Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 05, 2022

ORIGINAL RESEARCH

SPECTRUM OF ABNORMALITIES OF MAGNETIC RESONANCE IMAGING IN SHOULDER PATHOLOGIES

[1]Dr Simmi Bhatnagar, [2]Dr Amandeep Singh Bakshi, [3]Amulyajit Singh

[1]Associate Professor, [3]Junior Resident, Department of Radiodiagnosis, Govt. Medical College and Rajindra Hospital, Patiala, Punjab, India
[2]Professor, Department of Orthopaedics, Govt. Medical College and Rajindra Hospital, Patiala, Punjab, India

Correspondence:
Amulyajit Singh
Junior Resident, Department of Radiodiagnosis, Govt. Medical College and Rajindra Hospital, Patiala, Punjab, India
Email: amulyajits@gmail.com

Abstract

Background: The shoulder joint is structurally and functionally a complex joint. It is composed of bone, hyaline cartilage, labrum, ligaments, capsule, tendons and muscles. It links the upper limb to trunk and plays an important biomechanical role in daily activities. Indications for imaging of the shoulder has increased in the last few years. Due to the loose joint capsule, and the relatively large size of the humeral head compared to the shallow glenoid fossa it is one of the most mobile joints in the human body. Due to its increased mobility, it is the most commonly dislocated joint of the body. Various disease processes affects the shoulder joint.

Aims: To identify the common lesions of the shoulder joint and to describe the magnetic resonance features and analyze the type of shoulder abnormality based on these features**.**

Material and Methods: This is a descriptive study carried out on 50 patientspresented with shoulder pain and decreased range of motion who were referred to department of radiodiagnosis Rajindra Hospital, Patiala.

Results and Conclusion: In our study, out of 50 patients, Rotator cuff abnormalities were found in 39(78%) patients, AC joint arthrosis was found in 27(54%) patients, Bursitis/Bursal fluid was found in 38(76%) patients, Subacromial impingement was found in 25(50%) patients, Subcoracoid impingement was seen in 4(8%) patients, Glenohumeral joint effusion was seen in 23(46%) patients, labral pathologies were seen in 10(20%) patients, Long head of biceps tendinosis was seen in 9(18%) patients and rotator interval abnormalities was seen in 5(10%) patients.

Keywords: Magnetic resonance imaging, Rotator Cuff Tendon Abnormalities, Acromioclavicular Joint Arthrosis

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Introduction

Anatomy of shoulder joint

The glenohumeral joint is a synovial ball and socket joint. It includes a complex dynamic articulation between the glenoid of the scapula and the proximal humerus. The articulating surfaces of both the glenoid and humeral head have a lining of articular cartilage. The glenoid cavity is a shallow osseous element that is structurally deepened by a fibrocartilaginous rim and the glenoid labrum. It spans the osseous periphery of the vault. The labrum is continuous with the tendon of the biceps brachii at its superior aspect [(1).]

Structurally the joint capsule wraps around the anatomic neck of the humerus to the rim of the glenoid fossa. While the joint capsule itself is a contiguous supportive structure surrounding the articulating elements, the capsulolabral complexes include important characteristic thickened bands that constitute the glenohumeral ligaments. First described in 1829, the glenohumeral ligaments do not act as traditional ligaments that carry a pure tensile force along their length, but rather they become taut at varying positions of abduction and humeral rotation [(2-3)]. A synovial membrane forms the lining on the inner surface of the joint capsule. This membrane produces synovial fluid to reduce friction between the articular surfaces of the joint [(4)].

Imaging anatomy

MRI is preferred method for the evaluation of the shoulder joint. Newer techniques with improved spacial resolution have increased the diagnostic utility and frequency of the shoulder joint, radiologist interpreting these images should have the detailed understanding of the anatomy of shoulder joint and common and uncommon pitfalls to avoid misinterpretation of these images.

MRI has become an important diagnostic tool in the evaluation of rotator cuff, and the technology continues to evolve. Diagnostic specific sequencing such as fat suppression, special positioning such as abducted externally rotated (ABER) views and ultra-high field magnets allow for an unprecedented level of detail in imaging. Clinical expertise is required to differentiate between anatomic variants, incidental findings and true pathology. Although MRI findings may be diagnostic in some cases, clinical correlation with history and physical examination is critical. This requires good communication between the orthopedic surgeon and the radiologist to optimize diagnostic yield.

