Comparative Study between MRI and Ultrasound Sensitivity in Supporting Clinically Diagnosed Rotator Cuff Tear

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ABSTRACT

Background: The rotator cuff tendons are the key to the healthy function of the shoulder. Rotator cuff problems are frequently seen by orthopedic surgeons and tear of the rotator cuff usually considered a painful injury and event. Diagnosis is usually made through detailed history, physical examination and often imaging studies.

Objectives: To compare the sensivity of ultrasonography and magnetic resonance imaging for detection of rotator cuff tears (partial or full thickness) in patients with shoulder pain clinically diagnosed as rotator cuff tears.

Methods: During period from March 2013 to January 2015, 48 patients diagnosed as rotator cuff tear either partial or complete tear according to clinical examination 20 patients with full thickness tear and 28 patients with partial thickness tear all patients were send for US and MRI study to confirm the diagnosis at Al-Yarmouk Teaching hospital where we compare the results.

Results: Age ranging from (18 to 62) years with a mean of (48.6) years, 30 males (62.5%) and 18 females (37.5%). Dominant side was affected in (33) patients (68.75%), the non-dominant side was affected in (15) patients (31.25%). Among the 20 patients diagnosed as full thickness tear 17 patients (85%) were having full thickness tear and two patients (10%) were having partial thickness tear and one patient (5%) was having intact tendon.

Among the 28 patients diagnosed as partial thickness tear 18 patients (64.3%) were having partial thickness tear and four patients (14.3%) were having full thickness tear and six patients (21.4%) were having negative result (intact tendon). Sensitivity of US in detection of full thickness tear was 85% and sensitivity of US in detection of partial thickness tear was 64.3%. Among the 20 patients diagnosed as full thickness tear 13 patients (65%) were having full thickness tear and five patients (25%) were having partial thickness tear and two patients (10%) were having intact tendon. Among the 28 patients diagnosed as partial thickness tear 25 patients (89.3%) were having partial thickness tear and two patients (7.1%) were having full thickness tear and one patient (3.6%) was having negative result (intact tendon). Sensitivity of MRI in detection of full thickness tear was 65% while the sensitivity of MRI in detection of partial thickness tear was 89.3%.

Conclusions: Full thickness tear is diagnosed mainly by clinical examinations and ultrasonography is useful in the diagnosis with sensitivity of (85%). MRI is not so useful in the diagnosis with sensitivity of 65%. Partial thickness tear is diagnosed mainly by clinical examination and ultrasonography is not so useful in the diagnosis with sensitivity of (64.3) and thus those patients need for further evaluation with other test like MRI with sensitivity of 89

Keywords: Rotator cuff muscle tendon tear, Ultrasound, MRI.

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Several basic studies had been performed on the strength and rupture of the musculo-tendinous junction, tendon and insertion of the rotator cuff muscles[1].

Codman in 1931 was the first to note that many patients with inability to abduct the arm had incomplete or complete rupture of the supra spintus tendon, rather than primary bursal problem[2]. The prevalence of full-thickness rotator cuff tears is 7 to 40% in cadaveric studies[3]. Partial-thickness rotator cuff tears are

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more frequent 50% with higher incidence[3]. Up to 51% of patients older than age 80 years have asymptomatic rotator cuff tear (RCT)[3].

Classification of RCT: Loss of continuity of the rotator-cuff can be described in several ways, including acute or chronic, partial or full thickness tear, and traumatic or degenerative[4].

Etiology of RCT: Anatomical variation, reduction of the subcoracoid space, vascular etiology, trauma, microtrauma and overuse; and intrinsic rotator cuff degeneration[5,6].

Clinical presentation: Rotator cuff tears can be diagnosed clinically in patients with typical symptoms for chronic shoulder pain[7-11].

RCT are uncommon before the age of 40 years. Generally the older the patient had shoulder trauma and impingement syndrome the more likely to had a cuff tendon tears. The pain is of three types: Nocturnal, daytime and painful arc. Almost all patients complain from severe pain at night which may become debilitating. Pain usually exacerbated by overhead activities, worse with active rather than passive motion. This pain usually disappears within some weeks in full thickness tears.

