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ACCURACY OF PREOPERATIVE MRI IN DIAGNOSIS OF SUBSCAPULARIS TENDON TEAR

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ABSTRACT

Background : MRI is widely used to evaluate the rotator cuff pathologies of shoulder joint. The study was done to find the effectiveness of MRI in detecting subscapularis tendon tears in comparison with arthroscopy/surgery in a tertiary care hospital .

Methods : It was a prospective study done in MES academy of medical science in 83 patients who underwent MRI of the shoulder joint and subsequent surgery/ arthroscopy over a period of 12 months for suspected rotator cuff pathologies. The inclusion criteria included: (1) absence of prior surgery of the subscapularis tendon; (2) preoperative MRI at our institution; (3) surgery performed via arthroscopy or mini-open repair at our institution. Exclusion criteria: 1. Patients not having preoperative MRI taken at our institution. After applying the inclusion and exclusion criteria 61 patients were analyzed. Each patient's MRI was reviewed and the subscapularis tendon was evaluated in detail. The tendon was described as intact partial thickness tear (PTT) and full thickness tear (FTT). The integrity of other rotator cuff tendons (supraspinatus, infraspinatus and teres minor), ancillary findings such as subacromial-subdeltoid bursal effusion, subcoracoid bursal effusion, joint effusion, and acromioclavicular joint arthritis, and the patient's epidemiological data were also analyzed.

Results : MRI had 60.7% sensitivity, 100% specificity, 100% PPV, and 84.7% NPV for the identification of partial thickness tendon tears and 100% sensitivity, specificity, PPV, and NPV for Full thickness tendon tears. Shoulder MRI demonstrated an overall accuracy of 91.36% in diagnosing subscapularis tendon tears. The accuracy for detection of PTTs was 87.6%, and for FTTs was 100%

Conclusion : Preoperative 1.5T MRI has high sensitivity and high PPV for the diagnosis of FTTs of the supscapularis tendon , though it does not reliably predict PTTs of the subscapularis tendon. Shoulder arthroscopy should be considered in patients with negative MRIs and continuing symptoms.

Keywords: MRI-Magnetic Resonance Imaging, FTT-Full thickness tear, PTT- Partial thickness tear, 1.5 T-1.5 Tesla

INTRODUCTION

The supraspinatus, infraspinatus, teres minor, and subscapularis muscles and their tendons constitute the rotator cuff. MRI is a widely used imaging modality to detect rotator cuff tendon tears. Limited studies are available in the literature on the subscapularis muscle, despite it being the largest contributor to rotator cuff force [1]. The purpose of this study was to compare the accuracy of preoperative magnetic resonance imaging (MRI) scans in detecting subscapularis tendon tears with surgical findings, which are considered the gold standard.

MATERIALS AND METHODS

This was a prospective study undertaken at our institution to compare preoperative MRI findings of the subscapularis tendon with surgical findings. We conducted a prospective review of 83 study participants who underwent arthroscopy at MES Academy of Medical Sciences over a period of 12 months for suspected rotator cuff pathologies. The inclusion criteria for our study were as follows: (1) absence of prior surgery of the subscapularis tendon; (2) preoperative MRI at our institution; (3) surgery performed via arthroscopy or mini-open repair at our institution. Exclusion criteria included: 1. Patients not having preoperative MRI taken at our institution. 61 patients were analyzed after applying the inclusion and exclusion criteria.

The studies were executed on a superconducting 1.5-T Siemens Magnetom Avanto MR unit using dedicated shoulder array coils. Our protocol included : axial proton density fat-suppressed (3 mm, TR/TE, 2800/39), sagittal proton density fat-suppressed (3 mm, TR/TE, 2600/33), coronal oblique proton density fat-suppressed (3 mm, TR/TE, 2600/33), axial medic (3 mm, TR/TE, 776/19), coronal T2 weighted (3 mm, TR/TE, 3780/62), and coronal T1 weighted (3 mm, TR/TE, 531/13) sequences. The researcher reviewed each patient's MRI and evaluated the subscapularis tendon in detail. The tendon was described as

- intact
- partial thickness tear (PTT)
- full thickness tear (FTT)

Other variables analyzed include the integrity of other rotator cuff tendons, ancillary findings such as subacromial-subdeltoid bursal effusion, subcoracoid bursal effusion, joint effusion, and acromioclavicular joint arthritis, and the patient's epidemiological data.

