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Efficacy of Ultrasound & MRI in Diagnosis of Rotator Cuff Tears

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Abstract

Background and Aim: The real time capability of ultrasound in conducting dynamic studies in the shoulder is a great asset. The simplicity, rapidity, low cost, and accuracy makes ultrasound the most effective imaging method for screening of rotator cuff injuries. The purpose of our study was to compare the diagnostic efficacy of ultrasound and MRI in detection of full thickness and partial thickness rotator cuff tears in symptomatic patients, with arthroscopy used as gold standard. *Materials & Methods:* The authors performed a retrospective review of 150 consecutive patients who underwent arthroscopic repair of a full-thickness rotator cuff tear by a single surgeon at the study institution for a period of two years. *Results:* Out of 150 patients, 145 patients were found to have rotator cuff tears on arthoscopy. Out of total included 145 patients, 140 patients were positive on either ultrasound or MRI. Five patient with tendon tear diagnosed on arthroscopy was missed on both ultrasound and MRI. Out of 140 patients, 137 patients were diagnosed on ultrasound and 138 patients were diagnosed on MRI. *Discussion & Conclusion:* MRI also provides information about associated labral tears which are poorly evaluated by ultrasound and may need surgical management Arthroscopy is the gold standard for diagnosing rotator cuff tears. Ultrasound and MRI are comparable in both sensitivity and specificity. Since US is less expensive and more available, it could be considered as the screening method when rotator cuff integrity is the main question, and when well-trained radiologists and high resolution equipments are available.

Keywords: Diagnosis; Shoulder Pain; Ultrasound; MRI.

Introduction

The rotator cuff is the group of four tendons that stabilize the shoulder joint. The tendons hook up to the four muscles that move the shoulder in various directions. There are four muscles whose tendons form the rotator cuff: the subscapularis muscle, which moves the arm by turning it inward [1]; the supraspinatus muscle, which is responsible for elevating the arm and moving it away from the body; the infraspinatus muscle, which assists the lifting of the arm during turning the arm outward; and the teres minor muscle, which also helps in the outward turning of the arm [1,2].

A rotator cuff injury can cause a dull ache in the shoulder, which often worsens when you try to sleep on the involved side. Some risk factors of experiencing a rotator cuff tear cannot be changed: age, body mass index, and height [3]. Recurrent lifting and overhead motions are at risk for rotator cuff tears. People who have jobs that involve overhead work, such as carpenters, painters, custodians and servers are at risk of also experiencing a rotator cuff tear. People who play sports that involve overhead

motions, such as swimming, volleyball, baseball, tennis, and American football quarterbacks, are at a greater risk of experiencing a rotator cuff tear [4].

Tears of the rotator cuff tendon are described as partial or full thickness, and full thickness with complete detachment of the tendons from bone. Partial-thickness tears often appear as fraying of an intact tendon, full-thickness tears are "through-and-through"[5]. These tears can be small pinpoint, larger buttonhole, or involve the majority of the tendon where it still remains substantially attached to the humeral head and thus maintains function, full-thickness tears may also involve complete detachment of the tendon(s) from the humeral head and may result in significantly impaired shoulder motion and function. Shoulder pain is variable and may not be proportional to the size of the tear [6].

Basically shoulder impingement is a clinical diagnosis. The role of imaging in such condition is to identify the causal factors as well as to detect the involvement of tendon injuries and its extension as tears of the cuff muscles is difficult to be identified clinically. The decision making in the treatment of the rotator cuff tears relies mainly upon the correct diagnosis of the type and extent of the tear. According to the diagnosis whether conservative or surgical treatment is chosen, even the type of the surgical intervention (open or arthroscopic) would differ according to the diagnosis [7,8].

Several radiological imaging techniques including ultrasound, MRI and arthrography are used to evaluate tears of rotator cuff. Ultrasound of rotator cuff is quick and relatively painless. Its accuracy for diagnosing both partial and full thickness tear is very high. The size of tear can be classified and the findings used as the basis for management decisions [9]. The real time capability of ultrasound in conducting dynamic studies in the shoulder is a great asset. The simplicity, rapidity, low cost, and accuracy makes ultrasound the most effective imaging method for screening of rotator cuff injuries [10]. The purpose of our study was to compare the diagnostic efficacy of ultrasound and MRI in detection of full thickness and partial thickness rotator cuff tears in symptomatic patients, with arthroscopy used as gold standard.