It is not uncommon for these patients to have an acute traumatic event, severe trauma usually found in younger patients with acute tear.

Physical examination:[11-13] Forward flexion: If limited → arthritis, adhesive capsulitis or rotator cuff tears. Abduction: If abduction is painful, note the degree of abduction when the pain is elicited. Pain only between 60–120° (Painful arc) → impingement or RCT, if the patient cannot initiate abduction → weakness of deltoid or massive RCT. External rotation: increased passive external rotation mean massive rotator cuff tear involving subscapularis tendon.

Special tests: the painful arc test Neer impingement sign, Neer impingement test, Hawkins-Kennedy impingement sign, Job's test (empty can test), Drop arm sign (Codman's test).

Diagnostic imaging of the rotator cuff: Imaging methods used for the assessment of rotator cuff-related pathologies are plain radiography; single or double contrast arthrography, sonography, MRI, magnetic resonance (MR) arthrography and CT scan. In this study will focus on the ultrasound and MRI[14].

Ultrasound image of the supraspinatus tendon, showing an hypoechoic area (arrow) in the insertion (i.e. at the footprint) of the supraspinatus, which was interpreted by the experienced radiologist as tendinosis and by the general radiologist as a partial-thickness rotator cuff tear.

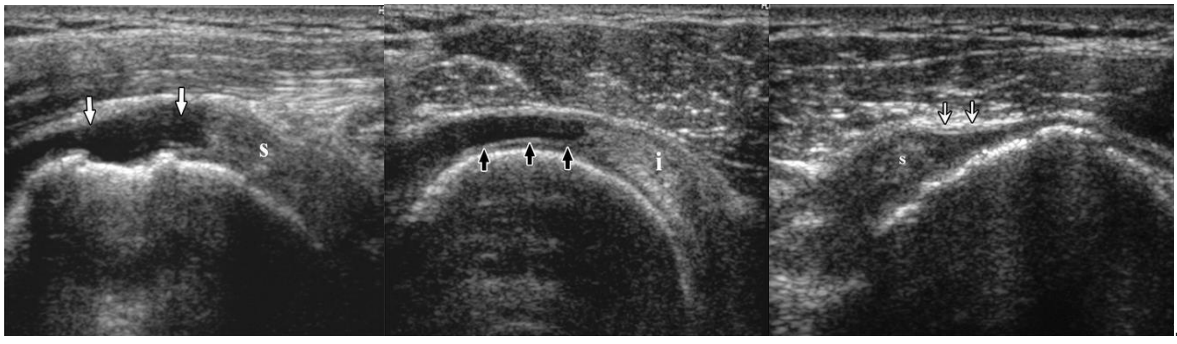

Figure 1: Discontinuity of the tendon. Figure 2: "double cortex". Figure 3: "sagging peribursal fat".

Standard criteria for diagnosing rotator-cuff tears:[15-20]

1- Full-thickness tear; either discontinuity of the normal homogeneous echogenicity of the tendon or non-visualization of the tendon. (Indirect signs include the double cortex sign the sagging peribursal fat sign, compressibility and muscle atrophy).

2- Partial-thickness tear: either flat bursal surface of the tendon or hypoechoic area.

Magnetic resonance imaging (MRI)[21,22] is useful in revealing and classifying atrophy and fatty degeneration, which can develop in the rotator cuff muscles as a consequence of a tendon tear and which are important prognostic factors for tendon repair.

Standard criteria for diagnosing rotator-cuff pathologies: (The MRI signal of normal tendons is low on all sequences). Full-thickness tear: A gap within the tendon on T1-weighted images gets brighter on T2-weighted images. Free fluid in the subacromial-subdeltoid bursa, obliteration of the peribursal fat strip, depending on extent and chronicity, retraction and fatty atrophy.

