Research Article

Diagnostic evaluation of magnetic resonance imaging in shoulder pathologies

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ABSTRACT

Background: Magnetic resonance imaging (MRI) is a sensitive and accurate non-invasive tool in investigating shoulder pathology, because of its multiplanar capability and excellent soft tissue resolution. **Objective:** The present study is undertaken to study usefulness, advantages, and pitfalls of MRI in patients presenting with symptoms of glenohumeral joint pathologies. **Materials and Methods:** The study included 50 patients referred for MRI shoulder after a detailed clinical workup. Images were acquired using various non-contrast-enhanced sequences and were analyzed for pathologies. **Results:** Among the 50 patients included in the study, the various pathologies were detected on MRI. Rotator cuff disease is the most common pathology of glenohumeral joint, for which MRI was done. Involvement of supraspinatus muscle or tendon was 74% in all the pathologies. Associated involvement of subscapularis and infraspinatus muscles does not show much difference. Of 42 patients diagnosed with supraspinatus tear, partial tear was seen in 34 patients (81%) and complete tear was seen in 8 (19%) patients. Involvement of supraspinatus muscle is the same in traumatic and non-traumatic injuries. **Conclusion:** MRI is the preferred test for evaluating impingement syndrome and rotator cuff pathology. We recommend that state-of-the-art conventional MRI, including fat-suppression sequences, be performed as the first MRI evaluation in shoulder pathologies.

KEY WORDS: Impingement; Magnetic Resonance Imaging; Rotator Cuff; Shoulder; Supraspinatus Muscle or Tendon

INTRODUCTION

Normal shoulder function is essential for day-to-day life. As the shoulder joint has a complex anatomy, imaging of the shoulder and its dysfunction is challenging for radiologist and orthopedic practitioners. Magnetic resonance imaging (MRI) played an important role as a non-invasive investigation due to its non-invasive nature, high degree of resolution, lack of contrast exposure and non-ionizing radiation, multiplanar capability, and excellent soft tissue resolution.[1,2] The most common indications for shoulder MRI are suspected shoulder instability, osteonecrosis, rotator cuff tear, infection, and neoplasm. Rotator cuff is being the most commonly affected, and subacromial impingement syndrome is the leading cause of rotator cuff injury.[3-5]

In this article, the most common indications for shoulder MRI are reviewed and discussed, but we focused primarily on the rotator cuff syndrome and shoulder instability. The present study was done to assess the prevalence of most common glenohumeral joint pathology and to study usefulness, advantages, and pitfalls of MRI in patients presenting with symptoms of glenohumeral joint pathologies.

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MATERIALS AND METHODS

The main source of data for this prospective study was 50 patients referred for shoulder MRI to the Department of Radiodiagnosis,

Geetanjali Medical College and Hospital, Udaipur, Rajasthan, during the period of September 2016–November 2017.

Method of Collection of Data

Patient selection

All patients diagnosed and suspicious of shoulder joint pathology were included in this study. They were advised and consulted by their physicians. Patients were explained about the procedure, and brief history of any prosthetic implant and illness was taken. Significant clinical findings of all patients were recorded. Previous investigations were reviewed (AP and axial radiograph of shoulder and sonography if done).

Duration of study

The study was conducted over a period of 14 months from September 2016 to November 2017.

Protocol

MRI of the shoulder was performed using 1.5T Somatom, Siemens imaging system. The sequences used were - AXIAL T1 weighted (T1W), AXIAL T2W, AXIALPD, CORONALOBLIQUE STIR, CORONAL OBLIQUE PD, and SAGITTAL OBLIQUE T2. No medication/IV contrast was used in the study.

Inclusion criteria

Adults between 18 and 70 years of age were included in the study.

Exclusion criteria

Patients below 18 and above 70 years of age; patients with known history of malignancy and previous operative history of the shoulder; and those who have contraindications for MRI such as pacemaker, metallic implants, and claustrophobia were excluded from the study.