Statistical Analysis

Significance was assessed at a 5% level of significance. Microsoft Excel was used to enter data, and analysis was done using SPSS version 25. Continuous data were summarized as means and standard deviations, and categorical data were summarized as absolute and proportional frequencies. After collecting the MRI and surgical findings, we calculated sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for MRI with arthroscopy or mini-open surgery as the gold standard, using a 95% confidence interval.

RESULTS

From November 2022 to October 2023, 72 patients were taken up for surgery for rotator cuff pathologies at our institution. 61 patients were included in the analysis following the application of inclusion and exclusion criteria, out of whom 40 had surgery-proven subscapularis tendon tears.

The age of the study population ranged from 44 to 72 years, with a mean of 54 years and a standard deviation of 6.5 years. There were 31 (77.5%) males and nine (22.5%) females. Subscapularis tendon tears were more frequently seen in males as compared to females. Surgery was performed in the right shoulder for 22 (55%) study participants and in the left shoulder for 18 (45%) study participants [Table 1]. 48.3% of participants had an MRI-detected subscapularis tendon tear, and 66.6% of participants had a surgery-proven subscapularis tendon tear. MRI detected 29 shoulders with subscapularis tendon tears, and surgery was positive for subscapularis tendon tears in 40 patients.

Of the 28 participants with surgery-proven PTTs, 11 cases were not detected on MRI [Figures 1 and 2]. Therefore, MRI had 60.7% sensitivity, 100% specificity, 100% PPV, and 84.7% NPV for the identification of PTTs. However, a complete agreement was seen between MRI and arthroscopy in the detection of FTTs. Of the 12 participants with surgery-proven FTT, MRI had 100% sensitivity, specificity, PPV, and NPV for FTTs [Figure 3, 4]. No false-positive findings were noted in this study for PTTs and FTTs. Shoulder MRI demonstrated an overall accuracy of 91.36% in diagnosing subscapularis tendon tears. The accuracy for detection of PTTs was 87.6%, and for FTTs, it was 100% [Table 2].

An associated supraspinatus tendon tear was seen in all cases of MRI-positive subscapularis tendon tears. Twenty-two patients had an associated infraspinatus tendon tear as well. None of the study population had teres minor or long head of biceps tendon tears. However, 76.6% of MRI positive subscapularis tendon tears had an associated instability of the long head of the biceps tendon. 41.6% was associated with subacromial subdeltoid bursal effusion, and 30.5% was associated with subcoracoid bursal effusion. Acromioclavicular joint osteoarthritis was seen in 53% of MRI detected subscapularis tendon tears [Table 3].

Table 1: Patient data

	Patients with MRI detected subscapularis tendon tears
No. of patients	29
Age (range)(years)	44-72
Shoulder side	
Right	16
Left	13
Sex	
Male	22
Female	7

Table 2: Comparison of diagnostic prediction of MRI versus arthroscopy for PTTSs and FTTs

	PTT	**FTT**
No. of patients - MRI positive and arthroscopy positive	17	12
No. of patients - MRI negative and arthroscopy positive	11	0
MRI Sensitivity	60.7%	100%
MRI Specificity	100%	100%
MRI PPV	100%	100%
MRI NPV	84.7%	100%
MRI accuracy	87.6%	100%

Table 3: Ancillary findings associated with subscapularis tendon tears on MRI

Supraspinatus tendon tear	100 %
Infraspinatus tendon tear	75.8%
Long head of biceps tendon instability	76.6%
Subacromial subdeltoid bursal effusion	41.6%
Subcoracoid bursal effusion	30.5%
Acromioclavicular joint osteoarthritis	53%