Partial-thickness tear: Signal abnormality within the tendon on T1-weighted Images. Increasing signal on T2-weighted Images. Contour abnormality.

Figure 4: T1 weighted image showing a partial-thickness tear.

Figure 5: T2-weighted image showing a full-thickness tear.

Methods

During the period from March 2013 to January 2015, we received 48 patients with an age range (18-62) years with the mean of (48.6) years with shoulder pain suspected to have rotator-cuff tears (RCT) at Al-Yarmouk Teaching Hospital outpatient department. Those patients were subjected to full history taking which include: Name, age, sex, occupation, pain characteristic include (site, duration, character, radiation, aggravation, relief, timing), any limitation of movement, and history of relevant illness or trauma. Full physical examination and special tests including: The painful arc, shoulder shrug and abduction paradox, cross body adduction, Neer impingement sign, Neer impingement test, Hawkins-Kennedy impingement sign, Job's test (empty can test), isolated supraspinatus function, drop arm sign (Codman's test) were done for them.

Our plan toward the patient was as follows: When we have a suggestive history in addition to the following signs (atrophy, tenderness, coarse crepitation and painful arc) we considered them suggestive of rotator-cuff pathology of the shoulder joint. When we found a suggestive history in addition to one or more of the following criteria (according to the suggestion of Louis Solomon, David J Warwick and Selvadurai Nayagam)[9]. These criteria included; Shrugging the shoulder, abduction paradox, drop arm sign, and negative Neer's test, we considered the case as full thickness tear.

When we found a suggestive history, absence of shoulder shrug, swing the arm sign, abduction paradox, and drop arm sign with presence of one or more of the following criteria (according to the suggestion of Louis Solomon, David J Warwick and Selvadurai Nayagam)[9]. These criteria included; Hawkins impingement sign, Job's test, cross body adduction, isolated supraspinatus function, and positive Neer's test, we consider the case as partial thickness tear.

All patients were classified into two groups: Patients with full thickness tear (F.T.T) and they were 20 patients. Patients with partial thickness tear (P.T.T) and they were 28 patients.

After diagnosing them as RCT (rotator cuff tear) all of them were sent for ultrasonographic (U/S) and MRI examinations and subjected to a prospective comparative study.

All ultrasonographs were real time procedure and performed by radiologists experienced in musculoskeletal ultrasound using a high-frequency linear-array transducer using the Siemens Sonoline versa pro machine 7.5 MHZ probe. P.T.T and F.T.T were diagnosed.

Magnetic resonance imaging: Multi-planar MR imaging 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 MRI were done by a radiologist having special interest in musculoskeletal imaging.

Results

Among the (48) patients and according to the criteria of clinical examination; (20) patients (41.7%) were having F.T.T and (28) patients (58.3%) were having P.T.T, (Table 1).

Mean age of patients in general was (48.6) years ranging from (18 to 62) years. Mean age of patients with F.T.T was (57.3) years ranging from (36 to 62) years. Mean age of patients with P.T.T was (47.2) years ranging from (18 to 55) years.

Among the 48 patients included in this study there were 30 males (62.5%) and 18 females (37.5%). Among the 20 patients with F.T.T; 11 patients (55%) were males and nine patients (45%) were females. Among the 28 patients with P.T.T; 19 patients (67.9%) were males and nine patients (32.1%) were females.

Among the (48) patients, the dominant side was affected in (33) patients (68.75%)

and the non-dominant side was affected in (15) patients (31.25%). Among the 20 patients with F.T.T; 17 patients (85%) were having their lesions in the dominant side and three patients (15%) were having their lesions in the non-dominant side. Among the 28 patients with P.T.T; 16 patients (57.1%) were having their lesions in the dominant side and 12 patients (42.9%) were having their lesions in the non dominant side.

The results of US were as follows: Among the 20 patients diagnosed as F.T.T clinically; 17 patients (85%) were having F.T.T, two patients (10%) were having P.T.T and one patient (5%) was having intact tendon. Among the 28 patients diagnosed as P.T.T; 18 patients (64.3%) were having P.T.T, four patients (14.3%) were having F.T.T and six patients (21.4%) were having negative result (intact tendon).

