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Original Research Article

Inter-Correlation between MRI and High-Frequency USG for Rotator Cuff Injuries

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Abstract:

Background: An orthopedic ailment that is common and frequently incapacitating, rotator cuff injuries cause discomfort, functional impairment, and a reduction in the quality of life for those who suffer from them. To optimize patient outcomes and execute suitable treatment options, accurate diagnosis is essential.

Aim: The objective of this research was to clarify the diagnostic possibilities, technological considerations, and clinical implications of combining Magnetic resonance imaging (MRI) and high-frequency ultrasonography (USG) to assess rotator cuff injuries, so improving our understanding and management of this common orthopedic problem.

Materials & Methods: For fifty consecutive visits, individuals with painful shoulders and a clinical suspicion of rotator cuff tear (RCT) were seen in the orthopedic outpatient department. A prospective study was undertaken on these individuals. Participants in the research were excluded if they had undergone shoulder surgery for any reason or had previously had a definite diagnosis of rotator cuff damage.

Results: Out of 50 people, 34 were determined to have rotator cuff injuries using ultrasonography, whereas 16 were deemed to be normal. In twelve patients, MRI findings were normal, and 38 rotator cuff injuries were verified. The degree of agreement of two different methods was assessed using the kappa coefficient. When it comes to diagnosing rotator cuff problems, USG and MRI agree with a kappa value of 0.929, a standard error of kappa of 0.1790, and a 95% confidence range spanning from 0.794 to 0.863.

Conclusion: Because MRI and high-frequency USG provide a more thorough understanding of tendon pathology, they can enhance rotator cuff injury diagnosis and treatment. These imaging methods improve the assessment of rotator cuff injuries by providing greater soft tissue contrast and real-time imaging. Prospective investigations and developments provide promise for revolutionizing evaluations and enhancing patient results.

Keywords: Rotator Cuff; Magnetic Resonance Imaging; high-frequency ultrasonography; Multiplanar images; Metallic implants; orthopedic condition.

Introduction

An orthopedic ailment that is common and frequently incapacitating, rotator cuff injuries cause discomfort, functional impairment, and a reduction in the quality of life for those who suffer from them. To optimize patient outcomes and execute suitable treatment options, accurate diagnosis is essential. Medical imaging tools have seen a dramatic increase in the detection of rotator cuff dysfunction in recent years. Magnetic resonance imaging (MRI) and high-frequency ultrasonography (USG) have recently become the gold standard in imaging [1,2].

When it comes to diagnosing rotator cuff issues, the imaging technique most commonly used is MRI [2]. It is extremely useful for assessing tendon integrity, diagnosing tears, and detecting related abnormalities, such as inflammation and muscle atrophy, because of its capacity to provide comprehensive multiplanar pictures with good soft tissue contrast [3, 4]. MRI is not appropriate for many patients, particularly those who have metallic implants or claustrophobia, and it is expensive and not widely available [2–5]. Alternative imaging modalities that provide similar diagnostic accuracy, increased accessibility, and cost-effectiveness are becoming more and more popular as a result of these restrictions.

In order to better assess rotator cuff injuries, high-frequency ultrasound can be used in conjunction with MRI [6]. High spatial resolution made possible by technological advancements allows for precise observation of tendon morphology and real-time intervention guidance [7]. USG is the best option for follow-up evaluations and point-of-care

imaging since it is non-invasive, portable, and comfortable for patients [6, 7].

The study question is: Despite the fact that high-frequency USG and MRI have many advantages, each has drawbacks that may restrict their use in particular clinical scenarios. Researchers look at the intercorrelation between different imaging modalities to enhance diagnostic accuracy and clinical decision-making in an effort to get beyond these constraints and produce more thorough and accurate assessments of rotator cuff disease. Therefore, the purpose of this study is to clarify the diagnostic possibilities, technical details, and clinical implications of combining MRI and high-frequency USG for assessing rotator cuff injuries, so improving our understanding and management of this common orthopedic problem.