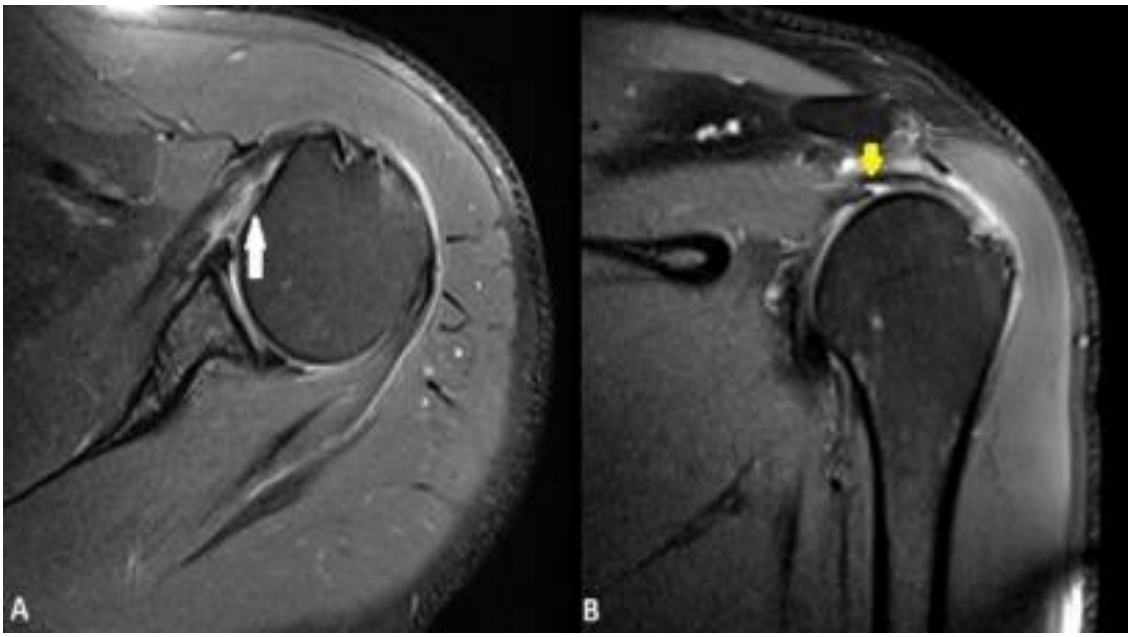

Figure 1: (A) Axial fat suppressed proton density (PDFS) MR image shows an articular surface PTT of the subscapularis tendon (white arrow) (B) Coronal PDFS MR image shows an articular surface PTT of the supraspinatus tendon (yellow arrow) in the same patient.