Sensitivity of US in comparison to clinical examination: Sensitivity of US in detection of F.T.T was 85% while sensitivity of US in detection of P.T.T was 64.3%.

The results of MRI were as follow: Among the 20 patients diagnosed as F.T.T clinically; 13 patients (65%) had F.T.T, five patients (25%) had P.T.T and two patients (10%) had intact tendon. Among the 28 patients diagnosed as P.T.T; 25 patients (89.3%) had P.T.T, two patients (7.1%) had F.T.T and one patient (3.6%) had negative result (intact tendon).

Sensitivity of MRI in comparison to clinical examination: Sensitivity of MRI in detection of F.T.T was 65% while sensitivity of MRI in detection of P.T.T was 89.3%.

Table 1: The distribution of the study sample according to (age, sex, side) findings.

Type of tear	Mean age	Gender		Side	
		Male	Female	Dominant	Non-dominant
F.T.T	(57.3)	11 (55%)	9 (45%)	17 (85%)	3 (15%)
P.T.T	(47.2)	19 (67.9%)	9 (32.1%)	16 (57.1%)	12 (42.9%)

Table 2: The distribution of the study sample according to US findings.

Type of the lesion	Ultrasonographic finding		
	F.T.T	P.T.T	Intact tendon
F.T.T (no. 20)	17	2	1
P.T.T (no. 28)	4	18	6
TOTAL (48)	…	…	…

Table 3: The distribution of the study sample according to MRI findings.

Type of lesion	MRI diagnosis		
	F.T.T	P.T.T	Intact tendon
F.T.T (no. 20)	13	5	2
P.T.T (no. 28)	25	2	1

Discussion

When assessing a patient with shoulder pain and sign of impingement, it is important to ascertain the integrity of the rotator cuff and the extent of the tear, if there is one. This information allows the surgeons to plan a strategy for further management of the patient. The importance of this study was that we tried to put a steps in evaluating RCT by US and MRI comparing the findings of these tools to the clinical findings trying to find the most useful and practical approach to patients with this problem that will decide the type of further management.

The total number in current study was 48 patients, (20) of them found to have F.T.T and (28) having P.T.T and this complies with the finding of K Yamanaka and H Fukuda[1] by that the P.T.T is being the most common tears of the rotator cuff tear.

Mean age of patients in general was (48.6) years ranging from (18 to 62) years. This complies with what LU Bigliani[23], Ghader and Imad M Sarsam[24] research, which confirms that degenerative process of the rotator cuff is an important factor in rotator cuff pathology so that the degenerative process will increase and healing will be slower.

Mean age of patients with F.T.T was (57.3) years ranging from (36 to 62) years which comply with the findings of Craig A Zeman et al, who said "these patients are usually elderly, 7th decade or older[25] and this is probably due to the shorter life span in our community.

Mean age of patients with P.T.T was (47.2) years ranging from (18 to 55) years. This complies with the findings of Fukoda H, K Hamada, T Nakajima)[26].

Among the 48 patients included in current study there were 30 males (62.5%) and 18 females (37.5%). Among the 20 patients with F.T.T 11 patients (55%) were males, 9 patients (45%) were females. Among the 28 patients with P.T.T 19 patients (67.9%) were males, 9 patients (32.1%) were females. This complies with the findings of Gartsman, Khan and Hummerman[27] and this is probably because males are involved in more active movements and jobs.

Among the (48) patients, the dominant side was affected in (33) patients (68.75%). The non-dominant side was affected in (15) patients (31.25%). Among the 20 patients with F.T.T 17 patients (85%) were having their lesions in the dominant side and 3 patients (15%) were having their lesions in the non dominant side. Among the 28 patients with P.T.T 16 patients (57.1%) were having their lesions in the dominant side and 12patients (42.9%) were having their lesions in the non-dominant side. This result complies with the findings of Rockwood, C. A., GR Willimas, WZ Burkhead[28] and Morrison, Frogamani, and Woodworth[29] that its due to the overuse of the dominant side in activities that may predispose to rotator cuff pathology and at the same time is more susceptible to trauma.

