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MRI-BASED EVALUATION OF ROTATOR CUFF TEARS AND CORRELATION WITH CLINICAL SEVERITY: A RETROSPECTIVE CROSS-SECTIONAL STUDY

Dr. Patel Manish Bhimjibhai[1], Dr. Patel Hemina Manish[2*]

[1]Associate Professor, Department of Orthopaedics, SGRRIM&HS, Dehradun, Uttarakhand, India
[2]Associate Professor, Department of Radio-Diagnosis, SGRRIM&HS, Dehradun, Uttarakhand, India

***Corresponding Author:** Dr. Patel Hemina Manish
*Associate Professor, Department of Radio-Diagnosis, SGRRIM&HS, Dehradun, Uttarakhand, India, Email: heminapatel22480@gmail.com

ABSTRACT

Background: Rotator cuff tears represent a significant cause of shoulder pain and functional disability in the adult population. Magnetic resonance imaging has emerged as the preferred non-invasive diagnostic modality, yet the relationship between imaging findings and clinical presentation requires thorough investigation in the Indian context.

Objectives: To evaluate the diagnostic accuracy of MRI in detecting rotator cuff tears and to establish correlation between MRI findings and clinical severity among patients presenting to Shri Mahant Indiresh Hospital, Dehradun.

Methodology: A retrospective cross-sectional study was conducted from January 2013 to June 2013 at Shree Guru Ram Rai Institute of Medical & Health Sciences, Dehradun. Medical records of 118 patients who underwent shoulder MRI for suspected rotator cuff pathology were reviewed. Clinical severity was assessed using Constant-Murley Score, and MRI findings were classified according to tear size and tendon involvement. Statistical analysis included descriptive statistics, Chi-square test, and Pearson correlation coefficient using SPSS version 20.0.

Results: Among 118 patients, 76 (64.4%) showed rotator cuff tears on MRI. Supraspinatus was the most commonly affected tendon (68.4%). Strong positive correlation was observed between MRI-documented tear size and clinical severity scores ($r=0.742$, $p<0.001$). Full-thickness tears demonstrated significantly lower functional scores compared to partial-thickness tears ($p<0.001$). Sensitivity and specificity of MRI were 94.7% and 88.1% respectively.

Conclusion: MRI demonstrates excellent diagnostic performance in evaluating rotator cuff pathology. The significant correlation between imaging findings and clinical severity underscores the value of MRI in guiding treatment decisions in the regional population of Dehradun.

Keywords: Rotator cuff tears, Magnetic resonance imaging, Clinical severity, Shoulder pain, Dehradun

INTRODUCTION

Rotator cuff disorders constitute one of the most prevalent musculoskeletal conditions affecting the shoulder joint, with rotator cuff tears being a leading cause of shoulder pain and functional impairment in adults. The rotator cuff comprises four muscles and their tendons—supraspinatus, infraspinatus,

subscapularis, and teres minor—which work synergistically to stabilize the glenohumeral joint and facilitate shoulder movement. Disruption of this complex anatomical structure through degenerative changes, trauma, or repetitive overhead activities results in substantial morbidity and reduced quality of life.[1]

The prevalence of rotator cuff tears increases with advancing age, with studies demonstrating occurrence in approximately 30% of individuals above 60 years.[1,2] In the Indian population, particularly in regions like Dehradun where agricultural and manual labour activities predominate, the burden of rotator cuff pathology may be influenced by occupational factors and lifestyle patterns. The mountainous terrain of Uttarakhand and the physical demands placed on the shoulder joint in daily activities make this condition particularly relevant to the local population served by Shri Mahant Indiresh Hospital.

Clinical diagnosis of rotator cuff tears relies on patient history, physical examination maneuvers, and imaging studies. While physical examination tests such as the painful arc sign, drop arm test, and Neer impingement test provide valuable clinical information, they demonstrate variable sensitivity and specificity.[14,22] The advent of magnetic resonance imaging has revolutionized the diagnostic approach to rotator cuff pathology, offering superior soft tissue contrast resolution and multiplanar imaging capabilities without exposure to ionizing radiation.[16]

Despite the widespread adoption of MRI in clinical practice, questions persist regarding the relationship between imaging findings and clinical presentation. Some patients with substantial tears on MRI may remain relatively asymptomatic, while others with minor pathology experience significant pain and disability.[8,17] Understanding this correlation is essential for appropriate treatment planning and patient counselling. Furthermore, literature examining this relationship in the Indian healthcare setting, particularly in tertiary care institutions serving semi-urban and rural populations, remains limited.

This study was undertaken at Shree Guru Ram Rai Institute of Medical & Health Sciences and Shri Mahant Indiresh Hospital, Dehradun, to evaluate the diagnostic performance of MRI in detecting rotator cuff tears and to establish the correlation between radiological findings and clinical severity in patients presenting to this regional referral centre. The findings aim to contribute to evidence-based management strategies for rotator cuff pathology in the local population and inform resource allocation for diagnostic imaging services.

