Bhagya Lakshmi Bommineni et al /J. Pharm. Sci. & Res. Vol. 15(12), 2023, 1247-1252

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Correlative Study of High Resolution Ultrasonography and MRI in the Diagnosis of Rotator Cuff Tear

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Abstract

Context: An important source of shoulder pain is rotator cuff tears, but MRIs are expensive and not widely available, particularly in developing nations. The purpose of this study was to determine the level of agreement between high resolution ultrasound and magnetic resonance imaging (MRI) in the diagnosis of rotator cuff tears (RCT).

Methods and Material: Following ultrasound and MRI, fifty consecutive individuals with shoulder discomfort who had a clinical suspicion of RCT received testing. A radiologist conducted the sonography in accordance with standard operating protocols. The existence of a full-thickness and partial-thickness RCT was rated as either positive or negative based on the results of the USG and MRI.

Statistical analysis: The kappa coefficient was used to evaluate the level of agreement between the two approaches. Out of fifty patients, sixteen were found to be normal and thirty-four were diagnosed with rotator cuff injuries based on ultrasonography. Twelve of the patients were identified as normal after an MRI test revealed 38 incidences of rotator cuff injuries. The kappa coefficient was used to evaluate the level of agreement between the two approaches. For the diagnosis of rotator cuff tears, the degree of agreement between USG and MRI was determined to be "very good."

Conclusions: Sixteen of the fifty patients had normal results from the ultrasound, and 34 of the patients were diagnosed with rotator cuff injuries. After these individuals underwent an MRI, 38 of them had rotator cuff injuries, while 12 were found to be normal. Kappa coefficient was utilized to evaluate the degree of agreement between the two methods. According to the findings, there was "very good" agreement between the USG and MRI in diagnosing rotator cuff injuries.

Key-words: Magnetic resonance imaging, Rotator cuff tears, Ultrasound.

Key message: When a patient presents with shoulder pain, high resolution sonography is an appealing screening option for rotator cuff issues. Most of the time, a well-executed ultrasound scan eliminates the necessity for more intrusive diagnostic procedures like arthrography and time-consuming, costly MRI examinations.

INTRODUCTION

The most common (10%) cause of shoulder discomfort and impairment is rotator cuff pathology. As one ages, the prevalence rises linearly starting in the third decade. [1] The gold standard radiological test for identifying full thickness rotator cuff injuries has historically been contrast arthrography. [2] Unfortunately, arthrography has a significant probability of delayed morbidity due to its intrusive nature. In addition, it takes a lot of time and money. [3] Arthrography is being replaced by two rival non-invasive imaging methods: magnetic resonance imaging (MRI) and ultrasonography (USG). For the assessment of pathologic disorders involving the rotator cuff, both MRI and USG are commonly utilized and virtually replace traditional arthrography. It has been demonstrated that high resolution real-time ultrasonography is an affordable method of rotator cuff examination. [4]

A number of scientists have proposed that for both full-thickness and partial-thickness tears, ultrasonography is just as accurate as MRI. These findings, along with the fact that ultrasonography is less expensive; imply that, if the examiner has received the appropriate training in this operator-dependent technique, ultrasonography might be the most economical imaging modality for rotator cuff injuries. [5]

MATERIALS AND METHODS

Fifty patients in a row who came with shoulder pain in the orthopedic outpatient department (OPD) and were clinically suspected of having a rotator cuff tear (RCT) were included in a prospective research. Patients who had undergone shoulder surgery for any reason or who had a history of rotator cuff tears were not allowed to participate in the trial. Seated on a revolving seat, the patients underwent examinations. Mylab X6 Esoate sonography equipment with a phased array linear 8 MHz to 11 MHz transducer was used for the procedure. The American Institute of Ultrasound in Medicine (AIUM) Practice Guidelines for the Performance of the Musculoskeletal Ultrasound Examination (2007) were followed in conducting the ultrasound examination. For comparison, an ultrasound examination of the contralateral shoulder was performed on each patient. Every patient had their shoulder MRI monitored, with the results of the scan being recorded and compared to the results of ultrasonography. Direct and indirect symptoms are part of the ultrasonographic criteria used to diagnose rotator cuff injuries. The direct indications, which comprise symptoms for both partial thickness and full-thickness rotator cuff tears, were deemed trustworthy in our investigation for sonographic diagnosis of rotator cuff injury.

