Pharmacophore

ISSN-2229-5402

Journal home page: http://www.pharmacophorejournal.com

MRI ASSESSMENT OF ROTATOR CUFF TEAR IN PATIENTS WITH SHOULDER PAIN

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ARTICLE INFO

Received:
12 Dec 2022
Received in revised form:
25 Mar 2023
Accepted:
27 Mar 2023
Available online:
28 Apr 2023

Keywords: Magnetic resonance imaging (MRI), Rotator cuff tear, Shoulder pain, MRI arthrography, Tendon tear

ABSTRACT

In the shoulder, a rotator cuff tear refers to a rupture of one or more of the tendons of one or more of the four rotator cuff muscles. Magnetic Resonance Imaging (MRI) is an effective method for diagnosing rotator cuff injuries, including tears. MRI can provide clear images of ligaments, tendons and muscles. Rotator cuff tears were diagnosed by MRI at King Salman Hospital and King Khalid Hospital in Hail. MR Unit with 1.5-T Siemens scanners was used to evaluate all patients with shoulder MRI protocol including fast spin echo sequence T1W & T2W was used. The fat saturating proton density (FSPD) can be obtained in four planes of imaging, namely axial, oblique, coronal, and sagittal oblique, three planes of axial, oblique, coronal, and sagittal oblique, as well as three planes of oblique. In this study, 50 patients were enrolled, ranging in age from 20 to 80 years, 28 of whom were males and 22 of whom were females. There were 61 to 80-year-old patients (40%) who were the oldest. Meanwhile, there were only 4 cases among the youngest patients between the ages of 20 and 30 (8%). Out of 50 patients, 28 were diagnosed with full-thickness tears (56%) and 22 cases were diagnosed with partial tears (44%) using MRI. The findings from this study suggest that MRI is highly effective for the detection of rotator cuff tears, both full-thickness tears and partial-thickness tears. In addition, it provides details regarding the tear, tendon retraction, joint effusion, and subacromial-subdeltoid bursa.

To Cite This Article: Alshammari QT, Alshammari AR, Alyahyawi AR, Alhmshe AS, Alshammari AS, Alshammari MF, et al. MRI Assessment of Rotator Cuff Tear in Patients with Shoulder Pain. Pharmacophore. 2023;14(2):19-25. https://doi.org/10.51847/q4TEobTCIz

Introduction

Pathologies of the rotator cuff on the shoulder blade are the most common cause of painful shoulders that occur due to a tight rotator cuff. The rotator cuff is one of the most common causes of shoulder pains and disability, and surgery is an essential part of managing these injuries [1-4]. A partial-thickness tear can be treated conservatively, while a full-thickness tear with active shoulder abduction, while the full-thickness tear can only be treated surgically, and has to be removed from the shoulder in the end [5]. A diagnosis of a disease is the first step to determining the treatment options that are available to the patient. There is only a limited amount of information that can be derived from clinical examinations alone when it comes to diagnosing shoulder pain and determining the site of origin. Four muscles make up the rotator cuff, the supraspinatus, the infraspinatus,