Appropriate MR imaging protocols and sequences, MR anatomy of the shoulder (including normal variants) are proposed to help or assist in management and treatment of common shoulder pathologies encountered (such as rotator cuff tears, impingement syndromes, instability, trauma, labral pathologies as well as less frequent causes of shoulder pain). The most common variants and pitfalls are related to the anterosuperior aspect of the shoulder joint. A new description of the attachment of supraspinatus and infraspinatus tendons at the superior aspect of the humerus, the rotator cable and the superior glenohumeral ligament complex is developed for the diagnosis of rotator cuff pathologies[(5)]

The glenohumeral joint has a great range of motion than any other joint of the body because of the shallow glenoid cavity and a large humeral head. There is relative laxity of the joint capsule which renders the joint relatively unstable

Conventional Magnetic Resonance Imaging (MRI) allows direct evaluation of rotator cuff muscles and tendons, medullary bone and neurovascular structures. The disadvantages

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include longer examination time and costly procedure, respiratory motion artifacts and claustrophobia in some of the patients. MR images are obtained with a dedicated shoulder coil at 1.5 Tesla field strength. The patient is placed in supine position with the arm in mild external rotation. Coronal oblique images are oriented parallel to the scapula or parallel to the course of the supraspinatus tendon (determined on axial images); sagittal images are oriented perpendicular to the coronal plane, covering the deltoid muscle and the scapula to include rotator cuff muscle bellies; axial images are performed from the acromioclavicular joint to below the axillary pouch[(6)]

Materials and methods

The study was conducted prospectively in the department of radiodiagnosis, Government medical college Patiala. 50 patients were selected randomly for this study that presented with shoulder pain and decreased range of motion to the department of orthopaedics of this institute. These patients were evaluated on the basis of detailed medical history, thorough clionicalexamnation and necessary investigations. All patients were evaluated using Seimens 1.5 TMRI machine.

Source of Data

The source of data for the study was patients with suspected shoulder Pain and decreased range of motion of shoulder joint referred from department or orthopedics, Government Medical College and Hospital , Patiala. Appropriate MRI sequences were performed for every patient.

50 cases was taken up for the study in order to derive a significant result and statistical analysis.

Inclusion criteria

- All the patients with shoulder pain and decreased range of motion requiring MRI as diagnostic modality.

Exclusion criteria

- Patients with previous operated history of shoulder.
- Patient with the history of claustrophobia.
- Patients having history of metallic implants insertion, cardiac pacemakers and metallic foreign body.
- Patient with major injuries like liver/spleen rupture and flial chest and patients with unstable vital parameters especially in the setting of trauma.

Study type

Descriptive Study

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Method of collecting data

1. Detailed clinical history.

All the patients with the chief complaint of pain, weakness, instability and limited range of motion.

Associated with catching or popping of the shoulder.

2. Physical examination.

Entire shoulder was exposed. Inspection and palpation was done. Range of motion and motor strength was tested.

3. Magnetic resonance imaging of the affected shoulder.

The MRI scans was performed on SIEMENS 1.5 T Magnetom AERA.

Shoulder coil: Large 16 Opening 200 mm and small 16 Opening 165 mm.

Two 16 channel coils were used to cover small and large shoulder anatomy. Each with 16-channel coil design with 16 integrated preamplifiers. The shoulder coil covers small and large shoulder joint anatomy. For narrow or wide shoulders, the coil can be attached at different positions on the base plate. It includes one base plate pad for high patient comfort. Slide connect technology is used for easy coil set up. Excellent visualization of small anatomical structures(labrum) is seen with reduction in slice thickness and measurement time.

Appropriate sequences were performed.

Position of the patient was supine.

Shoulder was placed in a neutral position.

Shoulder was placed in the isocenter in the bore of the magnet.

Sponge was placed at the elbow and one supporting the hand while the arm is strapped firmly to keep it in place.

Sequences followed were: - AXIAL PDFS, CORONAL PDFS, SAGITTAL PDFS, SAGITTAL T1WI, CORONAL T1WI , CORONAL T2FS and TRUE FISP 3D as per requirement .

