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Original Research Article

Ultrasound versus MRI: A Comparative Study in the Diagnosis of Rotator Cuff Injuries

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Abstract:

Background: Rotator cuff injuries are a common cause of shoulder pain and functional limitation, with prevalence increasing with age. Accurate and timely diagnosis is essential for effective management.

Aim: To evaluate the diagnostic accuracy of high-resolution ultrasonography (USG) compared with magnetic resonance imaging (MRI) in detecting partial and full-thickness rotator cuff tears.

Methodology: A prospective observational study was conducted on 60 patients aged 20–70 years with clinically suspected rotator cuff injuries. All patients underwent USG and MRI evaluations. Imaging findings were analyzed for tendon integrity, tear type, and secondary changes. Sensitivity, specificity, and agreement between modalities were calculated using MRI as the reference standard.

Results: Rotator cuff injuries were more prevalent in males, especially aged 21–30 years. USG detected 42% partial and 17% complete supraspinatus tears, while MRI identified 37% partial and 20% complete tears. Detection rates for infraspinatus and subscapularis tendons were comparable, though MRI was slightly more sensitive for subscapularis and full-thickness tears. No teres minor injuries were observed. USG demonstrated high reliability for initial assessment and dynamic evaluation.

Conclusion: Both USG and MRI are valuable in diagnosing rotator cuff injuries. USG offers a non-invasive, cost-effective screening tool, while MRI provides detailed evaluation for surgical planning. A combined, stepwise approach optimizes diagnosis and patient management.

Keywords: Rotator Cuff, Shoulder Pain, Ultrasonography, MRI, Tendon Tear, Musculoskeletal Imaging.

Introduction

Rotator cuff pathology is one of many factors contributing to shoulder pain and disability; when considered, it accounts for up to 10% of cases. The incidence of rotator cuff disorders is known to rise with age, which is likely due to degenerative changes that occur with age to the tendon, decreases in vascularity of the tendon, and accumulation of microtrauma. Rotator cuff pathology typically presents as pain, weakness and decreased range of motion; all significantly impairing activities of daily living and reducing quality of life [1]. Diagnosing rotator cuff pathology can be further complicated because there may be a delay in considering the pathology due to a lack of early and accurate diagnosis in a subject who presents with shoulder pain. Symptoms may not be definitive and can overlap with a variety of shoulder conditions including osteoarthritis, bursitis, or adhesive capsulitis or frozen shoulder.

Traditionally, contrast arthrography has been seen as the gold standard for diagnosing rotator cuff tears due to its exceptional inter-rater reliability and high sensitivity for visualizing full thickness tears. Unfortunately, contrast arthrography has drawbacks such as being more invasive, more costly, and ultimately causes potential risks of the invasive procedure itself including infection, an allergic reaction, and delayed morbidity. These multiple disadvantageous factors have increased the use of less invasive imaging techniques such as ultrasound and magnetic resonance imaging (MRI) that share comparable accuracy but without the same disruption to the patient [2]. As imaging techniques continue to improve over time, providers increasingly resort to less invasive imaging techniques to achieve a safe and timely diagnosis of rotator cuff injuries, especially in the aging population, which most often bears the greatest risk and functional consequences of injury.

Imaging modalities are critical in the evaluation of rotator cuff disease. As a result of its muscle delineation in soft tissue and multiplanar capability, magnetic resonance imaging (MRI) with dedicated shoulder protocols has become the most helpful option [3]. MRI can provide definitive information on tendon morphology, atrophy, fatty infiltration

changes as well as other intra-articular pathology which is pertinent to surgical decision-making. As previously noted, it has previously been customary to utilize invasive imaging modalities such as arthrography to describe rotator cuff tears. Noting the above, arthrography techniques have largely become obsolete [4]. MRI is comprehensive for both evaluation and pre-operative purposes, while simultaneously avoiding patient discomfort and procedural risk that are associated with orthographic evaluation, largely due to its high spatial resolution and non-invasive techniques that allow for pre-operative assessment to assist with surgical decision-making.

High-resolution real-time ultrasonography (USG) has emerged as an increasingly reliable alternative, especially when MRI availability or cost may be an issue. Contemporary ultrasonography employs high-frequency transducers, facilitating a dynamic assessment of the rotator cuff and enabling visual examination of tendon motion, impingement, minor partial-thickness tears, and other pathologies that may be missed in a static imaging. Research indicates that ultrasound (USG) provides diagnostic accuracy comparable to magnetic resonance imaging (MRI) in identifying rotator cuff injuries and evaluating tendinopathy [5]. Furthermore, USG allows for real-time guided interventions (i.e. injections), making it a flexible addition for assessment and management of rotator cuff disorders. Therefore, the utilization of USG in conjunction with MRI represents a multimodal approach to musculoskeletal imaging and evaluation of rotator cuff pathology in a manner that is efficient, non-invasive, and friendly to the patient.

