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Diagnostic Accuracy of Shoulder Ultrasound for Rotator Cuff Tear by Considering Shoulder Arthroscopy as Gold Standard

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Abstract

Rotator cuff disease is the leading cause of shoulder pain, and ultrasonography is widely used due to its non-invasive, cost-effective nature, though arthroscopy is considered the gold standard for diagnosis. This study aimed to compare the diagnostic accuracy of high-resolution ultrasonography with arthroscopy for detecting rotator cuff tears. Fifty patients suspected of having rotator cuff tears underwent both ultrasonography and arthroscopy over a one-year period. The results showed that 57% of patients were female, 43% were male, and the most affected tendon was the supraspinatus. Ultrasonography demonstrated high accuracy, with sensitivity and specificity of 93.61% and 100% for overall rotator cuff tears. For full-thickness tears, ultrasonography's sensitivity was 93.75% and specificity 100%, but sensitivity dropped to 77.27% for partial-thickness tears. Ultrasonography showed excellent accuracy in detecting full-thickness supraspinatus tears, though its sensitivity was lower for partial-thickness and infraspinatus tears. The study concluded that high-resolution ultrasonography is highly effective for detecting full-thickness tears but less sensitive for partial-thickness tears.

Keywords: Arthroscopy, Infraspinatus Tear, Rotator Cuff, Supraspinatus Tear, Ultrasonography

Introduction

The rotator cuff consists of four muscles and their tendons, which merge with the joint capsule to form a musculotendinous collar that surrounds the glenohumeral joint. It is essential for shoulder stability and rotational movements. Shoulder pain is the third most common musculoskeletal complaint in clinical practice, following back and neck pain, with rotator cuff disease being the leading cause.[1] Rotator cuff disorders include tears, tendinopathy, shoulder impingement syndrome, and subacromial-subdeltoid bursitis. Pain, stiffness, or weakness in the shoulder can significantly impair

function, limiting daily activities and work.[2] Approximately 23% of asymptomatic adults have rotator cuff tears, with prevalence increasing with age: 13% in people aged 50–59, 20% in those 60–69, 31% in the 70–79 group, and 51% in those over 80.[3] Age, occupation, trauma, acromion shape, joint degeneration, and bone spurs contribute to rotator cuff issues. The muscles making up the rotator cuff are the supraspinatus, infraspinatus, teres minor, and subscapularis, which work together to generate torque and stabilize the glenohumeral joint.[4] A tear in the rotator cuff can cause significant dysfunction of the shoulder joint.

Imaging plays a key role in diagnosing rotator cuff tears and determining whether conservative management or surgery is required. Various imaging methods, including conventional radiography, ultrasonography (USG), computed tomography, magnetic resonance imaging (MRI), and diagnostic arthroscopy, are used to evaluate rotator cuff tears.[5] High-resolution ultrasonography and MRI have shown similar accuracy in detecting and measuring the size of full- and partial-thickness tears. The sensitivity of high-resolution USG for full-thickness tears ranges from 89% to 100%, with recent studies reporting 100% sensitivity.[6,7] Ultrasonography offers advantages like availability, low cost, quick scan time, and the ability to perform dynamic, real-time imaging without ionizing radiation. However, the quality of the results depends heavily on the operator's expertise, making it a limitation.[8]

The purpose of our study is to find sensitivity of shoulder ultrasound for rotator cuff tear as considering shoulder arthroscopy as gold standard in detection of full thickness and partial thickness rotator cuff tears in symptomatic patients.

Data collection involved obtaining a detailed history from each patient, followed by a physical examination and assessment of shoulder joint range of motion. All patients exhibited signs and symptoms suggestive of a rotator cuff tear and underwent both ultrasonography and arthroscopy for diagnosis.

