

Role of MRI in Diagnosis of Rotator Cuff Tears

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ABSTRACT

Background: A rotator cuff tear is a tear of one or more of the tendons of the four rotator cuff muscles of the shoulder. The rotator cuff is a group of muscles that play an important role in function of the glenohumeral joint. Value of the clinical examination of a shoulder is often uncommonly exhibited; therefore, imaging modalities have valuable implications in the management of rotator cuff pathologies.

Aim: the purpose of this study is to assess the diagnostic accuracy of MRI in diagnosis of rotator cuff tears.

Materials and Methods: we examined 20 consecutive cases of shoulder arthroscopy, who had undergone preoperative investigation in the form of MRI. Comparing the accuracy of MRI for detection of full-thickness rotator cuff tears, using the operative findings as the 'gold standard' was used. All the patients presented to Radiology Department referred from Orthopedic Outpatient Clinic, El-Demerdash University Hospital and Nassir Institution, from January 2017 to October 2017.

Results: 16(80%) were males, 4(20%) were females, with age range from (27y) to (57y) (mean range 42y) complaining of symptoms and signs of shoulder pain which go more with RCT. The overall accuracy of MRI in diagnosis of RCT, was 99%, while sensitivity and specificity was 99%,98.8) respectively, with P value less than 0.05. **Conclusion:** MRI is an accurate diagnostic imaging method for RCT specially for the FTT, and considered to be best cost-effective, non-invasive imaging method for screening of rotator cuff tears. In patients who underwent surgery, MRI yielded comparably high sensitivity for detecting full-thickness RCT.

Keywords: Magnetic resonance imaging, rotator cuff tear, Arthroscopy

INTRODUCTION

Rotator cuff tears are one of the leading causes of shoulder pain with prevalence of 22.1% in general population, this prevalence increase with age^(1,2), and is among the most common condition affecting the shoulder⁽³⁾. Rotator cuff tears may be either acute (caused by injury) or chronic (cumulative degeneration)⁽⁴⁾. In case of acute, major stress is needed to cause a tear in a healthy tendon, while in case of tendon with preexisting degeneration the stress needed to cause a tendon tear is considerably smaller⁽⁵⁾.

Diagnosis for rotator cuff tears is based upon physical assessment and history, including description of previous activities and acute or chronic symptoms, as well as systemic physical examination of the shoulder⁽⁶⁾.

Diagnostic modalities, depend on circumstances, include X-ray, MRI, MR arthrography, double contrast arthrography, and Ultrasound⁽⁷⁾.

MR imaging can provide information about rotator cuff tears such as tear dimensions, tear depth or thickness, tendon retraction, and tear shape that can influence treatment selection and help determine the prognosis⁽⁸⁾.

In addition, tear extension to adjacent structures, muscle atrophy, size of muscle cross

sectional area, and fatty degeneration have implications for the physiologic and mechanical status of the rotator cuff⁽⁹⁾.

Conventional MRI with T2-weighted images in the oblique coronal and oblique sagittal planes is the preferred technique for imaging the rotator cuff⁽¹⁾.

The purpose of the present study is to assess the diagnostic accuracy of MRI in diagnosis of rotator cuff tears.

PATIENTS AND METHODS

This prospective study comprised of 20 consecutive patients with shoulder pain, who had undergone preoperative imaging in the form of US or MRI and subsequently proceeded to arthroscopic or arthroscopic surgery.

The study was approved by the Ethics Board of Ain Shams University.

Study criteria

Inclusion criteria:

- Patients with shoulder pain
- Shoulder disability
- No age predilection
- No sex predilection

Exclusion criteria:

- a) Heart pacemaker
- b) Insulin pumps
- c) Implanted hearing aids
- d) Neurostimulators
- e) Intracranial metal clips
- f) Metallic bodies in the eye

Data Processing:

- A. Data variables:** All patients were subjected to the following:
1. Full history taking with a special emphasis on:
 - a) Age
 - b) Sex
 - c) Mechanism of injury Trauma
 - d) Number of dislocation(s)
 - e) They are athletic or not.
 2. Clinical provisional diagnosis.
 3. Previous investigation e.g. X-ray, Gray scale ultrasound.
 4. Conventional MRI.
 5. Arthroscopic examination.