Shoulder pain is a common musculoskeletal complaint, often resulting in substantial limitations in activities of daily living and quality of life. An important subset of shoulder pain is rotator cuff tears, probably the most common contributor to functional incapacity. Early and accurate assessment is essential as early intervention may prevent the progression to significant loss of function and/or chronic pain. Rotator cuff pathology represents a spectrum of conditions even beyond partial-thickness or full-thickness rotator cuff tears. This pathologic sub-category can include degenerative cuff failure, impingement syndromes (subacromial impingement), tendinopathy (rotator cuff tendinopathy), posterior capsular tightness, subacromial abrasion, and cuff tear arthropathy [6]. Understanding the specific nature of rotator cuff injury is important for the development of effective treatment approaches for improved patient outcomes.

Magnetic resonance imaging (MRI) continues to be the gold standard in assessment of rotator cuff pathology because high-resolution images of the tendon, muscle, and adjacent soft tissue structures. MRI allows for an assessment of the location, size, and degree of tears, along with secondary pathology such as muscle atrophy or fatty infiltration, both of which are helpful prognostic factors. In many cases in the clinic, though, ultrasound has become an alternative point of care option. Ultrasound, of course, is a real time test, very cost-effective, and is reported to have very high sensitivity and specificity for rotator cuff lesions, especially when completed by an experienced healthcare provider [7]. As such, ultrasound can be used both as a screening tool, as well as a diagnostic test that can help promote early diagnosis of rotator cuff pathology and to help enhance the timely treatment and referral when needed.

Our study aims to fully evaluate the diagnostic performance of ultrasonography (USG) compared with MR imaging of rotator cuff pathologies. We will evaluate both partial and full-thickness rotator cuff tears, as well as acute and chronic rotator cuff injuries, and look at the range of presentations that could arise from either an acute traumatic event or degenerative change. We will look at USG and MR findings in relation to each other to test the validity of USG as a first-level, non-invasive and cost-effective imaging option [8]. Our study will consider the imaging changes in the field of the ability to detect related structural change, for example, tendon retraction, muscle atrophy, and calcifications, that need to be incorporated for treatment rationale and prognosis of the case.

Our investigation will assess the demographic factors of age and sex of subjects which suffer from rotator cuff disorders along with the imaging findings. The clinical presentation, including pain, function limitations, and duration of symptoms will all be related to the imaging findings, to help discern the clinical significance of any pathology identified. In addition, we will include the assessment of any secondary changes and sequelae, including joint degeneration or bursitis to provide a fuller picture of the disease process [9]. By adopting a multi-dimensional view, we may give a fuller understanding of the nature of rotator cuff injuries while also demonstrating the role of USG as a valid imaging modality to complement the MRI and provide additional benefit to clinical experience.

Methodology

Study Design: This study was conducted as a prospective observational investigation to assess and compare the diagnostic efficacy of ultrasonography (USG) and magnetic resonance imaging (MRI) in identifying rotator cuff injuries.

Study Area: The research was performed in the Department of Radio-Diagnosis, Katihar Medical College and Hospital, Katihar (Al-Karim University), Bihar, India, from January 2023 to December 2023.which has the ultramodern imaging facilities, including high resolution ultrasound and MRI machines suitable for bone and musculoskeletal purposes.

Study Participants

Inclusion Criteria

- Patients of both sexes aged 20–70 years.
- Clinical suspicion of rotator cuff injury (partial or full-thickness tears).
- Patients are presented with shoulder pain, weakness, or limited range of motion.
- Patients are willing to provide informed consent for participation in the study.

Exclusion Criteria

- History of previous shoulder surgery.
- Fractures around the shoulder joint.
- Congenital shoulder deformities.
- Active shoulder infections or inflammatory conditions.
- Contraindications for MRI (e.g., pacemakers, metallic implants, or severe claustrophobia).
- Patients are unwilling or unable to provide informed consent.

Sample Size: The study included 60 patients in total who satisfied the inclusion requirements.

Procedure: All enrolled patients underwent a detailed clinical evaluation followed by imaging with both ultrasound and MRI. Ultrasound examinations were performed using a high-frequency linear probe, focusing on detecting the presence, location, and extent of rotator cuff tears, tendon thickness, and associated bursitis. MRI scans were performed on a 1.5 Tesla machine, with sequences tailored for shoulder imaging to assess rotator cuff integrity, partial or complete tears, muscle atrophy, and secondary changes. Imaging findings from both modalities were independently interpreted by experienced radiologists and correlated with clinical features. Comparative analysis of diagnostic accuracy, sensitivity, and specificity of USG versus MRI was then performed.

