

A Study to Evaluate Diagnostic Accuracy of Ultrasound for Rotator Cuff Disorders Among Patients with Shoulder Pain in Comparison with MRI

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Received: 10-08-2026 / Revised: 04-09-2026 / Accepted: 12-10-2026

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Conflict of interest: Nil

Abstract

Background: Rotator cuff disorders are a common cause of shoulder pain and may range from tendinopathy and bursitis to partial- and full-thickness tendon tears. Magnetic resonance imaging (MRI) is considered the reference imaging modality because of its excellent soft-tissue contrast and ability to assess associated muscle and joint abnormalities. However, MRI is relatively expensive, less accessible, time-consuming, and may be contraindicated in some patients. High-resolution ultrasonography (USG) offers a rapid, non-invasive, cost-effective and dynamic method for evaluating rotator cuff and related shoulder pathology.

Methodology: A prospective, observational, and descriptive study was conducted at a tertiary care institute over a period of 18 months after obtaining Institutional Ethics Committee approval. A total of 50 patients aged 15–60 years, irrespective of gender, presenting with clinically suspected rotator cuff disorders and referred for both shoulder USG and MRI were included. Patients with previous shoulder surgery or dislocation, fractures, neoplastic lesions, congenital deformities, referred shoulder pain, MRI contraindications, or claustrophobia were excluded. USG evaluation included the biceps tendon, subscapularis, supraspinatus, infraspinatus, acromioclavicular joint, subacromial bursa, and impingement. MRI was considered the gold-standard reference investigation. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and correlation between USG and MRI findings were assessed.

Results: Ultrasonography demonstrated statistically significant correlation with MRI for all evaluated shoulder structures ($p < 0.001$). For the biceps tendon, USG showed 88.5% sensitivity, 100% specificity, 100% PPV, and 88.9% NPV. Subscapularis assessment showed 77.3% sensitivity, 100% specificity, 100% PPV, and 84.6% NPV. The highest diagnostic performance was observed for the supraspinatus tendon, with 96.8% sensitivity, 94.7% specificity, 96.8% PPV, and 94.7% NPV. For the infraspinatus tendon, sensitivity was 92.0%, specificity 96.0%, PPV 97.9%, and NPV 85.7%. USG demonstrated 90.0% sensitivity and 100% specificity for acromioclavicular joint abnormalities, while subacromial bursal pathology showed 85.0% sensitivity and 100% specificity. For impingement, USG demonstrated 91.3% sensitivity, 100% specificity, 100% PPV, and 87.5% NPV.

Conclusion: Ultrasonography demonstrated good diagnostic agreement with MRI across the evaluated shoulder structures, with high sensitivity, specificity, and predictive values. Its diagnostic performance was particularly strong for supraspinatus tendon pathology. Therefore, USG is an effective, accurate, accessible, and cost-effective imaging modality for the evaluation of shoulder pain and rotator cuff disorders and may serve as an appropriate initial imaging investigation in clinically suspected cases.

Keywords: Ultrasonography; MRI; Rotator cuff; Shoulder pain; Supraspinatus; Diagnostic accuracy; Sensitivity; Specificity.

DOI: 10.25258/ijcpr.18.10.62

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Introduction

Rotator Cuff Injury Syndrome is one of the furthestmost frequent conditions causing shoulder pain seen in clinics and ERs from tendinitis and subacromial or subdeltoid bursitis to partial or complete tears with secondary muscle wasting and

fatty atrophy, which ultimately lead to weakness in abduction of the shoulder joint, limitation of its mobility, bad sleep, and incapacity to work. Such problem is relevant both from medical and economic perspectives, since knowledge of the particular

injured tendon (supraspinatus is injured in most cases, next comes infraspinatus, then subscapularis), defect's thickness and size, degree of retraction, injury of the long biceps pulley or acromioclavicular osteoarthritis allows proper treatment, including conservative therapy or surgery [1]. It is standard to consider MR imaging the gold-standard cross-sectional examination method applied for diagnosing pathology in the shoulder because of high contrast and multicomponent analysis, which provides the opportunity to examine the cuff tendons, the labrum, cartilage, bone marrow edema, and muscle trophic changes. There is much scientific evidence that proves high sensitivity as well as specificity when it comes to complete tear diagnosis as well as good enough findings for partial tears, which are still difficult to diagnose by any other diagnostic tool. The weaknesses of MRI can be listed as increased price, lack of accessibility in hospitals due to financial insolvency, time constraints, contraindications (pacemakers or claustrophobia), and the need to maintain immobilization; all these things preclude using MRI first [2]. This has been the backdrop for high-resolution ultrasound (US) to emerge as a quick, non-ionizing, bedside test, providing real-time dynamic assessment of rotator cuff and peritendinous structures, cost-effective, without contraindications, and with high patient compliance; most importantly, improvements in high-frequency linear probes (10-15 MHz), with improved beam formation and tissue harmonic imaging abilities, have made up for the shortcomings in many conditions [3]. Evidence from contemporary literature suggests that US, when performed by skilled ultrasonographers, with a well-established scanning technique, has equal sensitivity and specificity as MRI in noticing complete-thickness supraspinatus tendon tear; partial-thickness tears might also be detected by US, with sensitivity and specificity sufficient for clinical application, although with potential for underestimating smaller-sized articular-sided tear. Furthermore, the additional benefits provided by US are the ability to test dynamic conditions such as the creation of subacromial impingement during shoulder abduction, dislocation or subluxation of the long head of the biceps tendon in external rotation, and catching or clicking, all of which are not possible on static MRIs and could help establish the connection between clinical and radiological diagnosis [4]. Additionally, the very same examination could serve to screen the patients who would benefit from guided injections into the subacromial-subdeltoid bursa, hydrodilatation for adhesive capsulitis, or other treatments around the tendons [5]. In particular, for example, positive findings in preoperative US of the subscapularis region have been shown; nevertheless, sensitivity relies on the tear location and the skills of the operator; hence,

