Section: Radiodiagnosis

Original Research Article

ROTATOR CUFF TEARS: ULTRASOUND ASSESSMENT WITH ARTHROSCOPIC VALIDATION

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ABSTRACT

Background: Rotator cuff tears are a leading cause of shoulder pain and functional impairment, particularly in middle-aged and elderly populations. Accurate imaging is essential for diagnosis, classification, and management planning. While magnetic resonance imaging (MRI) is often considered a reference standard, high-resolution musculoskeletal ultrasound has emerged as a practical first-line imaging modality. Arthroscopy remains the definitive reference standard, particularly in surgically indicated cases. **Aim:** To evaluate the role of high-resolution musculoskeletal ultrasound in diagnosing rotator cuff tears in patients presenting with unilateral shoulder pain, with arthroscopic validation in a clinically indicated subgroup.

Materials and Methods: This prospective observational study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital over a six-month period. A total of 120 patients with unilateral shoulder pain clinically suspected to have rotator cuff pathology underwent standardized high-resolution ultrasound examination using a 7.5–12 MHz linear transducer. Ultrasound findings were categorized as normal, partial-thickness tear, or full-thickness tear. Arthroscopy was performed in 68 patients based on clinical severity and surgical indication and served as the reference standard for validation. Descriptive statistics were used, and diagnostic performance of ultrasound was calculated in the arthroscopy subgroup.

Results: The mean age of the study population was 54.6 ± 11.8 years, with male predominance (58.3%). Ultrasound detected rotator cuff tears in 77 patients (64.2%), including 34 partial-thickness (28.3%) and 43 full-thickness tears (35.8%). Arthroscopy confirmed rotator cuff tears in 62 of 68 patients (91.2%), comprising 38 partial-thickness and 24 full-thickness tears. Ultrasound demonstrated a sensitivity of 94.7% for partial-thickness tears and 91.7% for full-thickness tears, with 100% specificity for both. The supraspinatus tendon was the most commonly involved, and associated findings included subacromial–subdeltoid bursitis (25.8%) and biceps tendon pathology (18.3%).

Conclusion: High-resolution musculoskeletal ultrasound is a reliable and effective imaging modality for evaluating rotator cuff pathology. When validated against arthroscopy, ultrasound demonstrates excellent diagnostic accuracy for both partial- and full-thickness rotator cuff tears. Given its accessibility, cost-effectiveness, and ability to identify associated shoulder abnormalities, ultrasound serves as an excellent first-line imaging tool in patients with shoulder pain, with MRI reserved for complex cases and pre-operative planning.

Keywords: Rotator cuff tear; Shoulder pain; Musculoskeletal ultrasound; Arthroscopy; Supraspinatus tendon; Diagnostic imaging.

INTRODUCTION

Shoulder pain is one of the most common musculoskeletal complaints encountered in outpatient practice and is a major contributor to functional limitation and reduced quality of life. Population-based evidence shows that shoulder pain has substantial prevalence in the community, with considerable variation by age and population type (Luime et al, 2004).[1] Rotator cuff disorders represent a major cause of shoulder pain, particularly in middle-aged and elderly individuals, with prevalence increasing with age and degenerative changes (Yamamoto et al, 2010).[2] Importantly, rotator cuff tears may also be present in asymptomatic individuals, indicating that imaging findings must be interpreted in clinical context (Tempelhof et al, 1999).[3] Mass-screening data further demonstrate that rotator cuff tear prevalence increases with advancing age and that asymptomatic tears may be more common than symptomatic tears (Minagawa et al, 2013).[4]

The rotator cuff consists of the supraspinatus, infraspinatus, subscapularis, and teres minor tendons, which function together to stabilize the glenohumeral joint and facilitate coordinated shoulder movement. Among these, the supraspinatus is most frequently involved because of its anatomical course beneath the acromion and susceptibility to impingement and degenerative strain, making early diagnosis clinically relevant to prevent progression to chronic pain, weakness, limited range of motion, and long-term disability (Yamamoto et al, 2010),[2] (Minagawa et al, 2013).[4]

