ROLE OF MRI IN ROTATOR CUFF INJURIES

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ABSTRACT

BACKGROUND

Rotator cuff unit plays an important role in the normal functioning of the shoulder joint and any injury to these muscles will lead to potential clinical consequences. Hence, it is necessary to understand its anatomy, functioning and to identify any deviation from its normal pattern in imaging. For this, MRI of shoulder joint gives us the required information in detail without actually subjecting the patients to ionizing radiation.

MATERIALS AND METHODS

Data source was the patients referred to the Department of Radiodiagnosis, MVJ Medical College and Research Hospital, Bangalore. The study included 30 patients, both male and female, with shoulder joint pain on clinical examination. The study period was from November 2015 to October 2017. MRI was performed using a 1.5 tesla MRI scanner (Siemens MAGNETOM ESSENZA).

RESULTS

The age of patients with rotator cuff pathologies ranged from 11 to 80 years. Males (70%) were most commonly affected compared to females (30%). The most commonly affected tendon was supraspinatus (97%) followed by subscapularis (17%) and infraspinatus (7%). Teres minor tendon was normal in all the patients.

CONCLUSION

MRI is currently the modality of choice for the imaging of the shoulder joint and to delineate the soft tissues of the shoulder joints. MR imaging is a wonderful tool for delineating normal structures and abnormalities of the rotator cuff and for determining the location and extent of rotator cuff tears before surgery. MR imaging can accurately demonstrate tendinosis, full-thickness and partial-thickness rotator cuff tears.

KEYWORDS

Shoulder Joint, Rotator Cuff Injury, Supraspinatus, Subscapularis, Infraspinatus, Teres Minor.

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BACKGROUND

The rotator cuff is a functional anatomic unit rather than four unrelated tendons, and injury to one component may have an influence on other regions of the rotator cuff.[1] A thorough understanding of the anatomy and function of the rotator cuff and of the consequences of rotator cuff disorders is essential for optimal treatment planning and prognostic accuracy. Identifying the disorder, understanding the potential clinical consequences, and reporting all relevant findings at rotator cuff imaging are essential. MRI has several advantages including good spatial resolution, good temporal resolution, wide field-of-view, and multiplanar imaging/reconstruction capabilities, all without using ionizing radiation.[1,2]

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Aims and Objectives

- To describe the MRI characteristics of rotator cuff injuries.
- To describe the distribution of pathologies in terms of age, gender, symptomatology and secondary changes/sequelae among the study population.

MATERIALS AND METHODS

Data source was the patients referred to the Department of Radiodiagnosis, MVJ Medical College and Research Hospital, Bangalore. The study included 30 patients, both male and female, with shoulder joint pain on clinical examination. The study period was from November 2015 to October 2017. MRI was performed using a 1.5 tesla MRI scanner (Siemens

MAGNETOM ESSENZA). A dedicated shoulder array coil was used, with patient in supine position with the arm at the side in neutral position or slight external rotation for a standard examination. MRI was performed using a 1.5 tesla MRI scanner (Siemens MAGNETOM ESSENZA). Axial, coronal and sagittal T1, T2, Proton Density (PD) and Short Tau Inversion Recovery (STIR) (in coronal plane) images were taken.

Inclusion Criteria

Patients who are clinically suspected to have a;

- Rotator cuff pathology.
- Both acute and chronic rotator cuff lesion.
- In those whom MR imaging reveals a rotator cuff lesion.

Exclusion Criteria

- Patients with metallic implants, cardiac pacemakers, cochlear implants.
- Post treatment patients.
- Post-surgery patients.
- Patients who are claustrophobic.
- Patient who are unwilling for imaging.

RESULTS

The present study was carried out to describe MRI characteristics of painful shoulder joint. Only patients fulfilling the inclusion and exclusion criteria were included in the study, and all the patients in this study showed rotator cuff pathologies.

Data Analysis

Thirty patients were included in the study, and the observations of these patients were compiled and analysed.

Age-wise Distribution of Patients

The age of patients with rotator cuff pathologies ranged from 11 to 80 years.