Results

The study was conducted on a total of 50 patients having shoulder pain and were referred to department of Radiodiagnosis of Govt. Medical College, Rajindra hospital, Patiala for Magnetic resonance imaging of shoulder. MRI findings were observed and correlated with clinical diagnosis, and analyzed to achieve the aims and objectives. The data collected was subjected to statistical analysis and results derived

Age distribution

The study group with clinical suspicion of shoulder pain comprised of total no of 50 patients from all age groups. Maximum patients were between 41-60 years (21), followed by 20-40 years (20), 61-80 years (7) and < 20 years (2).

Gender distribution

50 patients included in the study, 32 patients were males and 18 patients were females

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Duration of symptoms

50 patients, 18 patients had symptoms from 6months-12months, 15 patients had symptoms from > 12 months, 13 patients had symptoms from 1- 5 months and 4 patients had symptoms from upto 1 month.

History of trauma

21 (42 %) patients had history of trauma to the affected shoulder and 29 (58%) patients had no history of trauma.

Distribution of cases according to the spectrum of abnormalities

Spectrum of Abnormalities	No Of Patients	Percentage (%)
Rotator Cuff Abnormalities	39	78
Bursitis/Bursal fluid	38	76
AC Joint Arthrosis	27	54
Subacromial impingement	25	50
Glenohumeral joint Effusion	23	46
Labral Pathologies	10	20
Long head of Biceps tendinosis	9	18
Rotator interval abnormalities	5	10
Subcoracoid Impingement	4	8

Of 50 patients, Rotator cuff abnormalities were found in 39(78%) patients, Bursitis/Bursal fluid was found in 38(76%) patients, AC joint arthrosis was found in 27(54%) patients, Subacromial impingement was found in 25(50%) patients, Glenohumeral joint effusion was seen in 23(46%) patients, Labral pathologies were seen in 10(20%) patients, Long head of biceps tendinosis was seen in 9(18%) patients, Rotator interval abnormalities was seen in 5(10%) patients and Subcoracoid impingement was seen in 4(8%) patients.

Distribution of cases depending uponRotator cuff Tendons abnormalities

Tendons (n=50)	Partial thickness tear	Full thickness tear	Tendinosis	Normal
Supraspinatus	20(40%)	5(10%)	12(22%)	13(26%)
Infraspinatus	5(10%)	1(2%)	4(8%)	40(80%)
Subscapularis,	8(16%)	0	10(20%)	32(64%)
Teres Minor,	0	0	2(4%)	48(96%)

Out of 50 patients, Supraspinatus tendon partial thickness tear seen in 20(40%) patients, full thickness tear in 5 (10%) patients, tendinosis in 12(24%) patients and 13 (20%) patients did not show any tendon abnormality.

Out of 50 patients, Infraspinatus tendon partial thickness tear seen in 5(10%) patients, full thickness tear in 1 (2%) patient) and tendinosis in 4(8%) patients.

Out of 50 patients, 8(16%) patients were diagnosed with partial thickness tear, no patient of full thickness/ intrasubstance tear and 10(20%) patients had tendinosis of subscapularis tendon.

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Out of 50 patients, 2(4%) patients were diagnosed with tendinosis of teres minor tendon.

Distribution of cases depending upon ACJ Arthrosis

ACJ Arthrosis	Number of patients	Percentage (%)
Present	27	54
Absent	23	46
Total	50	100

Of 50 patients, 27(54%) patients had ACJ arthrosis and 23(46%) patients had normal acromioclavicular joint on MRI

Distribution of cases depending upon Labral pathologies

	Number of patients	Percentage (%)
Present	10	20
Absent	40	80
Total	50	100

Of 50 patients, 10 (20%) patients presented with labral pathologies. 40(80%) patients did not have labral pathologies.

Discussion

In our study, out of 50 patients, Rotator cuff abnormalities were found in 39(78%) patients, AC joint arthrosis was found in 27(54%) patients, Bursitis/Bursal fluid was found in 38(76%) patients, Subacromial impingement was found in 25(50%) patients, Subcoracoid impingement was seen in 4(8%) patients, Glenohumeral joint effusion was seen in 23(46%) patients, labral pathologies were seen in 10(20%) patients, Long head of biceps tendinosis was seen in 9(18%) patients and rotator interval abnormalities was seen in 5(10%) patients.