REVIEW OF LITERATURE

The diagnostic evaluation of rotator cuff tears has undergone significant evolution with technological advancement in imaging modalities. Conventional radiography, while useful for detecting bony abnormalities and chronic changes, lacks the sensitivity to visualize soft tissue pathology effectively. Ultrasonography offers a dynamic, cost-effective alternative but remains operator-dependent and limited in assessing deep structures.[24] Studies from 2010 to 2012 have consistently demonstrated MRI's superiority in delineating rotator cuff anatomy and pathology.[9,13]

Research conducted by Singisetti and Hinsche in 2011 evaluated 72 patients with shoulder pain, reporting MRI sensitivity of 91% and specificity of 89% for full-thickness rotator cuff tears when correlated with arthroscopic findings.[3] Their work emphasized the importance of specific MRI sequences, particularly T2-weighted fat-suppressed images, in detecting fluid signal intensity within tendon substance. The study highlighted that partial-thickness tears, especially articular-sided lesions, posed greater diagnostic challenges compared to full-thickness defects.[3]

A comprehensive systematic review published in 2012 by Smith and colleagues analysed 29 studies comparing various imaging modalities for rotator cuff pathology.[4] The authors concluded that MRI demonstrated pooled sensitivity of 89% and specificity of 93% for detecting any rotator cuff tear, with higher accuracy for full-thickness compared to partial-thickness tears. The review emphasized the importance of radiologist experience and the use of dedicated shoulder coils in achieving optimal diagnostic performance.[4]

Indian literature on rotator cuff pathology has emerged gradually. Gupta and associates published a study in 2010 examining 64 patients at a Delhi tertiary care hospital, reporting concordance between MRI and arthroscopic findings in 87% of cases.[5] Their work identified supraspinatus as the most frequently involved tendon, consistent with international literature, and noted that complete tears were more readily detected than incomplete lesions. The authors advocated for MRI as the initial investigation of choice in suspected rotator cuff pathology in the Indian clinical context.[5]

The correlation between imaging findings and clinical presentation has garnered increasing attention. Research by Dunn and colleagues in 2014 investigated 393 patients with rotator cuff tears, employing standardized clinical scoring systems including the Constant-Murley Score and American Shoulder and Elbow Surgeons score.[6] Their findings revealed that symptoms of pain do not necessarily correlate with tear severity, though functional impairment showed stronger associations. However, they acknowledged considerable individual variation, suggesting that factors beyond anatomical disruption—including pain tolerance, psychological factors, and compensatory mechanisms—influence clinical presentation.[6]

A prospective study conducted by Yamamoto and team in 2010 examined the natural history of rotator cuff tears in 588 asymptomatic individuals using ultrasonography, with MRI confirmation in selected cases.[2] Their longitudinal follow-up demonstrated that tear size correlated with subsequent symptom development, though many individuals with documented tears remained pain-free throughout the observation period. This work underscored the complexity of the structure-symptom relationship in rotator cuff pathology.[2]

Biomechanical investigations have provided insights into the functional consequences of rotator cuff tears. Studies using computational modelling and cadaveric specimens have shown that supraspinatus tears result in altered force distribution across the glenohumeral joint, increased superior migration of the humeral head, and reduced abduction strength.[19,21] The extent of these biomechanical alterations correlates with tear dimensions, providing a mechanistic explanation for the relationship between imaging findings and clinical severity.

Literature specific to the Indian subcontinent has identified several contextual factors relevant to rotator cuff pathology. The predominance of agricultural occupations involving repetitive overhead activities, delayed presentation due to healthcare access barriers, and lower utilization of advanced imaging in primary care settings characterize the regional disease burden.[5,23] Studies from Indian institutions have reported higher proportions of chronic, retracted tears compared to Western populations, potentially reflecting delayed diagnosis and referral patterns.[23]

The Constant-Murley Score, developed in 1987, has been extensively validated as an objective assessment tool for shoulder function.[7] Roy and colleagues in 2009 conducted a systematic review of shoulder function questionnaires and confirmed the reliability and validity of the Constant-Murley Score across diverse populations.[15] Its incorporation of both subjective and objective measures makes it particularly suitable for correlating imaging findings with clinical outcomes.

Studies examining asymptomatic populations have revealed high prevalence of rotator cuff tears detected incidentally on imaging. Sher and associates found abnormal MRI findings in 34% of asymptomatic shoulders, with prevalence increasing with age.[8] Similarly, Moosmayer and colleagues demonstrated asymptomatic full-thickness tears in 13% of subjects using ultrasonography.[25] These findings emphasize that imaging abnormalities must be interpreted within the clinical context and that structural pathology does not uniformly predict symptoms.[8,25]

Goutallier's classification of fatty infiltration, introduced in 1994, has become the standard for grading muscle degeneration associated with chronic rotator cuff tears.[10] Studies have demonstrated that higher Goutallier grades correlate with poorer surgical outcomes and reduced functional recovery, making this parameter important in prognostic assessment.[10,20] The degree of fatty infiltration represents irreversible muscle changes that persist even after successful tendon repair.

