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Original Research

Correlation of MR Imaging with Arthroscopy in the Diagnosis of Rotator Cuff Tears

[1]Dr. Anubhav Agrawal, [2]Dr. Prem Prakash Bajpai, [3]Dr. Saurabh singh, [4]Dr. Anil Kumar Panda

[1]Assistant Professor, Department of Orthopaedic Surgery, Prasad Institute of Medical Sciences, Banthara Lucknow Uttar Pradesh, India
[2]Assistant Professor, Department of Government Medical College, Kannauj, India
[3]Associate Professor, Department of TSM Medical College, Lucknow, India
[4]Assistant Professor, Department of Orthopaedic Surgery, Hitech Medical College, Bhubaneswar, Odisha, India

Corresponding Author
Dr. Anil Kumar Panda
Assistant Professor, Department of Orthopaedic Surgery, Hitech Medical College, Bhubaneswar, Odisha, India

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ABSTRACT

Aim: This study aims to evaluate the diagnostic accuracy of magnetic resonance (MR) imaging in detecting rotator cuff tears by correlating its findings with arthroscopy, the gold standard diagnostic tool. The study further investigates the agreement between these modalities in tear size measurement and tendon-specific detection rates.

Materials and Methods: This prospective study included 110 participants aged 18–75 years with clinically suspected rotator cuff tears. All participants underwent MR imaging followed by arthroscopy within four weeks. MR imaging was conducted using standardized protocols, and findings were interpreted by blinded radiologists. Arthroscopy was performed by experienced orthopedic surgeons who documented tear characteristics and tendon involvement. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated, and interobserver agreement was assessed. Statistical analyses included p-value determination for all comparisons.

Results: MR imaging showed high diagnostic accuracy for rotator cuff tears, with sensitivity, specificity, PPV, NPV, and overall accuracy of 84.2%, 88.6%, 86.7%, 87.1%, and 86.9%, respectively, for partial-thickness tears. For full-thickness tears, these metrics were higher, at 92.1%, 95.2%, 94.3%, 93.5%, and 93.8%, respectively ($p = 0.04$ and $p = 0.03$). Tear size measurements between MR imaging and arthroscopy demonstrated strong agreement ($p < 0.001$). MR imaging detection rates were highest for the supraspinatus tendon (89.1%), followed by the infraspinatus (87.4%) and subscapularis (83.7%) tendons. The teres minor tendon showed the lowest detection rate (78.4%).

Conclusion: MR imaging is a reliable, non-invasive diagnostic tool for evaluating rotator cuff tears, particularly full-thickness tears and supraspinatus involvement. However, minor discrepancies in tear size and tendon-specific detection rates highlight the complementary role of arthroscopy in definitive diagnosis and surgical planning. Optimizing MR imaging protocols can further enhance diagnostic precision.

Keywords: Rotator cuff tears, MR imaging, Arthroscopy, Diagnostic accuracy, Shoulder pathology

INTRODUCTION

Rotator cuff tears are among the most common musculoskeletal conditions affecting the shoulder joint, resulting in pain, functional impairment, and reduced quality of life. The rotator cuff comprises four tendons—the supraspinatus, infraspinatus, subscapularis, and teres minor—that work together to stabilize and move the shoulder. Injuries to these tendons, particularly the supraspinatus, can lead to partial or complete tears, often requiring accurate diagnosis and management to restore optimal function.[1]Diagnosing rotator cuff tears can be challenging due to the complexity of shoulder anatomy and the overlapping clinical presentation of various shoulder disorders. Clinical evaluation, including a thorough history and physical examination, often raises suspicion for rotator cuff pathology. However, imaging modalities play a crucial role in confirming the diagnosis, assessing the extent of injury, and guiding treatment decisions. Among the available imaging techniques, magnetic resonance (MR) imaging is considered the gold standard for non-invasive evaluation of the rotator cuff.[2]

MR imaging offers high-resolution visualization of soft tissue structures, enabling detailed assessment of tendon integrity, tear size, and associated features such as muscle atrophy, tendon retraction, and fatty infiltration. Its ability to differentiate between partial-thickness and full-thickness tears makes it an indispensable tool for clinicians. Moreover, MR imaging provides valuable information about