For the purpose of comparison, we divided the operative findings into five categories. These were, intact cuff, a partial- thickness tear, a small full-thickness tear (< 1 cm) grade I, a moderate-full thickness tear (1 – 3 cm) grade II, and a large / massive tear (> 3 cm) grade III.

Magnetic resonance imaging

Multi-planar MR imaging (GYROSCAN INTERNA 1.5T MAGNET (PHILIPS) of the shoulder was performed using coronal oblique proton density, coronal oblique T1 weighted, coronal oblique T2 weighted with fat saturation, sagittal oblique T2-weighted with fat saturation, and axial T2 weighted sequences. All MRIs were reported by a radiologist with special interest in musculoskeletal imaging. The criterion for a full-thickness rotator cuff tear was a focal, well-defined area of increased signal intensity on T1-weighted and T2-weighted images that extended from the bursal to the articular surface. A partial-thickness tear was defined when the fluid signals do not traverse the full thickness of the tendon.

Data analysis

All rotator cuff tendons were assessed during imaging, but only the integrity of the supraspinatus tendon, which was the most commonly involved tendon, was analyzed for the purpose of this study. The results of MRI were considered as negative when there was no tear or

a partial-thickness tear and positive when a full-thickness tear was found, for the purpose of this study. The results MRI were compared separately with the operative findings and were scored in a similar manner.

The accuracy of MRI (percentage of correct diagnosis) was calculated with 95% confidence intervals (95% CI). The sensitivity, specificity, and positive and negative predictive values (PPV and NPV) were also calculated for the diagnosis of full-thickness rotator cuff tears. Statistical analysis was not performed separately for partial-thickness tears, due to the limited number in this study.

RESULTS

This study included 20 patients with suspicion of rotator cuff injury by clinical examination. All the patients presented to Radiology Department referred from Orthopedic Outpatient Clinic, El-Demerdash University Hospital and Nassir Institution from January 2017 to October 2017. The MRI results were then compared with the collected data of Arthroscopy. We did US to 12 patients and the remaining (8) brought their own reports.

This study included 20 patients were 16 males and 4 females with age range from 27 years to 57 years (mean age 42 years), suffering from shoulder pain with signs and symptoms goes with rotator cuff injury.

The frequency & percentage according to sex in the study population are tabulated and represented by a chart where male patients represented 80% while female patients represented 20% (Table 1, Fig 1).

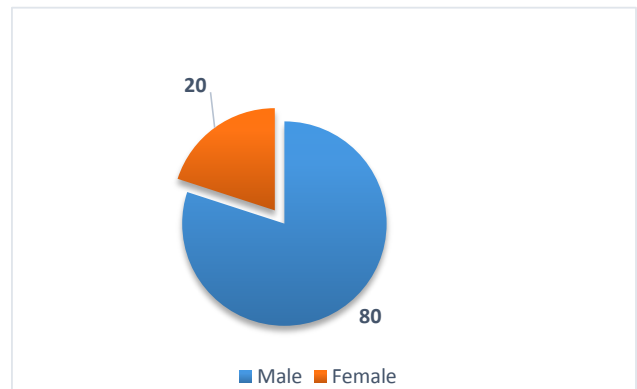


Fig (1): Pie chart of gender

Table 1: The frequency & percentage according to sex

Sex	Frequency	Percentage
Male	16	80%
Female	4	20%
Total	20	100%

Eleven patients were complaining of pain in the shoulder region, 9 patients presented with limited range of movement (Fig 2).