Accurate and timely imaging is critical for diagnosis, classification (partial vs full-thickness), and treatment planning. Historically, multiple diagnostic strategies have been used, but systematic evaluation of diagnostic tests for soft tissue shoulder disorders emphasizes the need for reliable and accessible imaging modalities that can guide management decisions (Dinnes et al, 2003).[5] MRI is often considered a reference standard for soft-tissue evaluation and pre-operative mapping, but its use may be limited by cost, availability, scan time, and contraindications. Comparative meta-analytic evidence suggests that ultrasound, MRI, and MR arthrography can all demonstrate high diagnostic performance, with MR arthrography typically providing the highest accuracy in some analyses (de Jesus et al, 2009).[6]

High-resolution musculoskeletal ultrasound has gained wide acceptance as a practical, non-invasive, cost-effective first-line imaging tool. Ultrasound offers real-time dynamic assessment, is not affected by metal artifacts, and enables correlation of imaging findings with site-specific pain (Okoroha et al, 2019).[7] Systematic review data demonstrate that ultrasound has high diagnostic efficiency for rotator cuff tears, supporting its role in clinically suspected cases (Liang et al, 2020).[8] Clinical studies also support ultrasound as a high-quality diagnostic tool for detecting partial and full-thickness tears when performed by trained operators (Aminzadeh et al, 2020).[9]

While imaging comparisons are important, arthroscopy remains the definitive reference standard, particularly for surgical candidates. Arthroscopy-correlated studies from Indian tertiary care settings have shown high sensitivity and specificity of ultrasound for both partial- and full-thickness tears, strengthening the validity of ultrasound as a front-line test in routine practice (Hapani et al, 2017).[10] Against this background, the present study was designed to evaluate ultrasound-based detection patterns of rotator cuff pathology in symptomatic patients and to validate ultrasound findings against arthroscopy in a substantial subgroup.

Aim

To evaluate the role of high-resolution musculoskeletal ultrasound in the diagnosis of rotator cuff tears in patients presenting with unilateral shoulder pain, with arthroscopic validation in a clinically indicated subgroup.

Objectives

1. To determine the prevalence and pattern (partial vs full-thickness; tendon distribution) of rotator cuff tears detected on ultrasound in patients with unilateral shoulder pain.
2. To assess the diagnostic performance of ultrasound against arthroscopy in the validation subgroup and to document associated abnormalities such as subacromial–subdeltoid bursitis and biceps tendon pathology.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted in the Department of Radiodiagnosis, NRI Academy of Medical Sciences, Chinakakani, over a period of one year (February 2025 to January 2026).

Study population and sampling

A total of 120 consecutive patients presenting with unilateral shoulder pain suspected clinically to be of rotator cuff origin were included. Patients were referred from Orthopaedics and General OPD for imaging evaluation.

Inclusion Criteria

- Age ≥ 18 years
- Clinical suspicion of rotator cuff pathology (pain on overhead activity, weakness, restricted range of motion, night pain, positive impingement signs)
- Willingness to undergo ultrasound evaluation and provide informed consent

Exclusion Criteria

- Recent trauma, fracture, or prior surgery involving the affected shoulder

- Known inflammatory arthropathy or systemic degenerative joint disease affecting shoulder assessment
- Inability to complete ultrasound examination or incomplete clinical data

Ultrasound examination protocol

All patients underwent high-resolution musculoskeletal ultrasound using a **7.5–12 MHz linear array transducer**. Scans were performed in a seated position using a standardized protocol including evaluation of:

- Supraspinatus, infraspinatus, subscapularis tendons
- Long head of biceps tendon
- Subacromial–subdeltoid bursa

Dynamic maneuvers were used where required to assess impingement and tendon continuity.

