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Diagnostic accuracy of magnetic resonance imaging for subscapularis tendon tears: a comparison with intraoperative arthroscopic findings

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Abstract

Background Subscapularis tendon (SSt) tears are frequently underdiagnosed by non-shoulder specialists. Delayed diagnosis may result in tendon retraction, muscle atrophy, and fatty degeneration, negatively affecting surgical outcomes. Magnetic resonance imaging (MRI) is widely used for preoperative evaluation, but its diagnostic accuracy for SSt tears remains controversial. This study aimed to evaluate the diagnostic performance of MRI in detecting SSt tears by comparing preoperative MRI findings with intraoperative arthroscopic findings.

Methods A retrospective analysis was conducted on patients who underwent shoulder arthroscopy for rotator cuff pathology between January 2014 and December 2023. Preoperative MRI evaluations were performed by an experienced musculoskeletal radiologist, while intraoperative assessment was conducted by an orthopedic surgeon specialized in shoulder surgery and served as the reference standard. The sensitivity, specificity, positive predictive value, negative predictive value, overall accuracy, prevalence, positive likelihood ratio, and negative likelihood ratio of MRI for detecting SSt tears were calculated with 95% confidence intervals (CIs).

Results A total of 128 patients were included, with a mean age of 65.4 years. Intraoperatively, SSt tears were identified and repaired in 77 patients, while 51 patients had an intact tendon. MRI reports identified SSt tears in 48 patients and reported an intact tendon in 80 patients. The sensitivity and specificity of MRI for detecting SSt tears were 45.5% (95% CI 0.346–0.567) and 74.5% (95% CI 0.610–0.848), respectively. The positive predictive value was 72.9% (95% CI 0.587–0.837), and the negative predictive value was 47.5% (95% CI 0.368–0.585). The overall accuracy was 57.0% (95% CI 0.483–0.654). The prevalence of SSt tears was 60.2% (95% CI 0.514–0.684). The positive likelihood ratio was 1.78 and the negative likelihood ratio was 0.73. Among 77 arthroscopically confirmed tears, 70 were partial thickness tears and 7 were full thickness tears. All 42 false negatives occurred in partial-thickness tears.

Conclusions MRI demonstrated limited sensitivity in detecting SSt tears despite moderate specificity. These findings indicate that MRI alone may be insufficient for establishing a reliable diagnosis. Clinical examination findings should be integrated with imaging results in the assessment of patients with shoulder pain.

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Keywords Subscapularis, Rotator cuff, Arthroscopy, Diagnostic accuracy, Shoulder

Introduction

The subscapularis tendon (SSt) is the largest and most powerful component of the rotator cuff and plays a fundamental role in anterior shoulder stability and internal rotation strength [1, 2]. Tears of the SSt are increasingly recognized as a clinically significant source of shoulder dysfunction, yet they remain underdiagnosed, particularly outside specialized shoulder units [3–5]. Partial-thickness and upper-border tears are especially prone to being overlooked during initial evaluation [4].

Delayed diagnosis of subscapularis tears may lead to progressive tendon retraction, muscle atrophy, and fatty infiltration, all of which negatively affect reparability and postoperative functional outcomes [6–9]. Therefore, early and accurate identification of subscapularis pathology is crucial for appropriate treatment planning and prognostic counseling.

Magnetic resonance imaging (MRI) is widely used as the primary imaging modality for assessing rotator cuff pathology and frequently guides referral and surgical decision-making [10, 11]. Although MRI has demonstrated high diagnostic performance for supraspinatus and infraspinatus tears, its accuracy in detecting SSt tears remains controversial [12–16]. Reported sensitivity values vary considerably, particularly in cases of partial-thickness tears [12–15]. Variability in tear morphology, imaging protocols, and interpreter experience may contribute to inconsistent results [17–20].

In routine clinical practice, MRI reports are often relied upon heavily by primary care physicians and non-specialized orthopedic surgeons when determining management and referral patterns [21]. A missed subscapularis tear on MRI may therefore delay referral to shoulder specialists and result in progression of tendon pathology [6, 22].

Although previous studies and meta-analyses have evaluated MRI accuracy for rotator cuff tears [11, 12], many relied on controlled research re-evaluation of imaging rather than routine clinical reports. The present study specifically evaluates the diagnostic performance of standard clinical MRI reporting acquired using a standardized 3-Tesla protocol and interpreted under real-world conditions. Additionally, this study provides morphology-based subgroup analysis, detailed Lafosse grading of false-negative cases, and likelihood ratio calculations to enhance clinical interpretability.