The patients in the study were divided into 7 age groups, viz., 11 to 20 years, 21 to 30 years, 31 to 40 years, 41 to 50 years, 51 to 60 years, 61 to 70 years and 71 to 80 years. There was no patients (0%) in 11-20 years age group, 5 (17%) in 21-30 years age group, 2 (7%) patients in 31-40 years age group, 7 (23%) patients in 41-50 years age group, 8 (27%) patients in 51-60 years age group, 6 (20%) patients in 61-70 years age group and 2 (7%) patients in 71-80 years group as given in Table 1 and Chart 1. Peak incidence of pathologies was seen in the 5th and 6th decade of life with 23% and 27% respectively.

Age Group	Frequency
11 to 20	0
21 to 30	5
31 to 40	2
41 to 50	7
51 to 60	8
61 to 70	6
71 to 80	2
Total	**30**

Table 1. Age-Wise Distribution of Patients

Sex-wise Distribution of Patients

Among 30 patients included in the study, 21 (70%) were male and 9 (30%) were female.

Sex	Frequency	Percent
Male	21	70%
Female	9	30%
Total	**30**	**100%**

Table 2. Sex-Wise Distribution of Patients

Affected Shoulder

Right shoulder was affected in 18 (60%), and left shoulder was affected in 12 (40%) patients.

Affected Shoulder	Frequency	Percent
Right	18	60%
Left	12	40%
Total	**30**	**100%**

Table 3. Affected Shoulder

Dominant Hand

Dominant Hand	Frequency	Percent
Right	29	96.67%
Left	1	3.33%
Total	**30**	**100%**

Table 4. Dominant Hand

Distribution of Abnormalities in Rotator Cuff Tendons

Tendon	Abnormal	Normal
Supraspinatus	29	1
Subscapularis	5	25
Infraspinatus	2	28
Teres minor	0	30

Table 5. Distribution of Abnormalities in Rotator Cuff Tendons

Out of the patients with shoulder joint pain referred to our department for MRI, 30 patients were selected for this study. These patients had rotator cuff abnormalities. In supraspinatus tendon, 29 (97%) were abnormal and 1 (3%) was normal. Of the subscapularis tendon, 5 (17%) were abnormal and 25 (83%) were normal. Two (7%) infraspinatus tendons were abnormal and 28 (93%) were normal. All the teres minor tendons were normal.

Supraspinatus Tendon Pathologies

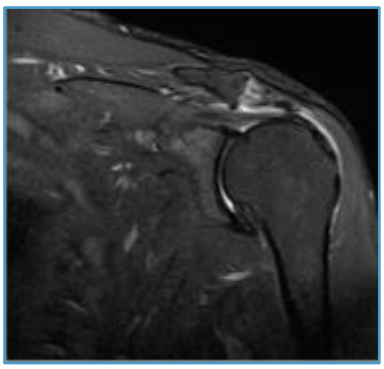

Figure 1

Figure 1. STIR, coronal section image of the shoulder joint reveals mild thickening of supraspinatus tendon and displaying hyperintense intensity suggestive of supraspinatus tendinosis.

Figure 2

Figure 2. STIR coronal section image of shoulder joint displaying hyperintensity at the junction of the muscular and tendinous part of the supraspinatus near its insertion suggestive of intrasubstance tear.

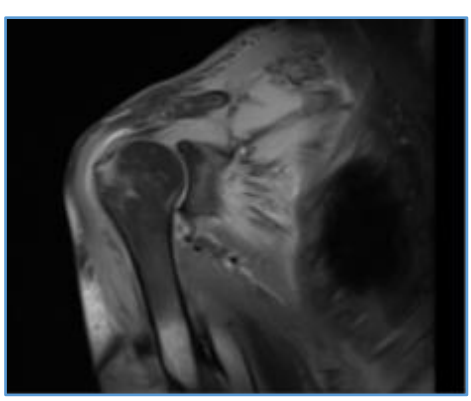

Figure 3

Figure 3. PD FS coronal section of shoulder joint displaying altered signal intensity appearing hyperintense at the bursal surface of the supraspinatus tendon suggestive of Supraspinatus partial tear at bursal surface.