The direct signs for full thickness rotator cuff tears (RCT) include: Absence of cuff tissue or non-visualization of rotator cuff, hypoechoic defect or full-thickness discontinuity with discernible tear edges, extreme cuff architectural deformation and a heterogeneously hypoechoic cuff with bursal fluid, the rotator cuff's focal weakening and loss of its outer border's convexity.

The indirect signs for full thickness RCT include: Thinning of the cuff (noticeable during passive movement), loss of convexity of the outer border of the rotator cuff, a focal hypoechoic zone inside the substance of the cuff, and a hypoechoic defect involving the articular or bursal surface. The final two criteria were compared with other related findings as previously described and overlapped with those for full-thickness tearing. A bright aspect of the humeral cartilage (also known as an uncovered cartilage sign or a cartilage interface sign), muscle atrophy, fluid in the joint cavity and subacromial/subdeltoid bursa, the ability to compress the deltoid muscle into a cuff defect or against the humeral head (also known as the naked tuberosity sign), and cortical outpouchings or pitting at the insertion of the rotator cuff tendons are the indirect sonographic signs for RCT. A1.5-T MR system (Philips) magnetic resonance imaging equipment was used for every MRI examination. For the shoulder, a flexible surface coil was employed. The patients were placed in a supine position within the magnet, with the afflicted arm rotated externally and the arms positioned along the thorax.

The MRI shoulder protocol : Proton density, STIR (short tau inversion recovery) and axial gradient echo pictures; oblique sagittal T1-weighted Fast spin echo (FSE) images; oblique coronal T1-weighted FSE, T2-weighted FSE images. The results of the MRI were divided into three categories: complete, partial, and full thickness rotator cuff injuries. The diagnosis of either a full-thickness or partial-thickness rotator cuff injury was made using established criteria.

MRI findings for a full-thickness rotator cuff tear include: Retraction of the musculotendinous junction and visualization of a whole tendon defect that stretches from the articular to the bursal surface of the tendon. The defect exhibits a fluid-like signal on long TR/TE (relaxation time/echo time) pictures. The diffuse loss of the peribursal fat plane, fluid in the glenohumeral joint, muscle atrophy, a reduction in the acromialhumeral distance to less than 7 mm, and the presence of cysts in the acromioclavicular joint are examples of secondary symptoms.

MRI findings for a partial-thickness rotator cuff tear include: A region of slightly elevated signal intensity on proton density images (PD images) that is enhanced on T2- weighted images, and that covers a single surface—the bursal surface, the articular surface, or the tendon substance itself—as well as contour irregularities, such as thickened or attenuated tendon, or partial retraction of cuff fibers. When a tear is situated on the superior bursal surface, it can be found in the subacromial–subdeltoid bursa; when it is located inferiorly at the articular surface, it can be found in the glenohumeral joint.

RESULTS

There were 22 (44%) female and 28 (56%) male participants. Hence, the ratio of men to women is 1.3:1. We identified no statistically significant differences in the prevalence of shoulder soreness based on gender. Patients experiencing shoulder pain were dispersed according to their decade of life as follows: There were 5 (10%) patients in the 30-40 age group, 11 (22%) in the 41-50 age group, 14 (28%) in the 51-60 age group, and 20 (40%) in the 61+ age group. Shoulder pain is more common as people become older, according to reports. The majority of patients (40%) were over the age of 61.

Of the 50 patients, 24 (48%) experienced night pain. Of the patients, 42 (84%) had discomfort in their right shoulder, while 8 (16%) had pain in their left shoulder. Of the thirty-three right-handed patients, thirty-two had right shoulder RCTs and one had left shoulder RCTs. Among the five left-handed patients, three had RCT of the left shoulder, and two had RCT of the right shoulder. It implies that wearing effects can more easily affect the dominant arm, which can result in RCT. Out of the fifty patients, twenty had full thickness tears, fourteen had partial thickness tears, and sixteen were normal on the ultrasound scan.

