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THE ASSESSMENT OF CAPABILITIES AND ADVANTAGES OF MAGNETIC RESONANCE IMAGING IN ROTATOR CUFF TEARS

M. Khodjibekov*[1], M. Tumasova[1], Yu. Khodjibekova[2], B. Axmedov[3]

[1]Tashkent Tashkent Medical University, Tashkent, Uzbekistan.

***Corresponding Author: M. Khodjibekov**

Tashkent Tashkent Medical University, Tashkent, Uzbekistan.

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ABSTRACT

Relevance. Magnetic resonance imaging (MRI), particularly when using surface coils, has become the preferred imaging modality for evaluating soft tissues surrounding the shoulder joint. Accurate diagnosis requires a thorough understanding of MRI characteristics of the rotator cuff tendons, the acromion, and associated abnormalities. **Materials and Methods.** The study was conducted at the Republican Specialized Scientific and Practical Medical Center of Traumatology and Orthopedics and four clinics of the Tashkent Medical Academy using a 1.5T MRI scanner. A total of 50 patients with rotator cuff lesions were examined. **Results.** Participant ages ranged from 19 to 66 years, with a mean age of 43 ± 14.8 years, and peak incidence occurring in the fifth and sixth decades of life. No significant gender differences were noted in the distribution of rotator cuff pathologies. Pain was the most frequently reported symptom. Abnormalities of the supraspinatus tendon were observed in 84% of patients, making it the most commonly affected tendon, followed by the subscapularis and infraspinatus tendons. No significant pathology was found in the teres minor tendon. The most prevalent supraspinatus tendon condition was tendinosis (38%), followed by partial tears (36%), with articular-surface partial tears being the most common type. Approximately 52% of patients presented with a type II (curved) acromion, making it the most frequent acromial morphology, followed by type III (hooked). Supraspinatus tendinopathy was more commonly associated with type II acromion. A reduced acromiohumeral distance was linked to supraspinatus tendinosis and an increased susceptibility to tears. Supraspinatus tendon tears were found in 45.5% of patients with an acromiohumeral distance of less than 8 mm, compared to 13.6% when the distance exceeded 10 mm. Notably, only 4.2% of patients with an acromiohumeral distance below 7 mm had a normal supraspinatus tendon. **Conclusion.** MRI provides orthopedic surgeons with critical information regarding the condition of tendons, bones, and joints. Accurate identification of abnormalities and clear reporting of relevant rotator cuff imaging findings are essential for determining an appropriate course of action. A comprehensive understanding of the structure and function of the rotator cuff, as well as the implications of its pathologies, is indispensable for effective diagnosis and treatment.

KEYWORDS: MRI, shoulder joint, rotator cuff.

Relevance. Rotator cuff (RC) tears of the shoulder joint are a major cause of pain and disability among all shoulder pathologies [Arkhipov S.V., 1998; Longo, 2012; Tashjian, 2012]. RC serves as a key dynamic stabilizer of the shoulder joint [Dokolin S.Yu., 2013; Egiazaryan K.A., 2017; Kuzmina V.I., 2015; Logvinov A.N., 2019; Denard, 2012].

Anatomically, the RC is located within the subacromial and subcoracoid spaces and is in close contact with the long head of the biceps tendon, which predisposes it to degenerative-dystrophic and traumatic changes, including tendinosis, partial- and full-thickness tears, and calcific tendinitis [Logvinov A.N., 2019; Strafun S.S., 2017; Shirokov V.M., 2012; Goutallier, 2011; McLean, 2019; Nyffeler, 2017].

Such injuries lead to dysfunction of the rotator cuff, resulting in chronic pain syndrome, which in turn reduces both general and occupational functionality of the upper limb [Kuzmina V.I., 2015; Logvinov A.N., 2019; Tikhilov R.M., 2011; Favard, 2009; Rashid, 2017].