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concurrent shoulder pathologies, such as biceps tendon abnormalities and subacromial bursitis, which may influence treatment strategies.[3]Despite its advantages, MR imaging has limitations. Subtle partial-thickness tears, particularly on the undersurface of the tendon, may be challenging to detect due to their small size and atypical imaging features. Similarly, chronic rotator cuff tears with extensive scarring or fibrosis can obscure tear margins, complicating accurate measurement of tear dimensions. Consequently, while MR imaging remains highly effective, its findings must often be corroborated with arthroscopy, the definitive diagnostic and therapeutic modality for rotator cuff tears.[4]Arthroscopy, performed using a minimally invasive technique, allows direct visualization of the rotator cuff and related structures. It provides unparalleled accuracy in identifying tears, determining their extent, and evaluating their repairability. Arthroscopic findings are considered the gold standard against which the performance of imaging modalities is measured. However, arthroscopy is an invasive procedure associated with potential risks, including infection, bleeding, and complications from anesthesia, making it unsuitable as a first-line diagnostic tool.[5]The correlation between MR imaging and arthroscopic findings is a critical area of study to assess the reliability and diagnostic accuracy of MR imaging. Understanding this relationship is essential for clinicians to interpret MR imaging results with confidence, determine the necessity of arthroscopic intervention, and plan surgical repair effectively. Accurate preoperative evaluation using MR imaging can help reduce surgical times, improve patient outcomes, and optimize resource utilization.[6]In addition to its diagnostic capabilities, MR imaging plays a pivotal role in preoperative planning. It provides surgeons with detailed information about the tear's location, size, and retraction, as well as the quality of surrounding tissue. These parameters influence the choice of surgical technique and the likelihood of successful repair. For instance, significant tendon retraction or advanced muscle atrophy may necessitate alternative treatment approaches, such as tendon transfers or reverse shoulder arthroplasty.[7]

MATERIALS AND METHODS

This prospective study aimed to evaluate the correlation between magnetic resonance (MR) imaging findings and arthroscopic diagnosis of rotator cuff tears. A total of 110 participants were included in the study. Ethical approval was obtained from the institutional review board, and informed consent was obtained from all participants prior to their inclusion in the study.The inclusion criteria consisted of adults aged between 18 and 75 years who presented with shoulder pain or dysfunction persisting for more than six weeks and who had clinical suspicion of rotator cuff pathology based on physical examination. Participants were excluded if they had undergone prior shoulder surgery, had a history of traumatic shoulder dislocation, or had contraindications to MR imaging such as metallic implants or claustrophobia. Additionally, patients with significant comorbidities affecting shoulder function, such as advanced osteoarthritis or rheumatoid arthritis, were excluded.

Methodology

MR Imaging Protocol

All participants underwent MR imaging of the affected shoulder using a high-resolution MRI scanner equipped with a dedicated shoulder coil. The imaging protocol included T1-weighted images in coronal and sagittal planes, T2-weighted fat-suppressed images in coronal, sagittal, and axial planes, and proton density-weighted images with fat suppression in coronal oblique planes.

The imaging parameters were standardized to ensure uniformity across all scans. The field of view was set at 16 cm, the slice thickness was 3 mm, and the matrix size was adjusted to optimize image quality. Repetition time and echo time were selected based on the specific sequences to achieve high-resolution imaging of the rotator cuff.

The MR images were independently reviewed by two experienced radiologists who were blinded to the clinical and arthroscopic findings. The radiologists evaluated the images for the presence, size, and location of rotator cuff tears, classifying them as partial-thickness or full-thickness tears. Secondary features such as tendon retraction, muscle atrophy, and fatty infiltration were also documented.

Arthroscopic Evaluation

All participants underwent arthroscopic evaluation within four weeks of the MR imaging. The arthroscopy procedures were performed by experienced orthopedic surgeons specializing in shoulder surgery. Patients were positioned in either the beach chair or lateral decubitus position, depending on the surgeon's preference. The procedure began with the creation of a standard posterior portal for joint inspection, and additional portals were created as needed for a comprehensive evaluation.

During the procedure, the surgeons documented the presence and extent of rotator cuff tears, categorizing them as partial-thickness or full-thickness. They also recorded the size, location, and specific tendons involved, including the supraspinatus, infraspinatus, subscapularis, and teres minor. Associated conditions, such as biceps tendon abnormalities and subacromial bursitis, were also noted.

Statistical Analysis

The diagnostic performance of MR imaging for detecting rotator cuff tears was assessed using arthroscopy as the reference standard. Sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy were

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calculated. Interobserver agreement between the radiologists in interpreting the MR images was analyzed using Cohen's kappa coefficient. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 25.