MRI can be recommended in case of persistent doubts from a negative US exam, as well as when a complete preoperative evaluation of a lesion with involvement of several tendons and their muscle quality grading (atrophic changes and fatty degeneration) is required in order to change the surgical approach [6]. Moreover, as regards imaging before arthroplasty surgeries, US may provide essential information concerning the status of the rotator cuff that should affect the selection of a suitable type of prosthesis and surgical approach, while in more complicated cases, MRI could provide advantages due to its larger field of view and additional information about the labrum and joint capsule. In this context, the issue of providing high-quality health care services at a reasonable price cannot be overlooked. In this connection, comparative analysis of the workflow has proved that inclusion of US imaging within clinician-led or radiologist-led shoulder management protocols increases efficacy and reduces costs in that MRI is done only where necessary to define a surgical procedure and a size of. It can be particularly valuable in the situation of overcrowded tertiary facilities in India, given limited access to scanners and scanning time, but the practicality of this protocol depends on whether the accurate diagnosis can be made with the aid of this imaging modality along with other factors like local technical equipment (GE LOGIQ F8 series), sonographer training, and patient population. Therefore, a comparison of the accuracy of the diagnosis between the two imaging modalities (ultrasound and MRI) performed by systematic means in the same facility is highly needed for improving the quality of care, and for collecting valid data to support decision-making of ethics/research boards, surgeons, and administrators [7]. In brief, this study attempts to assess the sensitivity, specificity, predictive values, and accuracy of shoulder ultrasound to detect diseases of the rotator cuff (tear, tendonitis, and bursitis) in adult participants through shoulder pain compared to MRI. For the American technique, the participants is placed in the sitting position, and careful assessment of the biceps tendon (short and long axes), subscapularis, supraspinatus, rotator interval, infraspinatus, teres minor, acromioclavicular joint, and subacromial-subdeltoid bursa is performed. The dynamic test for impingement is incorporated, and in case the posterior structures need evaluation, the frequency can be slightly lowered to 7–9 MHz [8]. MRI protocol in 3.0 Tesla involves the use of unique shoulder coils, fat-suppressed proton density as well as T2-weighted arrangements along the coronal, sagittal and axial planes together with additional T1-weighted axial and/or coronal imaging planes to detect and correlate any muscle atrophy or fatty changes [9]. With the help of standardizing information and use of common criteria to classify

tears, this study can provide specific evaluation of tendons (supraspinatus and subscapularis), presence of other features like bursal effusion, AC joint osteoarthritis, and rotator interval thickening along with computation of 2 x 2 statistics. Besides the issue of accuracy, there is also a practical element to the study: if US displays a significant negative predictive value in ruling out surgically significant full-thickness tears, then the adoption of a US-first and then MRI procedure will be cost-effective, reduce wait times, and increase patient convenience, but if any clinically significant discrepancies exist between the two methods, predominantly when it comes to partial-thickness or subscapularis tears, then an MRI-only approach may have to be considered in certain situations; in such a case, resource allocation will be based on empirical evidence [10]. Therefore, the study will help create institution-specific, ethical information that seeks to achieve both accuracy and cost-effectiveness [1–11].

Methodology

A prospective, observational, and descriptive study was conducted at A tertiary care institute equipped with advanced diagnostic imaging equipment aimed to establish the ability of ultrasonography to diagnose shoulder problems compared with MRI as the gold standard test. The research was carried out rendering to the ethical rules laid down in the Declaration of Helsinki, following ethical clearance by the Institutional Ethics Committee of Dr. D.Y. Patil Medical College, Hospital and Research Institute, Kolhapur. The research was carried out over a duration of 18 months. All the study participants were selected according to the inclusion and exclusion criteria. The sample size was 50. Written informed consent was obtained from all contributors after proper explanation regarding the objectives of the study, methods of radiographic examination, risk factors, and advantages of the procedure to the patients.

Inclusion Criteria: Participants aged between 15 - 60 years, irrespective of gender.

Participants offering by shoulder pain clinically supposed to be due to rotator cuff disorders, participants mentioned to the Department of Radiodiagnosis for assessment of shoulder pain with ultrasound as well as MRI, patients who provided

written informed consent to contribute in the research.

Exclusion Criteria: Participants by a preceding history of shoulder surgery or dislocation, participants with neoplastic lesions, fractures, or congenital shoulder deformities, patients with referred shoulder pain due to cervical spine pathology or cardiac disease, participants with contraindications to MRI, like cardiac pacemakers, ferromagnetic aneurysm clips, cochlear implants, or metallic foreign bodies, patients with claustrophobia who could not tolerate MRI scanning, these criteria ensured that only the relevant cases would be used, without any other factors affecting the shoulder pain being taken into account.

Study Procedure

Ultrasound Procedure: Performed using GE LOGIQ F8/F8 Expert ultrasound machine.

A linear high-frequency transducer (12 MHz) was employed, with lower frequencies (7–9 MHz) used for deeper structures.

Patients were seated on a backless chair, and systematic scanning was performed in both transverse and longitudinal planes.

Each tendon was examined dynamically for tears, retraction, or impingement. Subacromial-subdeltoid bursa and acromioclavicular joint were assessed.

Findings such as hypoechogenicity, discontinuity, tendon thinning, or fluid collections were documented.

MRI Procedure: Performed on a 3.0 Tesla Philips Achieva MRI scanner by means of a devoted shoulder coil. Standard protocol included: Proton Density (PD) fat-suppressed sequences in axial, coronal, as well as sagittal planes. T2-weighted fat-suppressed sequences in coronal and sagittal planes. T1-weighted sequences in axial as well as coronal planes.