In a study conducted by Tirman et al. (1997) highlighted conventional MR was indicated for rotator cuff tears, Impingement, Trauma, AC joint evaluation and labral pathologies [7].

In a similar study conducted by Onyambu et al. (2014),out of 120 patients studied for a spectrum of different diseases on MR, the most common lesion was tendinosis, followed by rotator cuff tears, degenerative diseases, bursitis and other pathologies [8].

Out of 50 patients, Supraspinatus tendon partial thickness tear was seen in 20(40%) patients, full thickness tear in 5 (10%) patients, tendinosis in 12(24%) patients and 13 (20%) patients did not show any tendon abnormality.

Out of 50 patients, Infraspinatus tendon partial thickness tear was seen in 5(10%) patients, full thickness tear in 1 (2%) patients and tendinosis in 4(8%) patients.

Out of 50 patients, 8(16%) patients were diagnosed with partial thickness tear, no patient of full thickness tear and 10(20%) patients had tendinosis of subscapularis tendon.

Out of 50 patients, 2(4%) patients were diagnosed with tendinosis of teres minor tendon. Rotator cuff injuries are classified into tendinosis, partial and complete tear. Tendinosis is degeneration of the tendon, and it may become thick, thin or remain normal in calibre. Focal irregularities and altered signal intensity was seen on T1,T2,PD images . Sein et al. (2007), in their study, showed high intra observer reliability in grading tendinosis[9].

Full thickness tears are usually seen as a defect extending from the articular surface to the

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bursal surface. Secondary signs include subacromial-subdeltoid bursitis, muscle atrophy and retraction of musculotendinous junction. Similar observations were made by Kawakawa et al. (2001)high interobserver variations were observed in most of the full thickness tears [10].Quill et al.(1990) studied the MRI findings in full thickness tears of the rotator cuff and concluded that interruption of the tendon continuity is the most specific MRI finding of full thickness rotator cuff tears, while subacromial fluid is the most common finding [11].

Partial thickness tear is diagnosed as a focal area of altered signal intensity on PD images and T2 weighted images and extends to one surface only. Partial thickness tears are classified according to the surface of the tendon involved, Articular sided and Bursalsided tears. Articular sided tears are more common, involving the tendon fibers adjacent to the humeral head. Bursal sided tears are less common, involving the superior fibers adjacent to the subacromial-subdeltoid bursa. In our study, articular surface tears were more common than the bursal surface. It is in concordance with the study conducted by McMonagle et al. (2012) in their study reported that articular-sided tears are by far the most common involving the tendon fibers adjacent to the humeral head [12].

Lagnocco et al. (2003), in their study, demonstrated supraspinatus to be the most commonly involved tendon and teres minor least commonly involved. The supraspinatus is most commonly involved because of its anatomical location between acromion and humeral head [13].

Brennke et al. (1992), in their study, highlighted patrial thickness tear of the supraspinatus is more common than the full thickness tear [14].

Acromioclavicular joint arthrosis was seen in the majority of the patients 27(54%) and no arthrosis was seen in 23(46%) patients.

This is in concordance with the study conducted by Schweitzer et al. (1994)out of 108 patients studied for chronic shoulder painAcromioclavicular joint arthrosis was seen in (67%) of the patients [15].

Out of 50 patients, 10 (20%) patients were diagnosed with labral pathologies. 40(80%) patients did not have labral pathologies. This study is in concordance with the study done by Bencardino et al. (2009)[16]. Different labral lesions are Bankart lesion and its variants, the anterior labroligamentous periosteal sleeve avulsion (ALPSA), and Perthes lesions. Noninstabilitylabral lesions include the SLAP lesions, labral cysts, and glenolabral articular disruption (GLAD) lesions.

Case 1. Patient has pain in right shoulder for 3 years related to history of weight lifting and restriction of movement. High signal intensity is seen along the bursal surface of supraspinatus tendon indicating tendinosis. (Figure A). Fluid is seen tracking along the biceps tendon indicating tenosynovitis (Figure B). OsAcromiale seen. (Figure C).