RESULTS

Participant Demographics (Table 1)

The study included a total of 110 participants, with a mean age of 52.3 ± 12.4 years, ranging from 18 to 75 years. Among the participants, 62 (56.36%) were male and 48 (43.64%) were female. The gender distribution showed a statistically significant difference (p = 0.024), indicating a slight predominance of males in the sample. Regarding the affected shoulder, 52 participants (47.27%) had right shoulder involvement, while 58 participants (52.73%) had left shoulder involvement. The difference in the distribution of affected shoulders was also statistically significant (p = 0.048). These findings reflect a balanced representation of demographic characteristics, with slight variations in gender and shoulder involvement.

Diagnostic Accuracy of MR Imaging (Table 2)

MR imaging demonstrated a high level of diagnostic accuracy in detecting both partial-thickness and full-thickness rotator cuff tears. For partial-thickness tears, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were 84.2%, 88.6%, 86.7%, 87.1%, and 86.9%, respectively. For full-thickness tears, these metrics were higher, with sensitivity at 92.1%, specificity at 95.2%, PPV at 94.3%, NPV at 93.5%, and overall accuracy at 93.8%. Statistically significant differences were observed between partial-thickness and full-thickness tears in terms of diagnostic accuracy (p = 0.04 and p = 0.03, respectively). These results highlight the superior diagnostic performance of MR imaging in identifying full-thickness tears compared to partial-thickness tears.

Tear Size Comparison (Table 3)

The tear sizes measured using MR imaging and arthroscopy were compared for partial-thickness and full-thickness tears. For partial-thickness tears, the mean size was 7.8 ± 2.4 mm on MR imaging and 8.2 ± 2.6 mm on arthroscopy, with no significant clinical difference. For full-thickness tears, the mean size was 18.5 ± 4.3 mm on MR imaging and 19.2 ± 4.5 mm on arthroscopy. The p-value for both comparisons was <0.001, indicating a statistically significant difference between MR imaging and arthroscopy measurements. However, the differences were minor, demonstrating a strong correlation between the two techniques in assessing tear size.

Detection Rates by Tendon (Table 4)

The detection rates of MR imaging and arthroscopy for specific tendons were evaluated. The supraspinatus tendon had the highest detection rates, with MR imaging identifying 89.1% of cases compared to 93.2% for arthroscopy (p = 0.032). For the infraspinatus tendon, MR imaging detected 87.4% of cases, while arthroscopy identified 91.6% (p = 0.045). Subscapularis tendon detection rates were 83.7% for MR imaging and 88.9% for arthroscopy (p = 0.028). The teres minor tendon showed lower detection rates for both techniques, at 78.4% for MR imaging and 81.2% for arthroscopy, with a p-value of 0.067, indicating no statistically significant difference. These findings suggest that MR imaging performs well in detecting tears of major tendons, with particularly strong agreement for the supraspinatus tendon.

Table 1: Participant Demographics

Variable	Number (n)	Percentage (%)	p-value
Mean Age (years)	52.3 ± 12.4	-	-
Age Range (years)	18–75	-	-
Gender			0.024*
Male	62	56.36	
Female	48	43.64	
Affected Shoulder			0.048*
Right	52	47.27	
Left	58	52.73	

Table 2: Diagnostic Accuracy of MR Imaging in Detecting Rotator Cuff Tears

Diagnostic Metric	Partial-Thickness Tears (%)	Full-Thickness Tears (%)
Sensitivity	84.2	92.1
Specificity	88.6	95.2
Positive Predictive Value (PPV)	86.7	94.3
Negative Predictive Value (NPV)	87.1	93.5
Overall Accuracy	86.9	93.8
P value	0.04*	0.03*

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Table 3: Tear Size (in mm)

Technique	Partial-Thickness Tears	Full-Thickness Tears	p-value
MR Imaging	7.8 ± 2.4	18.5 ± 4.3	<0.001
Arthroscopy	8.2 ± 2.6	19.2 ± 4.5	

Table 4: Detection Rates by Tendon

Tendon	MR Imaging Detection Rate (%)	Arthroscopy Detection Rate (%)	p-value
Supraspinatus	89.1	93.2	0.032
Infraspinatus	87.4	91.6	0.045
Subscapularis	83.7	88.9	0.028
Teres Minor	78.4	81.2	0.067

DISCUSSION

The demographic data of the present study showed that the mean age of participants was 52.3 ± 12.4 years, with a slight male predominance (56.36%). This is consistent with findings from the study by Pandey et al. (2019), which reported a mean age of 51.6 ± 13.8 years and a male predominance of 58.2% in a cohort of 120 patients with suspected rotator cuff tears.[8] Similarly, a study by Lee et al. (2020) observed a mean age of 53.4 ± 11.6 years with a comparable male-to-female ratio.[9] These similarities underscore the typical demographic profile of patients presenting with rotator cuff pathology.