Slice thickness: 3–4 mm. MRI findings such as hyperintense signals, tendon retraction, discontinuity, and muscle atrophy were recorded. Both the ultrasound and MRI readings were conducted by radiologists who had no idea what the results of both these methods would be. This assisted in ensuring there was no bias while comparing these two methods.

Results

Table 1: Cross-Tabulation of USG Findings with MRI Findings

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	1	0	0	2	0	0	3
Effusion	0	3	0	0	0	0	3
Full-thickness tear	0	0	3	0	0	0	3
Normal	0	0	0	23	0	0	23
Partial-thickness tear	0	0	0	1	10	0	11
Tendinopathy	0	0	0	0	0	7	7
Total	1	3	3	26	10	7	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A statistically important association was observed across ultrasonography and MRI results for biceps tendon pathologies ($p < 0.001$). These results indicate a high degree of arrangement between the 2

approaches because the most pairs lie on the diagonal line. Since the expected frequency is low for some cells, the significance of correlation was tested using Fisher's Exact Test.

Table 1a: Diagnostic Accuracy of Biceps Tendon USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	88.5
Specificity	100
PPV	100
NPV	88.9

Ultrasonography showed high diagnostic accuracy in differentiating normal from abnormal biceps tendon findings. Sensitivity was 88.5%, while specificity and positive predictive value were 100%,

indicating excellent ability to correctly identify normal cases. Negative predictive value was 88.9%, reflecting a low proportion of missed abnormal cases.

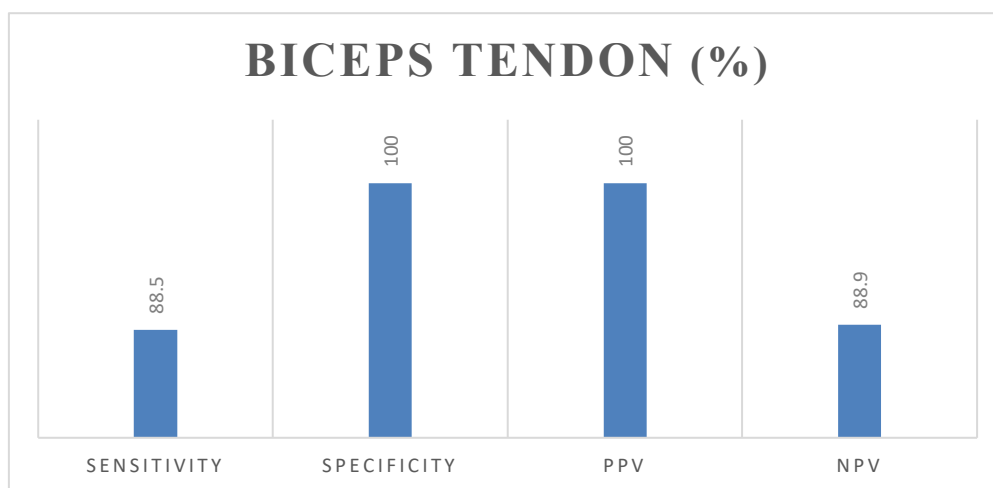
**Figure 1: Biceps Tendon (%)**

Table 2: Comparison of USG and MRI Findings of the Subscapularis Tendon

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	3	0	0	1	0	0	4
Effusion	0	6	0	1	0	0	7
Full-thickness tear	0	0	2	0	0	0	2
Normal	0	0	0	17	0	0	17
Partial-thickness tear	0	0	0	1	8	0	9
Tendinopathy	0	0	0	2	0	9	11
Total	3	6	2	22	8	9	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A statistically important relationship was established between the findings from ultrasonography and MRI regarding subscapularis tendon pathology ($p < 0.001$). Numerous dots were

aligned on the diagonal lines, which designates that there was a strong association among the two techniques employed. Because most of the cells had expected frequencies below five, Fisher's exact test was conducted.

Table 2a: Diagnostic Accuracy of Subscapularis Tendon USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	77.3
Specificity	100
PPV	100
NPV	84.6

Ultrasonography demonstrated good diagnostic accuracy in differentiating normal from abnormal subscapularis tendon findings. The value obtained for the sensitivity was 77.3%, indicating that some abnormal subjects were not identified. On the other

hand, the specificity and positive predictive standards obtained were 100%, indicating that there was a very good probability of identifying normal subjects.

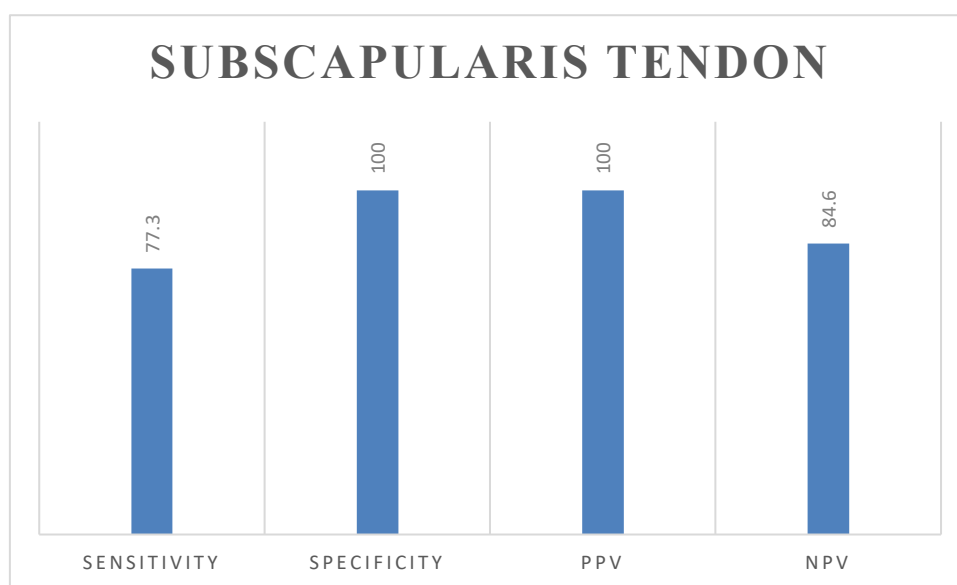
**Figure 2: Subscapularis Tendon**

Table 3: Comparison of USG and MRI Findings of Supraspinatus Tendon

USG Findings	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	0	1	0	0	1
Full-thickness tear	3	0	0	0	3
Normal	0	29	0	0	29
Partial-thickness tear	0	0	5	0	5
Tendinopathy	1	1	0	10	12
Total	4	31	5	10	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A statistical correlation exists between ultrasonography results and MRI results for the supraspinatus tendon lesion (p value < 0.001). The