As a result, 34 patients with rotator cuff tears were identified by USG. On MRI out of 50 patients 22 patients revealed complete thickness tears, 16 patients were identified as having partial thickness tear and 12 patients were normal. Thus a total of 38 patients were diagnosed as having rotator cuff injuries on MRI. Therefore, of the 50 patients, 34 were found to have rotator cuff injuries on ultrasonography, whereas the remaining 16 were found to be normal. Twelve of the patients were identified as normal after an MRI test revealed 38 incidences of rotator cuff injuries. The kappa coefficient was used to evaluate the level of agreement between the two approaches.

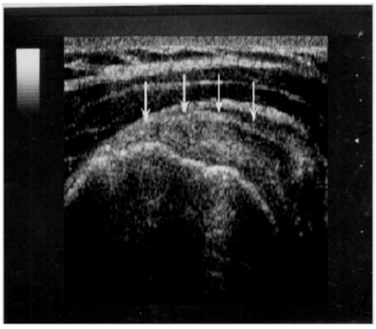
It was determined that there was "very good" agreement between USG and MRI in the diagnosis of rotator cuff injuries. Twenty out of the 34 patients with supraspinatus tears on USG had full thickness tears, while two of the patients who had full thickness tears confirmed by MRI were mistakenly given a partial thickness tear diagnosis. Additionally, an ultrasound revealed 12 partial thickness tears, and two patients who had an MRI that confirmed their partial thickness tear were given a false normal diagnosis. In total, 32 full thickness and 12 partial thickness supraspinatus tears were found by ultrasound; two false positive partial tears were also found; two false negative as normal tears were found; and fourteen patients were identified as normal (true negative).

Upon doing an MRI on these patients, it was found that 38 of them had supraspinatus tears, while the remaining 12 were found to be normal. Twenty-two of the 38 patients who had supraspinatus tears had complete thickness tears, while sixteen had partial thickness tears.

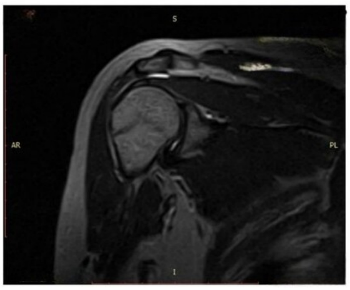
Table 1. Agreement between USG and MRI for the diagnosis of rotator cuff tears.

		USG			TOTAL
		No tear	PTT	FTT	
MRI	No tear	12	00	00	12
	PTT	04	12	00	16
	FTT	00	02	20	22
TOTAL		16	14	20	50

PT: partial-thickness rotator cuff tears, FTT: full-thickness rotator cuff tears, TP: true positive, TN: true negative, FP: false positive, FN: false negative.
Kappa= 0.818, SE of kappa = 0.069,
95% confidence interval: From 0.683 to 0.952
(0.20 and lower= no or poor agreement; 0. 21-0.4= low agreement; 0.41-0.60=moderate agreement; 0.61-0.80= good agreement; 0.81 and higher= very good agreement).

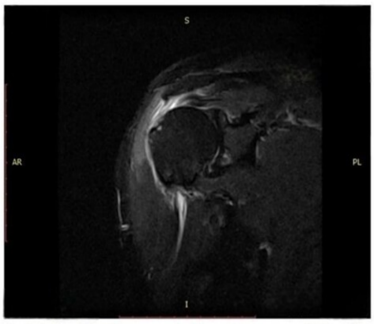


1a: USG showing the normal supraspinatus tendon (longitudinal view).

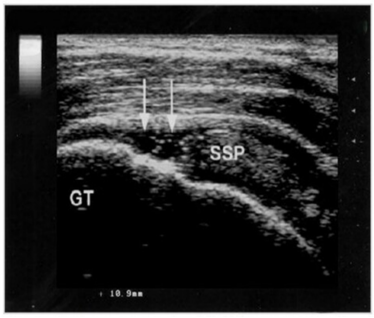


1b: Coronal oblique proton density weighted MR image showing the normal longitudinal view of the supraspinatus tendon.