The shoulder joint is composed of the humerus, clavicle, and scapula, offering a greater range of motion than any other joint while maintaining stability during daily activities. The shoulder complex consists of three joints: the glenohumeral, acromioclavicular, and sternoclavicular joints. The glenohumeral joint is a true synovial ball-and-socket joint formed by the head of the humerus and the glenoid fossa of the scapula. It allows extensive movements including abduction, adduction, flexion, extension, internal (medial) rotation, external (lateral) rotation, and circumduction, making it the most mobile joint in the human body. However, it is also the least stable joint, being the most frequently dislocated diarthrodial joint.

The acromioclavicular joint is likewise a diarthrodial joint, where the lateral end of the clavicle articulates with the acromion process. Under normal physiological conditions, this joint functions as a synovial gliding joint, facilitating shoulder abduction and flexion by connecting the scapula to the thorax. It also plays a role in transmitting forces from the upper limb to the axial skeleton. While the multiaxial nature of the shoulder joint provides an extensive range of motion, it also compromises skeletal stability.

Five primary stabilizers support the shoulder joint: (1) the rotator cuff muscles, (2) the biceps tendon, (3) the capsular structures and other associated elements that collectively maintain joint integrity and function, (4) the glenoid labrum, and (5) negative intra-articular pressure.

In recent years, there has been growing recognition that rotator cuff disorders are multifactorial in nature, involving both extrinsic and intrinsic mechanisms. The extrinsic mechanism is associated with repetitive microtrauma that places mechanical stress on the tendon, leading to microtears. The intrinsic mechanism involves tendon degeneration and critical vascular zones, which predispose the tendon to tearing even in the context of low-energy trauma. Given that the rotator cuff is a key stabilizer of the shoulder joint, its injury can result in significant dysfunction, including stiffness, restricted or painful movement, and limitations in daily activities.

With the development and refinement of advanced imaging technologies, the detection of rotator cuff injuries has markedly improved. A variety of imaging modalities—including conventional radiography, ultrasonography (USG), computed tomography (CT), MRI, and arthrography—are essential for diagnosing RC pathologies. In imaging assessment of RC, it is crucial to determine the condition of the cuff, understand potential clinical implications, and accurately report relevant findings.

Given these advancements, MRI has emerged as the preferred imaging modality for evaluating soft tissues around the shoulder joint. A precise understanding of MRI characteristics of the rotator cuff tendons and their associated abnormalities is critical for accurate diagnosis and effective treatment planning.

In this context, the objectives of the study are to deepen our understanding of pathological conditions affecting the RC tendons and to explore the challenges associated with MRI characteristics of these disorders. Furthermore, the study aims to examine the distribution of sex and age within the cohort, document presenting symptoms, and assess potential implications associated with rotator cuff pathologies.

OBJECTIVE

To evaluate the capabilities and advantages of MRI in the assessment of rotator cuff tears of the shoulder.

MATERIALS AND METHODS

We conducted a prospective, descriptive, and analytical study involving 50 patients with rotator cuff injuries of the shoulder, identified through MRI performed at the Department of Shoulder Pathology, Republican Scientific and Practical Center of Traumatology and Orthopedics. The study period extended from July 2022 to September 2023. The primary objective was to characterize the MRI features of rotator cuff pathologies and to evaluate how age and sex influence their distribution within the study population.

MRI examinations were performed based on the referral of the attending physician; no patient underwent MRI solely for the purposes of this research. All MRI scans were conducted using a Siemens 1.5 Tesla MRI system. Inclusion criteria comprised patients aged over 18 years with suspected rotator cuff pathology. Exclusion criteria included postoperative orthopedic implants, claustrophobia, pacemakers, metallic foreign bodies, biostimulators, neurostimulators, and cochlear implants. All patients meeting inclusion and exclusion criteria underwent MRI assessment.

A standardized pro forma was developed in alignment with the study objectives to record key clinical history, physical examination findings, and results of systematic assessment. In addition, anteroposterior (AP) radiographs of the shoulder joint or high-resolution ultrasonography were performed when clinically indicated.

On T1- and T2-weighted images, a **full-thickness rotator cuff tear** was defined as a focal, well-demarcated area of high signal intensity extending from the bursal to the articular surface. In contrast, a **partial-thickness tear** was diagnosed when fluid-equivalent signal intensity did not extend through the entire thickness of the tendon.