Statistical Analysis: Data was analyzed using statistical software (SPSS version 27). Descriptive statistics such as mean, standard deviation, and percentages were calculated. Sensitivity, specificity, positive predictive value, and negative predictive value of ultrasound were determined using MRI findings as the reference standard. The level of agreement between USG and MRI was assessed using the kappa statistics, and a p-value <0.05 was considered statistically significant.

Result

Table 1 illustrates the gender and age distribution of rotator cuff injuries among a sample of 60 patients. The highest number of cases was observed in the 21–30 years age group, accounting for 20 patients, with males (16) predominating over females (4). The 31–40 years group had 11 cases, balanced between females (5) and males (6). Both the 41–50 years and 51–60 years age groups had 9 cases each, with males consistently outnumbering females in each group (6 males vs. 3 females). The lowest incidence was seen in patients under 20 years, with only 4 cases (3 males, 1 female). Overall, males exhibited a higher prevalence of rotator cuff injuries across all age groups, and the condition was most common in young adults aged 21–30 years.

Table 1: Gender and Age Distribution of Rotator Cuff Injuries (Sample Size = 60)

Age Group	Females	Males	Total
<20 years	**1**	**3**	**4**
21–30 years	**4**	**16**	**20**
31–40 years	**5**	**6**	**11**
41–50 years	**3**	**6**	**9**
51–60 years	**3**	**6**	**9**
>60 years	**3**	**4**	**7**
Total	**19**	**41**	**60**

Table 2 shows the gender and age distribution of patients with rotator cuff injuries. Among the 60 patients studied, the mean age of females was slightly higher at 40.57 years compared to 37.44 years in males. The median age also reflected this trend, with females at 36 years and males at 31 years. The most frequently occurring age (mode) was 34 years for females and 29 years for males, indicating a tendency for injuries to cluster in the early to mid-30s, particularly among males. The standard deviation was higher in females (18.5) than in males (14.94), suggesting a wider variation in the ages of female patients compared to their male counterparts. Overall, rotator cuff injuries affected both genders in a similar age range, with a slightly older and more variable distribution among females.

Table 2: Gender and age Distribution of rotator cuff injuries

Statistic	Females (n=30)	Males (n=30)
Mean	40.57	37.44
Median	36	31
Mode	34	29
Standard Deviation	18.5	14.94

Table 3 compares the detection of rotator cuff injuries using ultrasound (USG) and MRI across four tendon types. For the supraspinatus tendon, USG identified 25 partial tears (42%) and 10 complete tears (17%), while MRI detected slightly fewer partial tears at 22 (37%) but more complete tears at 12 (20%), indicating that MRI may be more sensitive in identifying full-thickness tears. In the infraspinatus tendon, both modalities reported similar frequencies, with USG showing 6 partial (10%) and 4 complete (7%) tears, and MRI detecting 5 partial (8%) and 5 complete (8%) tears, suggesting comparable diagnostic performance. For subscapularis tears, MRI identified more partial injuries (7, 12%) than USG (4, 7%), though complete tears were relatively similar (USG 2, 3%; MRI 3, 5%). No injuries were detected in the teres minor tendon by either modality. Overall, the table illustrates that while USG and MRI largely correlate, MRI may be slightly more sensitive in detecting complete and subscapularis tears.

Table 3: Comparison of Findings in USG and MRI Modalities

	Frequency				Percentage			
Injury Type	**USG Partial Tear**	**USG Complete Tear**	**MRI Partial Tear**	**MRI Complete Tear**	**USG Partial Tear (%)**	**USG Complete Tear (%)**	**MRI Partial Tear (%)**	**MRI Complete Tear (%)**
Supraspinatus Tear	25	10	22	12	42%	17%	37%	20%
Infraspinatus Tear	6	4	5	5	10%	7%	8%	8%
Subscapularis Tear	4	2	7	3	7%	3%	12%	5%
Teres Minor Injury	0	0	0	0	0%	0%	0%	0%

Discussion

Rotator cuff injuries are a common source of shoulder pain as well as physical limitation, resulting in a significant burden on patients' quality of life. In our study, the majority of rotator cuff injuries occurred among male patients, with a large number of injuries accounted for by the 21–30 years age group which is consistent with the greater exposure risk to occupational and recreational activities in this demographic. These findings endorse already established knowledge that identified males as having an increased risk for traumatic rotator cuff injury; older age, and females specifically, present a demographic of degenerative rotator cuff tears. The means and medians in ages of our female patients were slightly older than males, which may indicate that degenerative change has a more pronounced effect on rotator cuff pathology in women.