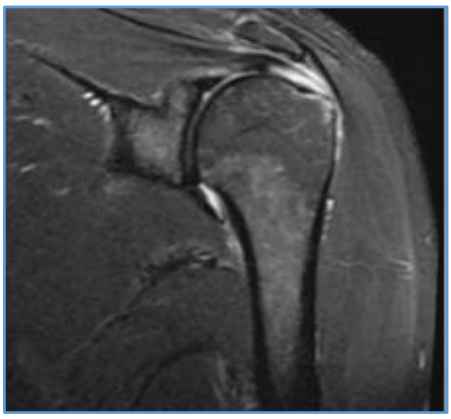

Figure 4

Figure 4. STIR coronal section of shoulder joint displaying altered signal intensity appearing hyperintense at the articular surface of the supraspinatus tendon suggestive of Supraspinatus partial tear at articular surface.

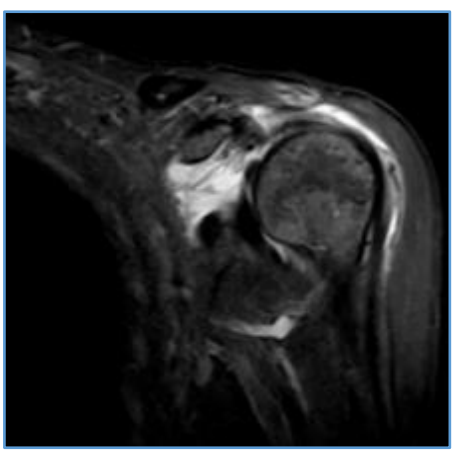

Figure 5

Figure 5. STIR coronal section of the shoulder joint revealing complete tear of the supraspinatus tendon with retraction of the fibres medially (fibres ending medial to the humeral head) suggestive of - supraspinatus tendon complete tear.

Supraspinatus	Frequency	Percent
Normal	1	3.33%
Tendinosis	4	13.33%
Partial tear - intrasubstance	6	20%
Partial tear - articular surface	7	23.33%
Partial tear - bursal surface	6	20%
Complete tear	6	20%
Total	**30**	**100%**

Table 6. Supraspinatus Tendon Pathologies

Of the 30 supraspinatus tendons, 4 (13.33%) showed tendinosis (Refer figure 1), 19 (63.33%) showed partial tear and 6 (20%) showed complete tear (Refer figure 5). Of the partial tears, articular surface partial tears (23.33%) were most common (Refer figure 4) followed by intrasubstance partial tears (20%) (Refer figure 2) and bursal surface partial tears (20%) (Refer figure 3).

Subscapularis Tendon Pathologies

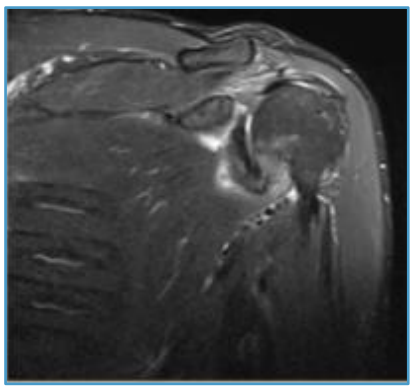

Figure 6

Figure 6. STIR coronal section of the shoulder joint revealing altered signal intensity in the deep/posterior fibres of subscapularis tendon near the musculotendinous junction displaying hyperintense signal intensity suggestive of Subscapularis tendinosis.

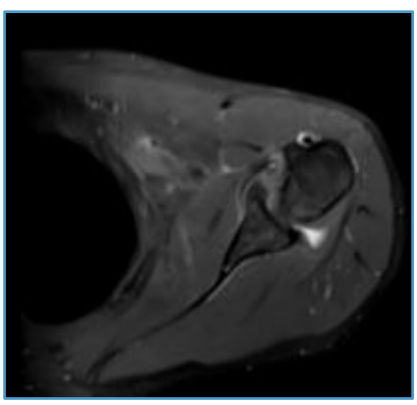

Figure 7

Figure 7. PD FS axial section of the shoulder joint revealing altered signal intensity in the deep fibres of subscapularis tendon displaying hyperintense signal intensity suggestive of Subscapularis tendinosis.