RESULTS

A total of 50 patients with rotator cuff disorders of the shoulder were included in the study. The mean age of participants was 43 ± 14.8 years, ranging from 18 to 68 years. The highest prevalence of rotator cuff pathology was observed in the 52–62-year age group (22.0%). More than half of the patients (56%) were male, while 44% were female.

The most frequently reported primary complaint was isolated shoulder pain, reported by 20 patients (40%). Other presenting complaints, in decreasing order of frequency, included joint stiffness (10 patients, 20%), a combination of pain and stiffness (9 patients, 18%), difficulty lifting the arm (7 patients, 14%), and weakness (4 patients, 8%). Less common pain-associated symptoms were numbness (2 patients) and skin discoloration (1 patient).

Assessment of the supraspinatus tendon revealed that nine patients (18%) had no abnormalities, whereas the remaining 41 patients (82%) demonstrated pathological findings. Among these 41 cases: 19 patients (38.0%) had tendinopathy; 18 patients (36%) presented with partial tears, and 4 patients (8.0%) had full-thickness tears (Figures 1a–1c, Table 1).

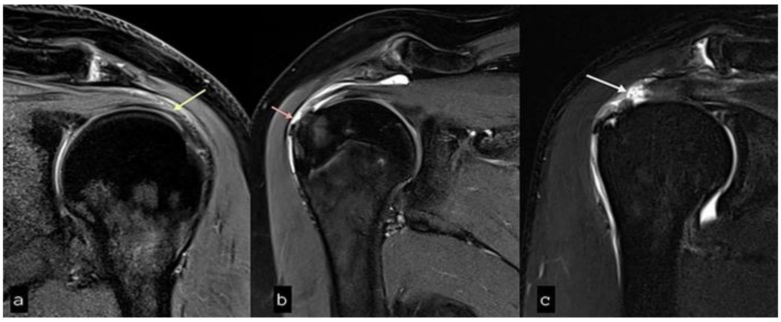

Fig. 1. Coronal proton density fat-saturated (PDFS) images demonstrating: (a) Supraspinatus tendon tendinopathy, (b) Partial tear of the supraspinatus tendon, and (c) Full-thickness tear of the supraspinatus tendon.

Table 1: Pathology of the Supraspinatus Tendon (n-50)

Pathology of the Supraspinatus Tendon	#	%
Without pathology	9	18.0
Tendinopathy	19	38.0
Partial tear	18	36.0
Full-thickness tear	4	8.0
total	50	100.0

Partial tears can be further classified into three categories: **intrasubstance tears**, which do not involve the tendon surfaces; **articular-sided partial tears**, which affect the humeral side of the supraspinatus tendon; and **bursal-sided partial tears**, which involve the acromial side. Among patients with partial tears, nine (50%) had articular-sided tears, three (16.7%) had intrasubstance tears, and six (33.3%) had bursal-sided tears (Figures 2a–2c).

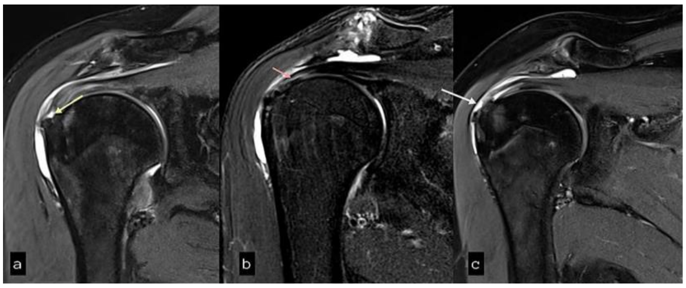

Fig. 2. Coronal proton density fat-saturated (PDFS) images illustrating: (a) a partial-thickness articular-surface tear of the supraspinatus tendon, (b) a partial-thickness intrasubstance tear of the supraspinatus tendon, and (c) a partial-thickness bursal-surface tear of the supraspinatus tendon.

Pathology of the infraspinatus tendon (Table 2): among nine patients with infraspinatus tendon pathology, four (44.4%) presented with tendinopathy, four (44.4%) with partial tears, and one (11.1%) with a complete tear.