RESULTS

In our study, the incidence of shoulder joint pathologies was highest in the age group of 41–50 years which is 38%. Mean age of our study population is 46.6 years. 28 males (56%) and 22 females (44%) were affected in our study and male: female ratio was 1.27:1. Among 50 patients included in the study, the various pathologies detected on MRI are tabulated in Table 1. Rotator cuff disease was found in 88% of cases, making it the most common pathology of glenohumeral joint, for which MRI was done. MRI was done in an emergency for traumatic injuries for 46% of patients. For the rest of 66% of patients, there was a chronic course, for which MRI was advised. The least common group was infective (10%). The most common symptom, for which MRI is done, is shoulder pain. In around half of the patients, pain is associated with restriction of joint movements. In patients with recent traumatic injury and infective etiology, swelling and redness of the joint are found. Of 50 patients with glenohumeral pathology, 42 patients (84%) presented with a history of shoulder pain. 33 patients (66%) presented with a history of restriction of joint movements. 11 (22%) patients presented with a history of localized swelling or redness.

In our study, involvement of supraspinatus muscle or tendon was 74% in all the pathologies. Involvement of subscapularis and infraspinatus muscles does not show much difference [Figure 1]. Of the 42 patients diagnosed with supraspinatus tear, partial tear was seen in 34 patients (81%) and complete tear was seen in 8 (19%) patients [Figure 2]. In supraspinatus tendon tear, traumatic (n = 21) and non-traumatic (n = 21) etiologies comprise the same number of patients. Partial supraspinatus tear was more commonly seen with traumatic injuries.

In patients with single tendon involvement, supraspinatus tendon was the most common tendon involved. Involvement of other tendon along with supraspinatus tendon varies as per table, but it does not show much difference. In 10% of patients, all the three major rotator cuff muscles were involved [Table 2]. Osteoarthritis of acromioclavicular joint is a common occurrence in our study. Many of these patients (42%) had partial tear of supraspinatus tendon along with osteoarthritis [Table 3]. Joint effusion is a common association of glenohumeral pathologies. Possible etiologies are a direct injury to bicipital tendon insertion site or associated

Table 1: Frequency of shoulder pathologies

Pathologies of shoulder joint	Number of patients (%)
Rotator cuff disease	44 (88)
Glenohumeral joint instability	11 (22)
Labral injuries	8 (16)
Traumatic injuries	23 (46)
Degenerative osteoarthritis	14 (28)
Infective etiology	5 (10)

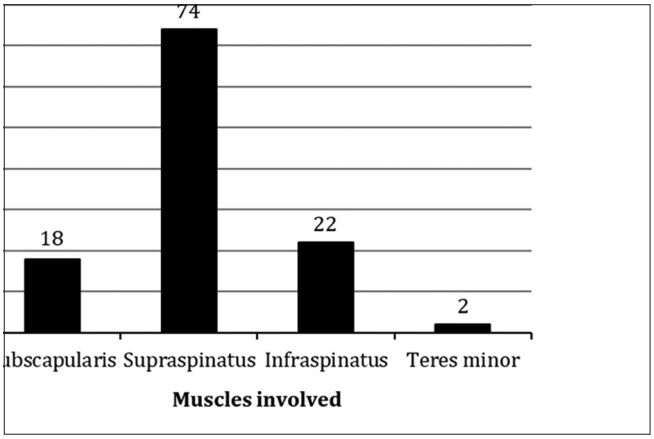

Figure 1: Involvement of muscles

inflammation in the early phase of pathology. Subacromial-subdeltoid bursitis was seen in 44% of patients. It was more commonly related to early inflammatory changes [Table 4].

Different types of pathologies are presented in Figures 3-9.