We hypothesized that MRI would demonstrate limited sensitivity in detecting SSt tears, particularly partial-thickness lesions, when compared with intraoperative arthroscopic findings.

Methods

Study design and patient selection

This retrospective study was conducted in accordance with the Declaration of Helsinki and institutional ethical standards and was approved by the Acıbadem Mehmet Ali Aydınlar University Medical Research Ethics Committee (Approval number: 2025-16/609). Between January 2014 and December 2023, 173 patients underwent shoulder arthroscopy at our institution. Patients were included if they had preoperative MRI and documented intraoperative evaluation of the SSt.

Exclusion criteria were:

- Previous shoulder surgery ($n = 12$).
- Acute fracture around the shoulder ($n = 8$).
- Inflammatory arthropathy ($n = 2$).
- Inadequate imaging or surgical documentation ($n = 23$).

After exclusions ($n = 45$), 128 patients were included in the final analysis (Fig. 1). Because the cohort consisted exclusively of surgically treated patients, individuals with mild symptoms who did not proceed to arthroscopy were not included.

MRI protocol and evaluation

All MRI examinations were performed using a 3-Tesla system (Siemens Magnetom Vida; Siemens Healthcare, Erlangen, Germany) with syngo MR XA60 software. Slice thickness was 3 mm with no interslice gap. Standard shoulder protocol included axial, oblique sagittal, and oblique coronal proton density and T2-weighted fat-suppressed sequences.

MRI scans were interpreted as part of routine clinical care by an experienced musculoskeletal radiologist. A tendon was classified as "torn" if the official radiology report described partial or full-thickness tear, discontinuity, or fiber defect of the SSt. Reports describing an intact tendon without tear were classified as "intact."

Arthroscopic evaluation

Arthroscopic assessment was performed by a shoulder-specialized orthopedic surgeon using standard posterior viewing and anterior working portals. The tendon insertion and upper border were directly visualized and probed. Any partial or full-thickness fiber disruption requiring repair was classified as a tear.

Statistical analysis

Intraoperative findings were considered the reference standard. Sensitivity, specificity, positive predictive value,

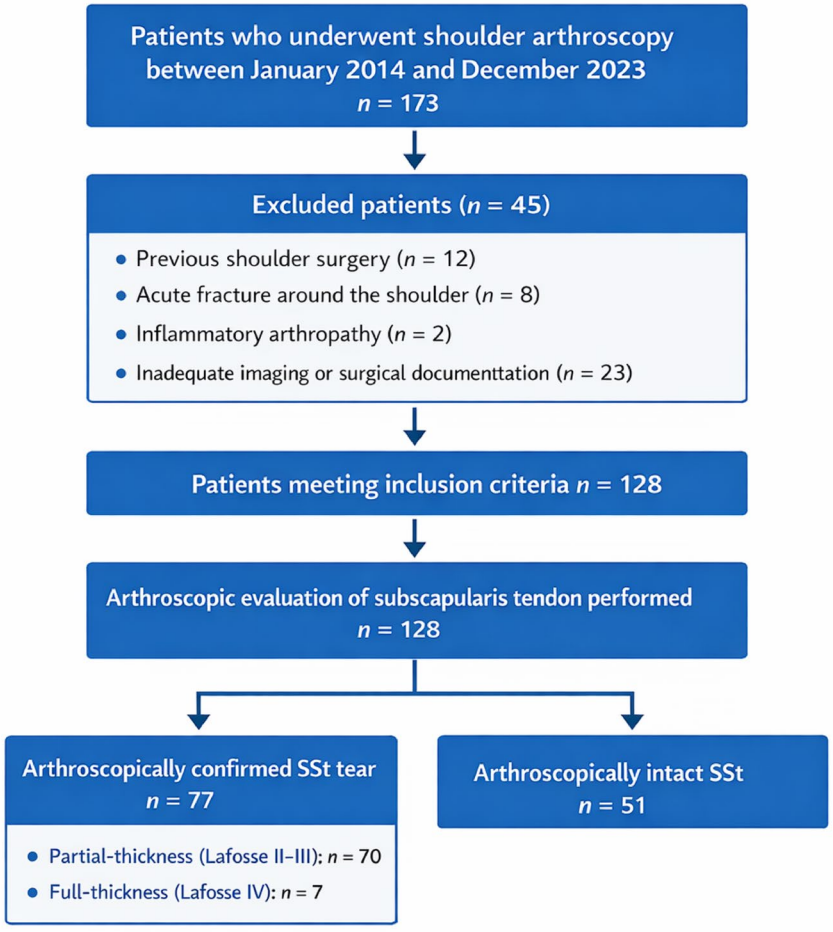


Fig. 1 Flowchart illustrating patient selection, exclusion criteria, and final study cohort

