



## Role of MRI Imaging in Evaluation of Rotator Cuff Injuries

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### ABSTRACT

Rotator cuff injuries are a common cause of shoulder pain and disability, especially in older adults and include a spectrum of pathologies such as full-thickness tears, partial-thickness tears and tendinosis. Early diagnosis is crucial to prevent further deterioration and maintain shoulder function. Magnetic Resonance Imaging (MRI) has become a cornerstone in evaluating rotator cuff injuries due to its high sensitivity and specificity. This study aims to assess the role of MRI in diagnosing rotator cuff injuries, identifying the most frequent pathologies and correlating MRI findings with clinical outcomes. This prospective observational study involved 50 patients presenting with shoulder pain, all of whom underwent MRI evaluation for rotator cuff pathologies. MRI scans were performed using a Siemens Magnetom 1.5T MR scanner. The MRI protocols included various sequences: PD fat-saturated, T2-weighted, T1-weighted oblique coronal and axial T2-weighted images with fat saturation, along with oblique sagittal imaging. These images were meticulously analyzed to identify lesions in the supraspinatus, infraspinatus, subscapularis and biceps tendon, as well as the presence of joint effusion. Comprehensive data on patient demographics, trauma history and tendon involvement were systematically collected and subjected to statistical analysis. Among the 50 patients, supraspinatus lesions were the most common finding, seen in 70% of cases, followed by infraspinatus lesions in 50% and subscapularis lesions in 32%. Biceps tendon pathologies were present in 24% of cases, while joint effusion was noted in 40%. Normal MRI findings were observed in 20% of cases. Full-thickness tears were seen in 30% of patients, partial-thickness tears in 40% and tendinosis in varying degrees across multiple tendons. Age-related progression of pathology was evident, with higher rates of rotator cuff tears in older patients. MRI is an invaluable tool in diagnosing rotator cuff injuries, providing detailed visualization of tendon tears, tendinosis and associated pathologies. The ability to distinguish between partial and full-thickness tears allows for better clinical decision-making, improving patient outcomes through timely and appropriate treatment.

## OPEN ACCESS

### Key Words

Rotator cuff injuries, shoulder pain, partial-thickness

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**Received:** 25 September 2024

**Accepted:** 20 October 2024

**Published:** 30 November 2024

**Citation:** Dharshika, Sathish Babu and Rohit, 2024. Role of MRI Imaging in Evaluation of Rotator Cuff Injuries. Res. J. Med. Sci., 18: 426-431, doi: 10.36478/makrjms.2024.12.426.431

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## INTRODUCTION

The rotator cuff is a leading cause of shoulder pain and disability, with surgery playing a vital role in the treatment of these injuries<sup>[1,2]</sup>.

Common pathologies affecting the rotator cuff tendons include full-thickness tears, partial-thickness tears and tendinosis<sup>[8]</sup>. Rotator cuff tears (RCTs) represent about 50% of shoulder injuries, frequently causing chronic pain and reduced function in the upper limb. As age increases, the incidence of RCTs also rises, with over 50% of people in their 80s affected<sup>[3,4]</sup>. Early diagnosis of rotator cuff tears is crucial, as many patients with asymptomatic tears may develop symptoms shortly thereafter, potentially resulting in irreversible fatty atrophy of the shoulder musculature. Timely identification through imaging can help prevent further deterioration and preserve shoulder function<sup>[5,6]</sup>.

MRI has proven to be highly accurate in detecting shoulder pathology, especially in the assessment of rotator cuff disease. This study explores the characteristics of rotator cuff tears, including tendinopathy and associated muscle atrophy, while evaluating the sensitivity and specificity of MRI in differentiating between partial and full-thickness tears through various sequences, such as T1-weighted, T2-weighted and fat-saturated images. MRI can assess the size and shape of the tear, the degree of tendon retraction, the extent of muscle atrophy and the quality of the remaining rotator cuff tendon. Additionally, it can effectively evaluate other potential sources of shoulder pain that may mimic rotator cuff tears<sup>[7,8]</sup>.

Furthermore, we examine the relationship between MRI findings and clinical outcomes, underscoring the critical role of MRI in guiding treatment decisions and postoperative evaluations.