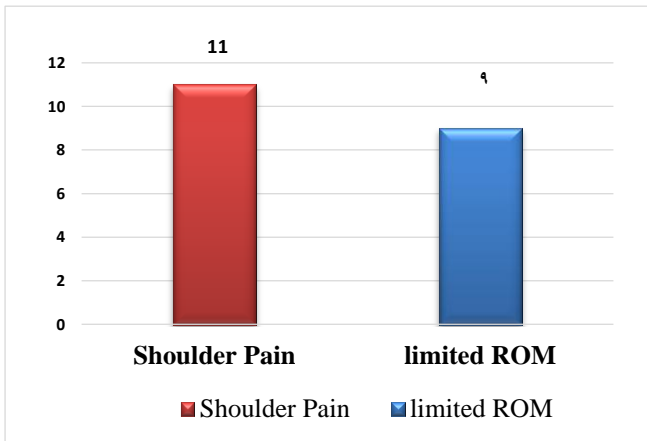


Fig (2): Clinical presentation in our study

Table 2: Sidedness of the lesions

SIDE	Frequency	Percentage	P value	Sig.
Right	13	65 %	0.4154	NS
Left	7	35 %		
Total	20	100.0		

Table (2) the frequency and the percentage of affection of the right and left shoulder side were 13 patients (65 %) and 7 patients (35%) respectively.

By comparing two proportions, the difference in sidedness is statistically insignificant ($p>0.05$). Most cases had rotator cuff tears in the form of FTT, PTT. The table below showed precisely the frequency and

percentages of each pathology detected in our case-series. There was no statistical difference in frequency of pathologies ($p>0.05$).

During arthroscopic interventions, the following diagnoses were elaborated during examination as in Table (3). The diagnoses were elaborated from arthroscopic examination. The percentage of full thickness tears were 50%, the partial thickness tear constituted 40 % of cases while tendinosis were found in 10% of cases.

Table 3: Frequencies of pathologies detected in our study

GI. Rotator cuff disorders	No. of patients	%	P value	Sig.
FTT	10	50	0.916	NS
PTT	8	40		
Tendennis	2	10		
Total No.	20	100		

In table 4, in our study MRI diagnosed 10 patients with full thickness tear and 2 patients with tendennis as the Arthroscopy did; but failed to detect only one case with partial thickness tear in comparison to Arthroscopy.

Table (4): Comparison between MRI and Arthroscopy in detection RCT

RCD	No of false negative cases in	No. of true positive cases detected by	No. of cases detected by
	MRI	MRI	Arthroscopy
Tendennis	-	2	2
PTT			
Articular side	1	3	4
Bursal side	-	3	3
Intertendennis	-	1	1
FTT	-	10	10
Total No.	1	19	20

In Table 5, the supraspinatus tendon are more prevalent either as a sole finding or in combination with other tendons like infraspinatus. Supraspinatus tendon affection was found in 55% of cases. There was no statistical significant difference in the distribution of pathologies.

Table 5: Frequencies of pathologies detected in our study

GI. Rotator cuff disorders	No. of patients	%	P value	Sig.
Supraspinatus tendon only	11	55	0.055	NS
Supraspinatus & infraspinatus tendons	5	25		
Supraspinatus & subscapularis tendons	3	15		
Subscapularis tendon	1	5		
Total No.	20	100		

In Table 6, the accuracy of MRI in diagnosis of RCT, was 99%, while sensitivity and specificity was 99%, (98.8) respectively, with P value less than 0.05.

Table 6: Total sensitivity, specificity and accuracy of MRI in diagnosis of RCD and associated findings

RCD & associated findings	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-value	Sig.
MRI	99.1	98.8	99	0.00001	Ns

CASE ILLUSTRATIONS

CASE 1

54 years old carpenter, complaining of painful right shoulder. On examination of his right shoulder, there is no swelling. He has vague tenderness over his acromioclavicular joint. He has a nearly full range of right shoulder movement, but experiences pain. He has a full reduce of movement of his elbow.