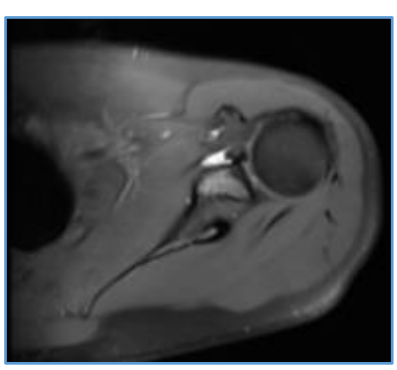

Figure 8

Figure 8. PD FS axial section of the shoulder joint revealing partial tear of subscapularis tendon at the site of musculotendinous junction with minimal fluid adjacent to the site of tear.

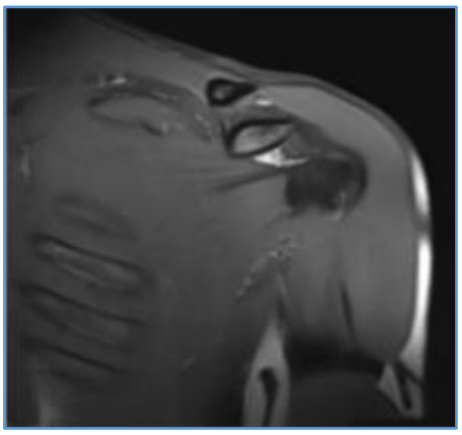

Figure 9

Figure 9. PD FS coronal section of the shoulder joint revealing partial tear of subscapularis tendon at the site of musculotendinous junction with minimal fluid adjacent to the site of tear.

Subscapularis	Frequency	Percent
Normal	25	83.33%
Tendinosis	4	13.33%
Partial	1	3.33%
Complete	0	0%
Total	**30**	**100%**

Table 7. Subscapularis Tendon Pathologies

Of the 30 subscapularis tendons, 4 (13.33%) showed tendinosis (Refer figure. 7 and 15), 1 (3.33%) showed partial tear (Refer figure. 6 and 10) and 25 (83.33%) were normal. No complete subscapularis tendon tear was noted in the study.

Infraspinatus Tendon Pathologies

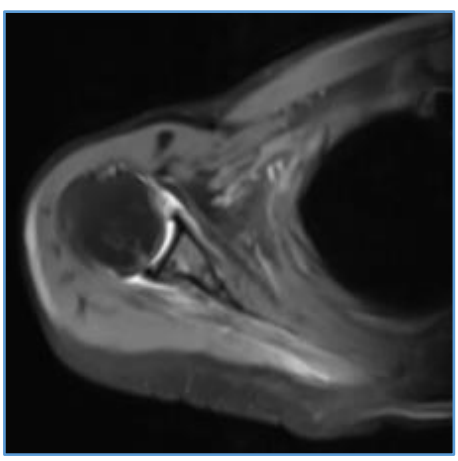

Figure 10

Figure 10. PD FS axial section of shoulder joint displaying altered signal intensity of the infraspinatus tendon, appearing hyperintense - suggestive of infraspinatus tendon partial tear.

Infraspinatus	Frequency	Percent
Normal	28	93.34%
Tendinosis	0	0
Partial tear	2	6.66%
Complete tear	0	0
Total	**30**	**100%**

Table 8. Infraspinatus Tendon Pathologies

Of 30 infraspinatus tendons, 2 (6.66%) showed partial tears (Refer figure. 5) and 28 (93.34%) were normal. No tendinosis and complete infraspinatus tendon tear were noted in this study.

Teres Minor Tendon Pathologies

Teres Minor	Frequency	Percent
Normal	30	100%
Tendinosis	0	0
Partial	0	0
Complete	0	0
Total	**30**	**100%**

Table 9. Teres Minor Tendon Pathologies

All teres minor tendons were normal in the study.