Table 1 Demographic characteristics of the study population (*n* = 128)

Variable	Value
Age, mean (range), years	65.4 (34–74)
Sex, n (%)	
Female	76 (59.4%)
Male	52 (40.6%)
Operated side, n (%)	
Right shoulder	89 (69.5%)
Left shoulder	39 (30.5%)

negative predictive value, prevalence, accuracy, and likelihood ratios were calculated with 95% confidence intervals (CIs). CIs were calculated using the exact binomial method.

Subgroup analyses were performed according to tear morphology (partial vs. full-thickness) and Lafosse classification.

Because of the retrospective design, no a priori sample size calculation was performed; however, CIs are reported to indicate estimate precision.

Results

The patient selection process and final study cohort are illustrated in Fig. 1.

Patient characteristics

A total of 128 patients were included in the study. The mean age was 65.4 years (range, 34–74 years). There were 76 female and 52 male patients. The affected shoulder was the right side in 89 patients and the left side in 39 patients (Table 1).

Intraoperative findings

Intraoperative arthroscopic evaluation identified SSt tears in 77 patients, all of whom underwent surgical repair (Fig. 2). In the remaining 51 patients, the SSt was found to be intact.

Among 77 arthroscopically confirmed subscapularis tears, 70 (90.9%) were partial-thickness tears (Lafosse II–III) and 7 (9.1%) were full-thickness tears (Lafosse IV) (Table 2). No isolated Lafosse type I lesions requiring only debridement were documented in the surgically

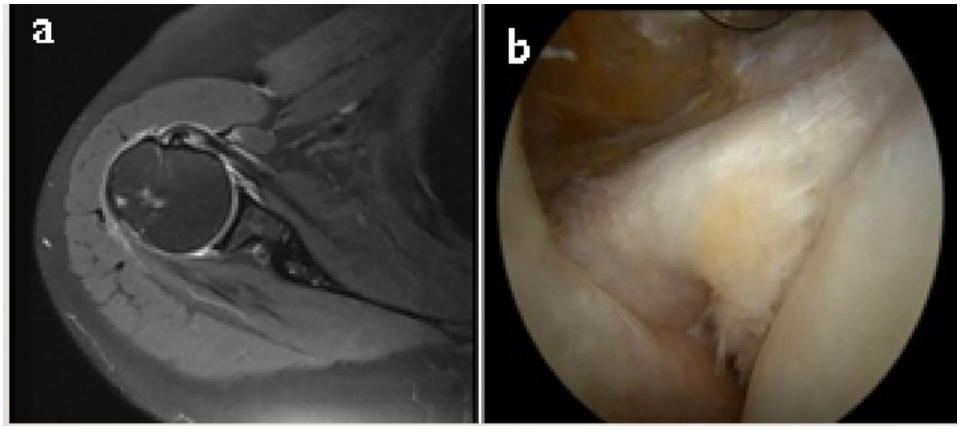


Fig. 2 **a** The subscapularis tendon appears intact in the axial MRI scan. **b** Arthroscopic view demonstrating a partial-thickness the subscapularis tear. Probing confirms fiber disruption consistent with Lafosse type II–III lesion

Table 2 Arthroscopic characteristics of subscapularis tears ($n = 77$)

Variable	*n* (%)
Partial-thickness tears (Lafosse II–III)	70 (90.9%)
Full-thickness tears (Lafosse IV)	7 (9.1%)
Lafosse II	36 (46.8%)
Lafosse III	34 (44.2%)
Lafosse IV	7 (9.1%)

Percentages calculated within arthroscopically confirmed subscapularis tears ($n = 77$). No isolated Lafosse type I lesions requiring only debridement were documented in the surgically treated cohort

Table 3 Concomitant rotator cuff pathology and biceps procedures ($n = 128$)

Variable	Total *n* (%)	Subscapularis tear present	Subscapularis tendon intact
Supraspinatus tear	124 (96.9%)	73	51
Infraspinatus tear	18 (14.1%)	18	0
Biceps procedure	89 (69.5%)	51	38
Tenotomy	69 (53.9%)	Not separately stratified	Not separately stratified
Tenodesis	20 (15.6%)	Not separately stratified	Not separately stratified

Subscapularis tendon tear status shown according to intraoperative findings

treated cohort. Concomitant cuff pathology and biceps procedures are summarized in Table 3.