majority of data points fall on the leading diagonal, indicating excellent agreement between USG and MRI. Due to the less than five count in numerous cells, Fisher's exact test was done to prove the statistical correlation.

Table 3a: Diagnostic Accuracy of Supraspinatus Tendon USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	96.8
Specificity	94.7
PPV	96.8
NPV	94.7

Ultrasonography showed excellent diagnostic accuracy in differentiating normal from abnormal supraspinatus tendon findings. Sensitivity was 96.8% and specificity was 94.7%, indicating a high ability to correctly identify both abnormal and normal cases. Both positive and negative predictive standards remained high, reflecting minimal false-positive as well as false-negative outcomes.

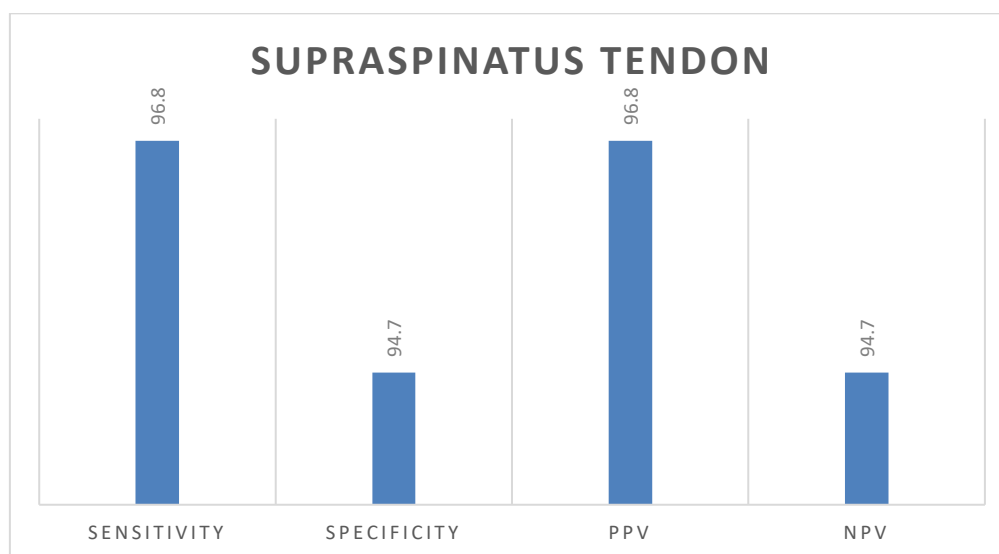
**Figure 3: Supraspinatus Tendon**

Table 4: Comparison of USG and MRI Findings of Infrapinatus Tendon

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	1	0	0	1	0	0	2
Effusion	0	2	0	0	0	0	2
Full-thickness tear	0	0	1	0	0	0	1
Normal	0	0	0	23	1	0	24
Partial-thickness tear	0	0	0	0	10	0	10
Tendinopathy	0	0	0	1	0	10	11
Total	1	2	1	25	11	10	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A highly important association among the results yielded through ultrasound scanning and MRI in the study of infrapinatus tendon pathology existed ($p < 0.001$). Most subjects appeared on the diagonal line;

hence, the two diagnostic modalities had high agreement. Due to many cells containing smaller expected values, Fisher's exact test was carried out.

Table 4a: Diagnostic Accuracy of Infrapinatus Tendon USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	92.0
Specificity	96.0
PPV	97.9
NPV	85.7

Ultrasonography demonstrated high diagnostic accuracy in differentiating normal from abnormal infrapinatus tendon findings. The sensitivity of the test was found to be 92.0%, while the specificity was 96.0%, indicating that the diagnostic test had great accuracy in detecting both cases. In addition, the positive predictive value is extremely high at 97.9%, while the negative predictive value is 85.7%.