DISCUSSION

In this study, 30 patients with shoulder pain were included. All the patients had rotator cuff pathologies. The MRI characteristics of the abnormality were described in the study. Age and gender distribution among the study population were also described. All the imaging was done using 1.5 Tesla machine in the Department of Radiodiagnosis of MVJ Medical College and Research Hospital.

A number of imaging techniques, such as conventional radiography, arthrography, ultrasonography, and MR imaging, can be utilized in the evaluation of shoulder pain related to impingement, tendinosis, and rotator cuff tear. Of these modalities, only MR imaging provides anatomic information along with superior soft-tissue contrast. MR imaging of the shoulder effectively demonstrates a variety of morphologic abnormalities that may be associated with tendon degeneration. Rotator cuff tears are also well represented and may be further characterized with regard to tendon involvement, degree of retraction, and secondary muscular atrophy.[3]

Age and gender-wise distribution of patients with rotator cuff pathology:

The prevalence of shoulder pain significantly increases with age, and the most common musculoskeletal complaint in patients >65 is shoulder pain. As rotator cuff tears are often asymptomatic, their true prevalence remains unknown and reports differ widely.[4]

In our study, the age of patients with rotator cuff pathologies ranged from 11 to 80 years. The peak incidences of pathologies were seen in the 5th and 6th decade of life with 23% and 27% respectively.

Various studies have pointed out that the prevalence of rotator cuff disease increases with age.[5,6,7]

Study/Author	Year	Patients (Age)	Sex
Yamamoto et al.[8]	2010	20.7% (22 to 85 years)	Male preponderance
Fehringer et al.[9]	2008	22% (≥65 years)	–
Milgrom C et al.[10]	1993	50% and 80% (70 years and 80 years respectively)	No statistically significant sex preponderance
Current study	2017	23% and 27% (50 and 60 years respectively)	21 (70%) of male and 9 (30%) of female

Table 10. Age and Gender-Wise Distribution of Patients with Rotator Cuff Pathology

Milgrom C et al., believed that rotator-cuff lesions are a natural correlate of ageing and are often present with no clinical symptoms. They have found no statistically significant difference in the incidence of impingement findings between dominant and non-dominant arms. The prevalence of partial or full-thickness tears increased markedly after 50 years of age: these were present in over 50% of dominant shoulders in the seventh decade and in 80% of subjects over 80 years of age.[10]

The aptly titled "Dead Men and Radiologists Don't Lie"study reports a total prevalence of Rotator Cuff (RC) tears in their cadaveric data group of 30.3% (11.75% had full-thickness tears; 18.49%, partial thickness tears), with the caveat that most of the cadavers, with a mean age of 70.1 years in that study, were older than the average patient.[4]

Yamamoto et al., screened 1366 shoulders, regardless of the presence or absence of symptoms, and found RC tears in 20.7%; their patients ranged from 22 to 85 years with a mean of 57.9 years. Their analysis also suggested risk factors for RC tears: a history of trauma, dominant arm, and older age.[4,8]

A high correlation between the onset of RC tears and increasing age has also been reported in several other studies —in one, 50% of patients >66 years that presented with a painful RC tear also had a RC tear in their opposite asymptomatic shoulder.[4]

Fehringer et al., found full-thickness RC tears in 22% of asymptomatic patient's ≥65 years. In younger asymptomatic adults, the prevalence of tears is expectedly lower: 5%and 11% in the fourth and fifth decades, respectively.[4,9]

More surprisingly, however prevalenc is 50% in the seventh decade and 80% in the 9th and 10th decades. These studies confirm that RC tears are extremely common, especially in the elderly.[4]

In our study, rotator cuff pathologies were seen in 21 (70%) of male and 9 (30%) of female.

