ORIGINAL ARTICLE

DIAGNOSTIC ACCURACY OF MRI IN CHARACTERIZATION OF ROTATOR CUFF TEARS

Qazi Saad Bin Khalid, Kamran Ellahi Memon, Samina Kausar Satti

Department of Radiology, Dallah Hospital, Riyadh, Saudi Arabia.

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ABSTRACT

OBJECTIVES: To assess the diagnostic accuracy of routine MRI in the detection and characterization of rotator cuff tears, by correlating the findings with arthroscopy. **STUDY SETTING AND DURATION:** Prospective study was conducted in Radiology department Dallah Hospital, Riyadh from July 2017 to December 2018. **METHODOLOGY:** A total of 104 patients were diagnosed with rotator cuff injury on MRI during study period, out of which 79 patients were selected for the study that underwent further evaluation with arthroscopy. The information was assessed for significant correlation between MRI analysis and arthroscopic findings utilizing kappa statistics. The sensitivity, specificity, predictive value and accuracy of MRI for the determination of full and partial thickness tears were determined utilizing arthroscopic findings as the reference standard. **RESULTS:** Out of 79 patients the males were 52 and 27 females, the youngest patient included was 23 years and the oldest patient was 76 years. Commonly rotator cuff tears were seen in patients over 40 years old. The sensitivity of MRI was found to be 88.9% from the results of this study with 100% specificity with 100% positive predictive value and 84.1% negative predictive value. The sensitivity of MRI for partial thickness tear was 100% and the specificity was 87.4%. The positive predictive value was 81.4% with 100% negative predictive value. The accuracy for full and partial thickness tears noted as 94.3% and 90.7% respectively. The p-value <0.01, kappa value was 0.87 for full thickness tears while 0.82 for partial thickness tears, suggestive of excellent level of conformity between MRI and arthroscopy for the investigation of rotator cuff tears. **CONCLUSIONS:** To diagnose rotator cuff tears the MRI revealed high sensitivity and specificity as well as also provides useful information for all the important therapeutic and prognostic implications.

Key words: Cuff Tears, Partial thickness, Full thickness, Shoulder joint.

Introduction

The common cause of painful shoulders is associated with rotator cuff pathologies. Conservative treatment can be used to manage partial thickness tear whereas surgical procedures are required for full thickness tear with some sort of active shoulder abduction. Treatment options can be best decided when accurate diagnosis is made.[1] Shoulder pains are poor indicator of the location of site of origin and the value of clinical examination alone is insignificant for management. Supraspinatus, infraspinatus, teres minor, and subscapularis muscles together with their tendons makes up rotator cuff. They play a main role in shoulder movements. Among all the orthopedic problems abnormalities of rotator cuffs of the shoulders are the most common.[2] Treatment options vary depending upon the extent of tendon tears. Those with partial tears or an intact rotator cuff with inflammation are more suitable for conservative treatment, and patients with complete tears of the cuffs are usually the likely candidates for surgical intervention.[3] The results of

Correspondence : Dr. Qazi Saad Bin Khalid
Department of Radiology,
Dallah Hospital, Riyadh,
Saudi Arabia.
Email: qsbk@hotmail.com

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the imaging of the shoulder may have clinical consequences as the decision to proceed with surgery or to continue conservative management depends on the accurate diagnosis of the extent of the rotator cuff tear.[4]

Before deciding the management options, the most considerate thing to be done is right diagnosis at the right time. In this regard, imaging plays a major role. The decision is required to be made on the extent and location of the tear whether partial or full thickness etc. Besides, decision regarding surgical options whether, arthroscopic or open, can only be made depending on the correct diagnosis. The standards by which such tears can be diagnosed accurately includes unenhanced MRI, Ultrasound and direct or indirect MR arthrography can be used not only for evaluating the painful area but also in finding the true depth of pathology.[5]

Of these procedures, arthrography was traditionally used for radiologic diagnosis, whereas sonography is more recently being used these days. The good thing about arthrography is detecting complete tears, but it has associated discomfort and risk due to its being an invasive procedure. On the other hand, it also misses the partial tears involving the superficial areas or the substance of the cuffs that makes it more unreliable by only highlighting the tears involving the deep surfaces.[6,7]