Sonographic diagnostic criteria

- **Full-thickness tear:** discontinuity extending from articular to bursal surface (with/without retraction)
- **Partial-thickness tear:** focal defect involving either bursal surface, articular surface, or intratendinous region without complete thickness disruption

Findings were categorized as **normal**, **partial-thickness tear**, or **full-thickness tear**.

Arthroscopy validation subgroup

Out of 120 patients, **68 underwent shoulder arthroscopy** based on clinical severity and surgical indication determined by Orthopaedics. Arthroscopy findings were used as the **reference standard** for validation analysis.

Data collection and statistical analysis

Demographic details, symptom duration, ultrasound findings, and associated abnormalities were recorded in a structured proforma. Descriptive statistics were expressed as mean ± SD for continuous variables and frequency/percentage for categorical variables. In the arthroscopy subgroup, ultrasound diagnostic performance was calculated (sensitivity and specificity) separately for partial- and full-thickness tears using standard formulas.

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants. Confidentiality and anonymity were maintained.

RESULTS

A total of 120 patients were evaluated. The mean age was 54.6 ± 11.8 years. There were 70 males (58.3%) and 50 females (41.7%). Dominant shoulder involvement was observed in 74 patients (61.7%).

Table 1: Demographic characteristics (n = 120)

Parameter	Value
Mean age (years)	54.6 ± 11.8
Male	70 (58.3%)
Female	50 (41.7%)
Dominant arm involvement	74 (61.7%)

The study population reflects a middle-aged predominance with slightly higher male representation and higher involvement of the dominant arm.

Duration of symptoms

Pain duration was <1 month in 24 (20.0%), 1–6 months in 58 (48.3%), and >6 months in 38 (31.7%).

Table 2: Duration of shoulder pain (n = 120)

Duration	Number of patients (%)
< 1 month	24 (20.0%)
1–6 months	58 (48.3%)
> 6 months	38 (31.7%)

Nearly half the patients presented in the subacute 1–6 month period.

Ultrasound findings (overall cohort)

Ultrasound showed rotator cuff tears in 77 patients (64.2%) and normal tendons in 43 (35.8%). Partial-thickness tears occurred in 34 (28.3%) and full-thickness tears in 43 (35.8%).

Table 3: Ultrasound findings (n = 120)

Ultrasound finding	Number of patients (%)
Normal rotator cuff	43 (35.8%)
Partial-thickness tear	34 (28.3%)
Full-thickness tear	43 (35.8%)
Total	120 (100%)

Full-thickness tears were marginally more common than partial-thickness tears among symptomatic patients.

Arthroscopy subgroup (validation cohort)

Out of 120, 68 patients underwent arthroscopy. Arthroscopy confirmed rotator cuff tears in 62 patients (91.2%), while 6 (8.8%) had no tear. Among arthroscopy-confirmed tears, 38 were partial-thickness and 24 were full-thickness.

Table 4. Arthroscopic findings (n = 68)

Arthroscopic finding	Number of patients (%)
No tear	6 (8.8%)
Partial-thickness tear	38 (55.9%)
Full-thickness tear	24 (35.3%)
Total	**68 (100%)**

Tear prevalence is higher in the arthroscopy cohort because arthroscopy was performed in clinically severe/surgical-indication cases.

Ultrasound vs arthroscopy correlation

In the arthroscopy subgroup, ultrasound detected 58 of 62 tears. A total of 4 tears were missed, predominantly chronic partial-thickness tears.

Table 5: Ultrasound–arthroscopy correlation by tear type (n = 68)

Tear type	Arthroscopy positive	US true positive	US false negative
Partial-thickness	38	36	2
Full-thickness	24	22	2
Total	**62**	**58**	**4**

Ultrasound showed strong agreement with arthroscopy, with most misses occurring in the partial-thickness category.