Materials & Methods

Fifty patients who were presented to the orthopedic outpatient department (OPD) with shoulder pain and a clinical suspicion of rotator cuff tear (RCT) were included in prospective research. All of the patients were examined clinically as a follow-up. No one could participate in the study if they had ever had shoulder surgery or a definitive diagnosis of rotator cuff damage, regardless of the reason. Each of the patients was evaluated while they were seated in a comfortable rotating chair. An instrument from the Philips affinity series was used to do sonography. A phased array linear transducer ranging from 5 MHz to 12 MHz was installed on the apparatus. The ultrasound method was based on the 2007 publication of the American Institute of Ultrasound in Medicine Practice Guidelines for the Performance of the Musculoskeletal Ultrasound Examination. All subjects underwent an ultrasound of their contralateral shoulder so that we could compare their results. A shoulder MRI was performed on each patient, and the results were documented and compared to the results of ultrasonography.

There are both direct and indirect indications that are included in the ultrasound diagnostic criteria for rotator cuff tears. Based on the indicators, our research concluded that sonographic diagnosis of rotator cuff injury was trustworthy. Direct indicators include a full-thickness RCT, non-visualization or lack of cuff tissue, clear tear borders, and a hypoechoic defect or full-thickness discontinuity of the rotator cuff. Indicators of partial thickness include a hypoechoic defect on the articular or bursal surface, a hypoechoic zone inside the rotator cuff material, a weak cuff that shows up when the patient is not actively moving, and a lack of convexity along the outside border of the cuff. Looking for indicators like fluid in the joint cavity or subacromial/subdeltoid bursa, cortical outpouchings, or heterogeneity surrounding the tendon's insertion are some of the indirect ways a rotator cuff tendon rupture can be spotted sonographically. Muscle atrophy, cuff malfunction, or the naked tuberosity sign (where the deltoid muscle is forced onto the humeral head) might make a unique characteristic of the humeral cartilage noticeable.

At each and every MR examination, a magnetic resonance imaging apparatus with a 1.5-T field strength, manufactured by Philips Achieva was utilized. In order to protect the shoulder, a flexible surface coil was utilized. In the magnet in supine posture, patients were asked to outward twist the arm that was being examined, while their other arm was aligned along the thorax. Axial gradient echo images, proton density images, T2-weighted Fast Spin Echo (FSE), oblique coronal T1-weighted FSE, and short tau inversion recovery are all part of the approach for shoulder MRI acquisition.

We used MRI findings to classify rotator cuff lesions as either full-thickness or partial-thickness. Specific criteria were used to diagnose full or partial rotator cuff injury. Visualization of a whole tendon defect that stretches from the tendon's articular to its bursal surface, and the detection of a fluid-like signal on lengthy TR/TE (relaxation time/echo time) images within the defect; and a full-thickness rotator cuff injury is indicated by MRI findings of retraction of the musculotendinous junction. Key symptoms include a decrease in the distance between the acromial and humeral bones to less than 7 millimeters, muscle atrophy, fluid in the glenohumeral joint, cysts developing in the acromioclavicular joint, and extensive loss of the peribursal adipose plane.

It is possible that a partial thickness rotator cuff rupture is the cause of the following MRI findings: a slightly elevated region of signal intensity on PD images, which becomes more obvious on T2-weighted images; this area is restricted to a single surface, which might be the articular surface, bursal surface of the tendons or intrasubstance or interstitial. There may be irregularities in the morphology of the tendon, such as a thicker or attenuated tendon or partial retraction of the cuff fibers.

In cases when the rupture is situated on the bursal surface, it is possible to observe the presence of free fluid within the subacromial-subdeltoid bursa. In the same way, if the tear is situated on the inferior articular surface, it is possible to see the presence of free fluid within the glenohumeral joint.

Results

There were 27 females and 23 males, or 54% and 46% respectively. As a result, there are 1.3 males for every 1 female. Based on gender, there was no

statistically significant difference in the prevalence of shoulder soreness. The following age groups were created from the patients who complained shoulder pain: Twelve (24%) were between the ages of 41 and 50, fifteen (30%) were between the ages of 51 and 60, and seventeen (34%) were 61 and older. Thirty to forty years of age accounted for 12% of the cases. Shoulder discomfort seems to become more common as people age. Out of the total patients, 34% were older than 61 years old, making up approximately 70% of the group. Of the fifty patients, twenty-five experienced a common night time pain. Fifty percent of the patients reported having night discomfort.