### Aim and Objectives:

#### Aim:

- To critically evaluate the role of MRI in accurately diagnosing and characterizing rotator cuff injuries, thereby enhancing radiological assessment protocols.

#### Objectives:

- To conduct a systematic analysis of MRI features associated with rotator cuff injuries, emphasizing the classification of tear types, tendon involvement and related findings such as joint effusion.
- To identify age-related trends in the prevalence and types of rotator cuff injuries detected via MRI.

## MATERIALS AND METHODS

This prospective observational study was conducted over the course of one year by the Radiodiagnosis

Department at Sree Mookambikai Institute of Medical Sciences. It included a diverse cohort of 50 patients presenting with shoulder pain, all of whom underwent MRI evaluations specifically targeting rotator cuff pathologies from November 2023 to April 2024. Prior to imaging, we ensured that no objects interfering with magnetic resonance imaging—such as pacemakers, metal implants, shrapnel from drug infusion devices, ferromagnetic prosthetic valves, or aneurysm clips—were present in the patients. MRI scans were performed using a Siemens Magnetom 1.5T MR scanner. The imaging protocols incorporated a range of sequences, including PD fat-saturated, T2-weighted, T1-weighted oblique coronal and axial T2-weighted images with fat saturation, along with oblique sagittal imaging. The acquired images were carefully analyzed to identify lesions in the supraspinatus, infraspinatus, subscapularis and biceps tendon, as well as to assess the presence of joint effusion. Detailed data on patient demographics, trauma history and tendon involvement were systematically collected and subsequently subjected to statistical analysis.

### Inclusion Criteria:

- Patients with symptoms of painful shoulder and limited movements of their shoulders.

### Exclusion Criteria:

- Contraindications for MRI, such as claustrophobia, metallic implants, or other contraindications.
- Inability to provide informed consent.

### Data Collection:

- Patient Demographics:**
  - Demographic information, including age, race and medical history, is collected.
- Clinical Indications:**
  - The clinical reasons for ordering the MRI shoulder are documented for each patient.

### Ethical Considerations:

- The study is conducted in compliance with the Declaration of Helsinki and relevant ethical guidelines. Informed consent is obtained from all participants. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Sree Mookambikai Institute of Medical Sciences. Patient confidentiality and data security were maintained throughout the study.

## RESULTS AND DISCUSSIONS

The study involved 50 patients with painful shoulders, comprising 28 males (56%) and 22 females (44%). (Table 1). Age distribution revealed that the highest incidence was among those aged 40-49 years (28.0%), followed by 50-59 years (24.0%). The least affected group was those aged 70 years and above (8.0%).

Duration of presenting symptoms varied from 15 days to 2 years with maximum patients with duration of 1-6 months. In (table 2), Out of 50 cases, males accounted for 56% (n=28), while females represented 44% (n=22), highlighting a higher prevalence of painful shoulder conditions in males.

(Fig 1) 42% of the cases (n=21) had a traumatic origin, whereas 58% (n=29) were non-traumatic, indicating that non-traumatic shoulder pain was more common. Figure 2. Among the cases, 30% (n=15) had full-thickness tendon tears, while 40% (n=20) had partial-thickness tears. An equal percentage (30%, n=15) had no tendon tear, revealing that partial-thickness tears were the most frequent pathology. In (table 5) and Fig 3, The most commonly affected tendon was the supraspinatus, with 24% showing full-thickness tears, 16% having partial-thickness tears, 20% having tendinosis, and 14% showing signs of atrophy. Infrapinatus involvement was noted in 16% of cases with full-thickness tears, while subscapularis and teres minor were less frequently affected. This distribution highlights the varying prevalence of tendon pathologies in the rotator cuff, which could be important for clinical considerations and management strategies. In (table 6), Supraspinatus lesions were the most frequent MRI finding, present in 70% of cases, followed by infrapinatus lesions in 50% and subscapularis lesions in 32%. Joint effusion was observed in 40% of cases, while 20% of patients had normal MRI findings.