Diagnostic performance of ultrasound (arthroscopy as reference)

Table 6: Diagnostic accuracy of ultrasound compared with arthroscopy

Tear type	Sensitivity (%)	Specificity (%)
Partial-thickness tear	94.7 (36/38)	100 (6/6)
Full-thickness tear	91.7 (22/24)	100 (44/44)

Ultrasound demonstrated excellent sensitivity and perfect specificity within this arthroscopy-validated subgroup.

Tendon involvement (arthroscopy-confirmed tears)

Among arthroscopy-confirmed tears (n=62), supraspinatus was the most frequently involved tendon. Multiple tendon involvement was also observed.

Table 7: Tendon involvement on arthroscopy (n = 62)

Tendon involved*	Number of patients (%)
Supraspinatus	41 (66.1%)
Subscapularis	14 (22.6%)
Infraspinatus	10 (16.1%)
Multiple tendons	19 (30.6%)

*More than one tendon may be involved in a single patient.

Supraspinatus predominance is consistent with typical impingement and degenerative mechanisms.

Associated ultrasound findings

Subacromial–subdeltoid bursitis was seen in **31 (25.8%)**, and biceps tendon pathology in **22 (18.3%)**.

Table 8: Associated ultrasound findings (n = 120)

Associated finding	Number of patients (%)
Subacromial–subdeltoid bursitis	31 (25.8%)
Biceps tendon pathology	22 (18.3%)

Ultrasound enabled simultaneous identification of coexisting pain contributors, improving overall clinical assessment.

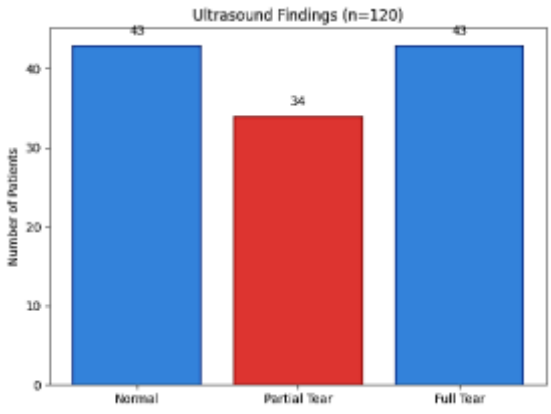
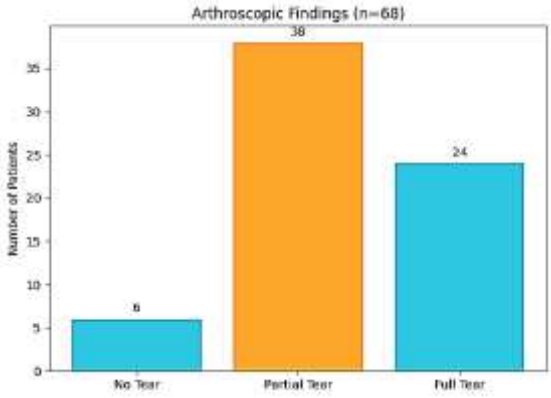


Figure 1

Figure 2



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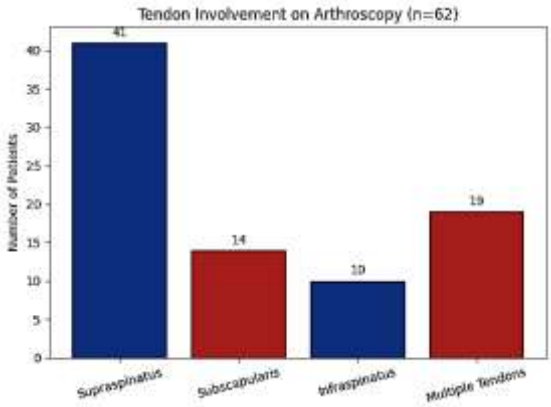