DISCUSSION

MRI of the shoulder joint has achieved wide acceptance due to the sensitivity and specificity of MR in detection of rotator cuff pathologies and impingement syndrome. The negative likelihood ratio for a rotator cuff tear is 0.08 with MRI.[6-8] In our study, rotator cuff disease was the most common pathology of glenohumeral joint, for which MRI was done. Among all the analyzed shoulder MRI examinations, rotator cuff injury was the most common injury (diagnosed in 44 [88%] patients),

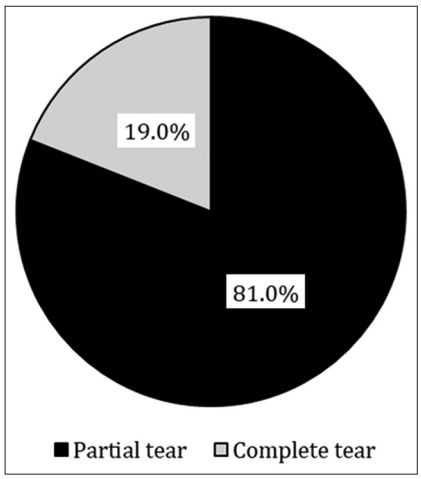

Figure 2: Involvement of supraspinatus tendon

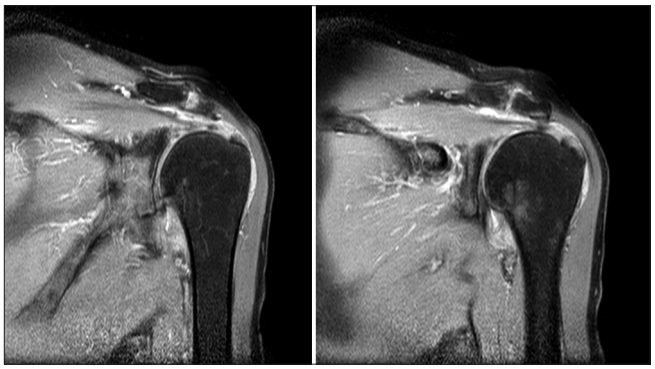

Figure 3: Tear of supraspinatus tendon

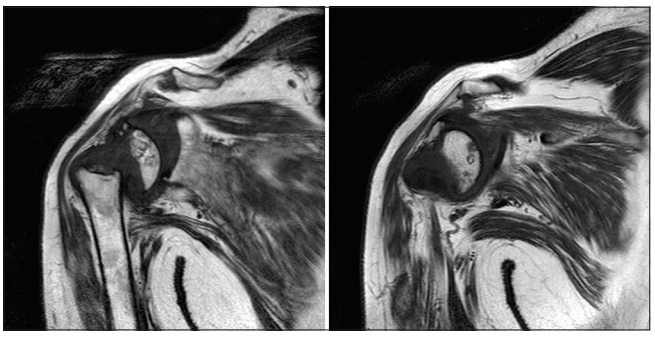

Figure 4: Tear of infraspinatus, supraspinatus and subscapularis tendons, displaced fracture of humeral neck with posterior dislocation of humeral head, osteoartritis of acromio-clavicular joint

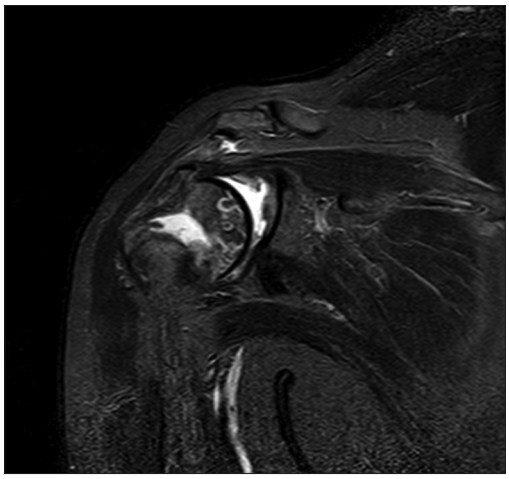

Figure 5: Complete tear of suprispinatus tendon, partial tear of teres minor and subscapularis tendon, Bankart's lesion

Table 2: Involvement of multiple tendons

Tendon involved	Number of patients (%)
Supraspinatus	24 (48)
Supraspinatus+subscapularis	7 (14)
Supraspinatus+infraspinatus	5 (10)
Supraspinatus+teres minor	1 (2)
Supraspinatus+infraspinatus+subscapularis	5 (10)