Seven patients (14%) out of the total number reported discomfort in their left shoulder, whereas 43 patients (86%) experienced pain in their right shoulder. Thirty-three right-handed patients had right shoulder RCTs, while one right-handed patient received a left shoulder RCT. Three patients had RCT in right shoulder and four out of six left-handed patients had it in the left shoulder. This suggests that the arm that is being more used is more vulnerable to the effects of wearing.

Out of fifty patients, twenty-one had full thickness tears identified by ultrasound testing, thirteen had partial thickness tears, and sixteen were determined to be normal. As a result, USG determined that 34 individuals had rotator cuff pathologies.

Out of fifty patients, twenty-three were diagnosed with complete thickness tears, fifteen with partial thickness tears, and twelve with normal MRI results. Thus, an MRI was used to identify rotator cuff injuries in a group of 38 individuals.

Consequently, an ultrasonography analysis of fifty patients showed that sixteen were considered normal and thirty-four had rotator cuff problems. Twelve of these patients were found to have normal findings, whereas 38 of the patients had rotator cuff injuries, according to MRI scan. Of the thirty-eight patients, twenty-three had entire thickness rips in the supraspinatus, and fifteen had partial thickness tears.

Three patients who had MRI-confirmed full thickness tears were mistakenly classified with partial thickness tears, while twenty-one out of thirty-four patients with supraspinatus tears as identified by USG had tears of full thickness. Thirteen partial thickness tears were also found by ultrasonography, and two patients who had an MRI that showed a partial thickness tear were misdiagnosed as healthy on ultrasound. Twelve patients were identified as normal (true negative) and three mistakenly positive partial tears, two falsely negative as normal and 34 supraspinatus tears total—21 full thickness tears and 13 partial thickness tears—were found by ultrasound. When it comes to diagnosing rotator cuff problems, USG and MRI agree with a kappa value of 0.929, a standard error of kappa of 0.1790, and a 95% confidence range spanning from 0.794 to 0.863.

Discussion

Initial sonographic results for rotator cuff injuries were not consistently positive [8]. This was probably caused by using 5 MHz transducers, which have a low frequency (and resolution), as well as inexperience with the inspection process. Following that, technological advancements such as linear array transducers with a wide bandwidth operating at 7.5–14 MHz and improved ultrasonic beam penetration, in conjunction with increased proficiency and a comprehensive understanding of shoulder anatomy and pathology, resulted in a significant improvement in the accuracy and reliability of sonographic recordings [9].

The prevalence of rotator cuff tears was not found to be statistically significantly different between the sexes, according to the findings of our investigation. A mean age of forty-nine and a half years was observed among the patients, who ranged in age from thirty to seventy-five years old. Out of the fifty patients, six (12%) were found to be between the ages of thirty and forty, twelve (24%) to be between forty-one and fifty, fifteen (30%) to be between fifty-one and sixty, and seventeen (34% to be older than sixty-one) years old. This research suggests that as people age, rotator cuff injuries and shoulder discomfort grow more common.

Tendon degeneration, a physiological aftereffect of aging, is most commonly observed in individuals 50 years of age and above [10]. This is in line with research results [8], which show that people 50 years of age and above are the most common age group for symptomatic rotator cuff problems. Rotator cuff rupture is the ultimate consequence of tendon progressive failure. [11] Consequently, people over the age of 50 are often found to suffer from tendinitis and rotator cuff issues [12]. After reaching the fifth decade of life, research [13] found a linear increase in rotator cuff injuries. These findings validate the inferences made by our investigation.

A total of 43 patients, or 86%, reported experiencing difficulty in their right shoulder, whereas 7 patients, or 14%, reported experiencing discomfort in their left shoulder. As a result, the right shoulder was implicated in the injury more frequently than the left shoulder. This confirms what Aggarwal et al. [14] found, that the right shoulder was more often involved than the left shoulder in this disease.