Materials & Methods

The authors performed a retrospective review of 150 consecutive patients who underwent arthroscopic repair of a full-thickness rotator cuff tear by a single surgeon at the study institution for a period of two years. Both MRI and ultrasound studies were reviewed individually twice by 2 senior-level musculoskeletal radiologists, each with more than 20 years of experience, and twice by a musculoskeletal fellow. The study was reviewed and approved by the institutional review board.

Magnetic Resonance Imaging examinations were performed with a 1.5 Tesla magnet MRI as a baseline. The protocol for each scanner was consistent. Ultrasound was performed with a Logiq E9 ultrasound machine, with 9–12 MHz transducers. Shoulder ultrasound examinations were performed in a standardized fashion, with the subject in a seated position. Evaluation included the rotator cuff musculature tendons, acromio clavicular joint, long head biceps tendon, posterior labrum, and spinoglenoid notch.

Inclusion Criteria

Patients who were clinically examined and suspected to have a rotator cuff pathology, either acute or chronic, in whom ultrasound or MRI examination revealed a rotator cuff lesion, and for whom arthroscopy was performed. Exclusion criteria: Patients in whom MRI is contraindicated and claustrophobic patients.

Diagnostic criteria for rotator cuff tear on ultrasound: Full thickness tears extend from the bursal surface to the articular surface. Partial thickness tears are focal defects in tendon that involve only the bursal or articular surface or within the substance of the tendon. Non visualization of tendon, hypoechoic discontinuity of tendon are direct signs of tear. Indirect signs include the double cortex sign, sagging peri bursal fat sign, compressibility and muscle atrophy. Cortical irregularity of greater tuberosity, shoulder joint effusion, fluid along biceps tendon and fluid in axillary pouch and posterior recess are the secondary associated signs. Diagnostic criteria for rotator cuff tear on MRI: Presence of tendon defect filled with fluid is the most direct sign of rotator cuff tear. It appears as hyper intense signal area within the tendon on T2 weighted and proton density fat suppressed sequences. Tendon retraction may also be present. Indirect signs on MRI are sub deltoid bursal effusion, medial dislocation of long head of biceps tendon, fluid along biceps tendon, and diffuse loss of peri bursal fat planes.

Results

Out of 150 patients, 145 patients were found to

have rotator cuff tears on arthoscopy. Out of total included 145 patients, 140 patients were positive on either ultrasound or MRI. Five patient with tendon tear diagnosed on arthroscopy was missed on both ultrasound and MRI. Out of 140 patients, 137 patients were diagnosed on ultrasound and 138 patients were diagnosed on MRI. Out of 145 patients, 100 patients were having full thickness tear and 45 patients were having partial thickness tear on arthroscopy. Of the 100 patients with full thickness tears, 94 were positive on ultrasound and 93 were positive on MRI. Of the 45 patients diagnosed with partial thickness tears, 43 patients were positive on ultrasound and 45 patients were positive on MRI (Table 1). Out of 145 patients, 94 patients were having isolated supraspinatus tendon tear, 14 patients were having isolated infraspinatus tear, 14 patients were having isolated subscapularis tendon tear and 8 patient was having isolated teres minor tear; rest of the 10 patients were having two or more tendon tears.

Table 1: Total number of rotator cuff tears diagnosed on ultrasound, MRI and arthroscopy

Rotator Cuff Diseases	Number of Patients		
	Ultrasound	MRI	Arthroscopy
Partial thickness tear	43	45	45
Full thickness tear	94	93	100
Other pathologies	2	2	5
Total cuff tears	140	140	150

Table 2: Sensitivity and specificity of ultrasound and MRI for diagnosis of partial thickness and full thickness rotator cuff tears

Rotator Cuff Diseases	Ultrasound		MRI	
	Sensitivity	Specificity	Sensitivity	Specificity
Full thickness tear	93.23%	98%	90.12%	98%
Partial Thickness tear	91%	99%	98.46%	99%

Discussion

Much research has been done examining the effectiveness of musculoskeletal ultrasound in diagnosing rotator cuff tears, and ultrasound has been shown to be of similar effectiveness to MRI in diagnosing rotator cuff pathology. However, often these studies examine the implementation in tightly controlled formats that do not fully reflect the environment in which many patients receive care [11,12].