Table 3: Bony changes (*n*=23)

Bony changes	Number of patients (%)
Fracture	6 (26)
Osteoarthritis of acromioclavicular joint	11 (42)
Osteoarthritis of glenohumeral joint	3 (13)
Bone contusion	7 (30)
Defect on posterolateral aspect of humerus	3 (13)
Osteomyelitis	5 (21)
Bony cyst	1 (4)

Table 4: Joint effusion

Joint effusion	Number of patients (%)
In joint cavity	14 (28)
In subacromian subdeltoid bursa	22 (44)
In bicipital grove	22 (44)
In all above three compartments	3 (6)

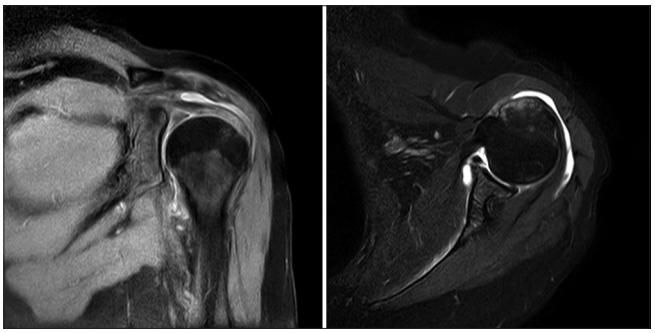

Figure 6: Subarticular edema in antero-inferior glenoid with labral tear - Bankart's lesion

Figure 7: Complete supraspinatus tear, partial infraspinatus tear, osteoarthritic changes in acromioclavicular joint

which is concordant with a study by Tuite indicating that supraspinatus muscle tendon is damaged in 95% of rotator cuff pathologies.[9] Involvement of supraspinatus muscle was the same in traumatic and non-traumatic injuries. Associated involvement of subscapularis and infraspinatus muscles did not show much difference. MR features are 100% sensitive and 100% specific for combined full and partial thickness tears.[10]

According to Carrino

- Grade 0 - Normal - uniform low signal intensity of tendon.
- Grade I - Increased signal intensity in tendon, more obvious on T1W image (T1WI) and proton images but not seen or less obvious on T2WI.
- Grade II - Tendinosis/tendinitis - Increased signal intensity on T2WI that does not involve inferior (articular) or superior (bursal) surface.
- Grade III - Degenerative - Increased signal intensity on T2WI in one or multiple areas but no changes to the criteria of partial tear.
- Grade IV - Partial tear - Increased signal intensity on T2WI that involves the inferior or superior surface of the tendon.
- Grade V - Full thickness tear with few spared fibers.
- Grade VI - Full thickness tear without tendon retraction.

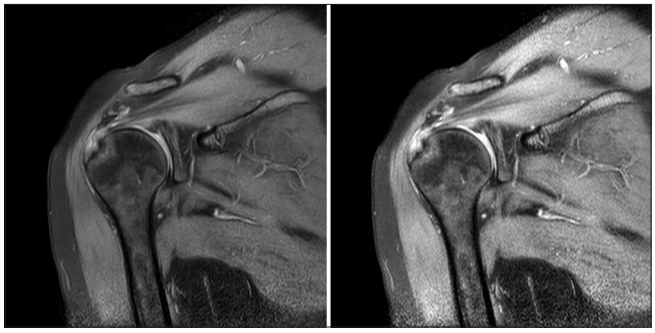

Figure 8: Partial supraspinatus tear on interstitial and bursal attachment7

Figure 9: Osteomyelitis changes

- Grade VII - Full thickness tear with tendon retraction.

Sometimes, tear may not show hyperintensity inT2WI, so few secondary signs which may suggest tear are as follows:

- Fatty atrophy of muscle belly in the complete tear as hyperintensity on T1WI associated with loss of volume.
- Tendons may be completely nonvisualized due to retraction in the complete tear.
- Loss of peribursal or subdeltoid fat plane and fluid in subacromial-subdeltoid bursa.
- Joint effusion.
- Marrow signal changes and cyst formation in greater tuberosity on fat-suppressed T2WI with osseous changes such as osteophytosis and spur formation suggest cuff tendinopathy in advanced stages.