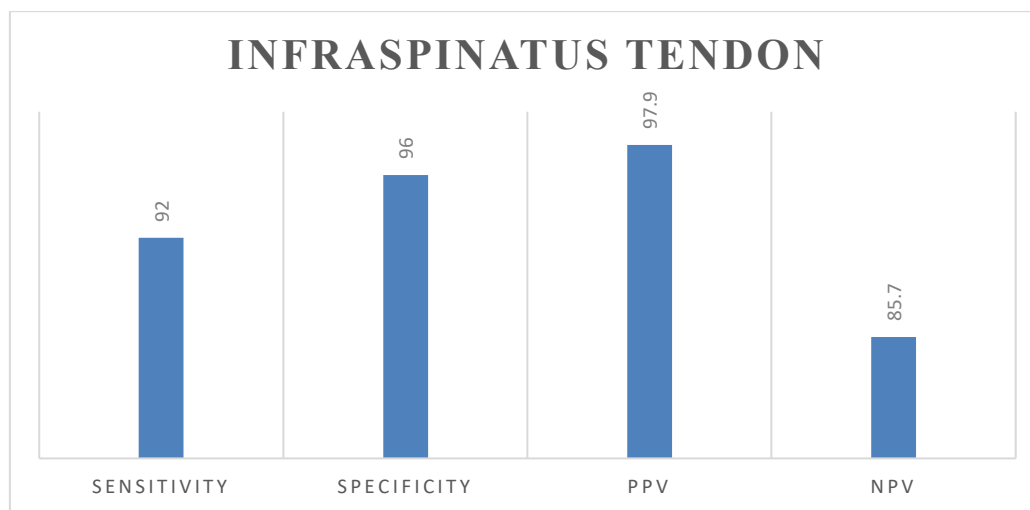
**Figure 4: Infrapinatus Tendon**

Table 5: Comparison of USG and MRI Findings of the Teres Minor Tendon

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	5	0	0	2	0	0	7
Effusion	0	1	0	0	0	0	1
Full-thickness tear	0	0	1	1	0	0	2
Normal	0	0	0	20	0	0	20
Partial-thickness tear	0	0	0	1	4	0	5
Tendinopathy	0	0	0	0	0	15	15
Total	5	1	1	24	4	15	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

There was a statistically important correlation between ultrasonography and magnetic resonance imaging findings for teres minor tendinopathy ($p < 0.001$). The majority of the values fell along the diagonal line, suggesting that there is a high degree

of contract between the 2. Nevertheless, because there were some cells with low expected counts, Fisher's exact test was also accomplished to confirm the statistical meaning.

Table 5a: Diagnostic Accuracy of Teres Minor Tendon USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	83.3
Specificity	100
PPV	100
NPV	80.0

Ultrasonography demonstrated good diagnostic accuracy in differentiating normal from abnormal teres minor tendon findings. The sensitivity was 83.3%, which implied that some of the abnormal cases were not included in the test. The specificity

and positive predictive value were 100%, which is an indication of perfect accuracy in identifying normal cases. The negative predictive value was 80%.

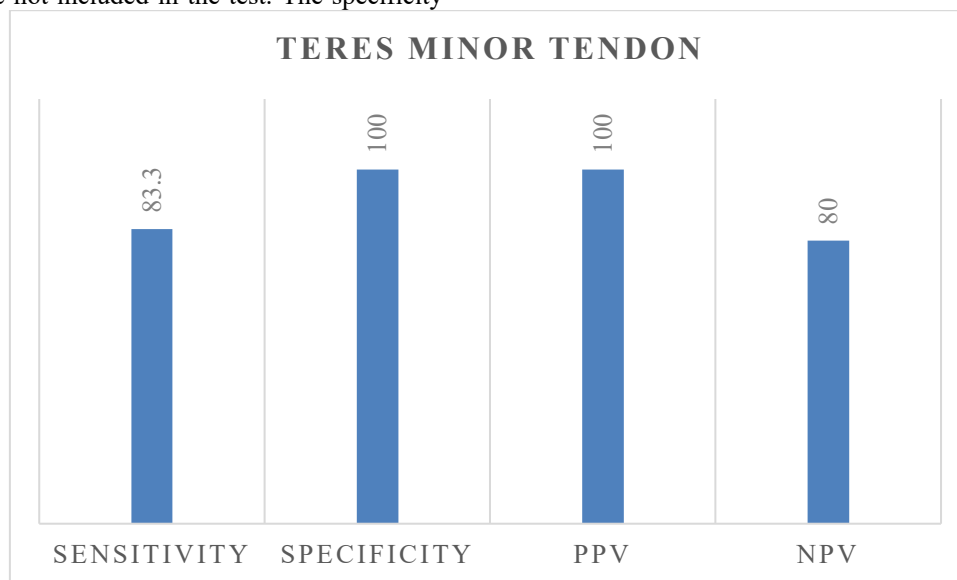
**Figure 5: Teres Minor Tendon**

Table 6: Comparison of USG and MRI Findings of AC Joint

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	2	0	0	0	0	0	2
Effusion	0	1	0	0	0	0	1
Full-thickness tear	0	0	2	2	0	0	4
Normal	0	0	0	27	0	0	27
Partial-thickness tear	0	0	0	0	4	0	4
Tendinopathy	0	0	0	1	0	11	12
Total	2	1	2	30	4	11	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

Statistically, there exists an association between the results of ultrasound as well as magnetic resonance imaging of the acromioclavicular joint ($p < 0.001$). Majority of the cases were grouped diagonally,

suggesting that there was high correlation between ultrasound and MRI. Fisher's Exact test was considered appropriate for the analysis since most cells had low frequencies.

Table 6a: Diagnostic Accuracy of AC Joint USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	90.0
Specificity	100
PPV	100
NPV	90.9

Ultrasonography demonstrated high diagnostic accuracy in differentiating normal from abnormal AC joint findings. Sensitivity was 90.0%, indicating that a small proportion of abnormal cases were

missed. Specificity and positive predictive value were 100%, reflecting excellent ability to correctly identify normal cases. The negative prognostic value was 90.9%, suggesting a low likelihood of false-negative findings.