Table 1: Age and Sex Distribution of Painful Shoulders

Age Group (Years)	Male (n=28)	% of Males	Female (n=22)	% of Females	Total (n=50)	% of Total
20-29	3	10.7%	2	9.1%	5	10.0%
30-39	4	14.3%	3	13.6%	7	14.0%
40-49	8	28.6%	6	27.3%	14	28.0%
50-59	7	25.0%	5	22.7%	12	24.0%
60-69	4	14.3%	4	18.2%	8	16.0%
≥70	2	7.1%	2	9.1%	4	8.0%
<b>Total</b>	<b>28</b>	<b>100%</b>	<b>22</b>	<b>100%</b>	<b>50</b>	<b>100%</b>

The majority of cases were observed in the 40-49 age group, with 28% of the total cases. Males constituted 56% of the overall study population, with 8 cases (28.6%) in the 40-49 age group, while females represented 44%, with 6 cases (27.3%) in the same age group. The smallest age group was ≥70 years, comprising only 8% of the total cases, with an equal distribution between males and females.

Table 2: Distribution of Cases According to Sex

Sex	No. of Cases (n=50)	Percentage (%)
Male	28	56%
Female	22	44%
<b>Total</b>	<b>50</b>	<b>100%</b>

Table 3: Distribution of Cases According to Trauma

Trauma History	No. of Cases (n=50)	Percentage (%)
Traumatic	21	42%
Non-traumatic	29	58%
<b>Total</b>	<b>50</b>	<b>100%</b>

(Table 3) Summarizes the distribution of shoulder pain cases based on trauma history among the 50 patients studied.

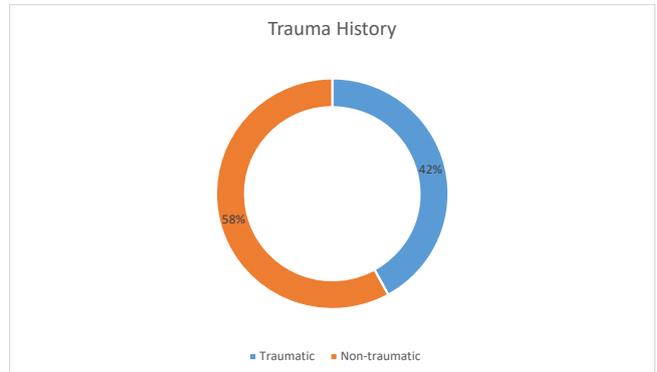


Fig.1: Pie Chart Showing Distribution of Cases According to Trauma

Table 4: Distribution of Cases According to Thickness of Tendon Involved

Tendon Involvement	No. of Cases (n=50)	Percentage (%)
Full-thickness tear	15	30%
Partial-thickness tear	20	40%
No tear	15	30%
<b>Total</b>	<b>50</b>	<b>100%</b>

The table summarizes the distribution of tendon involvement among 50 cases. It categorizes the findings into three groups: full-thickness tears, partial-thickness tears and cases with no tears.

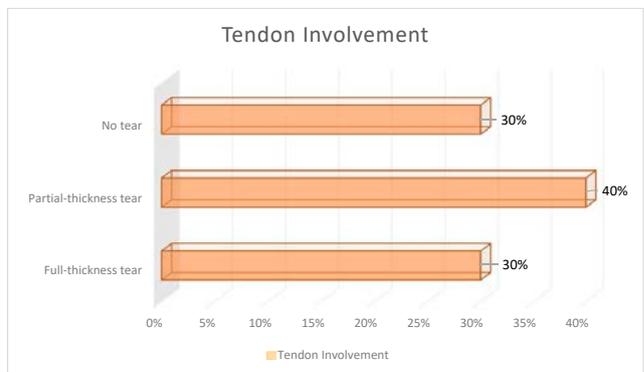


Fig.2: Horizontal Bar Chart Showing Distribution of Cases According to Thickness of Tendon Involved

Table 5: Frequency Distribution of Rotator Cuff Tendon Pathologies on MRI

Tendon	Normal	Tendinosis	Partial Thickness Tear (PTT)	Full Thickness Tear (FTT)	Atrophy
Supraspinatus	15 (30%)	10 (20%)	8 (16%)	12 (24%)	7 (14%)
Infrapinatus	18 (36%)	6 (12%)	5 (10%)	8 (16%)	6 (12%)
Subscapularis	22 (44%)	4 (8%)	3 (6%)	5 (10%)	4 (8%)
Teres Minor	35 (70%)	3 (6%)	1 (2%)	2 (4%)	1 (2%)

The table presents the prevalence of various shoulder tendon conditions in four major rotator cuff tendons: Supraspinatus, Infrapinatus, Subscapularis and Teres Minor. Each tendon is assessed for normal tendon status, tendinosis, partial thickness tears (PTT), full thickness tears (FTT) and atrophy, expressed as percentages.

