnostic modality in determining rotator cuff tear with the gold standard modality, i.e., MR imagining. Though much work has been done comparing the effectiveness of ultrasound, it is similar to MR imaging as a tool of diagnosis for rotator cuff tears.[13,14] The current study comprising eighty-eight patients found moderate agreement (*p*-value 0.591) between Ultrasound and MR imaging in determining rotator cuff tear. This study found higher diagnostic accuracy of ultrasound while considering MR imaging as the gold standard, as sensitivity was reported as 72.27% and specificity as 81.82%. These results are in line with the current literature. Meiers *et al*.[10] did not find a considerable difference between the MR imaging and ultrasound sensitivity values. Additionally, a large number of studies and meta-analyses done across a variety of populations for comparing the ultrasound and MR imaging showed similar finding.[15,16]

Another part of our results was to calculate the negative and positive predictive values from our sample. Taking MRI as the gold standard and comparing it with our ultrasound results we found a positive predicted value of 80.95%, which meant that 80.95% of all identified rotator cuff tears were actually present in patients. This was low compared to Chauhan *et al*.[6] which had a value of 97.2%. However, our value is higher than Mohtasib *et al*.[17] a recent study from Saudi Arabia found a positive predicted value of 51%.

On the flip side our negative predicted value came out to be 78.26%. This meant that the probability that subjects with a negative screening test truly without rotator cuff tear is close to 78%. This was low compared to Chauhan *et al*.[6] which had a value of 95.5%. However, our value is higher compare to Mohtasib *et al*.[17] a recent study from Saudi Arabia which found a positive predicted value of 60%. These differences could be attributed to sample size as well as variations in methodology and the specifics of the ultrasound procedure.

In short, in light of the agreement of the current study findings and previously published literature, ultrasound can very well be used as a first line screening modality to determine and observe the recovery of rotator-cuff tears, with MR imaging as required for a more detailed look when needed.[3-18]

LIMITATIONS OF STUDY

The findings of our study could be observed in light of the limitation that we found in our study was the lack of comparison of ultrasound and MR imaging with surgical findings where performed. Moreover, other possible effect modifiers such as occupation, presence of comorbidities (diabetes, hypertension, dyslipidemia) and smoking status were not included in this study. The study findings could also be improved by assessing the interobserver variability in reporting ultrasound findings of rotator cuff tears.

CONCLUSION

Our study results demonstrated high diagnostic accuracy of ultrasound than that of MR imaging for deter-mination of rotator cuff tears. Furthermore, a moderate agreement in these modalities also suggests that ultrasound can be used as the first line of investigation for diagnosing rotator cuff tears. In contrast, MR imaging can be used secondarily as a problem-solving tool for a more detailed look at the anatomy where required. Ultrasounds have long been accepted as a cheaper option in the two modalities. In addition, it is a faster and a dynamic study &, compared to MR imaging, requires less elaborate and complicated machinery and setup.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

S & MA: Data acquisition, data analysis, critical review, approval of the final version to be published.

AN & MA: Conception, study design, drafting the manuscript, approval of the final version to be published.

TA & ZRS: Critical review, data interpretation, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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