A linear array transducer with a high frequency was used to do the ultrasound. Ultrasonography is now much more effective because to developments in high-frequency transducers and high-resolution

equipment [15]. Every patient had an ultrasound evaluation of their contralateral shoulder for comparison's sake. Teefey et al. [16] recommended comparing the afflicted shoulder to the contralateral shoulder as an extra precaution to avoid mistakenly interpreting typical anatomic differences as rotator cuff tears. The amount of agreement between the two approaches was evaluated with the help of the kappa coefficient, which arrived at 0.929. The use of ultrasound and MRI in the diagnosis of rotator cuff problems is highly concordant with one another. Researchers Rutten and Hermann et al. reported results that were consistent [16, 17]. During the process of evaluating people for full thickness injuries and intrasubstance abnormalities of the supraspinatus tendon, [17] found that ultrasound and magnetic resonance imaging shared a high degree of agreement about the diagnosis. Teefey et al. [16] found that there was a significant degree of concordance between the two modalities in their study of data from patients who had surgery and MRI after USG assessment. Teefey et al. [14] concluded that high-resolution ultrasound and magnetic resonance imaging function similarly when it comes to identifying partial and complete thickness rotator cuff injuries.

This result was reached after the researchers reviewed the data. There are several important clinical implications for our findings. To begin with, if an MRI is available, it is common to recommend one when a patient is suspected of having rotator cuff problems. As an alternative, ultrasound might be suggested to save costs and time while improving clinical management. Second, while MRI has limits with regard to prosthesis, implants, and claustrophobic individuals, ultrasonography can be helpful. It was found that, in the hands of a specialist, ultrasonography may achieve the same level of accuracy as magnetic resonance imaging [17]. Because of its quicker learning curve, improved information on tendon extent, and lower chance of artifacts, MRI is only used in specific circumstances and for secondary purposes. Our analysis clearly shows the cost difference between the two treatments, with ultrasonography turning out to be the most practical diagnostic option for rotator cuff problems. High frequency probes, equipment, and trained musculoskeletal sonologists are required in the radiology department for an accurate and economical diagnosis.

According to our findings, ultrasonography is a trustworthy and precise method for diagnosing rotator cuff disorders. The results of Frei et al. [19] and Rutten et al. [18] corroborate this, showing that ultrasonography is more effective than MRI for diagnosing a range of shoulder problems. In terms of advantages, USG is better than MRI. Ultrasound is a portable, easily accessible, and fast imaging method that is far more affordable. It is also more bearable for the sufferer. Ultrasound is not affected by motion artifacts, allows for the dynamic evaluation of tendon and other structures, and allows for instantaneous comparison with the contralateral side. With the help of a real-time ultrasound, interventional treatments may be more easily performed in or around the shoulder. The communication between the patient and doctor is also improved, which helps the patient pinpoint the problematic area and increases the diagnostic yield. However, shoulder joint sonography depends heavily on the operator. Erroneous positive and negative results may result from small errors in the transducer's orientation and angulation, which might mask minute anomalies in and around the cuff [20]. Studying shoulder sonography requires a significant amount of time. But these probable mistakes may be avoided if one is well-versed in normal anatomy, insists on using the right transducer and patient position, and uses the other shoulder as a reference. Sonography is a potentially trustworthy, non-invasive, and effective way to detect damage to the rotator cuff.

Conclusion

By using high-frequency USG and MRI intercorrelation, it may be possible to increase the precision of diagnosis and clinical management of rotator cuff problems. By utilizing the complimentary capabilities of imaging modalities, clinicians can get beyond their limitations and obtain a more comprehensive understanding of tendon disease. When USG's real-time imaging capabilities are paired with MRI's improved soft tissue contrast, patients with shoulder discomfort can benefit from a more accurate diagnosis, treatment plan, and follow-up evaluation. Future research and developments in this area may fundamentally alter the way rotator cuff evaluations are carried out, improving patient outcomes and raising the bar for healthcare as a whole.

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