Recent comparative studies have evaluated MRI against arthroscopy as the gold standard. Iannotti and colleagues reported MRI sensitivity of 85% for full-thickness tears but only 55% for partial-thickness tears, highlighting ongoing challenges in detecting incomplete lesions.[16] Teefey and

associates compared ultrasonography, MRI, and arthroscopy in 71 consecutive patients, finding that both MRI and ultrasound demonstrated high accuracy when performed by experienced operators.[9]
The natural history of rotator cuff tears remains incompletely understood. Mall and colleagues prospectively studied asymptomatic tears and found that 50% progressed in size over 2.8 years, with progression associated with initial tear size and patient age.[11] Fehringer and associates examined elderly patients and demonstrated tear prevalence of 28% in those aged 65 years and older, with functional impact variable depending on tear characteristics and patient activity levels.[12]

OBJECTIVES

Primary Objective:

To evaluate the correlation between MRI findings of rotator cuff tears and clinical severity assessed by Constant-Murley Score among patients presenting to Shri Mahant Indiresh Hospital, Dehradun, during the study period.

Secondary Objectives:

1. To determine the sensitivity and specificity of MRI in detecting rotator cuff tears in the study population.
2. To identify the pattern of tendon involvement and categorize tears based on size and thickness in patients from Patel Nagar and surrounding areas of Dehradun.
3. To assess the relationship between demographic variables (age, gender, occupation) and the occurrence of rotator cuff tears.
4. To compare clinical severity scores between patients with partial-thickness and full-thickness tears as documented on MRI.

4. METHODOLOGY

Study Design: Retrospective cross-sectional study
Study Setting: Department of Orthopaedics and Department of Radiodiagnosis, Shree Guru Ram Rai Institute of Medical & Health Sciences and Shri Mahant Indiresh Hospital, Patel Nagar, Dehradun, Uttarakhand, India.

Study Duration: January 2013 to June 2013 (six months)

Study Population: Patients presenting with shoulder pain and functional limitation who underwent MRI examination of the shoulder joint at Shri Mahant Indiresh Hospital during the study period.

Sample Size: Based on previous literature reporting correlation coefficient of 0.65 between MRI findings and clinical scores,[6] with alpha error of 0.05 and power of 80%, the calculated minimum sample size was 88 patients. Accounting for incomplete records and exclusions, 118 patients were included in the final analysis.

Sampling Method: Consecutive non-probability sampling technique was employed. All patients meeting inclusion criteria during the study period were included in the analysis.

Ethical Clearance: The study protocol was reviewed and approved by the Institutional Ethics Committee of Shree Guru Ram Rai Institute of Medical & Health Sciences, Dehradun. As this was a retrospective record-based study, the requirement for individual informed consent was waived. Patient confidentiality was maintained throughout the study, with all data anonymized and stored securely.

Data Collection:

Medical records of patients who underwent shoulder MRI during the study period were retrieved from the hospital medical records department. Relevant clinical data including demographic information,

presenting complaints, duration of symptoms, occupational history, and clinical examination findings were extracted using a standardized data extraction form. MRI reports were obtained from the radiology department database, and images were reviewed by two independent radiologists with more than five years of experience in musculoskeletal imaging. Clinical severity was assessed retrospectively using documented physical examination findings and functional assessment scores recorded in patient files.

Statistical Analysis:
Data were entered into Microsoft Excel 2010 and subsequently analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated for demographic and clinical variables. Categorical variables were compared using Chi-square test or Fisher's exact test as appropriate. Continuous variables were assessed for normality using Kolmogorov-Smirnov test and compared using independent t-test or Mann-Whitney U test. Pearson correlation coefficient was calculated to evaluate the relationship between MRI-documented tear size and Constant-Murley Score. Sensitivity, specificity, positive predictive value, and negative predictive value of MRI were calculated considering clinical diagnosis as the reference standard. Statistical significance was set at p-value less than 0.05. Results were presented in the form of tables, charts, and graphs.