As compare to arthrography, sonography is noninvasive and sensitive to diagnosis of even the partial tears. But that also has some limitations of being requiring a dedicated small-part transducer, health workforce dependence and inability to visualize parts of cuff beneath the acromion. In light of disadvantages faced by these procedures, the field of research is in search of the procedure that can overcome all these limitations and others unseen.[8] The patients with severe glenohumeral osteoarthritis who are indicated for total shoulder arthroplasty (TSA) has been seen to benefit from the valuable tool of diagnosis known as Magnetic Resonance imaging and abbreviated with MRI.[9] It is shown to have high soft tissue contrast that allows for the differentiation of fat, muscle, cartilage and tendon, which is noninvasive and comfortable.[10] This study aims to find out the diagnostic accuracy of this gigantic invention of humans (MRI) to evaluate its impact on diagnosis and management of such painful tears.

Methodology

This prospective study was conducted in Radiology department, Dallah Hospital Riyadh from July 2017 to December 2018. Study was duly approved by Institute s ethical committee. A total of 104 patients with MRI diagnosed injury of rotator cuffs came to the setting, out of these 79 patients were further evaluated in detail by arthroscopy. Kappa statistics were used to analyze the significant correlation between diagnosis made by MRI and arthroscopy. Arthroscopic findings were used as a reference standard to calculate specificity, sensitivity, predictive values and correctness of MRI in diagnosis of partial thickness or full thickness tears of rotator cuffs.

An aggregate of 104 patients came to the clinic and determined to have rotator cuff injury through MRI amid the examination time frame. Eighteen subjects were then excluded due to non-willingness to further undergo arthroscopy. These left out cases were suffering from tendinosis, and intrasubstance tear with a frequency of 12 and 6, respectively. A total of seven more cases were excluded from the study due to loss to follow up. Patients with history of prosthesis in shoulder or any surgery, with mental implants in the body and pacemakers and claustrophobic patients etc. were also excluded from the study as well. This study then included 79 subjects as respondents to our study and then further evaluated for arthroscopic findings at the study setting. Study was undertaken after the permission was granted from Institutional Ethics Committee. All the subjects were made part of the study after written informed consent was duly understood and signed by the participants or their legal care takers in case of patient being unable to read or write.

MR protocol used for the evaluation of the rotator cuff includes fast spin echo sequence T1W & T2W in the four planes i.e. axial, oblique, coronal, and sagittal oblique etc. as well as three planes of a Fat Saturated Proton Density (FSPD). Magnetum Avanto MR Unit using a surface oil with superconducting 1.5-T siemens were used to evaluate all the patients. TR/TE of 2650/30 was used to obtain FSPD sequence. Other imaging parameters includes TR/TE of 420/11 and 3500/70 for T1W and T2W, respectively. Other imaging parameters included slice thickness, interslice gap,

field of view and a matrix size being 3 mm, 1 mm, 160 mm, and 256 x128, respectively.

Tears were classified as full thickness or partial thickness on MRI. Further classifications were made to partial tears depending on whether it is articular surface or bursal surface. Arthroscopy is unable to detect intra substance tears (tears involving tendons) so such tears were not included in the study to make the comparison worthy. MRI assessed the size and depth of tears. Assessment of adjacent structures were also done for checking involvement. Ancillary findings such as joint effusion, bursal fluid, or bone changes were also noted and documented. Detailed arthroscopic evaluation was done on all the included patients.

Descriptive analysis was done on SPSS ver.22 for calculations. Besides, other data was entered on MS excel spreadsheet. Significance of association between two variables was tested by using chi square of test of independence. Level of agreement between MRI and arthroscopic findings were done using kappa statistics. A statistically significant p value was taken to be less than 0.05

Results

An aggregate of 79 patients who were assessed with both MRI and arthroscopy for rotator cuff tears, were incorporated into this investigation. The males were 52 and 27 were females, proposing a male transcendence of 1.5:1. The youngest patient was 23 years and the oldest was 76 years with 51.47–10.54 years mean age. Great majority of rotator cuff tears were seen in patients over 40 years old, which were noted 62 (78%) out of 79 patients. The right sided dominancy was accounted for in 68 (86%) patients and left sided predominance was reported in 14. The most widely recognized presenting complaint was pain seen in 69 (87.3 %) patients, trailed by restricted range of motion, which was found in 26/79 (32.9%) patients. 11 (13.9%) patients provided history of trauma.