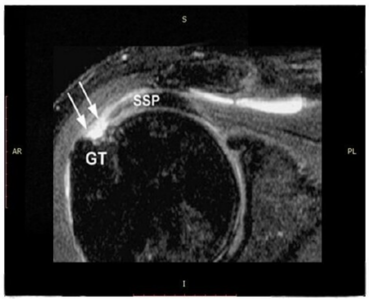
2a: Ultrasound images of supraspinatus tendon (longitudinal axis) showing full-thickness tear of supraspinatus tendon (between the calipers). Note the loss of normal superior convexity of the supraspinatus tendon with deltoid muscle and dipping of the deltoid muscle into torn tendon gap.



2b: Corresponding coronal oblique fat suppressed MR image shows the full-thickness rotator cuff tear and the torn retracted edge of the supraspinatus tendon, with tendon retraction to the level of the humeral dome.

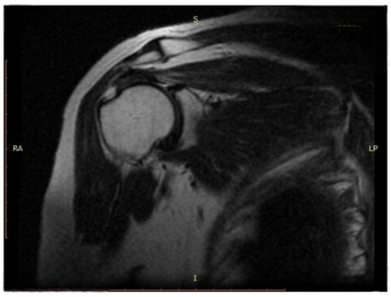


3a: USG appearance of a full-thickness rotator cuff tear (arrows) at the insertion of the supraspinatus tendon (SSP). (GT =greater tuberosity).

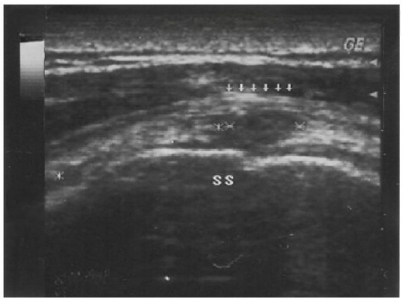


3b: The corresponding oblique coronal fat suppressed MR image, showing the same configuration of the full-thickness tear (arrows) of the supraspinatus tendon (SSP). (GT = greater tuberosity).

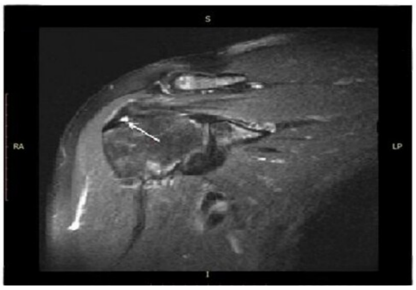
4a: USG shows a hypo echoic defect involving the bursal surface of the supraspinatus tendon suggestive of bursal surface partial thickness rotator cuff tear.



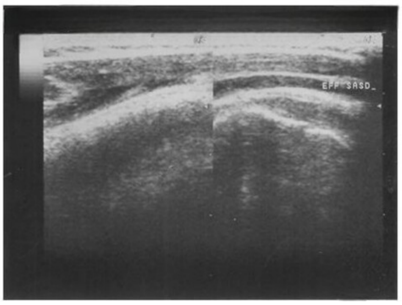
4b: T2 weighted MR image shows a hyperintense area involving the bursal surface of the of the supraspinatus tendon suggestive of bursal surface partial thickness rotator cuff tear.



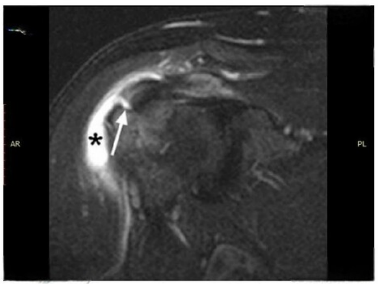
5a: USG demonstrates a hypoechoic area involving the articular surface of the supraspinatus tendon with a few intact bursal sided fibers suggestive of articular surface partial thickness tear.



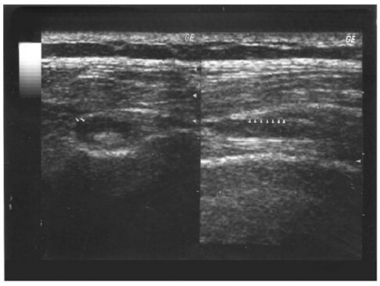
5b: Coronal oblique T2 weighted image shows a partial thickness tear (arrow) of the articular-sided fibers that involves.