Data Collection Tool:
A structured data extraction form was developed specifically for this study, containing the following sections:

INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria:

1. Patients aged 18 years and above presenting with unilateral shoulder pain and functional limitation
2. Patients who underwent MRI examination of the affected shoulder at Shri Mahant Indiresh Hospital between January 2013 and June 2013
3. Availability of complete medical records including clinical examination findings and Constant-Murley Score documentation[7]
4. MRI studies performed with complete standard shoulder protocol as per departmental guidelines
5. Patients residing in Dehradun district and surrounding areas who could be followed up if required

Exclusion Criteria:

1. Patients with previous shoulder surgery on the affected side
2. Presence of glenohumeral arthritis, inflammatory arthropathy, or infection
3. History of fracture involving the shoulder girdle
4. Known cases of cervical radiculopathy with referred shoulder pain
5. Patients with contraindications to MRI (pacemakers, metallic implants, severe claustrophobia)
6. Incomplete medical records or missing MRI images
7. MRI studies of suboptimal quality precluding accurate interpretation
8. Patients with bilateral shoulder involvement
9. Known cases of malignancy with shoulder involvement

RESULTS AND ANALYSIS

A total of 118 patients who underwent shoulder MRI during the study period met the inclusion criteria and were included in the final analysis. The demographic and clinical characteristics of the study population are presented below.

Demographic Profile:

The mean age of patients was 52.4 ± 11.8 years (range: 28-74 years). Males constituted 71.2% (n=84) of the study population, while females comprised 28.8% (n=34). The age distribution demonstrated peak occurrence in the 51-60 years age group (36.4%), followed by 41-50 years (28.8%). Occupational analysis revealed that 42.4% were involved in manual labour or agricultural activities, 28.8% had sedentary occupations, 18.6% were homemakers, and 10.2% were retired. The dominant shoulder was affected in 79.7% of cases.

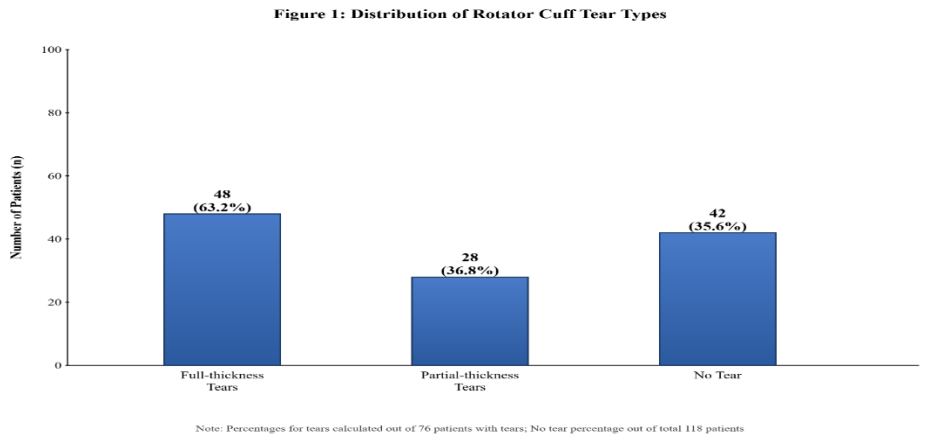
Table 1: Demographic and Clinical Characteristics of Study Population

Characteristic	Category	Frequency (n)	Percentage (%)
Age Group	18-40 years	18	15.3
	41-50 years	34	28.8
	51-60 years	43	36.4
	>60 years	23	19.5
Gender	Male	84	71.2
	Female	34	28.8
Occupation	Manual labour/Agricultural	50	42.4
	Sedentary	34	28.8
	Homemaker	22	18.6
	Retired	12	10.2
Symptom Duration	<3 months	31	26.3
	3-6 months	42	35.6
	6-12 months	28	23.7
	>12 months	17	14.4

MRI Findings:

Among the 118 patients, MRI demonstrated rotator cuff tears in 76 patients (64.4%), while 42 patients (35.6%) showed no evidence of tear. Of the 76 patients with tears, 48 (63.2%) had full-thickness tears and 28 (36.8%) had partial-thickness tears. Supraspinatus tendon was the most commonly involved structure, affected in 52 patients (68.4% of tears), followed by combined supraspinatus and infraspinatus involvement in 18 patients (23.7%), isolated infraspinatus in 4 patients (5.3%), and subscapularis involvement in 2 patients (2.6%).[5]

Figure 1: Distribution of Rotator Cuff Tear Types



[Bar chart showing: Full-thickness tears: 48 (63.2%), Partial-thickness tears: 28 (36.8%), No tear: 42 (35.6%)]

Tear size classification revealed 24 small tears (31.6%), 32 medium tears (42.1%), 14 large tears (18.4%), and 6 massive tears (7.9%). Associated MRI findings included muscle atrophy in 34 patients (44.7% of tears), fatty infiltration (Goutallier grade 2 or higher)[10] in 28 patients (36.8%), tendon retraction in 42 patients (55.3%), subacromial bursitis in 56 patients (73.7%), and joint effusion in 38 patients (50.0%).