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the teres minor, and the subscapularis. A large part of the shoulder's movement is controlled by them. The rotator cuff of the shoulders is the most common orthopedic problem among all orthopedic problems [6].
Tendon tears can be treated in a variety of ways, depending on their severity and extent. There are most certainly some cases where conservative treatment is an option. People with partial tears of the rotator cuffs or those with rotator cuffs that appear to be intact but inflamed are likely to benefit from surgical intervention [7]. According to the results of the imaging of the shoulder, depending on the accuracy of the diagnosis of the extent of the rotator cuff tear, as well as whether the decision to proceed with conservative management or to undergo surgery will be made, the results of the imaging could have clinical implications [8]. It is imperative to make the right diagnosis at the right time before making an informed decision regarding the therapeutic options available to you. The importance of imaging in this regard cannot be overstated. To determine whether the tear is partial or full thickness, it is necessary to decide how large the tear is and where in the body it is located. Moreover, it is only after the correct diagnosis has been made that a decision can be made regarding the surgical options available, whether it is arthroscopic or open surgery [9].
To diagnose such tears accurately, a variety of standard imaging techniques, including unenhanced Magnetic Resonance Imaging (MRI), ultrasound, and direct or indirect, can be used. MRI arthrography can not only be used to determine the true extent of the pathology but can also be used to evaluate the painful area. In terms of radiologic diagnosis, arthrography has traditionally been used for radiologic diagnosis, whereas sonography has become more common in recent years [10]. Arthrography has the advantage that it can detect complete tears, but it is invasive so there is also the possibility of discomfort and risks associated with it, even though it is a good procedure. However, as well as this, it also misses the partial tears that involve superficial areas or the substance of the hands in the cuffs as a result of only detecting the tears that involve the deep surfaces of the hands. Therefore, this makes it less reliable by highlighting only deeply embedded tears [11]. There is no invasiveness involved with sonography as opposed to arthrography, and it can detect even the partial tears that require surgery. This procedure has some advantages, however, there are some limitations as well, such as the requirement for a dedicated very small-part transducer, the dependence of the health care worker, and the inability to see parts of the cuff beneath the acromion of the arm [12].
This procedure has many disadvantages, and the field of research is currently trying to figure out how to find a procedure that can overcome all these limitations, as well as many other limitations that have not yet been revealed. It has been shown that MRI is one of the most useful tools to utilize when diagnosing the severity of glenohumeral osteoarthritis in patients who are indicated for total shoulder arthroplasty (TSA) and to guide surgical treatment. It is an imaging technique that addresses the glenohumeral joint and is also known as magnetic resonance imaging, also known as MRI [13]. A new development in MRI has made it possible to determine the extent of shoulder pathology with greater ease than ever before. The technology used in current MRI scans has made it possible to improve diagnostic capabilities. Rotator cuff tears have been diagnosed using MRI as well as magnetic resonance arthrograms (MRAs) [14]. The technique provides a high contrast of soft tissue to allow for the differentiation of fat, muscle, cartilage, and tendon, so the procedure can be performed non-invasively and comfortably [15]. The purpose of this study is to study the diagnostic accuracy of magnetic resonance imaging in the identification of a rotator cuff tear in the presence of shoulder pain.

Materials and Methods

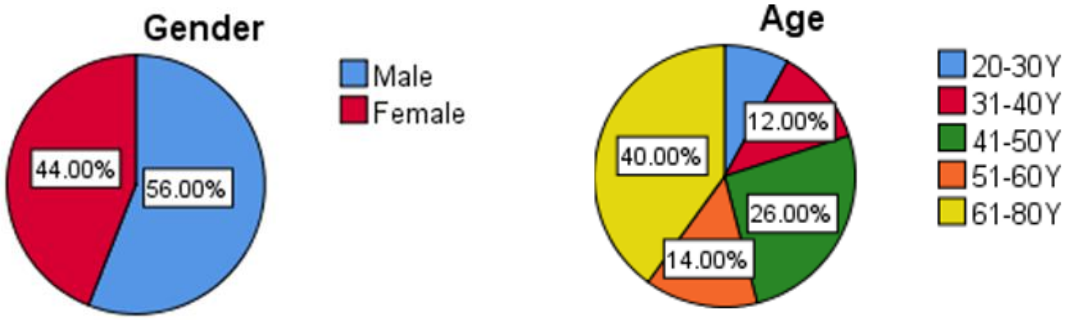
The study was conducted at the King Salman Specialist Hospital and King Khalid Hospital in Hail city, Kingdom of Saudi Arabia, which is the diagnostic radiology department of the King Salman Specialist Hospital and King Khalid Hospital over 6 months from June 2022 to December 2022. We analyzed a sample of 50 patients who tested positive for a rotator cuff tear in the Hail region of Saudi Arabia, and we conducted MRI on those who were positive. Make sure that patient privacy and confidentiality are maintained as well as the destruction of information collected during the research process once it has been completed. In accordance with the Declaration of Helsinki's principles, this study was carried out according to these principles. It has been approved by the Human Research and Ethics Committee of the University of Hail, the King Salman Specialized Hospital, and the King Khaled Hospital (H-20220182), and all patients have provided written informed consent. Patients with confirmed shoulder rotator cuff tears, aged from 20 to 80 years both male and female patients were included in the study whereas patients who are claustrophobic, mentally unstable, and patients with metal implants were excluded from the study.
As part of the MR protocol for the evaluation of the rotator cuff, the fast spin echo sequence T1W & T2W was used. The fat saturating proton density (FSPD) can be obtained in four planes of imaging, namely axial, oblique, coronal, and sagittal oblique, three planes of axial, oblique, coronal, and sagittal oblique, as well as three planes of oblique. During the evaluation process of all patients with concerns related to their health, the Magnetum Avanto MR Unit with 1.5-T Siemens scanners was used to evaluate all patients. Aside from TR/TE of 420/11 and 3500/70, other imaging parameters can be seen such as T1W and T2W images at periods of 420/11 and 3500/70. The imaging parameters also included the slice thickness, the inter-slice gap, the field of view, as well as the size of the matrices, which were 3 mm, 1 mm, 160 mm, and 256 x 128, respectively.
Statistical analysis will be performed using SPSS (version 26) to analyze the data. The data will be reported as a number (percentage) or mean and standard deviation with a 95 percent confidence interval (CI) whenever appropriate. To determine statistical significance, a two-sided p-value of 0.05 was used.