MRI showing discontinuity of the supraspinatus tendon which is seen as fluid signal intensity (arrow) indicating full thickness tear, also there are changes in articular cartilage of GH joint. The tear was 3.5 cm in size with minimal retraction (Fig 4&5). US shows the rupture of the tendon (arrow), which is presented by hypoechogenicity in US.

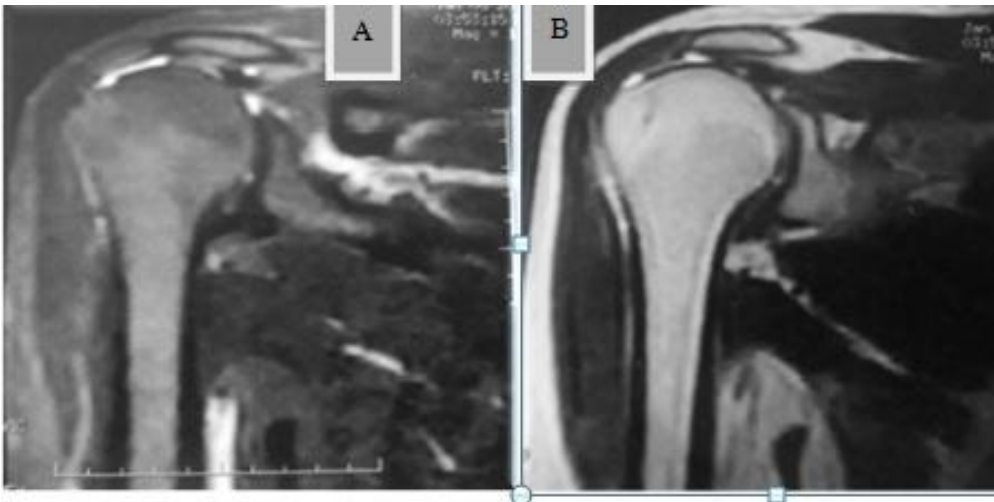


Fig (3): (A) MRI shoulder, showing full thickness tear of supraspinatus, coronal, STIR. (B) MRI shoulder, coronal, T2WI

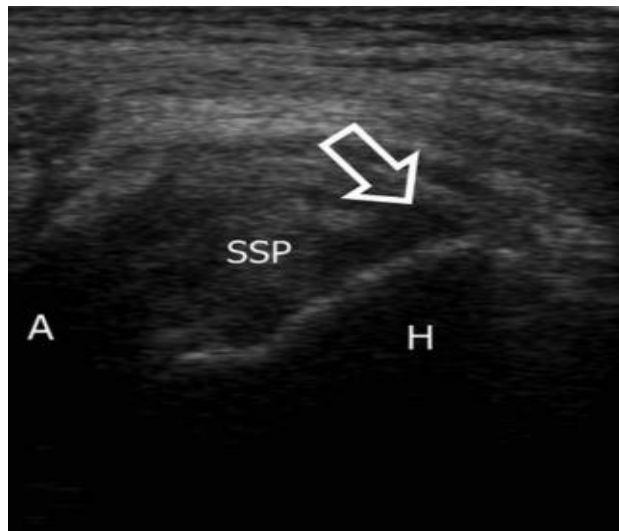


Fig (4): The arrows point out the rupture, hypoechoic in the US. A; Acromion; H; Humerus; SSP; Supraspinatus tendon.

CASE 2

39 years old female teacher, complaining of right shoulder pain for 11 months. On examination she had positive impingement test. MRI showing discontinuity of supraspinatus tendon which is seen as fluid signal intensity with gap about 2.5 cm with retraction (Fig. 6), with mild effusion in glenohumeral joint.