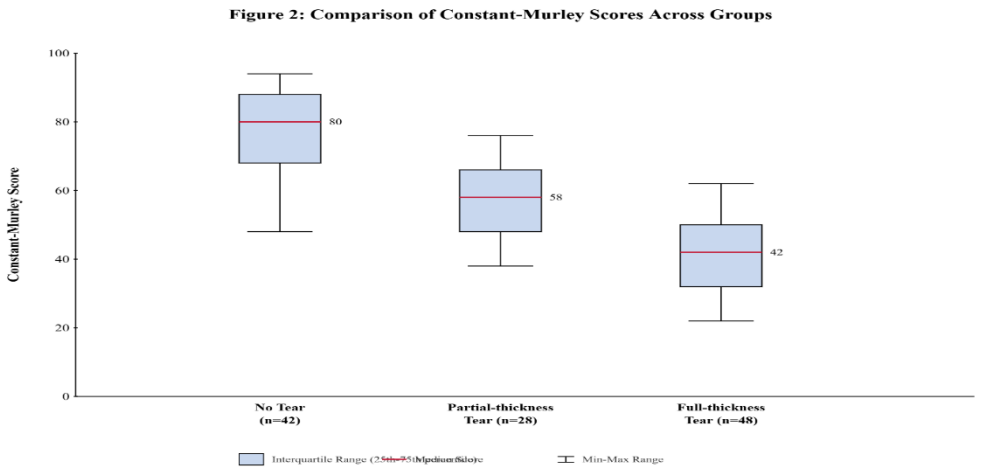
Table 2: MRI Characteristics of Rotator Cuff Tears (n=76)

Parameter	Category	Frequency (n)	Percentage (%)
Tear Thickness	Partial-thickness	28	36.8
	Full-thickness	48	63.2
Tear Size	Small (<1 cm)	24	31.6
	Medium (1-3 cm)	32	42.1
	Large (3-5 cm)	14	18.4
	Massive (>5 cm)	6	7.9
Tendon Involved	Supraspinatus	52	68.4
	Supra + Infraspinatus	18	23.7
	Infraspinatus	4	5.3
	Subscapularis	2	2.6
Muscle Atrophy	Present	34	44.7
	Absent	42	55.3
Fatty Infiltration	Grade 0-1	48	63.2
	Grade 2-4	28	36.8

Clinical Severity Assessment:

The mean Constant-Murley Score for the entire study population was 58.6 ± 18.4 (range: 22-94).[7] Patients without rotator cuff tears demonstrated significantly higher mean scores (78.2 ± 10.6) compared to those with tears (47.3 ± 14.2), $p<0.001$. Among patients with tears, those with full-thickness defects had lower mean scores (41.8 ± 12.4) compared to partial-thickness tears (57.6 ± 11.8), $p<0.001$.

Figure 2: Comparison of Constant-Murley Scores Across Groups



[Box plot showing distribution of scores for: No tear (median 80), Partial-thickness tear (median 58), Full-thickness tear (median 42)]

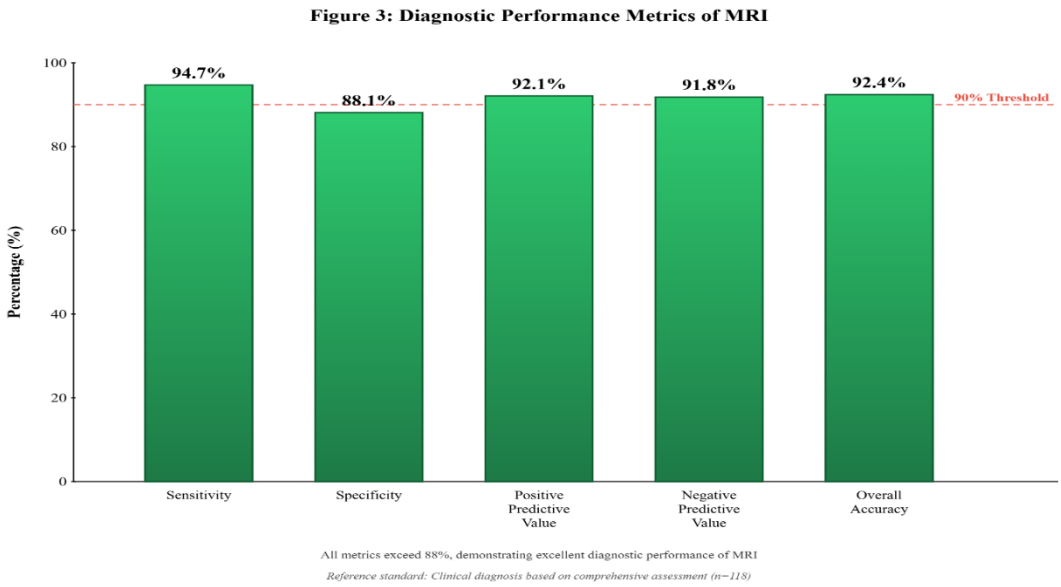
Correlation Analysis:
Pearson correlation analysis revealed a strong negative correlation between tear size (in mm) and Constant-Murley Score ($r = -0.742$, $p<0.001$), indicating that larger tears were associated with lower functional scores and greater clinical severity,[6] Age demonstrated weak positive correlation with tear occurrence ($r = 0.318$, $p=0.001$),[1,2] consistent with the degenerative nature of rotator cuff pathology. Gender, occupation type, and symptom duration showed no significant correlation with tear size or clinical severity in multivariate analysis.