Results and Discussion

The patients involved in this study underwent MRIs of the shoulder at King Salman Specialist Hospital and King Khalid Hospital and were found to have rotator cuff tears on both scans. A total of 50 patients were enrolled in the study, of which 28 were males and 22 were females, as shown in **Figure 1a**, with a predominance of patients aged between 61 and 80 years (F=20, P=40%) followed by patients aged 41 to 50 years (F=13, P=26%). In the meantime, only four cases were reported of patients between the ages of 20-30, as shown in **Figure 1b**. Out of 50 patients, 28 were diagnosed with full-thickness tears (P = 56%) and 22 cases were diagnosed with partial tears (P =44%) using MRI. **Table 1** shows characteristic of study sample by Age and gender.

Table 1. Characteristic of study sample by Age and gender

	Frequency	percentage
20-30Y	4	8.0
31-40Y	6	12.0
41-50Y	13	26.0
51-60Y	7	14.0
61-80Y	20	40.0
Total	50	100.0
Male	28	56.0
Female	22	44.0
Total	50	100.0



a) b)

Figure 1. Characteristic of study sample by a) Gender, b) Age

Among the 28 patients who were diagnosed with a full-thickness tear, 16 males were diagnosed with the condition, as compared to 12 males diagnosed with partial tears out of 22 cases. Of the females diagnosed with full-thickness tears were 12, 10 women were diagnosed with partial tears, which means that 12 females presented with full-thickness tears. The incidence of a partial tear is more likely to be detected in the same way in all age groups, since all age groups present approximate occurrence rates of tears, ranging from 13% to 27%, as shown in **Table 2**. In contrast, a full-thickness tear is more likely to be diagnosed among patients aged 61-80 years (F=15, P=53.6%) since there is a divergence in the occurrence of full-thickness tears among age groups.

Table 2. Percentage of Full thickness and Partial thickness tear

	Frequency		Percent
Valid	FTT: Full-thickness tear	28	56.0
	PTT: Partial tear	22	44.0
	Total	50	100.0

A total of 50 MRI scans were analyzed to determine the location of the injured tendon for each patient (supraspinatus, infraspinatus, subscapularis, and teres minor). It was found that 45 patients had injured supraspinatus tendons in the study, with 24 cases diagnosed as tearing the tendons completely (P=53.3%) and 21 cases being diagnosed as partial tears (P=46.7%). **Table 3** summarizes the distribution of FTT and PTT on MRI according to gender and age. It has been observed that supraspinatus tendon injuries are more common among patients vs. infraspinatus tendon injuries, as shown in **Table 4**.