Methods

This study included clinically suspected cases of rotator cuff injury who underwent high-resolution ultrasonography (USG) and arthroscopy of the shoulder at the Departments of Radiodiagnosis and Orthopaedics, Dr. SNMC Medical College and associated Hospitals, Jodhpur, between June 2023 and June 2024. The study was designed as a hospital-based, prospective observational study. A total of 50 patients were enrolled, with the sample size determined using a 95% confidence interval and an expected sensitivity of 75% for partial-thickness rotator cuff tears, based on previous literature. The sample size calculation was based on the formula for sensitivity and was rounded up to 50 subjects.

Quantitative variables, including age, sex distribution, and the involvement of specific tendons such as supraspinatus (SSP), infraspinatus (ISP), subscapularis (SSC), long head of the biceps (LHB), and subacromial-subdeltoid bursa, were expressed as frequencies and percentages. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated by comparing USG findings with arthroscopy results. The chi-square test was applied to assess differences in proportions, with a p-value of less than 0.05 considered statistically significant.

For the ultrasonography procedure, sonograms were obtained using a Philips Affiniti 70 ultrasound machine equipped with a high-frequency (7–15 MHz) linear array transducer. The patient was seated on a stable stool with back support, allowing access to all aspects of the

shoulder. The examiner either sat or stood behind the patient, positioned so that their shoulder was higher than the patient's, allowing for optimal ultrasound access and control. Most shoulder USG exams were completed within 10 minutes, often less than 5 minutes in cases of normal shoulders. A 10–15 MHz transducer provided adequate penetration and resolution, with tissue harmonic imaging used to improve tear detection. Proper technique involved ensuring that the tendon was perpendicular to the sound beam to minimize anisotropy, and clear, hyperechoic bone cortex visualization under the tendon indicated proper beam orientation.

USG Criteria Used to Diagnose the Rotator Cuff Tears (RCTs)

Full Thickness Tears (FTTs)

a. Nonvisualisation or absence of cuff tissue because of complete avulsion and retraction under acromion with approximation of the deltoid muscle to surface of the humeral head.
b. Focal defect in the rotator cuff extending through entire substance of rotator cuff created by a variable degree of retraction of the torn tendon ends.
c. Ability to compress the deltoid muscle by the probe within a defect or against the humeral head.
d. Supraspinatus tears extending 2.5 cm or more posterior to the biceps tendon in the transverse view are regarded as tears extending into the infraspinatus.

Partial Thickness Tears (PTT)

a. Focal hypoechoic or mixed hyper and hypoechoic defect not traversing the entire tendon thickness, involves articular (Articular Surface PTT) or bursal surface (Bursal Surface PTT).
b. A focal hypoechoic zone within the substance of rotator cuff (Mid Substance PTT).
c. Minimal flattening (Loss of Convexity) of bursal side of the rotator cuff (Bursal Surface PTT).

Inclusion criteria

All clinically suspected cases of rotator cuff tear who underwent both USG and arthroscopy

Patients contraindicated for MRI or those who were claustrophobic.

Exclusion criteria

Patients who had undergone USG but not arthroscopy,

Previous rotator cuff repairs

The condition in which USG or arthroscopy was technically challenging.

Arthroscopic Examination

Were performed by two experienced orthopedic surgeons with 10 and 8 years of experience. The patient was in beach chair position during arthroscopic procedure. Rotator cuff was approached from the posterior portal and the following anatomical structures were examined, the intra-articular part of the biceps tendon, subscapularis tendon, superior glenohumeral ligament and humeral head of the glenohumeral joint, rotator cuff, the integrity of the labrum and Subacromial Subdeltoid Bursa (SASDB). Findings were noted and the presence or absences of full and partial thickness (Articular or Bursal) rotator cuff tears were recorded.

Result & discussion

This study comprises of 50 patients with clinically suspected rotator cuff tear, who underwent ultrasonography and arthroscopy of the shoulder for the evaluation of rotator cuff tear in Dr. S.N. medical college, jodhpur associated hospitals. Findings in the patients studied were tabulated using Microsoft excel. All statistical analyses were conducted using the SPSS statistical package (Version 17.0). Observations of these 50 patients were compiled and analysed.