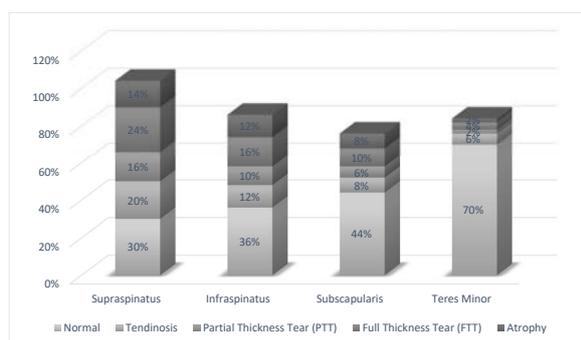


Fig. 3: Compound Bar Chart Showing Frequency Distribution of Rotator Cuff Tendon Pathologies on MRI

Table 6: MRI in Rotator Cuff Pathology

MRI Findings	No. of Cases (n=50)	Percentage (%)
Supraspinatus tear	35	70%
Infrapinatus tear	25	50%
Subscapularis tear	16	32%
Biceps Tendinosis	12	24%
Joint Effusion	20	40%
Normal MRI Findings	10	20%

The table summarizes MRI findings from a cohort of 50 cases, highlighting a notably high incidence of rotator cuff tears, particularly involving the supraspinatus. Additionally, joint effusion was commonly observed as an associated finding in these cases.

The rotator cuff consists of the Supraspinatus, Infrapinatus, Teres Minor and Subscapularis muscles, which attach to the proximal humerus and encircle the glenohumeral joint from three different directions-ventrally, superiorly and dorsally. The tendons of these muscles merge to form a protective structure around the joint, covering it from the front, top, and back.

The study indicates that painful shoulders predominantly affect middle-aged individuals, particularly those in the 40-59 year age group. This aligns with existing literature suggesting that shoulder pathologies are common in this demographic due to a combination of degenerative changes and overuse. MRI remains a pivotal tool in diagnosing rotator cuff pathologies.

Our clinical investigation demonstrated a high prevalence of MRI-evident rotator cuff abnormalities, including both partial and complete tears and indicated a notable age-related progression of these findings. Additionally, the study revealed a significant incidence of tendinosis across all age groups evaluated<sup>[1]</sup>.

Normal rotator cuff tendons, composed primarily of collagen bundles, exhibit a uniform hypointense signal intensity across all MRI pulse sequences because of their rapid T2 decay. Degenerative and traumatic

changes in the rotator cuff tendons, known as tendinosis or tendinopathy is a consequence of excessive load on RC tissues. Tendinosis can be graded as mild, moderate, or severe. The tendon may appear normal in caliber or exhibit either diffuse or focal thickening. Moderately increased focal irregularities or diffuse intermediate intrasubstance signal intensity on T1- and T2-weighted images. Thinning of the tendon is seen in chronic tendinopathy. This altered MRI signal intensity typically does not reach the same T2 signal intensity as fluid., instead, it often appears more globular and less linear than the signal abnormalities associated with rotator cuff tears.

In practice, distinguishing between severe tendinosis and a partial thickness tear can sometimes be challenging, necessitating consideration of both possibilities in the differential diagnosis<sup>[8-11]</sup>.

No two rotator cuff tears are identical, making their diagnosis and treatment complex. Tears can be either partial or complete. Partial tears involve the articular surface, the bursal surface, or both, with varying depths and extents into the tendon. Typically, partial tears do not establish a direct communication between the bursal and articular surfaces. Articular-sided tears are more prevalent, whereas bursal-sided tears are typically harder to identify. The size of partial-thickness rotator cuff tears (PTRCT) should be assessed in three dimensions and graded by the percentage of tendon thickness involved: Grade 1 (<25%), Grade 2 (25-50%), and Grade 3 (>50%). Low-grade PTRCTs (Grades 1 and 2) are usually managed conservatively, while high-grade tears (Grade 3) may necessitate surgical repair. In contrast, complete tears extend through the full thickness of the rotator cuff, creating a direct connection between the subacromial bursa and the glenohumeral joint. Full-thickness rotator cuff tears (FTRCTs) involve complete disruption of the tendon. They can be classified by size as small (<1 cm), medium (1-3 cm), large (3-5 cm), or massive (>5 cm). Larger tears generally have a less favorable prognosis. Tear size may also guide the choice of surgical approach. Additionally, tendon retraction should be assessed and graded based on its location, whether near the insertion site, at the level of the humeral head, at the glenoid, or medial to it.