According to Yamamoto A et al., there is a male preponderance for RC tears in the general population.[8] However, according to Milgrom C et al., there is no statistically significant sex preponderance.[10]

Distribution of Abnormality in Rotator Cuff Tendons

Author/Study	Year	Abnormality in Rotator Cuff Tendons			
		Supraspinatus	Subscapularis	Infraspinatus	Teres Minor
Mall NA et al.[11]	2013	84%	78%	39%	
Alexandre L et al.[12]	2015	100%	20%	60%	
Sugaya H et al.[13]	2015		27.4%		
Kumar G[14]	2017	81%			Normal in all the cases
Current study	2017	97%	17%	7%	Normal in all the patients

Table 11. Comparison of Various Studies for the Distribution of Abnormality in Rotator Cuff Tendons

In our study, the most commonly affected tendon was supraspinatus in 29 (97%) patients followed by subscapularis in 5 (17%) patients and infraspinatus in 2 (7%) patients. Teres minor tendons were normal in all the patients in our study.

Alexandre L et al., conducted a study on 97 patients to describe a new full-thickness tear pattern of the posterosuperior rotator cuff with reversal healing. The intraoperative findings showed torn supraspinatus tendon in all cases. The subscapularis was involved in one of the five cases and the infraspinatus was involved in three of the five cases.[12]

Patten RM conducted a study to describe the MR imaging findings in the shoulders of patients with subscapularis tendon tear. In all patients, MR imaging showed the contours of the subscapularis tendon to be poorly defined and the tendon itself to be of abnormally high signal intensity on T2- or T2*-weighted images. Discontinuity and frank retraction of the tendon were evident in 7 patients (78%). Thickening of the distal portion of the tendon (n=3) and calcification (n=1) were seen less frequently.[15]

According to a study conducted by Kumar G, out the 100 patients, supraspinatus was the most common pathological tendon with 81% cases showing abnormalities. The rotator cuff tears were more common in the later age groups and tendinosis more common in the early age groups. Partial tears of rotator cuff were more common than complete tears; 58% cases showed partial tear in supraspinatus as compared to 14% cases of complete tear. Articular surface tears were most common partial tears seen in 46.5% cases.[14]

According to a systemic review published by Mall NA et al., supraspinatus injury was involved in 84% of tears and infraspinatus was torn in 39% of shoulders.[11]

Supraspinatus Tendon Pathologies

Author/Study	Year	Tendinosis	Partial Tear			Complete Tear
			Intra substance	Articular surface	Bursal surface	
Löhr and Uhthoff[16]	2007		32%			
Fukuda[17]	2000			27%	18%	
Kumar G[14]	2017			46.5%		14%
Current study	2017	13.33%	20%	23.33%	20%	20%

Table 12. Comparison of Various Studies for the Supraspinatus Tendon Pathologies

In our study of 30 patients, 19 (63.33%) showed partial tear and 6 (20%) showed complete tear. Of the partial tears, articular surface partial tears (23.33%) were most common followed by intrasubstance partial tears (20%) and bursal surface partial tears (20%).

Sher et al., reported that 4% of individuals younger than 40 years old and more than 50% of individuals older than 60 without shoulder pain showed partial and full thickness rotator cuff tears on MRI.[18,19]

Löhr and Uhthoff found an incidence of 19% for full thickness tears and 32% for partial thickness tears in 306 cadaveric studies.[16,19]

Fukuda reported 13% partial-thickness supraspinatus tears with 18% bursal side partial-thickness supraspinatus tears, 55% intratendinous partial-thickness supraspinatus tears, and 27% articular-sided partial-thickness supraspinatus tears in 249 cadaveric studies.[17,19]

Subscapularis Tendon Pathology

In our study, of the 30 subscapularis tendons, 4 (13.33%) showed tendinosis, 1 (3.33%) showed partial tears and 25 (83.33%) were normal. No complete subscapularis tendon tear was noted in the study.