Age of the study group ranged from 39 to 80 years with mean age of 55.1± 10.8 years. Age of the patients with rotator cuff tears ranged from 40 to 80 years with the

mean age of 55.6 ± 10.6 years. In present study RCT was common in fifth, sixth and seventh decade of life and prevalence increases after 40 years of age. Milgrom et al, which showed that the prevalence of rotator cuff tears increases after the age of 40 years due to age related degeneration of the rotator cuff tendons.[10]

In this study 57.44% of females and 42.55 % males had rotator cuff tear, showing slight female predominance, however it is statistically not significant. Study by Milgrom et al among 90 patients which showed no statistically significant differences in the incidence of rotator-cuff lesions related to gender.[10]

72.34% of the rotator cuff tears were found in the dominant arm and all the dominant arms were right sided. This study shows that RC tears were common in dominant arm. Study by Yamamoto A et al showed that rotator cuff were common in dominant arms.[12]

63.82% of the patients with rotator cuff tear had given the history of fall and trauma to the corresponding shoulder within 6 months of presentation but not associated with dislocation of the shoulder. It demonstrated that history of trauma is very common in the rotator cuff tear. Pettersson G et al showed that partial and full thickness rotator cuff tears after trauma are more common in older patients, suggesting that older, more degenerated tendons are weaker and tear more easily.[13]

38.29% of patients who had rotator cuff tears were known diabetics with mean duration of disease was 7.87 years. Study by Michele Abate et al, 48 subjects with diabetes and 32 controls showed that prevalence of SSP tears in diabetics was 31% compared to the 10% in control group.[14]

Supraspinatus is the most commonly affected tendon among the rotator cuff tears, involved in 95.74% cases. Followed by Infraspinatus (31.91%) and Subscapularis (12.76%) tears. Teres minor was not involved in any cases. All the rotator cuff tears involved Supraspinatus tendon except two in which subscapularis was the only tendon which torn. This is consistent with the study conducted by Jerosch et al on dissected specimen of shoulder joints of 122 patients. That study found that isolated supraspinatus tendon tear occurred in 78% of cases. De Palma et al examined 96 cadaver shoulders and showed similar finding of supraspinatus as the commonly affected tendon.[15]

For overall detection of the rotator cuff tear, high resolution ultrasonography in comparison with the arthroscopy has sensitivity, specificity, PPV and NPV of 93.61%, 100%, 100% and 50% respectively. For detection of full thickness rotator cuff tears (FTT-RC) USG sensitivity, specificity, PPV and NPV was 93.75%, 100%, 100% and 90%. Sensitivity, specificity, PPV and NPV of USG in comparison with the arthroscopy for detection of the partial thickness tear (PTT) was 77.27%, 100%, 100%, and 84.84%. In this study it's very evident that high resolution USG has high sensitivity and specificity for detection of FTT-RC but for detection of PTT-RC its sensitivity is relatively less.

Meta-analysis by Joseph O. de Jesus showed sensitivity and specificity of USG in comparison with arthroscopy for detection of RC-FTT was 95.4% and 98.9% and for RC-PTT was 85.9% and 96%, respectively.[15] The present study found that ultrasonography was highly accurate for detecting full-thickness rotator cuff tears as mentioned in literature.

USG has sensitivity, specificity, PPV & NPV of 100% in detection of supraspinatus (SSP) FTT. For detection SSP-PTT sensitivity, specificity, PPV & NPV is 86.66%, 100%, 100% and 94.59% respectively. 66.60% of SSP-PTT are articular side and 33.4% are bursal side. Our study showed that USG is highly accurate in detection of

SSP-FTT and comparatively less sensitive in detection of SSP-PTT.