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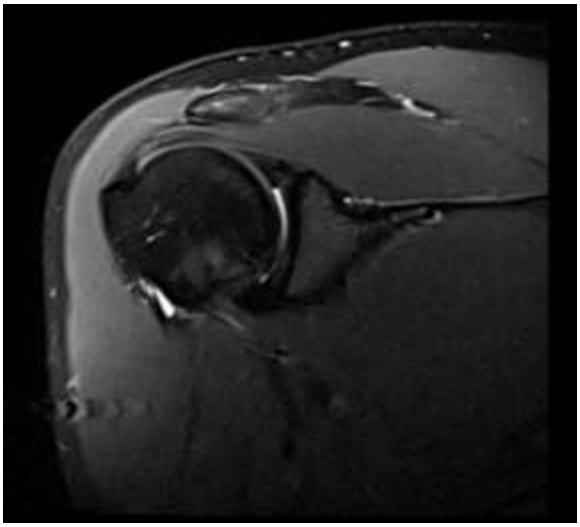

Figure 1(A) PDFS COR images shows supraspinatus tendinosis.

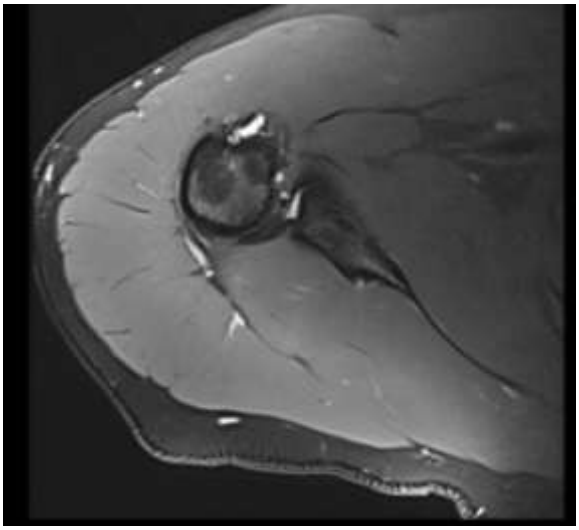

Figure1(B) PDFS Axial showing increase fluid around the biceps tendon

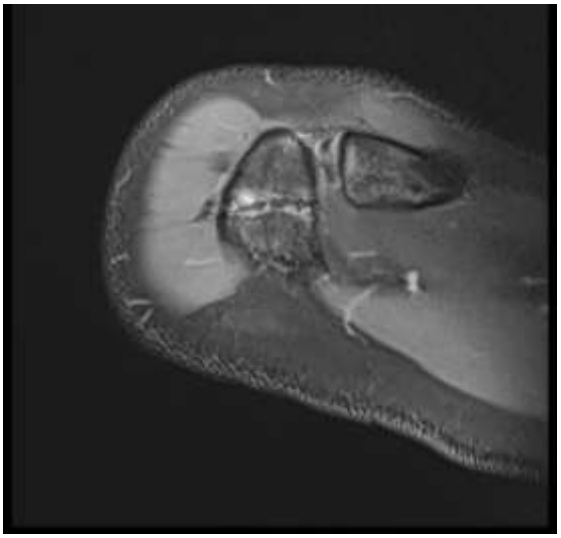

Figure 1 (C): PDFS Axial images showing OsAcromiale

Case 2 65 years old female has pain in right shoulder with restriction of motion since last three months related to history of trauma. High signal intensity is seen in the fibers of supraspinatus tendon suggestive of-Partial thickness tear. (Figure A). High signal

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intensity with thinning of fibers of subscapularis tendon suggestive of- Partial thickness tear with fluid in subscapularis recess and atrophy of subscapularis muscle fibers. (Figure B).