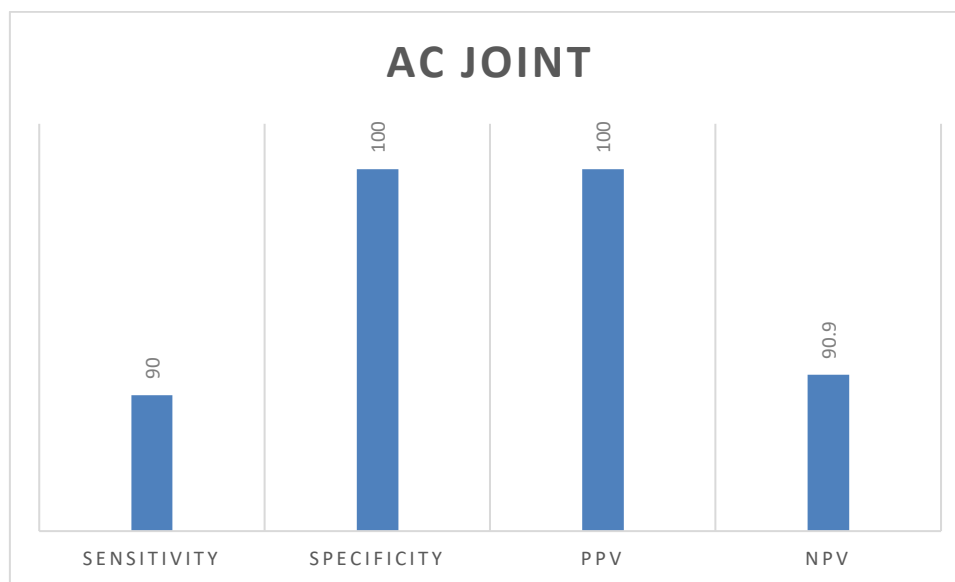
**Figure 6: AC Joint**

Table 7: Comparison of USG and MRI Findings of Subacromial Bursa

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	6	0	0	0	0	0	6
Effusion	0	3	0	0	0	0	3
Full-thickness tear	0	0	2	0	0	0	2
Normal	3	0	0	17	0	0	20
Partial-thickness tear	0	0	0	0	8	0	8
Tendinopathy	0	0	0	0	0	11	11
Total	9	3	2	17	8	11	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A statistically important association remained observed among ultrasonography as well as MRI findings of the subacromial bursa ($p < 0.001$). However, there were cases where there were inconsistencies, particularly those that had normal

bursitis readings in the USG test. This is due to the few numbers that were expected, hence the use of Fisher's Exact Test, along with the implication of a statistical method.

Table 7a: Diagnostic Accuracy of Subacromial Bursa USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	85.0
Specificity	100
PPV	100
NPV	85.0

Ultrasonography demonstrated good diagnostic accuracy in differentiating normal from abnormal subacromial bursal findings. Sensitivity was 85.0%, indicating some abnormal cases were missed. Specificity and positive predictive value were 100%,

reflecting excellent ability to correctly identify normal cases. The negative predictive value was 85.0%, suggesting a moderate likelihood of false-negative results.

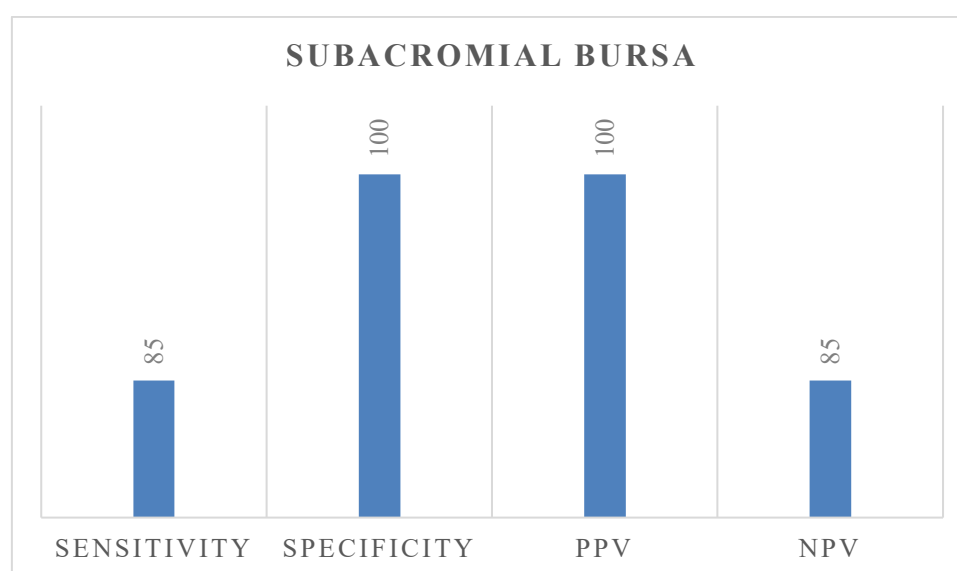
**Figure 7: Subacromial Bursa**

Table 8: Comparison of USG and MRI Findings of Impingement

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	1	0	0	0	0	0	1
Effusion	0	2	0	1	0	0	3
Full-thickness tear	0	0	5	0	0	0	5
Normal	0	0	0	21	1	0	22
Partial-thickness tear	0	0	0	0	6	0	6
Tendinopathy	0	0	0	1	0	12	13
Total	1	2	5	23	7	12	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A statistically important association remained observed among ultrasonography alongwith MRI results of impingement-related pathologies ($p < 0.001$). Most cases were concordant between USG and MRI, with values concentrated along the

diagonal. A few discrepancies were noted where abnormal cases were categorized as normal on USG. Given the occurrence of low predictable counts in multiple cells, Fisher's exact test was applied and long-established the statistical implication.

Table 8a: Diagnostic Accuracy of Impingement USG vs MRI (Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	91.3
Specificity	100
PPV	100
NPV	87.5

Ultrasonography demonstrated high diagnostic accuracy in differentiating normal from abnormal impingement findings. Sensitivity was 91.3%, indicating a small proportion of abnormal cases were missed. Specificity and positive predictive

value were 100%, reflecting excellent ability to correctly identify normal cases. The negative predictive value was 87.5%, indicating a low probability of false-negative results.