Table 3. Distribution of FTT and PTT on MRI according to gender and age

		FTT: Full-thickness tear		PTT: Partial tear		Total
		F	P	F	P	F
Gender	Male	16	57.1%	12	54.5%	28
	Female	12	42.9%	10	45.5%	22
Total		28	100%	22	1005	50
Age	20-30Y	1	3.6%	3	13.6%	4
	31-40Y	3	10.7%	3	13.6%	6
	41-50Y	7	25.0%	6	27.3%	13
	51-60Y	2	7.1%	5	22.7%	7
	61-80Y	15	53.6%	5	22.7%	20
Total		28	100%	22	100%	50

Table 4. Percentage of Supraspinatus and Infraspinatus injury

		Frequency	Percent
Valid	SS: Supraspinatus	45	90.0
	IS: Infraspinatus	5	10.0
	Total	50	100.0

The study found only five cases with suspected tears of the infraspinatus tendons. Out of 4 of these cases, 4 were diagnosed with full-thickness tears (P=56%), while one case was diagnosed with a partial tear of the tendons. It is worthwhile to note that there are no cases of either injured teres minor tendons or injured subscapularis tendons observed in the study. As shown in **Table 5**, there is a significant association between tendon retraction and RCT type among 50 patients with RCTs ($\chi 2$= 7.48, P<0.05).

Table 5. Distribution of patients with FTT and PTT on MRI according to injuredtendon location (N=50) and association analysis

			Tear Type		Total
			FTT: Full-thickness tear	PTT: Partialtear	
Tear Location	SS: Supraspinatus	Count	24	21	45
		% within Tear Location	53.3%	46.7%	100.0%
		% within Tear Type	85.7%	95.5%	90.0%
		% of Total	48.0%	42.0%	90.0%
	IS: Infraspinatus	Count	4	1	5
		% within Tear Location	80.0%	20.0%	100.0%
		% within Tear Type	14.3%	4.5%	10.0%
		% of Total	8.0%	2.0%	10.0%
	Total	Count	28	22	50
		% within Tear Location	56.0%	44.0%	100.0%
		% within Tear Type	100.0%	100.0%	100.0%
		% of Total	56.0%	44.0%	100.0%
X^2			7.483		
P (sig.)			0.006		

A total of 71.4% of cases with full-thickness tears and 63.3% of those with partial tears were diagnosed with joint effusions in the joints. In addition, 53.6% of patients with a full-thickness tear and 31.8% of patients with a partial tear had subacromial-subdeltoid (SASD) bursal effusion present. Additionally, SA bursal effusion was found in 25% of cases with a full-thickness tear and 18.2% of cases with a partial tear. The other findings we noticed were that we observed the HOA of the A/C Joint in 3 cases, in which there was a full rupture of the joint, and in 6 cases, in which there was a partial rupture of the joint, as shown in **Table 6**.

Table 6. presence of ancillary findings among RCT patients with FTT and PTT

		Tear Type		
		FTT	**PTT**	**Total**
SA bursal effusion	Count	7	4	11
% within SA bursal effusion		63.6%	36.4%	100.0%
% within Tear Type		25.0%	18.2%	22.0%
% of Total		14.0%	8.0%	22.0%
Total	Count	28	22	50
% within SA bursal effusion		56.0%	44.0%	100.0%
% within Tear Type		100.0%	100.0%	100.0%
% of Total		56.0%	44.0%	100.0%
SASD bursal effusion	Count	15	7	22
% within SASDbursal effusion		68.2%	31.8%	100.0%
% within Tear Type		53.6%	31.8%	44.0%
% of Total		30.0%	14.0%	44.0%
Total	Count	28	22	50
% within SASDbursal effusion		56.0%	44.0%	100.0%
% within Tear Type		100.0%	100.0%	100.0%
% of Total		56.0%	44.0%	100.0%
Joint effusion	Count	20	14	34
% within Seen of Joint effusion		58.8%	41.2%	100.0%
% within Tear Type		71.4%	63.6%	68.0%
% of Total		40.0%	28.0%	68.0%
Total	Count	28	22	50
% within Seen of Joint effusion		56.0%	44.0%	100.0%
% within Tear Type		100.0%	100.0%	100.0%