**One Approach to Grading Rotator Cuff Tears on MRI Includes the Following:**

- **Grade 0:** Normal tendon appearance.
- **Grade I:** Increased T2 signal with intact tendon structure.
- **Grade II:** Increased T2 signal with structural changes (e.g., thickening or irregularities).
- **Grade III:** Well-defined tear, which may be partial or full-thickness, complete or incomplete.

Our data indicate that the presence of small amounts of fluid in the joint and tendon sheath is quite common. However, drawing further conclusions regarding fluid accumulation is challenging, except to note that large glenohumeral joint effusions are associated with advanced MRI-evident changes in the rotator cuff tendons. A significant amount of fluid in the biceps tendon sheath should only be interpreted as indicative of biceps tendon disease in the absence of joint effusion. Our findings suggest that when large effusions are present in the biceps tendon sheath, they may serve as a useful marker for biceps tendon disease, given that isolated fluid in the biceps tendon sheath is rare, particularly in asymptomatic individuals<sup>[1]</sup>.



Fig. 4: Focal High Signal Intensity Within the Distal Supraspinatus Tendon on Coronal Oblique PDFS MRI Image-Supraspinatus Tendinosis

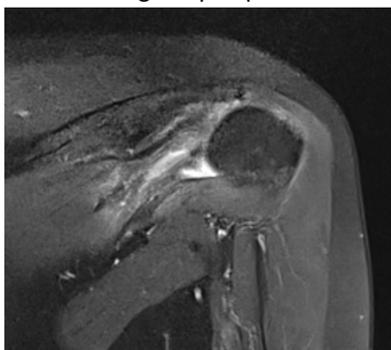


Fig. 5: PDFS MRI Image Showing Hyperintensities in the Infraspinatus Muscle with Non Visualisation of Infraspinatus Tendon-Infraspinatus Tear

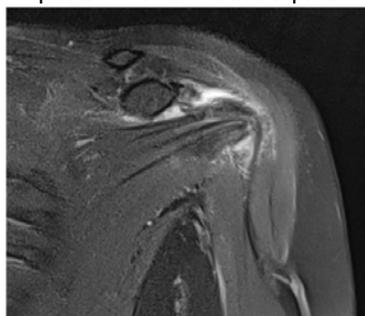


Fig. 6: PDFS MRI Image Showing Hyperintensities in the Subscapularis Tendon with Mild Subscapular Recess-Subscapularis Tendinosis



Fig. 7: Intrasubstance Signal Changes on T2W, PD Fs Noted at the Distal Supraspinatus Tendon Below the Left Acromioclavicular Joint-Partial Thickness Intrasubstance Tear

### CONCLUSION

Our results emphasize MRI's vital role as a non-invasive tool for accurately diagnosing rotator cuff injuries, ultimately enhancing patient care. This study highlights the diverse nature of rotator cuff pathology, with partial-thickness tears and supraspinatus tendon involvement being most common in patients with shoulder pain, especially among males and those aged 40-49. Non-traumatic injuries were more prevalent. The predominance of non-traumatic cases (58%) suggests that degenerative conditions, such as rotator cuff tears, are significant contributors to shoulder pain. This finding reinforces the need for preventive measures and early intervention strategies, particularly in patients with risk factors for shoulder degeneration.

The MRI findings reinforce the critical role of the supraspinatus tendon in shoulder pathologies, as lesions in this tendon were the most common. These findings underscore the importance of focusing on the supraspinatus in diagnosing and managing shoulder pain, particularly in middle-aged males. The identification of joint effusion in 40% of patients suggests an inflammatory component that may accompany rotator cuff injuries. This points to the potential for conservative management strategies that address both structural and inflammatory aspects of shoulder pain.

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