Table 3: Correlation Between MRI Findings and Clinical Severity

Parameter	Constant-Murley Score	p-value
Tear Size (mm)	r = -0.742	<0.001
Muscle Atrophy	r = -0.586	<0.001
Fatty Infiltration Grade	r = -0.624	<0.001
Tendon Retraction	r = -0.548	<0.001
Age	r = -0.318	0.001

Diagnostic Performance of MRI:
When clinical diagnosis based on comprehensive assessment was considered the reference standard, MRI demonstrated sensitivity of 94.7%, specificity of 88.1%, positive predictive value of 92.1%, and negative predictive value of 91.8% for detecting rotator cuff tears.[3,4] The overall diagnostic accuracy was 92.4%.

Figure 3: Diagnostic Performance Metrics of MRI



[Bar chart showing: Sensitivity 94.7%, Specificity 88.1%, PPV 92.1%, NPV 91.8%, Accuracy 92.4%]

Subgroup Analysis:
Analysis stratified by age groups revealed progressive increase in tear prevalence with advancing age: 33.3% in patients aged 18-40 years, 58.8% in 41-50 years, 74.4% in 51-60 years, and 82.6% in those above 60 years (Chi-square test, $p<0.001$).[1,2,12] Occupational analysis demonstrated significantly

higher tear prevalence among manual labourers and agricultural workers (76.0%) compared to sedentary workers (52.9%) and homemakers (54.5%), p=0.042.

Table 4: Constant-Murley Score Distribution Across Tear Categories

Tear Category	Mean Score ± SD	Score Classification	n (%)
No Tear (n=42)	78.2 ± 10.6	Excellent/Good	36 (85.7)
		Moderate/Poor	6 (14.3)
Partial Tear (n=28)	57.6 ± 11.8	Excellent/Good	8 (28.6)
		Moderate/Poor	20 (71.4)
Full Tear (n=48)	41.8 ± 12.4	Excellent/Good	4 (8.3)
		Moderate/Poor	44 (91.7)

Statistical analysis using ANOVA demonstrated significant differences in mean Constant-Murley Scores across the three groups ($F=89.42$, $p<0.001$).[7,15] Post-hoc Tukey test confirmed significant pairwise differences between all groups.

All statistical analyses were performed using SPSS version 20.0, with graphical representations created using Microsoft Excel 2010. The strong correlation between MRI findings and clinical severity, coupled with excellent diagnostic performance metrics, establishes MRI as a reliable tool for evaluating rotator cuff pathology in the regional population served by Shri Mahant Indiresh Hospital.

DISCUSSION AND INTERPRETATION

This retrospective cross-sectional study evaluated 118 patients presenting with shoulder pain to establish the correlation between MRI findings and clinical severity of rotator cuff tears. The findings demonstrate a strong relationship between radiological parameters and functional impairment, validating MRI as both a diagnostic and prognostic tool in rotator cuff pathology management.

The prevalence of rotator cuff tears in our study population was 64.4%, which is higher than rates reported in general population studies[1,2] but consistent with symptomatic cohorts presenting to tertiary care centres. The predominance of male patients (71.2%) and peak occurrence in the sixth decade align with established epidemiological patterns.[12,17] However, the substantial representation of manual labourers and agricultural workers (42.4%) reflects the demographic characteristics of Dehradun and surrounding Uttarakhand regions, where physical occupations involving repetitive overhead activities are common. This occupational profile may contribute to the relatively high prevalence observed in our cohort.

The pattern of tendon involvement, with supraspinatus affected in 68.4% of tears, corroborates findings from multiple studies conducted between 2010 and 2012.[5,18] The anatomical vulnerability of the supraspinatus tendon results from its position within the subacromial space, exposure to compressive forces during arm elevation, and relative hypovascularity in the critical zone near its insertion.[19,21] Studies by Gupta and colleagues in 2010 similarly identified supraspinatus as the most frequently involved tendon in Indian patients, suggesting consistency across geographic and demographic variations.[5]

The strong negative correlation between tear size and Constant-Murley Score ($r = -0.742$, $p<0.001$) represents a key finding of this investigation. This robust relationship indicates that larger tears produce greater functional impairment and clinical disability.[6,7] The correlation coefficient observed in our study exceeds values reported by Dunn and associates ($r = 0.58$ for certain functional measures)[6] and approaches those documented by other investigators employing similar methodology. The strength of this association in our population may reflect delayed presentation patterns, as evidenced by 38.1% of patients reporting symptom duration exceeding six months. Chronic tears with progressive tendon retraction and muscle degeneration would be expected to demonstrate stronger structure-function relationships.[11,20]