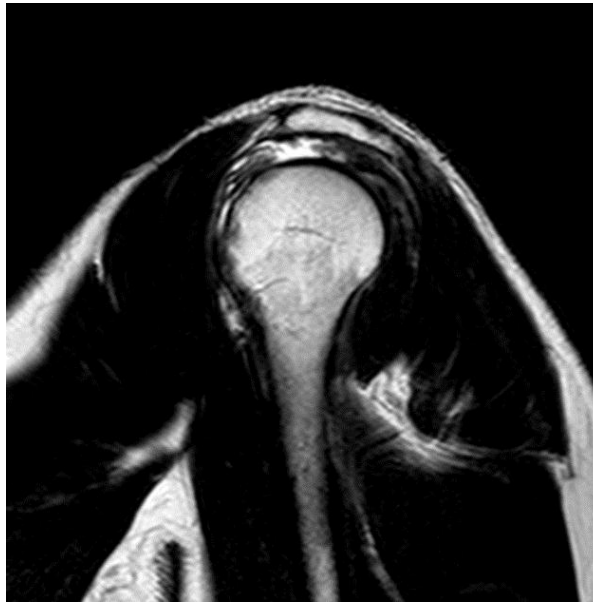


Fig (5): MRI, T2WI, sagittal view showing full thickness tear of supraspinatus.

DISCUSSION

A rotator cuff tear is a tear of one or more of the tendons of the four rotator cuff muscles of the shoulder. A rotator cuff 'injury' can include any type of irritation or overuse of those muscles or tendons, and is among the most common conditions affecting the shoulder⁽¹⁰⁾.

The tendons of the rotator cuff, not the muscles, are most commonly involved, and of the four, the supraspinatus is most frequently affected, as it passes below the acromion. The role of the supraspinatus is to resist downward motion. The supraspinatus resists downward motion while the shoulder is relaxed as well as when carrying weight. Such a tear usually occurs at its point of insertion onto the humeral head at the greater tubercle. Even though the supraspinatus is the most commonly injured muscle of the four muscles in the rotator cuff, the other three muscles that comprise the rotator cuff, the infraspinatus, teres minor, and subscapularis, may also be injured⁽⁵⁾.

Magnetic resonance imaging (MRI) and ultrasound are comparable in efficacy and helpful in diagnosis although both have a false positive rate of 15 - 20%. MRI can reliably detect most full-thickness tears although very small pinpoint

tears may be missed. In such situations, an MRI combined with an injection of contrast material, a MR-arthrogram, may help to confirm the diagnosis. It should be realized that a normal MRI cannot fully rule out a small tear (a false negative) while partial-thickness tears are not as reliably detected⁽¹¹⁾.

While MRI is sensitive in identifying tendon degeneration (tendinopathy), it may not reliably distinguish between a degenerative tendon and a partially torn tendon. Again, magnetic resonance arthrography can improve the differentiation. An overall sensitivity of 91% (9% false negative rate) has been reported indicating that magnetic resonance arthrography is reliable in the detection of partial-thickness rotator cuff tears. However, its routine use is not advised, since it involves entering the joint with a needle with potential risk of infection. Consequently, the test is reserved for cases in which the diagnosis remains unclear⁽²⁾.

Musculoskeletal ultrasound, avoid the radiation of X-ray and the expense of MRI. This modality can also reveal the presence of other conditions that may mimic rotator cuff tear at clinical examination, including tendinosis, calcific tendinitis, subacromial subdeltoid

bursitis, greater tuberosity fracture, and adhesive capsulitis⁽⁵⁾.

But US in MSK system considered as a dynamic study, cause it depend on the movement of the joint by the patient, so its results depending on the professionalism of the practitioners. However, MRI provides more information about adjacent structures in the shoulder such as the capsule, glenoid labrum muscles and bone and these factors should be considered in each case when selecting the appropriate study⁽⁴⁾.

The arthroscopic technique demonstrates similar results to open surgery, and is associated with advantages such as: preservation of the deltoid, possibility of articular diagnosis and lower surgical morbidity⁽¹²⁾.