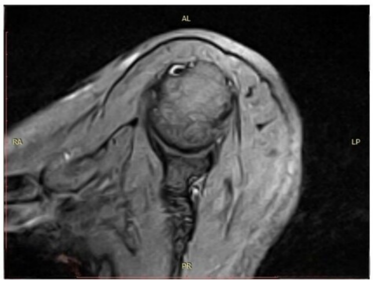
6a: USG shows increased anechoic fluid in the subacromial-subdeltoid bursa.



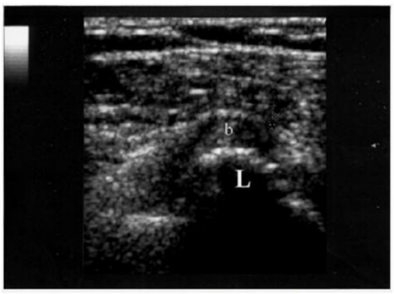
6b: A fat-suppressed coronal MR image demonstrates subacromial-subdeltoid bursal fluid (asterisk). Also a bursal-sided partial thickness tear (arrow) is seen near the insertion of the cuff.



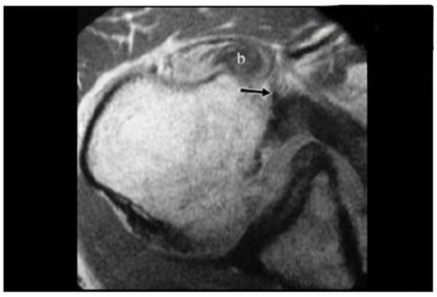
7a: USG shows anechoic fluid surrounding the biceps tendon. Transverse view is shown on right side and the longitudinal view is shown on left side.



7b: GRE MR image (axial view) shows hyperintense fluid surrounding the biceps tendon.



8a: Transverse USG image shows subscapularis tendon tear with subluxation of the long head of the biceps tendon (b) perched on the lesser tuberosity (L) of the humerus.



8b: Corresponding axial proton density weighted MR image shows tear of the subscapularis tendon (arrow), with subluxation of the long head of the biceps tendon (b) perched on the lesser tuberosity (L) of the humerus.

DISCUSSION

Because of limited experience with the examination process and the use of low frequency (and low resolution) 5 MHz transducers, the initial sonographic results in the detection of rotator cuff injuries differed.[6] Sonographic outcomes and dependability were subsequently greatly enhanced by technology advancements such as 7.5–14 MHz linear array broad-bandwidth transducers, improved ultrasonic beam penetration, and expanded experience and in-depth knowledge of shoulder anatomy and pathology.[7] In line with the findings of Milgrom et al.'s study, ours found no statistically significant variation in the prevalence of rotator cuff tears by gender.[8] The mean age of the cases was 48.02 years, with ages ranging from 30 to 72. Of these fifty patients, five (10%) belonged to the age group of thirty to forty, eleven (22%) to the age group of forty to fifty, fourteen (28%) to the age group of fifty to sixty, and twenty (40%) to the age group of sixty years and above. This indicates that as people age, rotator cuff injuries and shoulder pain may become more common. Tendon degeneration is a common occurrence in persons over 50 years of age and is a result of ageing.[9] This is consistent with a research by Brandt et al. that found people over 50 years old are more likely to experience symptomatic rotator cuff injuries. Rotator cuff rupture follows progressive tendon failure. [10]