Ultrasound is the most operator-dependent imaging study for the shoulder, and it is becoming more popular as a first-line imaging modality for evaluating rotator cuff tears [13]. Although several studies and meta-analyses have shown comparable accuracy in diagnosing both total and partial tears, ultrasound is often considered inferior to MRI for preoperative imaging because it provides less detail on morphologic changes in the cuff musculature [14]. The current findings showed low agreement between MRI and ultrasound in characterizing full-thickness rotator cuff tears. Ultrasound had lower interobserver reliability and decreased measurement of large rotator cuff tears.

Increasing collaboration between musculoskeletal radiologists and orthopedic surgeons has emphasized the importance of retraction and muscle status in predicting success in rotator cuff surgery. Previous studies evaluated the reliability of ultrasound and MRI in the diagnosis of rotator cuff tears as well as the characterization of rotator cuff tears with MRI. To the authors' knowledge, no studies have looked at the agreement of ultrasound and MRI in characterizing rotator cuff tears with regard to the specifics of tear size, muscle atrophy, and fatty infiltration.

Shoulder disorders are very common among the general population. The logical use of diagnostic tests is an important component of effective clinical practice. X-rays cannot directly reveal tears of the rotator cuff, a 'soft tissue', and consequently, normal X-rays cannot exclude a damaged cuff [15]. However, indirect evidence of pathology may be seen in instances where one or more of the tendons have undergone degenerative calcification. Also, large tears of the rotator cuff may allow the humeral head to migrate upwards (high-riding humeral head) which may be visible on X-ray. Prolonged contact between a high-riding humeral head and the acromion above it, may lead to X-rays findings of wear on the humeral head and acromion and secondary degenerative arthritis of the glenohumeral joint, called cuff arthropathy, may follow. Incidental X-ray findings of bone spurs at the adjacent

acromioclavicular joint may show a bone spur growing from the outer edge of the clavicle downwards towards the rotator cuff. Spurs may also be seen on the underside of the acromion, once thought to cause direct fraying of the rotator cuff from contact friction, a concept currently regarded as controversial [16].

The study shows 91% sensitivity and 99% specificity of ultrasound in diagnosing partial thickness tear. The sensitivity and specificity of MRI in diagnosing partial thickness tear was 91% and 99% respectively. The sensitivity and specificity of MRI for diagnosing full thickness tear was 98% and 96.12% each and that for ultrasound was 98% and 93.23% respectively (Table 2). The high sensitivity and specificity of ultrasound and MRI in evaluating rotator cuff tears in our study compared to certain other studies may be attributed to sampling bias due to inclusion of only arthroscopicaly proven rotator cuff pathologies in the study. Amongst all tendons, supraspinatus tendon is most commonly injured, followed by combined injury of two or more tendons.

Ultrasound and MRI have comparable sensitivity and specificity for both full thickness and partial thickness tears. These results, combined with the lower cost and easy availability of ultrasound, suggest that ultrasound may be the most cost effective imaging method for screening of rotator cuff tears. For practitioners without ultrasound expertise, MRI can be used.

Conclusion

MRI also provides very detailed soft tissue information required for surgical management specifically tendon retraction and status of muscle atrophy/ fatty infiltration. MRI also provides information about associated labral tears which are poorly evaluated by ultrasound and may need surgical management Arthroscopy is the gold standard for diagnosing rotator cuff tears. Ultrasound and MRI are comparable in both sensitivity and specificity. Since US is less expensive and more available, it could be considered as the screening method when rotator cuff integrity is the main question, and when well-trained radiologists and high resolution equipments are available.

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