The diagnoses based on MRI reported that 43 out of 79 were found with full thickness tears and 36 were found with partial. When partial tears were further evaluated 29 were found to be articular surface tear while seven of them were bursal surface tears. On the other hand, arthroscopy demonstrated 46 full thickness tears and 31 patients with partial thickness tear out of which the articular surface tear was found in 26 and bursal surface tear was found in 5 cases. The two patients who were determined to have articular surface partial thickness tear on MRI, did not reveal any tear on arthroscopy.

	Full thickness	Partial thickness	Normal	Total
MRI	43	36	-	79
Arthroscopy	46	31	2	79

Table 1: The full and partial thickness tears distribution of patients on MRI and arthroscopy.

n=79	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy	p-value	Kappa coefficient
Full thickenss tears	88.9	100	100	84.1	94.3	<0.01	0.87
Partial thickenss tears	100	87.4	81.2	100	90.7	<0.01	0.82

Table 2: Correlation of MRI findings with arthroscopy

Findings	Frequency	Percentage
Subacromial subdeltoid bursal effusion	48	60.7%
Sub coracoid fluid	38	48.1%
Joint effusion	35	44.3%
Acromio-clavicular joint arthrosis	32	40.5%
Type II acromion	34	43%
Hill Sach's and Bankart	3	3.8%
Labral tear	5	6.3%

Table 3: Ancillary findings of MRI in patients with rotator cuff tears.

All the patients were found with supraspinatus tendon tear 79 (100%) revealing that it is the most commonly involved tendon, 17 (21.5%) patients were represented with infraspinatus tendon involvement. The involvement of subscapularis tendon was noted in 13 (16.5%) patient, while teres minor tear was completely absent in this study population.

The sensitivity of MRI was 88.9%, and specificity was 100% in diagnosing full thickness tears which were seen in 43 out of 46 patients. The positive predictive value was 100% and the negative predictive value was 84.1%. For the partial thickness tears sensitivity was reported to be 100% and specificity 87.4% the positive predictive value was 81.4 % while negative predictive value was 100%. MRI was reported with

94.3% of accuracy for full thickness tears and 90.7% for partial thickness tears. The value of p was reported less than 0.01 for partial as well as for full thickness tears. The calculated kappa value was found 0.87 for full thickness tears and for partial thickness tears it was 0.82 which represents a better level of conformity between MRI and arthroscopy for investigation of rotator cuff tears.

The most common auxiliary finding on MRI study shown was fluid in Subacromial-Subdeltoid (SASD) bursa which was seen in 48 cases making (60.7%) of the study population. 38 (48.1%) patients were found to have fluid in the sub coracoid bursa while 35 (44.3%) patients presented with joint effusion. Acromio-Clavicular joints arthrosis was noted in 32 (40.5%) patients. In addition, Hill Sachs/Bankart s lesion was seen in one (3.8%) patient and one patient presented with labral tear (3.8%).

Discussion

This study and previous literature show that rotator cuff injury is found more in men than women. There is more involvement of the right shoulder and predominant arm as compared to left shoulder and non-dominant arm. Larger part of the rotator cuff tears (78%) were found in patients over the age of 40. Accordingly, the compounding factors for rotator cuff injuries in our examination were male, right shoulder and predominant arm, and advanced age. This study findings matches with the study of Yamamoto An et al., who explained that rotator cuff tears were mostly related to older age, male and targeted the dominant arm.[11] Advanced age makes ligaments degenerate ultimately leading to tears, happening most frequently after the fourth decade and expanding directly from that point.

As this study used the arthroscopic diagnosis as a reference where the full thickness tears were noted in 46/79 (58.2%) and 31/79 (39.2%) participants had partial thickness tears. Supraspinatus was found in all the patients (100%) thus the tendon most commonly involved. Then infraspinatus involvement was found in 21.2% of the patients and subscapularis pathologies in (16.4%). In our study there were no teres minor pathologies noted. A patient diagnosed on MRI and clinical basis as having the partial thickness articular surface tear had tendinopathy and bursitis diagnosed by arthroscopy with no proof of tendon tear. MRI revealed a focal signal change within the articular surface of rotator cuff and SASD bursa. It s probably that the signal changes of tendinitis were over diagnosed and reported as partial thickness tear on MRI, while the symptoms present in the individual were because of tendinopathy and bursitis.