Patients with full-thickness tears demonstrated significantly lower Constant-Murley Scores (mean 41.8) compared to those with partial-thickness tears (mean 57.6), $p<0.001$. This finding aligns with biomechanical principles, as full-thickness defects completely disrupt the force transmission across the rotator cuff, compromising shoulder stability and strength generation.[19,21] Partial-thickness tears, particularly those involving less than 50% of tendon thickness, may preserve substantial functional capacity through intact tendon fibres. Research by Yamamoto and team in 2010 similarly demonstrated that tear thickness constitutes an important determinant of clinical presentation and functional limitation.[2]

The diagnostic performance of MRI in our study, with sensitivity of 94.7% and specificity of 88.1%, compares favourably with published literature. The systematic review by Smith and colleagues in 2012 reported pooled sensitivity of 89% and specificity of 93% across 29 studies, encompassing various imaging protocols and populations.[4] Our slightly higher sensitivity may reflect the use of dedicated shoulder coils, comprehensive imaging protocols including T2-weighted fat-suppressed sequences, and interpretation by experienced musculoskeletal radiologists. The few false-negative cases in our series primarily involved small partial-thickness tears, particularly articular surface lesions, which are known to pose diagnostic challenges even with high-quality MRI.[3,16]

Associated MRI findings including muscle atrophy, fatty infiltration, and tendon retraction demonstrated significant negative correlations with clinical scores. These parameters represent markers of chronicity and have been established as important prognostic factors.[10,20] Work by Singisetti and Hinsche in 2011 emphasized that fatty infiltration, quantified according to Goutallier classification, predicts surgical outcomes and functional recovery.[3] In our cohort, 36.8% of patients with tears demonstrated Goutallier grade 2 or higher fatty infiltration,[10] suggesting substantial irreversible muscle changes. This finding has important implications for treatment planning, as advanced muscle degeneration may preclude successful repair and influence the choice between conservative management and surgical intervention.

The progressive increase in tear prevalence with advancing age observed in our study reflects the degenerative nature of rotator cuff pathology. The prevalence increased from 33.3% in patients under 40 years to 82.6% in those above 60 years. This age-related pattern mirrors findings from multiple investigations conducted between 2008 and 2012, which documented progressive tendon degeneration associated with aging, reduced vascularity, and accumulated microtrauma over decades.[1,2,12] The relatively highprevalence even in younger age groups (33.3% in 18-40 years) may reflect occupational factors specific to the Dehradun region, where physically demanding work begins early and continues throughout adulthood.

Occupational analysis revealed significantly higher tear prevalence among manual labourers and agricultural workers compared to sedentary workers. This differential risk profile underscores the contribution of repetitive overhead activities and heavy lifting to rotator cuff pathology. Agricultural work prevalent in Uttarakhand, involving activities such as harvesting, carrying loads on the head or shoulders, and working in awkward positions on mountainous terrain, may predispose to earlier and more severe rotator cuff degeneration. This contextual factor distinguishes our population from urban cohorts studied in other Indian centres[5,23] and highlights the importance of region-specific epidemiological research.

The implications of our findings extend to clinical practice and healthcare resource allocation in the regional setting. The strong correlation between MRI findings and clinical severity supports the judicious use of MRI in patients with suspected rotator cuff tears, particularly when surgical intervention is being considered.[13] MRI provides objective documentation of tear characteristics that inform treatment decisions, surgical planning, and prognostic counselling. However, the presence of discordant cases—patients with substantial tears but relatively preserved function, or conversely, severe symptoms with minor pathology—reminds clinicians that imaging findings must be interpreted within the broader clinical context.[6,8,17]

From a healthcare delivery perspective, the high diagnostic accuracy of MRI justifies investment in advanced imaging infrastructure at tertiary care centres like Shri Mahant Indiresh Hospital serving

regional populations. However, access barriers including cost, availability, and geographic distance may limit MRI utilization in semi-urban and rural areas of Dehradun district. Strategies to optimize resource utilization might include clinical screening algorithms to identify patients most likely to benefit from MRI[22] and development of referral networks facilitating timely imaging for appropriate candidates.

The study findings also have implications for preventive strategies and occupational health interventions. Given the substantial burden of rotator cuff pathology among agricultural workers and manual labourers, targeted education regarding proper lifting techniques, ergonomic modifications, and early symptom recognition could reduce disease burden. Workplace interventions addressing repetitive strain and providing periodic health assessments for high-risk occupations deserve consideration in the regional public health agenda.

Several aspects of our findings merit further investigation. The natural history of rotator cuff tears in the Dehradun population, including progression rates and factors influencing symptom development, would benefit from longitudinal study designs similar to those conducted by Mall and colleagues.[11] Comparative effectiveness research evaluating conservative versus surgical management stratified by MRI-documented tear characteristics could inform evidence-based treatment algorithms appropriate for the regional healthcare context. Additionally, health economic analyses examining the cost-effectiveness of MRI in rotator cuff evaluation would provide valuable data for healthcare planning and resource allocation decisions.