According to a study conducted by Sugaya H et al., 27.4% of rotator cuff tears (119/435) had subscapularis tendon tears. Partial-thickness tears were observed in 78 shoulders, including 49 longitudinal and 28 transverse tears, and all of them were affected on the articular side.[13]

According to a systemic review published by Mall NA, et al., subscapularis tears were present in 78% of injuries. After the study, they concluded that traumatic rotator cuff tears

are more likely to occur in relatively young (age 54.7), largely male patients who suffer a fall or trauma to an abducted, externally rotated arm.[11]

Infraspinatus Tendon Pathologies

In our study of 30 infraspinatus tendons, 2 (6.66%) showed partial tears and 28 (93.34%) were normal. No tendinosis and complete infraspinatus tendon tear were noted in the study.

According to a study conducted by Puri NA et al., they have summarized that interaction between the infraspinatus tendon and the strained supraspinatus tendon exists, leading to increases in infraspinatus tendon strain. For a small supraspinatus tendon tear, the mechanical interaction between the supraspinatus and infraspinatus tendon did not result in increases in infraspinatus tendon strain. Therefore, when considering treatment and risk of progression of a supraspinatus tendon tear, not only the load-bearing capacity of the remaining intact portion of the tendon must be assessed, but evaluation of the nearby infraspinatus tendon and the competence of the interaction between the two tendons must also be considered.[20]

In our study of the 30 biceps tendon, 12 (40%) showed fluid around the tendon with no abnormal signal in the tendon, and 18 (60%) of the tendons showed no abnormality.

According to a study conducted by Kumar G, in the year 2017, biceps (long head) tendon showed abnormalities in 60% of the evaluated cases, with tenosynovitis being the most common pathology seen in 36% cases. Rotator cuff pathologies showed positive correlation with the biceps tendon pathologies. In 81 cases of rotator cuff abnormalities, 53 showed biceps pathologies ($p < 0.05$). Chen et al. in a study of 176 patients of rotator cuff pathologies found that among the single tendon rotator cuff tears, the incidence of biceps tendon pathology was seen in 71% cases ($p<0.001$). The incidence increased when multiple tendons were involved. Similarly, Beall et al., found that tears of long head of the biceps tendon showed positive correlation with the supraspinatus and subscapularis tendon tears.[14,21,22]

According to a study conducted by Dubrow SA et al., 29/66 (43.9%) of patients were having a pathologic lesion of the Long Head of Biceps (LHB) tendon (19 partial and 10 complete tears), while diagnostic arthroscopy identified tears in 59/66 patients (89.4%; 50 partial and 16 complete). The sensitivity and specificity of MRI for detecting partial tearing of the LHB were 27.7% and 84.2%, respectively (positive predictive value = 81.2%, negative predictive value = 32.0%). The sensitivity and specificity of MRI for complete tears of the LHB were 56.3% and 98.0%, respectively (positive predictive value = 90.0%, negative predictive value =87.5%).[23]

Types of acromion and related pathologies:[1]

The acromial process of the scapula has been classified into four types:

Type 1: Flat
Type 2: Curved downward
Type 3: Hooked downward anteriorly
Type 4: curved upward

A higher prevalence of rotator cuff tears- especially bursal-surface tears—is found in type 3 and possibly in type 2 acromia, likely in association with traction-type enthesophyte spurs from the coracoacromial ligament.

A significant association has been noted between the lateral acromial angle depicted with coronal oblique sequences and rotator cuff disease as seen at MR imaging.

Acromioclavicular osteophytes from the inferior surface of the joint have also been associated with supraspinatus tendon tears.

Thickening of the coracoacromial ligament, as well as the presence of an os acromiale (unfused acromial apophysis) have been associated with rotator cuff impingement.

MR imaging, with its multiplanar capability, provides important information regarding the coracoacromial arch, including acromion type, presence of acromioclavicular osteophytes, narrowing of the impingement interval, and presence of an os acromiale.

CONCLUSION

MR imaging is a useful modality for delineating normal structures and abnormalities of the rotator cuff and for determining the location and extent of rotator cuff tears before surgery. MR imaging can accurately demonstrate tendinosis, full-thickness and partial-thickness rotator cuff tears. MR also helps in imaging of coracohumeral distance, acromioclavicular distance, effusions, bursitis and bone changes.

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