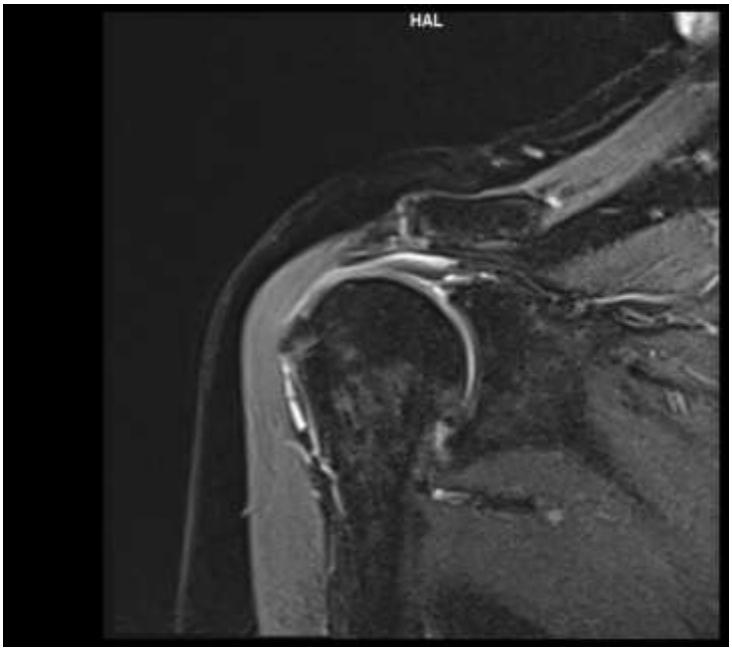

Figure 2(A): PDFS COR images showing partial thickness tear of supraspinatus with subacromial impingement

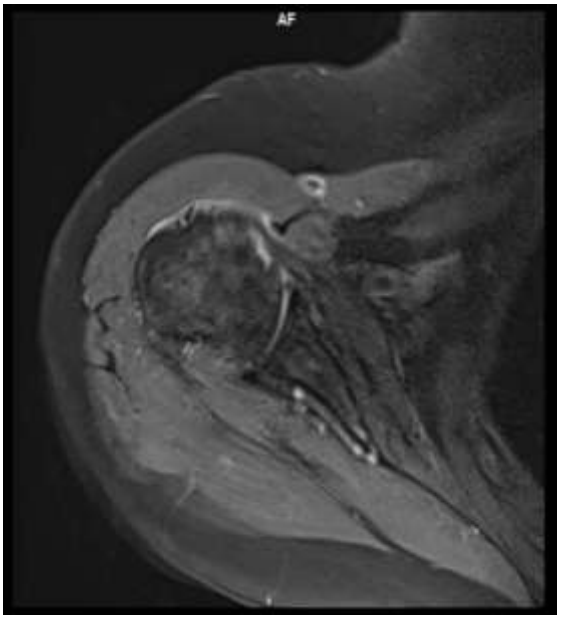

Figure 2(B) PDFS Axial images showing partial thickness tear of subscapularis

Case 3 64 year old female had pain in right shoulder which exaggerated on movement with restriction of movements since last 6 months. Focal full thickness tear of anterior fibers of the supraspinatus tendon near its insertion (Figure A). Focal partial thickness tear of the posterior fibers of the subscapularis tendon (Figure B). Fluid is seen in subacromial-subdeltoid bursa with mild joint effusion (Figure C).

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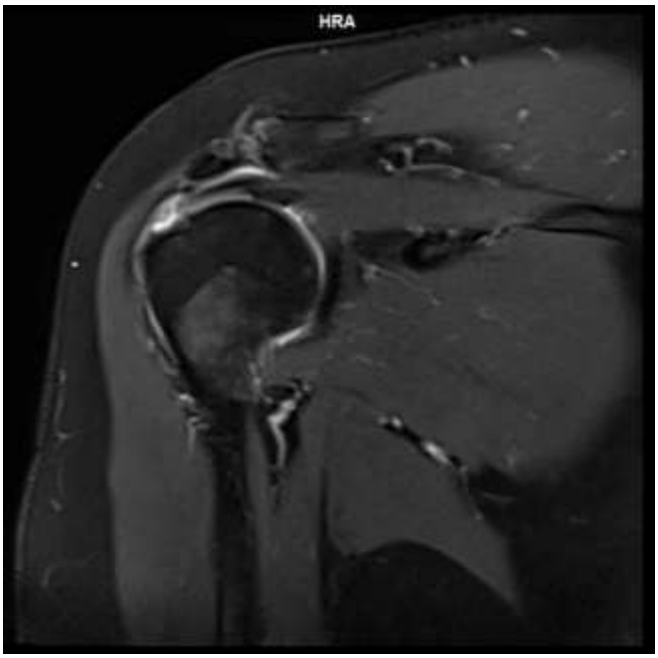

Figure 3(A): PDFS COR showing full thickness supraspinatus tear with AC joint arthrosis and impingement over musculotendinous junction.