Correlation between MRI and intraoperative findings

Comparison of MRI findings with intraoperative arthroscopic findings revealed that MRI correctly identified SSt tears in 35 patients and correctly identified an intact tendon in 38 patients. False-negative MRI findings were observed in 42 patients, in whom a SSt tear was detected intraoperatively despite being reported as intact on MRI (Fig. 2a and b). False-positive MRI findings were observed in 13 patients.

Based on these findings, the sensitivity of MRI for detecting SSt tears was 45.5% (95% CI 0.346–0.567), and the specificity was 74.5% (95% CI 0.610–0.848). The positive predictive value (PPV) was 72.9% (95% CI 0.587–0.837), and the negative predictive value (NPV) was 47.5% (95% CI 0.368–0.585). Overall accuracy was 57.0% (95% CI 0.483–0.654), prevalence was 60.2% (95% CI 0.514–0.684), positive likelihood ratio (LR +) was 1.78, and negative likelihood ratio (LR–) was 0.73 (Table 4).

Table 4 Diagnostic performance of magnetic resonance imaging compared with arthroscopy

Parameter	Value	95% confidence interval
Sensitivity	0.455	0.346–0.567
Specificity	0.745	0.610–0.848
Positive predictive value	0.729	0.587–0.837
Negative predictive value	0.475	0.368–0.585
Accuracy	0.570	0.483–0.654
Prevalence	0.602	0.514–0.684
Positive likelihood ratio	1.78	Not applicable
Negative likelihood ratio	0.73	Not applicable

Diagnostic performance calculated using intraoperative arthroscopy as the reference standard. Confidence intervals were calculated using the exact binomial method

Subgroup analysis

All 42 false-negative MRI cases occurred in partial-thickness tears. Among false negatives:

- Lafosse II: 22 (52.4%).
- Lafosse III: 20 (47.6%).
- Lafosse IV: 0.

Sensitivity was 40.0% for partial-thickness tears and 100% for full-thickness tears (7/7; 95% CI 59.0%–100%). Representative arthroscopic findings of false-negative cases are shown in Fig. 2.

Discussion

The most important finding of this study is that preoperative MRI demonstrated low sensitivity in detecting SSt tears when compared with intraoperative arthroscopic findings, despite showing moderate specificity [12–14]. Nearly half of the SSt tears identified intraoperatively were not detected on preoperative MRI, highlighting a substantial diagnostic gap between imaging findings and actual tendon pathology [4, 22].

Previous studies evaluating the diagnostic accuracy of MRI for SSt tears have reported highly variable results. While MRI has been shown to reliably detect supraspinatus and infraspinatus tendon tears, its sensitivity for SSt pathology has consistently been lower, particularly for partial-thickness and upper-border tears [12, 15–18]. Reported sensitivity values in the literature range widely, and our findings fall within the lower spectrum of these reports, reinforcing concerns regarding the reliability of MRI in identifying SSt involvement [13–16].

Several factors may explain the limited sensitivity of MRI observed in this study. The anatomical orientation of the SSt, its close relationship with surrounding structures, and the frequent presence of concomitant rotator cuff pathology may obscure subtle tears on standard MRI sequences [17, 18]. In addition, partial-thickness and non-retracted tears may not produce obvious signal changes, making them more difficult to detect [13, 16]. Variability in imaging protocols and the inherent limitations of static imaging in assessing dynamic tendon function may further contribute to underdiagnosis [19, 20].

From a clinical perspective, the findings of this study have important implications. In routine practice, MRI reports are often heavily relied upon by physicians working in primary care or non-specialized orthopaedic settings to guide management decisions and referrals [21]. A false-negative MRI result may delay referral to shoulder and elbow specialists, allowing progression of tendon retraction, muscle atrophy, and fatty degeneration, which can compromise surgical reparability and outcomes [6–9]. Therefore, clinical examination findings and a high index of suspicion should be emphasized when evaluating patients with shoulder pain, even in the presence of MRI reports suggesting an intact SSt [4, 16].