Pathology of the subscapularis tendon (Table 3): among 21 patients with subscapularis tendon pathology, 15 (71.4%) had tendinopathy, five (23.8%) had partial tears, and one (4.8%) had a complete tear.

Table 2: Pathology of the infraspinatus tendon (n-50).

Pathology of the infraspinatus tendon	#	%
Without pathology	29	58.0
Tendinopathy	15	30.0
Partial tear	5	10.0
Full-thickness tear	1	2.0
total	50	100.0

Table 3: Determination and evaluation of acromion type (n = 50)

Acromioclavicular configuration	#	%
Horizontal	17	34.0
Posterior downsloping	13	26..0
Anterior downsloping	6	12.0
Inferolateral downsloping	12	24.0
Low-lying	2	4.0
total	50	100.0

In the evaluation of acromion types, the following distributions were observed: A flat-type acromion was identified in seven patients (14%), while more than 50% of cases demonstrated a curved-type acromion (Figures 3a–3d). The remaining 34% of patients presented with either a hooked or convex acromion type. Notably, the curved type emerged as the most prevalent configuration in this study (Table 4).

Among the participants, 17 patients (34%) exhibited a horizontal acromion, and 12 (24%) demonstrated an inferolateral tilt. Moreover, two patients (4%) showed a low-lying acromion. Within the subgroup of 12 patients with an inferolateral tilt, two (16.7%) had normal supraspinatus tendons, three (25%) had tendinosis, five (41.6%) had partial tears, and two (16.7%) had full-thickness tears.

Posteroinferior displacement of the acromion was observed in 13 patients (26%), while anteroinferior displacement was noted in six patients (12%). In the group with a horizontal or upward-oriented acromion, three patients (17.6%) had normal tendons, four (23.5%) exhibited tendinosis, and ten (58.8%) demonstrated tendon tears (Table 5).

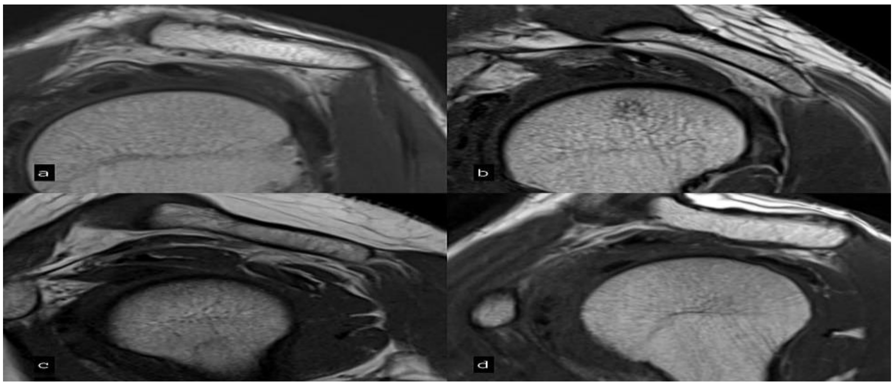

Fig. 3. Sagittal T1-weighted images depicting acromion types: (a) Flat – Type I, (b) Curved – Type II, (c) Hooked – Type III, and (d) Convex – Type IV.

Table 5: Correlation between Acromioclavicular Joint Configuration and Supraspinatus Tendon Pathology (n = 50)

Pathologies of the supraspinatus tendon	Types of acromion							
	Flat		Curved		Hooked		Convex	
	n	%	n	%	n	%	n	%
Without pathology	1	14.3	2	7.7	5	35.7	1	33.3
Tendinopathy	3	42.9	13	50	3	21.4	0	-
Partial tear	3	42.9	8	30.8	5	35.7	2	66.7
Full-thickness tear	0	-	3	11.5	1	7.1	0	-
total	7	100	26	100	14	100	3	100

The relationship between the acromiohumeral distance (AHD) and supraspinatus tendon pathology was also evaluated. AHD was measured as the distance between the superior articular surface of the humeral head and the inferior surface of the acromion. Patients were categorized based on their AHD measurements: less than 8 mm, 8–10 mm, and greater than 10 mm. Tendinopathy was most prevalent among patients with AHD less than 8 mm, occurring in 54.2% of this group, whereas the lowest prevalence (11.1%) was observed in patients with AHD greater than 10 mm. Partial tears were most frequent (41.2%) in the 8–10 mm category, which also included a significant proportion of full-thickness tears. The association between AHD and supraspinatus tendon pathology was statistically significant ($p > 0.02$) (Table 6).