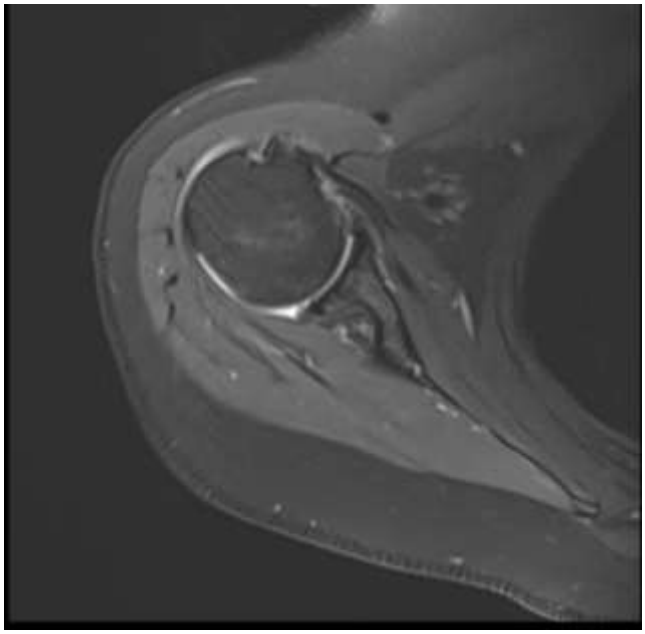

Figure 3(B): PDFS Axial showing partial tear of subscapularis with glenohumeral joint effusion.

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Figure 3(C): T2 FS COR images showing complete tear of the supraspinatus with glenohumeral joint effusion and fluid in subacromial-subdeltoid bursa

Case 4 59 year old male Presented with pain in right shoulder since last 12 months.focal full thickness tear of the supraspinatus near its insertion. AC Joint arthrosis (Figure A)

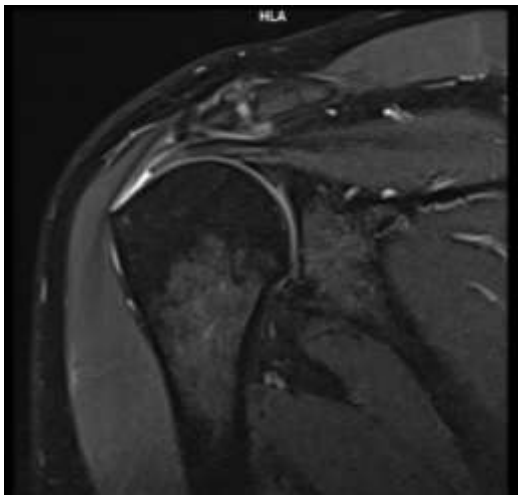

Figure 4(A): PDFS COR shows full thickness tear of supraspinatus and AC Joint arthrosis

Case 5: 60 year old female presented with pain in right shoulder since last 2 years associated with restriction in movement. High intensity signal on PDFS images within the supraspinatus tendon near its insertion site s/o complete tear of supraspinatus tendon. (Figure A). Tendon of long head of biceps is thickened with intermediate signal intensity and surrounded by significant amount of fluid in the bicipital groove s/o Tendinosis with tenosynovitis of long head of biceps tendon (Figure B)

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Figure 5(A): PDFS COR images showing complete tear of the supraspiantus with AC joint arthrosis.