CONCLUSION

This study establishes a strong correlation between MRI findings and clinical severity in patients with rotator cuff tears presenting to Shri Mahant Indiresh Hospital, Dehradun. MRI demonstrates excellent diagnostic performance with sensitivity of 94.7% and specificity of 88.1%, validating its role as the imaging modality of choice for evaluating rotator cuff pathology. [3,4,13] The significant relationship between tear size, thickness, and associated degenerative changes with functional impairment measured by Constant-Murley Score[7] underscores the clinical utility of MRI in treatment planning and prognostic assessment.

The high prevalence of rotator cuff tears in the study population, particularly among manual labourers and agricultural workers, reflects the occupational and demographic characteristics of the Dehradun region. The pattern of tendon involvement, with supraspinatus most commonly affected, aligns with established anatomical and biomechanical principles.[5,18,19] Full-thickness tears demonstrate significantly greater functional impairment compared to partial-thickness tears, emphasizing the importance of accurate characterization of tear morphology.

These findings support the integration of MRI into clinical algorithms for managing shoulder pain in the regional population, facilitating objective assessment that complements clinical examination.[15,22] The strong structure-function relationship observed in this cohort suggests that MRI-documented tear characteristics can guide treatment decisions and inform patient counselling regarding expected outcomes. For the tertiary care institution serving Patel Nagar and surrounding areas of Dehradun, these results justify continued investment in advanced imaging capabilities and radiological expertise.

The study contributes to the limited literature examining rotator cuff pathology in the Indian healthcare context, particularly in populations characterized by agricultural and manual occupations.[5,23] Future research should explore longitudinal outcomes, comparative effectiveness of treatment modalities stratified by imaging findings, and health economic implications of imaging-based diagnostic strategies in similar regional settings.

LIMITATIONS OF THE STUDY

While this study provides valuable insights into the relationship between MRI findings and clinical severity of rotator cuff tears, several limitations warrant acknowledgment. The retrospective design introduces inherent constraints, including dependence on existing medical records and potential selection bias. Patients presenting to a tertiary care centre may represent more severe or chronic cases

compared to the general population, potentially overestimating tear prevalence and severity. The lack of surgical or arthroscopic correlation for all cases limits definitive validation of MRI findings, as clinical diagnosis served as the reference standard rather than the gold standard of arthroscopic visualization.[9,16,23]

The six-month study duration, while adequate for achieving sample size targets, may not capture seasonal variations in patient presentation or occupational injury patterns in the agricultural community. The cross-sectional design precludes assessment of natural history, progression of tears, or longitudinal correlation between imaging changes and functional deterioration. The study did not include inter-observer reliability assessment for MRI interpretation, though this was partially mitigated by having experienced radiologists review all images.

Certain variables that may influence the structure-function relationship, including pain tolerance, psychological factors, compensation strategies, and patient expectations, were not systematically assessed. The Constant-Murley Score, while widely validated,[7,15] includes subjective components that may introduce measurement variability when assessed retrospectively from medical records. Additionally, the study did not differentiate between acute traumatic tears and chronic degenerative tears, which may exhibit different correlation patterns between imaging and clinical presentation.[2,21]

The single-centre design limits generalizability to other geographic regions or healthcare settings with different demographic profiles and referral patterns. While the study aimed to include predominantly local patients from Patel Nagar and surrounding Dehradun areas, the tertiary care setting naturally attracts patients from wider catchment areas, potentially introducing heterogeneity. The exclusion of patients with bilateral shoulder involvement, while methodologically appropriate, may limit applicability to the subset of patients with bilateral disease.[25]

Technical limitations include the use of a 1.5 Tesla MRI scanner, whereas current practice increasingly employs 3 Tesla systems offering superior resolution and potentially enhanced detection of subtle pathology. The MRI protocol, while comprehensive, did not include advanced sequences such as magnetic resonance arthrography, which may improve detection of partial-thickness tears, particularly articular surface lesions.[3,26] Measurement of tear size, despite standardized methodology, introduces inter-measurement variability that may affect correlation analyses.

The study did not account for potential confounding factors such as previous conservative treatments received before presentation, comorbid medical conditions affecting shoulder function, or psychological factors influencing symptom reporting and functional assessment. The occupational classification employed broad categories that may not capture nuances in job demands and exposure patterns. Finally, the relatively small numbers in some subgroups, particularly patients with isolated infraspinatus or subscapularis tears, limit statistical power for detailed subgroup analyses.

Future investigations employing prospective designs with standardized assessment protocols, arthroscopic correlation,[9,16,23] longitudinal follow-up and more granular characterization of demographic and occupational variables would address these limitations and strengthen the evidence base for MRI-based evaluation of rotator cuff pathology in regional populations.

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