As a result, those over 50 are more likely to experience tendinitis and rotator cuff tears [11]. Milgrom et al.[8] demonstrated a linear rise in rotator cuff injuries after reaching the fifth decade of life,. These observations support the conclusions of our investigation. Eight patients (16%) and 42 patients (84%) reported having pain in their left shoulder and right shoulder, respectively. Consequently, the right shoulder was affected more often than the left. It is consistent with research by Bouaziz et al.[12] which discovered that the right shoulder is involved more frequently than the left (32%), with a rate of 68%. We used a high frequency linear array transducer to perform the ultrasonography. The effectiveness of ultrasonography has significantly risen with the development of high frequency transducers and high resolution equipment. [13] Each patient had an ultrasound of their contralateral shoulder performed for comparison. Rutten [14] suggested comparing the typical anatomic differences with the contralateral shoulder as a backup measure to prevent normal differences from being mistaken for tears. The kappa coefficient was used to evaluate the agreement between the two approaches (Kappa= 0.818). For the diagnosis of rotator cuff tears, the degree of agreement between USG and MRI is regarded as "very good." Rutten [14] and Alasaarela et al. [15] also reported similar outcomes. In their evaluation of thirty patients with 31 sore shoulders, Alasaarela et al. found that US and MRI agreed well in diagnosing full thickness rips and intrasubstance anomalies of the supraspinatus tendon (kappa coefficient = 0.73). According to Rutten's [14] analysis of data from 68 patients who had surgery and MRI after a USG evaluation, there was a good degree of agreement between US and MRI (the computed kappa coefficient was 0.78). After examining 68 patients, Rutten [14] found that high-resolution US and MR imaging function diagnostically similarly for identifying partial and full thickness rotator cuff injuries, with corresponding accuracy of 87% and sensitivities and specificities of over 90%. There are numerous significant clinical implications for our work. In their evaluation of thirty patients with 31 sore shoulders, Alasaarela et al. [15] found that US and MRI agreed well in diagnosing full thickness rips and intrasubstance anomalies of the supraspinatus tendon (the kappa coefficient = 0.73). First, MRIs are typically recommended for patients who are suspected of having rotator cuff injuries (if accessible). Ultrasonography could be suggested as an alternative, which would save money and time while also improving clinical care. Second, ultrasonography can help patients who are claustrophobic, have prosthetics, or have implants & conditions that are restricted by MRI. In skilled hands, ultrasound accuracy has been found to be on par with MRI accuracy. [16] Because the MRI has a shorter learning curve and a lower likelihood of artefacts, it should only be used sparingly and in specific instances. It also offers more information regarding the extent of tendons. Our study unequivocally demonstrates that ultrasonography is a more cost-effective technique to perform for rotator cuff tear detection due to the cost difference between the two procedures. Experienced musculoskeletal sonologists, high frequency probes, and equipment are essential for an accurate and economical diagnosis to be made in the radiology department. According to our research, ultrasonography can accurately diagnose rotator cuff diseases. This finding is consistent with the findings of Kenn et al. [17] and Lach et al. [18] who demonstrated that ultrasound can reliably and accurately diagnose a wide spectrum of shoulder abnormalities when compared to MRI. The US has a number of benefits over the MRI. Ultrasound is a more widely available, portable, rapid, and cost-effective imaging technique that is also simpler for patients to tolerate.

In addition to allowing for instantaneous comparison with the contralateral side and the dynamic evaluation of tendons and other structures, ultrasound is not affected by motion artefacts. The capacity of US to operate in real time enhances the yield of diagnostic tests by facilitating interventional treatments in or around the shoulder and facilitating improved patient-physician contact by enabling the patient to point to the bothersome location. Sonography of the shoulder joint, however, is quite operator dependent.

Small mistakes in the angulation and orientation of the transducer can readily mask minute irregularities inside and around the cuff, leading to false positive and false negative readings. [19] The learning curve for shoulder sonography is rather high. However, by having a complete understanding of normal anatomy, strictly enforcing optimal transducer and patient position, and using the opposite shoulder for comparison, these potential errors can be avoided. Because of this, sonography may become a non-invasive, dependable, and efficient method of identifying rotator cuff injuries.

CONCLUSION:

We may draw the conclusion that MRI and USG diagnostic accuracy are similar. Because USG and MR imaging have similar levels of accuracy, they can be employed as the main modality for rotator cuff evaluation. Availability, patient preference, and the clinical information being sought should all be taken into consideration when selecting a modality. Patients who report with shoulder pain may find high resolution sonography to be a useful screening tool for rotator cuff issues. Most of the time, an ultrasonography done correctly can replace more invasive diagnostic procedures like arthrography and time-consuming, costly MRI examinations.

Funding: No funding sources.

Conflict of interest: None declared.

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