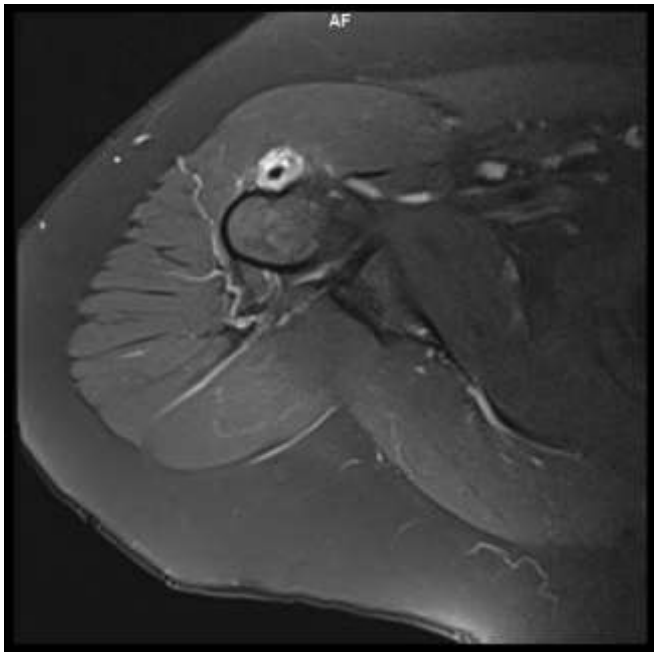

Figure 5(B): PDFS Axial images showing increase in fluid around the biceps tendon along with altered signal intensity

Case 6: 28 year old male presented with pain in right shoulder since last 11 months. There is a large centric slightly expansile cystic lesion ms~ 6.4 cm X 1.8 cm which is T1 hypointense and T2 hyperintense in diaphysis of humerus likely bone cyst. (Figure A)

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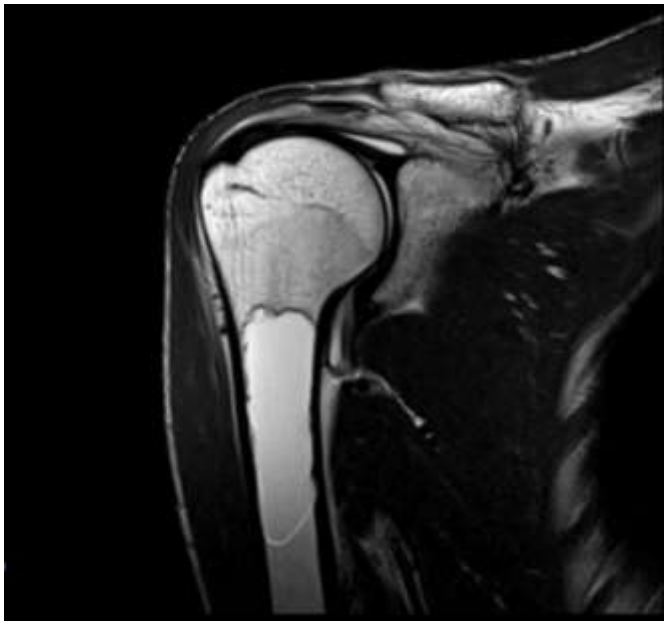

Figure 6(A): T2 WI showing a hyperdense bone cyst in the diaphysis of humerus

Conclusion

MRI has always been successful in overall assessment of joint structure. MRI provides excellent soft-tissue detail and has multiplanar capability. It has the ability to evaluate labrum, various glenohumeral ligaments, joint capsule, articular cartilage and detailed information of tear with associated findings. Major limitations are cost factor and availability. Second, MRI is contraindicated in patients with prosthesis, implants and claustrophobia. Familiarity with the normal anatomy and common pitfalls reduce errant interpretation but does not eliminate them entirely. MR is the best non invasive imaging modality for the diagnosis of rotator cuff abnormalities. MR reports should thoroughly describe tears and not simply indicate whether a tear is present. MR imaging of shoulder is considered efficacious especially in the setting of indeterminate clinical findings and can stratify patients, guiding further surgical management.

The present study also demonstrates a valuable role of MR imaging in the examination of a wide spectrum of shoulder abnormalities such as acromioclavicular joint abnormalities, evaluation of bursae around the shoulder joint, labral pathologies, glenohumeral joint effusion, long head of biceps tendon abnormalities, shoulder impingement syndrome and rotator interval abnormalities. MR imaging depicts the anatomy of shoulder joint without the need of intravenous contrast agents or any joint manipulation. Rotator cuff tendons and muscles can be assessed on MR imaging without arthrographic technique.

Limitation of study

The only limitation of the study is the sample size. A large population is desirable to reach accurate results.

Author Contribution

Dr Simmi Bhatnagar, Dr Amandeep Singh Bakshi and Dr Amulyajit Singh all contributed equally in the conduct of the study and preparation of manuscript.

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