This study has several strengths. Intraoperative arthroscopic evaluation by an experienced shoulder surgeon was used as the reference standard, which is widely accepted as the most reliable method for assessing SSt integrity [22, 23]. In addition, MRI interpretations were based on routine radiology reports rather than image re-evaluation, reflecting real-world clinical practice and enhancing the external validity of the findings [12, 21].

Low sensitivity of MRI for subscapularis tears has been reported previously, including in systematic reviews and meta-analyses [11, 12]. The present study adds clinically actionable nuance by reporting results from a standardized 3-Tesla protocol within a single institution, presenting morphology-based subgroup findings and detailed Lafosse grading of false-negative cases, and providing CIs and likelihood ratios to support real-world interpretation. In particular, we found that all false negatives occurred in partial-thickness tears (Lafosse II–III), highlighting that the diagnostic gap is driven mainly by subtle tear patterns that are known to be difficult to visualize on routine MRI.

Field strength and local expertise may influence diagnostic performance. All imaging in this cohort was acquired on a 3-Tesla system using a standardized protocol, reducing technical heterogeneity. Despite this, sensitivity remained limited, suggesting that the observed under-detection of partial tears may reflect intrinsic challenges of lesion morphology and routine reporting rather than low-field imaging alone. However, as a single-center study using a single radiologist's reports, these results may partially reflect local reporting patterns and may not be directly generalizable to all settings.

Likelihood ratios support the clinical interpretation of MRI findings. The LR + of 1.78 indicates that a positive MRI modestly increases the probability of a tear but does not independently confirm diagnosis. An LR+ below 2 suggests only a small change in post-test probability. Whereas the LR– of 0.73 indicates that a negative MRI does not sufficiently reduce post-test probability to reliably exclude partial subscapularis pathology. The relatively low NPV further indicates that a negative MRI cannot reliably exclude subscapularis pathology. Therefore, MRI should be interpreted as an adjunct to clinical evaluation rather than a standalone rule-out test, particularly when examination suggests subscapularis involvement.

However, this study has limitations. Its retrospective design may introduce selection bias [7]. Because the cohort consisted of patients undergoing arthroscopy, the prevalence of tears was high and predictive values may not generalize to broader non-surgical populations (spectrum bias). Second, the index test and reference standard were not completely independent, which may introduce incorporation bias, as the operating surgeon was not formally blinded to MRI reports, although arthroscopic classification was based on direct visualization and probing of the tendon. Third, MRI evaluations were based on written routine reports from a single musculoskeletal radiologist; interobserver variability and standardized

multi-reader assessment were not performed [24]. Fourth, although we report morphology and Lafosse grade, detailed stratification by tear size or more granular subtypes beyond Lafosse grouping was not performed, which may influence diagnostic performance estimates. Finally, the number of full-thickness tears was relatively small (n = 7), limiting precision for that subgroup estimate. Despite these limitations, the present findings demonstrate that routine MRI reporting may miss a substantial proportion of surgically confirmed partial subscapularis tears, supporting the need for heightened clinical suspicion and careful evaluation even when MRI is negative.

Conclusion

Preoperative MRI demonstrated limited sensitivity for the detection of SSt tears when compared with intraoperative arthroscopic findings. These findings suggest that MRI alone may be insufficient as a standalone diagnostic tool in certain clinical contexts. Therefore, clinical evaluation should be integrated with imaging findings in the assessment of patients with shoulder pain. Early referral to shoulder and elbow specialists may help reduce diagnostic delay and improve treatment planning.

Abbreviations

SSt	Subscapularis tendon
MRI	Magnetic resonance imaging
PPV	Positive predictive value
NPV	Negative predictive value
CI	Confidence interval

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Not applicable.

Author contributions

GK contributed to the conception and design of the study, performed intraoperative arthroscopic assessments and revised the manuscript. SKD contributed to data acquisition, statistical analysis, prepared figures and drafted the manuscript. OT contributed to data acquisition and assisted with intraoperative evaluation. YBT contributed to data analysis and interpretation. ACA contributed to the conception of the study, supervised the research process, and revised the manuscript. All authors reviewed and approved the final version of the manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the Acıbadem Mehmet Ali Aydınlar University Medical Research Ethics Committee (Approval number: 2025-16/609). Written informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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