As shown in both this study and previous literature, rotator cuff injuries are more common in men than in women, according to research conducted in this study and other publications. This indicates that the dominant arm and right shoulder are more likely to be involved than the dominant arm and left shoulder. The majority of rotator cuff tears are seen in patients over the age of 40 and 40% of the tears are found in patients over the age of 60 years. Accordingly, a variety of factors were involved in the development of rotator cuff injuries in our examination, including the presence of the male gender, the right shoulder and dominant arm, and advanced age, all of which contributed to the development of these injuries. Based on these findings, Yamamoto An *et al*., published in the Journal of Orthopedic and Sports Medicine, concluded that rotator cuff tears are most frequently associated with older age, and male gender, and involved the dominant arm in the majority of cases [16]. The same findings were found by Gururaj Sharma *et al*., (2017) in a study that involved 27 male patients and 18 female patients, indicating a higher incidence of males than females the youngest patient was 22 years old, and the oldest patient was 72 years old. The majority (78%) of rotator cuff tears have been seen in patients over the age of forty years old who have already undergone shoulder surgery [17]. The degeneration of ligaments in older people makes them more prone to tears as they age; they most commonly occur after the fourth decade, and they tend to extend straight from that point forward.

MRI was used to diagnose a total of 50 patients, 28 of which were diagnosed with full-thickness tears (P = 56%), and 22 cases were diagnosed with partial tears (P = 44%). However, there was a higher percentage of males aged over 40 years than females in terms of the number of full-thickness tears. According to this study, it is in agreement with Gururaj Sharma *et al*., who found that from of forty-five patients that were evaluated on MRI, 26 of the patients had been diagnosed with full-thickness tears while 19 had been diagnosed with partial thickness tears [17]. Typically, a full-thickness rotator cuff tear is seen as a focal discontinuity of the tendon, accompanied by fluid that extends between the two surfaces. This defect tends to appear as a high signal on T2W images, which appears to traverse through the tendon completely, which gives the impression that it is present throughout the tendon. In some cases, there is an extremely small percentage of patients for whom tendon defects appear as low signals, due to the formation of scar tissue or fibrosis around the tendon [18]. The supraspinatus is the most commonly affected rotator cuff among all those. A study by Koganti *et al*. supported these findings: they found that in 82% of the 50 patients covered by the study, the supraspinatus tendon was abnormal, making it the most commonly affected tendon, followed by the subscapularis tendon and the infraspinatus tendon [19].

The presence of the subacromial bursa effusion was also an auxiliary finding that was observed along with the tendon tears, namely that the bursa effusion was 63.6% full thickness and only 36.4% partial thickness. It was found that 68.2% of patients had full-thickness subacromial subdeltoid bursa effusion while 31.8% had partial thickness. According to Hollister *et al*., an SASD bursum effusion combined with a joint effusion can be used in conjunction with a rotator cuff swelling to assess rotator cuff tears with high specificity and high positive predictive value for diagnosis [20]. In addition to demonstrating marrow edema, fractures, Hill-Sachs and Bankart lesions, and subchondral cysts in the shoulder joint, imaging with an MRI scanner can also provide valuable information about the status of the shoulder joint to assist with the diagnosis and treatment of shoulder joint conditions. Thus, shoulder MRIs provide us with a more comprehensive view of the shoulder joint structures that can help to diagnose as well as treat diseases related to the shoulder joint.

Conclusion

In conclusion, the results of the study indicate that MRI is highly effective at detecting rotator cuff tears both at full thickness and partial thickness. As well as providing detailed information on the ruptured tendon, joint effusion, and bursa of the subacromial-subdeltoid joint, it also provides information on tendon retraction. It is still considered the gold standard for evaluating rotator cuff injuries to the shoulder; however, arthroscopy is invasive and may not be appropriate for all patients. The use of MRI as a non-invasive imaging method provides patients with suspected rotator cuff injuries with an excellent option for evaluation. A comprehensive evaluation of the tear type and extent, as well as the presence of additional findings such as tendon retraction, muscle atrophy, and fatty degeneration, will provide the treating physician with comprehensive information that will assist him in planning the treatment and predicting the patient outcomes.

Acknowledgments: The authors would like to acknowledge King Salman Specialist Hospital and King Khaled Hospital for providing the infrastructure and faculties to conduct this study.

Conflict of interest: None

Financial support: None

Ethics statement: None

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