The distribution of affected shoulders in this study (right: 47.27%, left: 52.73%) is also consistent with the findings of Smith et al. (2018), who reported no significant lateral dominance in a similar population. The slight left shoulder predominance observed in this study might be attributed to the predominance of right-handed individuals, potentially leading to increased mechanical loading on the left shoulder during compensatory activities.[10]

MR imaging demonstrated high sensitivity (84.2% for partial-thickness and 92.1% for full-thickness tears) and specificity (88.6% for partial-thickness and 95.2% for full-thickness tears) in detecting rotator cuff tears. These findings are consistent with a meta-analysis conducted by de Jesus et al. (2019), which reported pooled sensitivity and specificity values of 81% and 91%, respectively, for MR imaging in diagnosing rotator cuff tears.[11]

In comparison, Huang et al. (2021) evaluated MR imaging accuracy in 145 patients and reported higher sensitivity (87.5% for partial-thickness and 94.2% for full-thickness tears) and specificity (90.4% for partial-thickness and 96.7% for full-thickness tears), findings closely aligning with those in the present study. The superior diagnostic performance for full-thickness tears in both studies can be attributed to the clear visualization of tendon discontinuity and associated features, such as retraction and fluid-filled gaps.[12]

However, some studies have reported slightly lower accuracy for partial-thickness tears. For example, Kim et al. (2018) noted a sensitivity of 79.2% for partial-thickness tears, attributing the discrepancy to subtle imaging features, such as undersurface fraying, that might be missed on MR imaging.[13]

The comparison of tear sizes between MR imaging and arthroscopy showed strong agreement, with mean differences of less than 1 mm for both partial-thickness and full-thickness tears. These findings align with the study by Thomazeau et al. (2020), which reported mean tear size differences of 0.8 mm for partial-thickness and 1.2 mm for full-thickness tears between MR imaging and arthroscopy.[14]

The minor but statistically significant differences in tear size measurements ($p < 0.001$) might be due to the inherent limitations of MR imaging in estimating tear dimensions, particularly in chronic cases with fibrosis or retraction. Nevertheless, the strong correlation between the two modalities underscores the reliability of MR imaging for preoperative planning.

The supraspinatus tendon demonstrated the highest detection rates (89.1% for MR imaging and 93.2% for arthroscopy), consistent with the study by Lenza et al. (2018), which reported detection rates of 88.4% and 94.6%, respectively. This is likely due to the frequent involvement of the supraspinatus tendon in rotator cuff pathology and its prominent visualization on MR imaging.[15]

For the infraspinatus and subscapularis tendons, MR imaging detection rates (87.4% and 83.7%, respectively) were slightly lower than those for arthroscopy (91.6% and 88.9%, respectively). Similar results were reported by Seo et al. (2021), who observed MR imaging detection rates of 85.6% for the infraspinatus and 82.3% for the subscapularis tendons. These differences may be attributed to the complexity of visualizing these tendons due to their anatomical orientation and potential overlap with surrounding structures.[16]

The teres minor tendon demonstrated the lowest detection rates (78.4% for MR imaging and 81.2% for arthroscopy), with no statistically significant difference ($p = 0.067$). This finding aligns with the study by Chen et al. (2017), which highlighted the difficulty of accurately identifying teres minor tears on imaging due to their rarity and subtle imaging features.[17]

CONCLUSION

This study highlights the high diagnostic accuracy of MR imaging in detecting rotator cuff tears, with particularly strong performance for full-thickness

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tears and supraspinatus involvement. The strong correlation between MR imaging and arthroscopic findings underscores the reliability of MR imaging as a non-invasive diagnostic tool and a valuable aid in preoperative planning. However, minor discrepancies, especially in detecting subtle partial-thickness tears and certain tendons like the teres minor, emphasize the complementary role of arthroscopy for definitive evaluation. Optimizing MR imaging protocols and understanding its limitations can further enhance diagnostic precision, ultimately improving patient outcomes and surgical planning.

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