Pitfalls[11,12]

- Partial volume averaging with superior + lateral infraspinatus tendon.
- Vascular watershed area.

- Magic angle effect is the orientation of collagen fibers at 55° relative to main magnetic field.
- Hyperintense focus within rotator cuff on T2WI.
- Partial volume averaging with fluid in biceps tendon sheath/subscapularis bursa.
- Partial volume averaging with fat of peribursal fat.
- Motion artefacts: Respiration, vascular pulsation, and patient movement.
- Fatty atrophy of muscle.

Osteoarthritis of acromioclavicular joint was a common occurrence in our study (42%). Many of these patients had a partial tear of supraspinatus tendon along with osteoarthritis, which is concordant with other studies indicating it as one of the causes of rotator cuff injury.[13]

Findings seen in our study showed that traumatic injuries result in fractures (26%) and bone contusion (30%). Involvement of glenohumeral joint in infective etiology is much less common. Joint effusion is a common association of glenohumeral pathologies. Possible etiologies are direct injury to bicipital tendon insertion site or associated inflammation in the early phase of pathology. Subacromial-subdeltoid bursitis was seen in 44% of patients.

MRI proves to be a valuable tool in the evaluation of biceps tendon disorders, avascular necrosis, inflammatory processes, and tumors.[8]

Pitfalls in Diagnosis of Labral Tears[14-16]

In several trials, relatively low sensitivity and negative predictive value has been noticed which makes the diagnosis of labral lesions challenging.[17,18] MRI appearance of labrum is usually triangular. The configuration of the anterior labrum may vary considerably from one individual to another, and in the same person, labral shape changes with rotation of the humerus.

Some normal structures may be misinterpreted as labral tears. The hyaline articular cartilage of the glenoid extends under and undercuts the base of the labrum. At MRI, this produces a linear area of increased signal intensity that may resemble a tear. At the level of the subscapularis tendon, the middle glenohumeral ligament runs parallel to the anterior labrum and also shows low signal intensity. The space between the ligament and the labrum may mimic a tear along the outer border of the labrum, but its true nature is usually revealed when one follows the ligament along its normal course on sequential images.

The sublabral recess or foramen can mimic a labral tear. A collection parallel to the shape of the bony glenoid and extending medially is probably a normal structure, whereas a collection that turns in a lateral direction into the substance of the labrum is most likely a tear. The exact location of the fluid collection may also provide a hint because a normal recess or foramen should not extend posterior to the biceps origin, whereas a labral tear often does.

MRI may reveal occult fractures, which appear as a line of abnormal signal intensity extending through cancellous bone to reach a cortical surface. Rotator cuff tears associated with greater tuberosity fractures can also be assessed. MRI can also demonstrate soft tissue injuries such as the glenoid labrum and cartilage disruption. Injuries to the muscles, such as the pectoralis major, can also be demonstrated. MR findings on proton-density-weighted images include hyperintense edema in the clavicle, sternum, humerus, or ribs, reflecting injury to the attachment sites of the pectoralis major tendons. Edema and hemorrhage in the muscle, myotendinous junction, perifascial zone, or subcutaneous fat can also be demonstrated. The degree of tendon retraction can also be assessed. In addition, both computed tomography and MRI are important to demonstrate incidental findings associated with trauma, such as a hemothorax or pneumothorax.[19,20]

CONCLUSION

MRI has become the gold standard for diagnostic imaging of the soft tissue injury of the shoulder. This is mainly because of its non-invasive nature, high degree of resolution, lack of contrast exposure, non-ionizing radiation, and the ability to evaluate and analyze multiple potential pathologic processes.[18] As the shoulder joint has a complex anatomy, imaging of the shoulder and its dysfunctions is one of the most challenging regions for radiologists and orthopedicians. Technical development in MRI and clinical advances in shoulder therapy ensures that MRI will continue to play an important role in the diagnostic and therapeutic management of patients with shoulder disease.

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