Our study included 20 patients, 16 (80%) were males, 4 (20%) were females, with age range from (27y) to (57y) (mean range 42y) complaining of symptoms and signs of shoulder pain which go more with RCT. All the patient presented to Radiology Department referred from Orthopedic Outpatient Clinic, El-Demerdash University Hospital and Nassir Institute from January 2017 to October 2017. 12 of the 20 patients were examined with ultrasound and the remaining 8 patients brought their own reports. All of them examined with MRI and the MRI results were then compared with the collected data of arthroscopy.

65% of the patients in our study were complain of right shoulder RCT, while 35% were with left shoulder RCT, by the fact that right shoulder is moved more than the left during normal life style or during sports.

A similar studies conducted by Pavic *et al.*⁽¹⁾ conducted large scale study with a total of 200 consecutive patients who met the inclusion criteria. The mean age was 39 years (range 15 to 83 years); 147 (73.6%) were male and 53 (31.2%) female. 133 of male cases involved the right shoulder predominantly, as they use their right side more than the left and most of them were athletics. In contrary Chen *et al.*,⁽¹²⁾ study sample was conducted on 36 patients. The mean age 53.1y±9.4, females constituted 91% of case series. Right shoulder pathology was found in 32 (88.9%) of cases.

Fischer *et al.*⁽¹³⁾ investigate 45 consecutive patients prospectively. That included (28 women, 17 men; mean age 68.3 years, range

49-81 years). 25 patients had right-sided and 20 patients left-sided shoulder lesions.

Our study was different from Saraya & El Bakry⁽⁴⁾ who did their prospective trial with 40 patients, 27 females (67.5%) and 13 males (32.5%) with their age ranging from 24 to 65 years (mean age 56).

In our study compared to arthroscopy, MRI sensitivity for tendinosis detection was 98% with 90% accuracy, while for partial thickness tears, its sensitivity, specificity, and accuracy were 98%, 90%, 94% respectively. But in full thickness tears its sensitivity and specificity were 100% each with PPV <0.05. This is agree with the results of.

Youssef *et al.*,⁽²⁾ found that the sensitivity, specificity and accuracy of MRI had 99.2%, 98.8% and 99% respectively.

Abd-ElGawad *et al.*,⁽¹⁴⁾ concluded that MRI had sensitivity, specificity and accuracy of 84.6%, 92.6% and 90%, respectively in diagnosing partial thickness tears (PTT); 100%, 88.2% and 95%, respectively in diagnosing full thickness tears (FTT).

Co and coworkers⁽¹⁵⁾ measured the sensitivity and specificity of MRI to be nearly 99% and 96%, respectively.

Roy *et al.*,⁽¹¹⁾ found during their meta-analysis that diagnostic accuracy of MRI in the characterization of full-thickness RCT was high with overall estimates of sensitivity and specificity over 90%. As for partial RC tears and tendinopathy, overall estimates of specificity were also high (>90%), while sensitivity was lower (67%-83%).

Naqvi *et al.*, (2009)⁽¹⁶⁾ elaborated the diagnostic indices from 91 patients with rotator cuff disorders. The positive predictive value (PPV) for the MRI was 92%, the negative predictive value (NPV) was 84%. The accuracy of MRI was 89.09% (95% CI = 77.82% to 95.26%).

Amin *et al.*,⁽¹⁷⁾ investigated the MR sensitivity and concluded that it is a sensitive, minimally invasive technique that can be utilised for the diagnosis and grading of RCD lesions, reducing the need for diagnostic arthroscopy. Our study agrees with their results with regards to the accuracy of the MR, as they found that; out of 200 patients, 111 were diagnosed with a RCD lesion by MRI, and in our study, 19 of 20 cases were reported with rotator cuff lesions.

CONCLUSION

In conclusion, MRI is an accurate diagnostic imaging method for RCT specially for the FTT, and considered to be best cost-effective, non invasive imaging method for screening of rotator cuff tears. In patients who underwent surgery, MRI yielded comparably high sensitivity for detecting full-thickness RC.

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