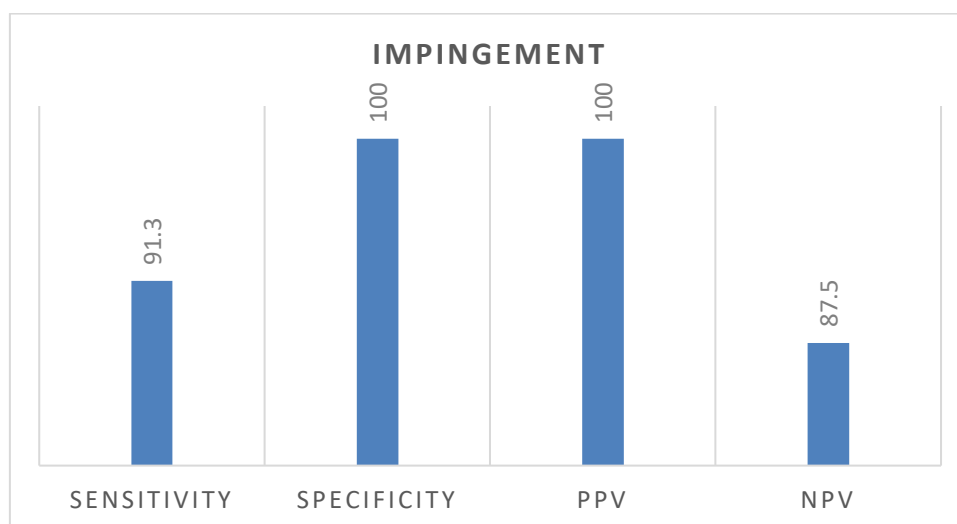
**Figure 8: Impingement**

Table 9: Comparison of USG and MRI Findings of Posterior Labrum

USG Findings	MRI Bursitis	MRI Effusion	MRI Full-thickness Tear	MRI Normal	MRI Partial-thickness Tear	MRI Tendinopathy	Total
Bursitis	1	0	0	0	0	0	1
Effusion	0	5	0	1	0	0	6
Full-thickness tear	0	0	3	1	0	0	4
Normal	0	0	0	23	0	0	23
Partial-thickness tear	0	0	0	1	5	0	6
Tendinopathy	0	0	0	0	1	9	10
Total	1	5	3	26	6	9	50

Fisher's Exact Test (Monte Carlo): $p < 0.001$

A statistically important association was observed among ultrasonography and MRI findings of posterior labrum pathologies ($p < 0.001$). Most cases were concordant between USG and MRI, as reflected by the diagonal distribution. A few

mismatches were observed where abnormal findings were categorized as normal on USG. Due to low expected frequencies in multiple cells, Fisher's exact test was useful and confirmed numerical significance.

Table 9a: Diagnostic Accuracy of Posterior Labrum USG vs MRI(Normal vs Abnormal)

Parameter	Value (%)
Sensitivity	88.5
Specificity	100
PPV	100
NPV	88.9

Ultrasonography demonstrated high diagnostic accuracy in differentiating normal from abnormal posterior labrum findings. Sensitivity was 88.5%, indicating a small proportion of abnormal cases were missed. Specificity and positive predictive

value were 100%, reflecting excellent ability to correctly identify normal cases. The negative predictive value was 88.9%, indicating a low probability of false-negative results.

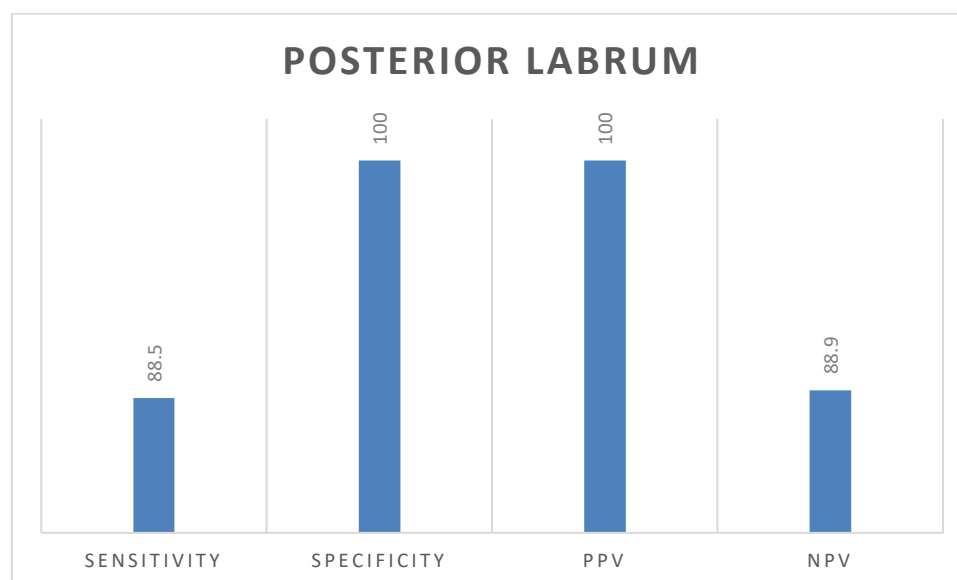
**Figure 9: Posterior Labrum**

Table 10: Overall Diagnostic Accuracy of USG Compared to MRI (All Structures)

Structure	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Biceps Tendon	88.5	100	100	88.9
Subscapularis Tendon	77.3	100	100	84.6
Supraspinatus Tendon	96.8	94.7	96.8	94.7
Infraspinatus Tendon	92.0	96.0	97.9	85.7
Teres Minor Tendon	83.3	100	100	80.0
AC Joint	90.0	100	100	90.9
Subacromial Bursa	85.0	100	100	85.0
Impingement	91.3	100	100	87.5
Posterior Labrum	88.5	100	100	88.9

Ultrasonography demonstrated overall high diagnostic accuracy across all evaluated shoulder structures when compared with MRI. Sensitivity ranged from 77.3% to 96.8%, indicating generally strong ability to detect abnormal findings, with relatively lower sensitivity in subscapularis and teres minor tendons. Specificity was consistently high (mostly 100%), reflecting excellent ability to correctly identify normal cases. PPV was always high, while NPV was different; therefore, there was some possibility of false negatives. In conclusion, the usefulness of using ultrasound for detecting problems with the shoulder joint is proven by the fact that its effectiveness is comparable to that of an MRI.