Ultrasonography: Among the 20 patients diagnosed as F.T.T; 17 patients (85%) had F.T.T and two patients (10%) had P.T.T and one patient (5%) had intact tendon. This complies with the findings of Cirage S Robart[30] Brenneck and Morgan[31], Paavolainen and Ahovuo[32].

Among the 28 patients diagnosed as P.T.T; 18 patients (64.3%) had P.T.T and four patients (14.3%) had F.T.T and six patients (21.4%) had negative result (intact tendon). Which doesn't comply with Msamore and Woodword[33] findings, could be due to advance experience in US technology nowadays.

The small number of patients that appear to have intact rotator-cuff by ultrasonography may include those patients who have their lesions obscured by the acromial process. This means that ultrasonography has less ability in diagnosing P.T.T than diagnosing the F.T.T.

Sensitivity of US in detection of F.T.T was 85%. Sensitivity of U/S in detection of P.T.T was 64.3%. This result complies with the findings of K Takais and Koubunn Makino[34] who reported 88% sensitivity for full-thickness and 70% for partial-thickness tears. This means that US is a useful test in diagnosis and early detection of F.T.T and this will help in the arranging the management which is mainly operative especially in active, young patient. But US is not so useful in the diagnosis of P.T.T and may needs other tool for its evaluation, this is probably because US cannot detect certain types of P.T.T especially intra-tendinous tears, as there are three subtypes of P.T.T[15]. US hardly

detect small tear < 1cm of RCT. US in the shoulder is highly operator dependent[35]. Most sonographers used a (10-12MHz) scanner to provide the best image but in our hospital we used Siemens Sonoline versa pro machine 7.5 MHZ probe.

In MRI: From the (48) standard patients that were having RCT. M.R.I done to them: In the 20 patients diagnosed as F.T.T. 13 patients (65%) were having F.T.T. and 5 patients (25%) were having P.T.T. and 2 patients (10%) were having intact tendon. In the 28 patients diagnosed as P.T.T. 25 patients (89.3%) were having P.T.T. and 2 patients (7.1%) were having F.T.T. and 1 patient (3.6%) was having negative result (intact tendon).

Sensitivity of MRI in detection of F.T.T was 65%. Sensitivity of MRI in detection of P.T.T was 89.3%. This result complies with Claiborne A Christani, who said: "Partial thickness tear and tendinitis have similar imaging characteristics"[2], this means that MRI is a useful test in diagnosis and early detection of P.T.T, it help also in getting information about the condition of surrounding soft tissue like joint capsule and labrum and surrounding bones, and this complies with the findings of Iannotti et al[22] more than F.T.T and this will help in the further management which may be conservative or operative especially in active, young patient. So MRI is not so useful in the diagnosis of F.T.T and this is need for more tests to be evaluated.

In conclusions: F.T.T is diagnosed mainly by clinical examination and ultrasonography is useful in confirming the diagnosis with sensitivity of (85%). MRI is not so useful in the diagnosis with sensitivity of (65%). P.T.T. is diagnosed mainly by clinical examination and ultrasonography is not so useful in the diagnosis with sensitivity of (64.3) and thus those patients need further evaluation with other tool like MRI which proved its superiority with a sensitivity of (89.3) in our study.

Recommendation: US being less expensive, less time-consuming, non-invasive, safe with no risk of radiation, and quick, more dynamic, and less demanding for patients, should be used as the first-line of investigation for suspected full thickness rotator cuff tear F.T.T, to confirm the diagnoses where appropriate skills are available. Patient with suspicion of partial thickness rotator cuff tear P.T.T, need to be evaluated by MRI test to confirm the diagnoses where appropriate skills are available.

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