The full thickness rotator cuff tear appears as focal discontinuation of tendon with fluid extending from one surface to another. This appears as high signals on T2W images completely traversing through the tendon, however, in a limited percentage of patients the tendon defect can appear as low signals due to fibrosis or scarring.[12] Fluid is also usually seen in the SASD bursa and in the joint space. However, in some cases these findings may not be appreciated altogether, and the only indirect signs seen are retracted tendon, tendon atrophy and superior subluxation of humeral head.

Partial thickness tears were not as frequent as full thickness tears in our investigation and were observed in 31/79 (39.2%) patients. Out of these, 26 individuals had articular surface tears while the bursal surface tears were found in 5 cases.

These observations are in concurrence with different investigations which also reveals that the articular surface tears are much more frequent than the bursal surface tears.[13,14]

On MRI the partial thickness tears appear as focal area of tendon defect with fluid signals partially traversing the tendon not extending completely from one surface to another on T2W sequences. Fat saturated images may better delineate tendon defect by further accentuating the fluid signals.[15] Apart from tendon deformity, supplementary findings may include surface irregularities or reduced tendon bulk or thickness.

The findings of our study demonstrate that MRI has high sensitivity, specificity and positive predictive value as proved on arthroscopy in the diagnoses of rotator cuff. 93.3% accuracy was found for full thickness tears and 90.7% for partial thickness. Sensitivity and specificity were found to be 88.9% and 100% for full thickness tear, while it was 100% and 87.4% for partial thickness tears. For both the value of p was less than 0.01. The high kappa coefficient showed better agreement between MRI

reports and arthroscopy diagnoses.

Most of the previous studies results matches the result of this study that the MRI sensitivity and specificity was in range of 85-100%.[16] A huge mega analysis was done in 2009 by de Jesus JO et al., which concluded that for full thickness tear the MRI sensitivity was 92.1% and specificity was 92.9% while for partial thickness it was 63.6% and 91.7%.

Therefore, in our study MRI has shown good accuracy in the identification of and characterization of rotator cuff tears, which may have significant impact on deciding the management of these injuries. Davidson JF et al., revealed that in patients with full thickness tears, the preoperative MRI can be utilized in determining the pattern of rotator cuff tear, surgical planning and probable outcome.[17] Likewise, in patients with partial thickness tears further mode of action can be decided after ascertaining if the tear is more than half the tendon thickness or less as it can have significant implications on management strategies.[18]

In association with the tendon tears further auxiliary findings were also observed such as the fluid in the SASD bursa which was the most common finding in both full and partial thickness tears. SASD bursa fluid was found in 60.7% of patients, while sub coracoid bursal fluid was observed in 48.1% of patients. 44.3% patients presented with joint effusion. Hollister MS et al., inferred that the SASD bursa fluid in conjunction with joint effusion is highly specific with high positive predictive value for the diagnoses of rotator cuff tear.[19]

Another typically related finding in patients with rotator cuff tears was degenerative changes in the acromioclavicular joint which was found in 32 out of the 79 patients in our investigation. Results of this study showed that mean age of patients with AC joint degeneration was 51.3 yrs (– 12.85) and 78% individuals were above age 40yrs. These observations are in consensus with the previous studies, proposing that increasing age is related with hypertrophic AC joint arthrosis, which in turn leads to rotator cuff tears.[20]

Interestingly the atrophy of the muscle also plays an important role in rotator cut tear as the tone and power of the muscles depend a lot on their thickness. MRI can easily assess the muscle bulk and determine the degree of atrophy which has serious implications on post-surgical prognosis. Goutallier D et al., describe that fatty degeneration has significant impact on suboptimal return of shoulder work after surgery and is also associated with higher tear recurrence.[21]

Some other related observations on MRI were marrow edema, fracture, Hill-Sachs and Bankart lesions and subchondral cysts Therefore, MRI gives a comprehensive analysis regarding the shoulder joint structures which is very useful for diagnosis and management.

Conclusion

Our study indicates high sensitivity and specificity of the MRI for partial and full thickness rotator cuff tears and shows great relationship with the findings of arthroscopy. The gold standard for investigating the rotator cuff injuries remains arthroscopy but is invasive and is not ideally suitable for all patients. Hence, MRI offers a fantastic non-invasive modality which can be utilized to evaluate patients with suspected rotator cuff injuries. MRI provides comprehensive data about the tear type and extent as well as the additional findings like tendon retraction, atrophy of the muscle and fatty degeneration to help the treating physician in planning management and predicting the prognosis.

Conflict of Interest: Authors declared none

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