Figure 4

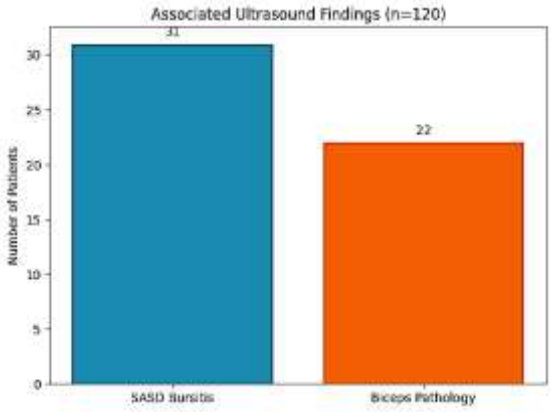

Figure 5

DISCUSSION

The present prospective observational study evaluated the diagnostic role of high-resolution musculoskeletal ultrasound in patients presenting with unilateral shoulder pain clinically suspected to have rotator cuff pathology, with arthroscopy used as the reference standard in a clinically indicated validation subgroup. In the overall cohort of 120 patients, ultrasound detected rotator cuff tears in 64.2% of cases, with full-thickness tears (35.8%) identified slightly more frequently than partial-thickness tears (28.3%), while 35.8% demonstrated normal rotator cuff tendons. This distribution highlights the substantial burden of rotator cuff pathology in symptomatic patients and reinforces the relevance of ultrasound as a first-line imaging modality in routine clinical practice.

Arthroscopic validation and diagnostic accuracy

Arthroscopy was performed in a subset of 68 patients selected on the basis of clinical severity and surgical indication, accounting for the higher prevalence of rotator cuff tears (91.2%) observed in this subgroup. When ultrasound findings were correlated with arthroscopy, ultrasound demonstrated excellent diagnostic performance, with a sensitivity of 94.7% for partial-thickness tears and 91.7% for full-thickness tears, along with a specificity of 100% for both tear types. The few missed cases were predominantly chronic partial-thickness tears, which are known to be diagnostically challenging due to subtle morphological changes and minimal fluid signal, a limitation consistently reported in arthroscopy-validated studies (Hapani et al., 2017).[10]

Comparison with arthroscopy-correlated literature

The diagnostic accuracy observed in the present study is in close agreement with arthroscopy-correlated evidence from Indian tertiary care settings. Hapani et al. reported sensitivity values of 94.1% for partial-thickness tears and 90% for full-thickness tears, with 100% specificity for both, findings that closely mirror the results of the present study (Hapani et al., 2017).[10] Similarly, Vishnumurthy et al. demonstrated high sensitivity and specificity of ultrasound for full-thickness tears, while noting comparatively reduced sensitivity for partial-thickness tears, emphasizing the inherent diagnostic difficulty of early or chronic partial tears (Vishnumurthy et al., 2016).[11] The consistency of findings across these studies reinforces the reliability of ultrasound when standardized scanning protocols and adequate operator expertise are employed.

Tendon involvement pattern

In the present study, the supraspinatus tendon was the most frequently involved structure among arthroscopically confirmed tears, followed by the subscapularis and infraspinatus tendons, with multiple tendon involvement observed in a significant proportion of patients. This distribution is anatomically and biomechanically plausible, as the supraspinatus tendon traverses the subacromial space and is particularly vulnerable to impingement and degenerative changes. Similar patterns of tendon involvement have been consistently reported in arthroscopy-validated studies, further supporting the external validity of the present findings (Hapani et al., 2017).[10]

Added diagnostic value of ultrasound

Beyond the detection of tendon tears, ultrasound enabled identification of associated abnormalities such as subacromial–subdeltoid bursitis (25.8%) and biceps tendon pathology (18.3%). These associated findings are clinically important because they frequently contribute to pain severity and functional limitation and may influence therapeutic decisions,

including targeted injections and rehabilitation strategies. The ability of ultrasound to perform real-time dynamic assessment and correlate imaging findings with site-specific tenderness enhances its overall diagnostic utility (Aminzadeh et al., 2020).[9]