Discussion: MRI has become an essential tool for evaluating musculoskeletal disorders, particularly with the development of surface coils. MRI offers distinct advantages over conventional imaging methods, especially in its ability to visualize shoulder soft tissue components in multiple planes. This capability allows for precise identification and quantification of rotator cuff abnormalities, which is critical for accurate diagnosis and treatment. Unlike ultrasonography, MRI effectively visualizes the subacromial space—where many rotator cuff problems occur—and provides detailed differentiation of tear quality, clearly classifying them according to standard criteria.

Age distribution of rotator cuff pathology: In this study, patients with rotator cuff pathology ranged from 19 to 66 years old, with a mean age of 43.3 ± 14.8 years. The highest prevalence was observed in individuals aged 50 years and older, consistent with previous studies indicating increased rotator cuff degeneration with age. Research suggests that intrinsic factors play a significant role in rotator cuff disorders, with age-related changes in tendon microvascularization and structure correlating with patterns of degeneration typically observed in tendinopathy.

Gender distribution: The study population showed an almost equal gender distribution: 52% male and 48% female. This aligns with existing literature, which does not report significant gender differences in the prevalence of rotator cuff pathology.

Clinical presentation: Pain was identified as the predominant symptom among patients with rotator cuff problems, particularly exacerbated by overhead activities. This aligns with prior studies highlighting pain as a key indicator of rotator cuff dysfunction, often accompanied by weakness and restricted range of motion.

Pathology analysis: Impingement syndrome, leading to tendinopathy and varying degrees of rotator cuff tears, was common in this cohort. The supraspinatus tendon was the most frequently affected, consistent with findings from other studies. Notably, abnormalities of the teres minor were not observed, reflecting its lower incidence compared to other tendons.

Partial tears were classified based on the extent of tendon involvement, demonstrating that these tears can occur on any tendon surface. Fluid accumulation in the subdeltoid bursa often aids in assessing the severity and type of partial tears. Full-thickness tears, more commonly seen in the supraspinatus tendon, were also documented in accordance with established literature.

Acromion morphology and pathology: Acromion type and orientation significantly influenced rotator cuff pathology. In this study, the curved acromion was the most prevalent morphology and was associated with higher rates of supraspinatus tendinopathy and tears. Previous studies have similarly linked specific acromion types with increased impingement risk, particularly types II and III. Acromion alignment also plays a critical role in shoulder biomechanics, especially during abduction and rotation. This study found that a substantial portion of participants had acromion types associated with elevated impingement risk, further complicating rotator cuff pathology.

Limitations: The study acknowledges limitations, including a small sample size and the lack of correlations with arthroscopic findings. Future research should include larger cohorts and integrate clinical, pathological, and surgical correlations to better understand disease progression and improve treatment protocols.

Conclusions: MRI is a valuable diagnostic tool for assessing rotator cuff injuries, providing critical information regarding tendon, bone, and joint status. The findings of this study support the recommendation of MRI as a first-line imaging modality when rotator cuff tears are suspected. A comprehensive understanding of shoulder rotator cuff anatomy and associated pathologies is essential for accurate diagnosis and effective treatment planning.

Additional Information

Human Subjects: Informed consent was obtained from all participants involved in this study. Ethical approval was granted by the Institutional Ethics Subcommittee at Dr. DY Patil Medical College, Hospital, and Research Centre (Approval No. IESC/PGS/2019/167).

Animal Subjects: All authors confirm that no animals or animal tissues were used in this study.

Conflicts of Interest: In accordance with the ICMJE uniform disclosure form, all authors declare the following:

- **Payment/Services Information:** This work did not receive financial support from any organization.
- **Financial Relationships:** All authors declare that they have no financial relationships, either currently or within the past three years, with any organizations that could be perceived as having an interest in the submitted work.
- **Other Relationships:** All authors declare no other relationships or activities that could influence the submitted work.

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