In a study by Kiran Singisetti and Andreas Hinsche in 96 shoulders, ultrasonography in comparison with arthroscopy showed sensitivity, specificity, PPV and NPR of 89%, 43%, 76% and 100% for SSP tear detection.[16]

For detection of ISP-FTT, USG has sensitivity, specificity, PPV and NPV of 77%, 100%, 100% and 95.3% respectively. But in detection of ISP-PTT its sensitivity is significantly less, its just 33%.

Tables & Graph, Figures

Table 1: Comparing the overall RC tear detection in arthroscopy and USG

	Arthroscopy			
USG		Positive	Negative	Total
	Positive	44	0	44
	Negative	3	3	6
	Total	47	3	50

Graph 1: Comparing the overall rotator cuff tear detection in arthroscopy and USG

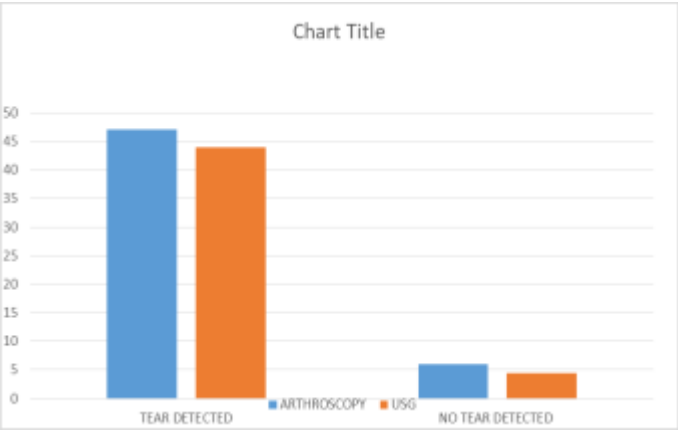

Figure 1: USG and Arthroscopic images of Supraspinatus full thickness tear

Figure 1 A:

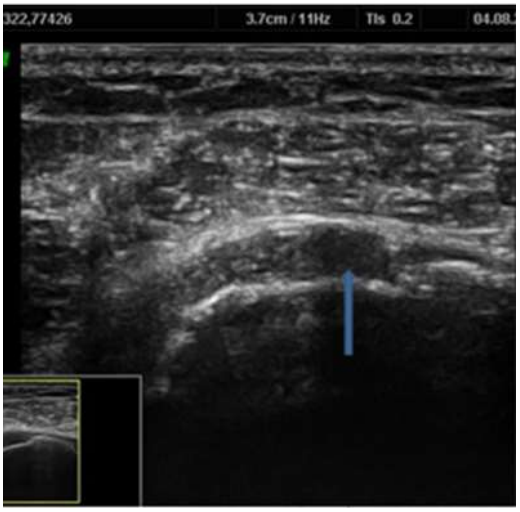

Figure 1 B:

Figure 1 C & D:

74 year old male patient presented with pain and restricted right shoulder movements since about 6 months. (a) Longitudinal (b) Transverse, USG images showing full thickness tear of right SSP

tendon (arrow) with retraction of the tendon ends. Arthroscopic images of the same patient showing full thickness tear of right supraspinatus tendon (c) and tendon repair with anchors (d). Long and thin arrow represents torn supraspinatus tendon and short and thick arrow represents greater tuberosity of humeral head. Curved arrow in (d) represents anchor.

Conclusion

High-resolution ultrasonography is the preferred initial imaging technique for evaluating suspected rotator cuff tears. It is noninvasive, widely accessible, portable, and more cost-effective than other options. Patients generally tolerate it well. Unlike MRI, ultrasonography allows for dynamic imaging and comparison with the unaffected shoulder. It has high sensitivity and specificity for detecting full-thickness rotator cuff tears, especially in the supraspinatus tendon, which is the most frequently affected. Ultrasonography is also effective in identifying partial-thickness supraspinatus tears and full-thickness infraspinatus tears, though it is less sensitive in detecting partial-thickness infraspinatus and subscapularis tears.

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