Ultrasound versus MRI: pragmatic clinical positioning

Although MRI remains superior for comprehensive pre-operative evaluation, including assessment of tendon retraction, muscle atrophy, fatty infiltration, and associated intra-articular pathology, several meta-analyses have demonstrated comparable diagnostic performance of ultrasound and MRI for both partial- and full-thickness rotator cuff tears (de Jesus et al., 2009).[6] Systematic reviews further support the high diagnostic efficiency of ultrasound in clinically suspected rotator cuff pathology (Liang et al., 2020).[8] More recent pooled analyses suggest that MRI may demonstrate marginally higher sensitivity for detecting "any tear," but these differences are often modest and may not be clinically decisive, particularly in resource-constrained settings (Toh et al., 2024).[12] These findings support a pragmatic imaging pathway in which ultrasound serves as the first-line investigation, with MRI reserved for equivocal cases and detailed surgical planning.

Strengths and limitations

The strengths of this study include its prospective design, use of a standardized ultrasound protocol, and incorporation of arthroscopy as a reference standard in a substantial validation subgroup. However, certain limitations must be acknowledged. Ultrasound is operator dependent, inter-observer variability was not assessed, and arthroscopy was performed primarily in patients with more severe symptoms or surgical indications, introducing potential selection bias. Future multi-center studies with larger arthroscopy-validated cohorts and formal assessment of inter-observer agreement would further strengthen the generalizability of these findings.

Table 9: Arthroscopy-validated ultrasound performance: present study vs key studies

Study	Arthroscopy (n)	Partial-thickness Sensitivity (%)	Partial-thickness Specificity (%)	Full-thickness Sensitivity (%)	Full-thickness Specificity (%)
Present study	**68**	**94.7**	**100**	**91.7**	**100**
Hapani et al., 2017 (10)	30	94.1	100	90.0	100
Vishnumurthy et al., 2016 (11)	Arthroscopy-correlated	76.9*	100*	94.7*	100*

Values as reported in arthroscopy-correlated diagnostic tables.

Table 10. Pooled and comparative evidence supporting ultrasound use

Study	Evidence type	Key finding relevant to present study
de Jesus et al., 2009 (6)	Meta-analysis	No significant difference between ultrasound and MRI for partial- or full-thickness tears
Liang et al., 2020 (8)	Systematic review & meta-analysis	Ultrasound shows high overall diagnostic efficiency for rotator cuff tears
Toh et al., 2024 (12)	Meta-analysis	MRI shows marginally higher sensitivity for "any tear," but differences are modest

CONCLUSION

High-resolution musculoskeletal ultrasound is a reliable, accurate, and clinically effective imaging modality for the evaluation of rotator cuff pathology in patients presenting with shoulder pain. In this prospective study, ultrasound demonstrated a high detection rate for rotator cuff tears, with excellent sensitivity and specificity when validated against arthroscopy, particularly for full-thickness tears. Partial-thickness tears, although more challenging, were also detected with high sensitivity.

The supraspinatus tendon was the most commonly involved structure, consistent with established anatomical and biomechanical vulnerability. In addition to tendon tears, ultrasound effectively identified associated abnormalities such as subacromial–subdeltoid bursitis and biceps tendon pathology, providing a comprehensive assessment of potential pain generators in a single examination.

Given its real-time dynamic capability, cost-effectiveness, accessibility, and strong arthroscopy-validated diagnostic performance, ultrasound serves as an excellent first-line imaging tool for the evaluation of rotator cuff disorders. MRI should be reserved for equivocal cases, complex pathology, or detailed pre-operative planning. Wider adoption of standardized ultrasound protocols and focused training can further enhance diagnostic accuracy and optimize patient care, particularly in resource-constrained healthcare settings.

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