Discussion

Biceps Tendon: USG showed a statistically significant correlation with MRI for biceps tendon pathology ($p < 0.001$), with sensitivity of 88.5%, specificity of 100%, PPV of 100%, and NPV of 88.9%. These findings demonstrate that ultrasonography is highly reliable for diagnosing biceps tendon lesions, particularly when positive. Singal et al. (2021) and Gupta et al. reported high specificity of ultrasound in detecting shoulder abnormalities, although some lesions may be missed [17,18]. Thus, the present findings support the diagnostic utility of USG in biceps tendon assessment.

Subscapularis Tendon: USG and MRI showed a statistically significant correlation for subscapularis tendon pathology ($p < 0.001$). The diagnostic performance of USG demonstrated 77.3% sensitivity, 100% specificity, 100% PPV, and 84.6% NPV. Although sensitivity was comparatively lower than that of other evaluated structures, the excellent specificity and PPV indicate that positive USG findings were highly reliable. Selvaraj et al. (2019) similarly reported lower ultrasound performance for subscapularis tears compared with supraspinatus tears [14]. Singal et al. (2021) and Gupta et al. (2022) also reported limitations of ultrasound in detecting subscapularis pathology [17,18].

Supraspinatus Tendon: The supraspinatus tendon showed excellent diagnostic performance of USG

compared with MRI, with a statistically significant correlation ($p < 0.001$). USG demonstrated 96.8% sensitivity, 94.7% specificity, 96.8% PPV, and 94.7% NPV, representing the highest sensitivity among the evaluated structures. These findings indicate that ultrasound was particularly accurate for detecting supraspinatus tendon pathology. Previous studies have also demonstrated strong diagnostic performance of ultrasound for supraspinatus tears, with Selvaraj et al. (2019) reporting 93% sensitivity and 97% specificity [14]. The present findings are therefore consistent with previous evidence supporting the high accuracy of USG in supraspinatus pathology.

Infraspinatus Tendon: A statistically significant correlation was observed between USG and MRI for infraspinatus tendon pathology ($p < 0.001$). USG demonstrated 92.0% sensitivity, 96.0% specificity, 97.9% PPV, and 85.7% NPV, indicating strong diagnostic performance. These findings are comparable to the results reported by Selvaraj et al. (2019), who observed 88% sensitivity and 96% specificity for infraspinatus tears [14]. The present findings therefore support the usefulness of USG for evaluating infraspinatus pathology.

Acromioclavicular Joint: USG showed a statistically significant correlation with MRI for acromioclavicular joint abnormalities ($p < 0.001$), with 90.0% sensitivity, 100% specificity, 100% PPV, and 90.9% NPV. These findings indicate excellent diagnostic reliability of ultrasound in evaluating AC joint pathology. Alagappan and Prabhu (2015) reported comparable findings between USG and MRI for associated shoulder abnormalities, supporting the role of ultrasound in shoulder assessment [12]. The present results further support USG as a useful diagnostic modality for shoulder disorders.

Subacromial Bursa: A statistically significant correlation was observed between USG and MRI for subacromial bursal pathology ($p < 0.001$). USG demonstrated 85.0% sensitivity, 100% specificity, 100% PPV, and 85.0% NPV. These findings indicate high specificity and reliability of ultrasound for detecting bursal abnormalities. Alagappan and Prabhu (2015) reported similar results for bursal

effusion and emphasized the value of ultrasound in subacromial assessment [12]. Mahmoud (2016) also reported high diagnostic accuracy of ultrasound compared with MRI [13].

Impingement: USG and MRI showed a statistically significant correlation for impingement-related pathology ($p < 0.001$). Ultrasound demonstrated 91.3% sensitivity, 100% specificity, 100% PPV, and 87.5% NPV, indicating high diagnostic accuracy. Alagappan and Prabhu (2015) emphasized the value of ultrasound for dynamic assessment of impingement syndromes [12], while Mahmoud (2016) reported high sensitivity and accuracy of ultrasound in shoulder pain evaluation [13]. These findings support the use of USG for assessment of impingement-related shoulder disorders.

Overall Diagnostic Accuracy: Overall, ultrasonography demonstrated good diagnostic agreement with MRI across the evaluated shoulder structures. Sensitivity ranged from 77.3% to 96.8%, with the highest sensitivity observed for the supraspinatus tendon (96.8%). Specificity was 100% for several evaluated structures, while supraspinatus and infraspinatus tendons demonstrated specificities of 94.7% and 96.0%, respectively. PPV ranged from 96.8% to 100%, while NPV ranged from 80.0% to 94.7%. Liang et al. (2020) reported pooled sensitivity of 95% for USG in diagnosing rotator cuff tears [16]. Naseem and Sarfraz (2025) reported sensitivity of 94%, specificity of 91%, and accuracy of 92% in their review of prospective studies [19]. Aminzadeh et al. (2020) also demonstrated high sensitivity and specificity for ultrasound in rotator cuff pathology [15]. Thus, the present findings support USG as an accurate and effective imaging modality for evaluating shoulder and rotator cuff disorders, particularly supraspinatus pathology.

Conclusion: This study showed that ultrasound is an effective and accurate diagnostic imaging technique to evaluate patients who suffer from shoulder disorders and rotator cuff disorders compared with MRI, which acts as a gold standard imaging test. Ultrasound showed a very good correlation with MRI in terms of all evaluated shoulder structures and was found to be very accurate, particularly in evaluating supraspinatus tendon disorders. Generally speaking, ultrasound was found to have excellent sensitivity, specificity, and predictive values in diagnosing most of the shoulder disorders and therefore makes for a good diagnostic imaging tool for shoulder pain and rotator cuff disorders.

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