The comparison of ultrasound (USG) to magnetic resonance imaging (MRI) for the evaluation of rotator cuff injury showed that both techniques were similarly efficacious in detecting tears in both the supraspinatus and infraspinatus tendons. Ultrasound (USG) identified 42% of partial thickness tears and 17% of full thickness tears in the supraspinatus tendon, whereas MRI found 37% of partial thickness tears and 20% of full thickness tears, little differing from USG findings.

The more percentage of partial and full thickness tears found with MRI implies there may be greater sensitivity for full-thickness tears with the MRI modality. Overall, these findings add to the body of literature Narasimhan et al., (2017) [10] reported a prevalence of subscapularis tears in patients requiring rotator cuff restoration at 31.4%. The sensitivity of ultrasound for detecting these tears was 39.5%, while the specificity was 93.1%, resulting in an overall accuracy of 75.8% for ultrasound. demonstrating the role and utility of USG as a first-line, non-invasive imaging evaluation that provides a rapid, cost-effective imaging assessment. Meanwhile, the role of MRI is important when further imaging evaluation is required, or the surgeon plans to pursue surgical intervention.

In relation to the subscapularis tendon injuries, MRI demonstrated slightly improved detection rates for partial tears (12% v 7% for USG), while total tears were detected at similar rates between all imaging modalities. The teres minor tendon had no injuries detected by either the USG or MRI and reflects the limited prevalence of isolated teres minor tears in the literature. Collectively, this covert comparison highlights the integration of USG and MRI. USG has a role in their dynamic assessment and point-of-care diagnosis. MRI complemented the detailed soft tissue anatomy and assessment of secondary changes such as muscle atrophy and fatty infiltration. Brandt et al., (2016) [11] reported that ultrasonography exhibited a sensitivity of 89% and a specificity of 43% for detecting supraspinatus tendon tears, while

demonstrating a sensitivity of 30% for identifying subscapularis tendon tears.

The age distribution data additionally reinforces the idea that rotator cuff injuries occur throughout adulthood with the most common age of presentation being in the early to mid-30s, particularly in males. The standard deviation data indicate a greater variability in patient age in female patients, suggesting a broader spectrum of potential degenerative etiologies. The pattern of age distribution corroborates the concept of both traumatic and degenerative mechanisms of injury in the evaluation of the patient and emphasizes the importance of using age-appropriate imaging on these patients. Fischer et al., (2015) [12] reported detection accuracies of 77.8% for the subscapularis tendon, 84.4% for the infraspinatus tendon, and 91.1% for the supraspinatus tendon which aligns with our findings.

Findings from a clinical perspective indicate that USG can be safely used as an effective screening tool in outpatient settings or those with limited resources. USG can reasonably accurately identify both partial and complete tears and may be appropriate for evaluation, follow-up, and guidance for interventional procedures like corticosteroid injections for conservative treatment. MRI, however, is reserved as the preferred imaging modality when the ability to accurately characterize the size of the tear, any associated tendon retraction, and distal muscular changes is required for surgical decision-making. The strong association of findings between USG and MRI in this study reiterates the feasibility of a sequential imaging modality, both in terms of accuracy of diagnosis and resource utilization in hire healthcare settings. De Jesus et al., (2009) [13] asserted that there is no statistically significant difference in the sensitivities and specificities of MRI compared to ultrasonography in identifying full- or partial-thickness rips.

In summary, this study showed that both USG and MRI can be helpful in the diagnosis of rotator cuff injury. While MRI was slightly more sensitive, particularly in the detection of complete tears and subscapularis tears, high-resolution USG is a useful initial assessment tool that provides a reliable, non-invasive, and cost-effective assessment tool. The appropriate imaging tool ultimately stems from the integration of clinical evaluation and appropriate imaging, which improves the timely diagnosis, improves characterization of the injury, and improves management decisions, which ultimately improves patient outcomes and functional recovery.

Conclusion

In conclusion, the present study clarifies the advantageous roles of ultrasonography (USG) and magnetic resonance imaging (MRI) in identifying rotator cuff dysfunction, since each modality offers distinct benefits. MRI somewhat outperforms USG in sensitivity for detecting complete tears and subscapularis tears, but its ability to visualize detailed anatomy makes it particularly useful for preoperative evaluation and assessing secondary changes to the rotator cuff such as atrophy or fatty infiltration. USG is a dynamic, non-invasive and cost-effective modality, making it a solid first-line diagnostic investigation particularly in outpatient clinics or in low resource settings. Findings from the present study also indicate that rotator cuff injuries in younger adult males are more common perhaps due to higher exposure occupationally and recreationally, whereas females demonstrated a more equal age distribution amongst degenerative changes. Overall, a thorough clinical evaluation together with the results, makes for a straightforward accurate and timely diagnosis and the ability to provide a more tailored management plan which can improve outcomes for patients.

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