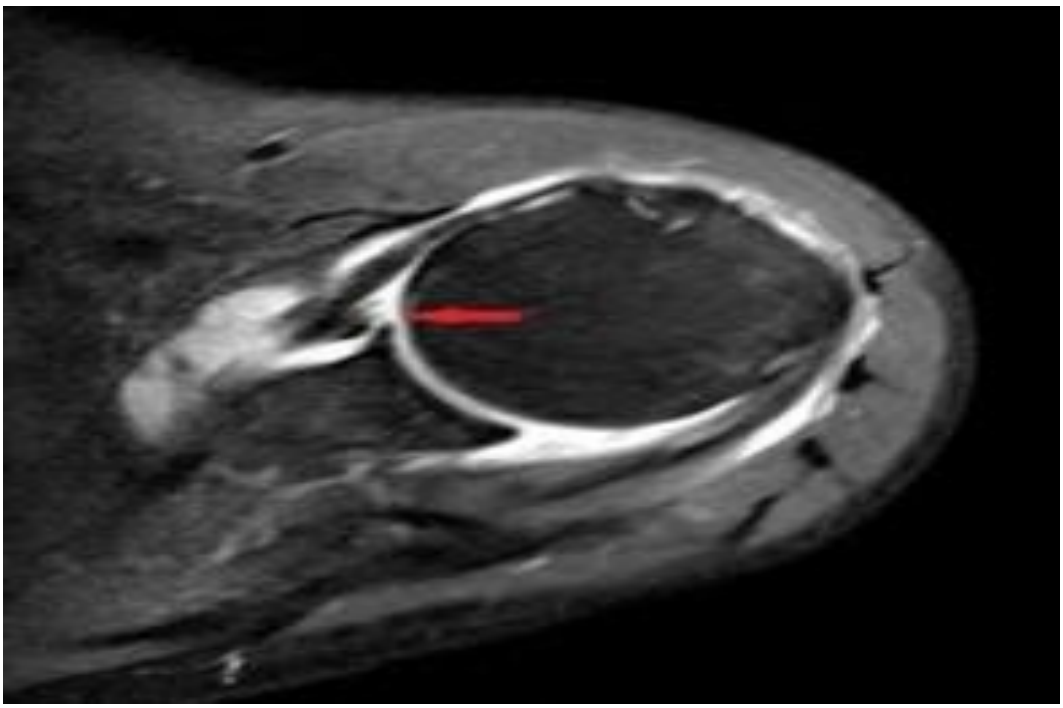

Figure 2: MRI of a 50-year-old male patient with chronic left shoulder pain. Axial PDFS image shows PTT along the articular surface of the subscapularis tendon (red arrow), which was confirmed on arthroscopy

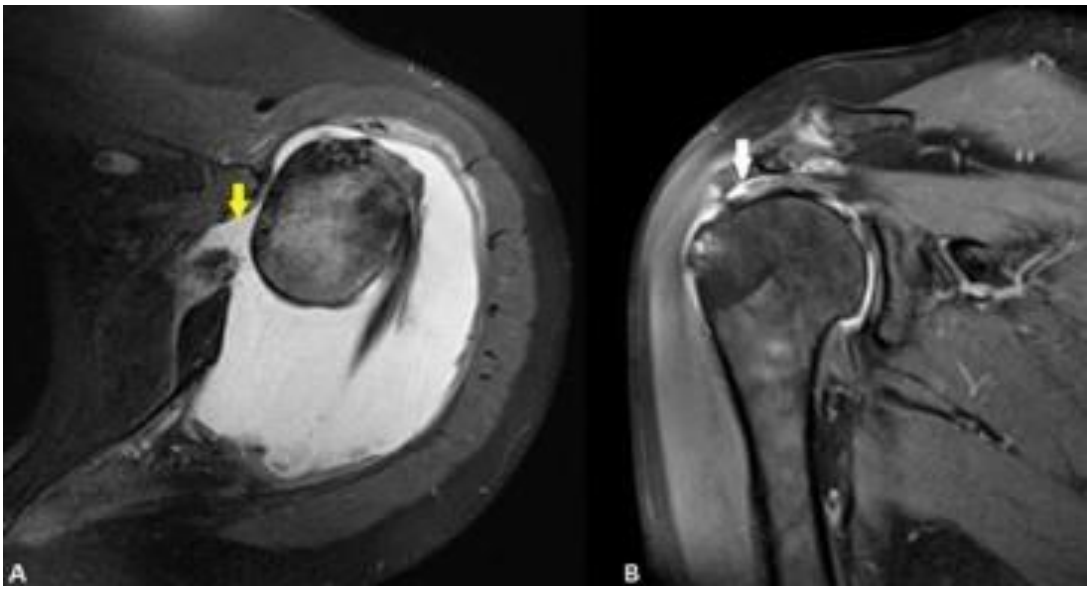

Figure 3: MRI of a 46-year-old female patient with left shoulder pain. (A) Axial PDFS image shows FTT of the subscapularis tendon(yellow arrow) (B) Coronal PDFS image show FTT of the supraspinatus tendon (white arrow) in the same patient.

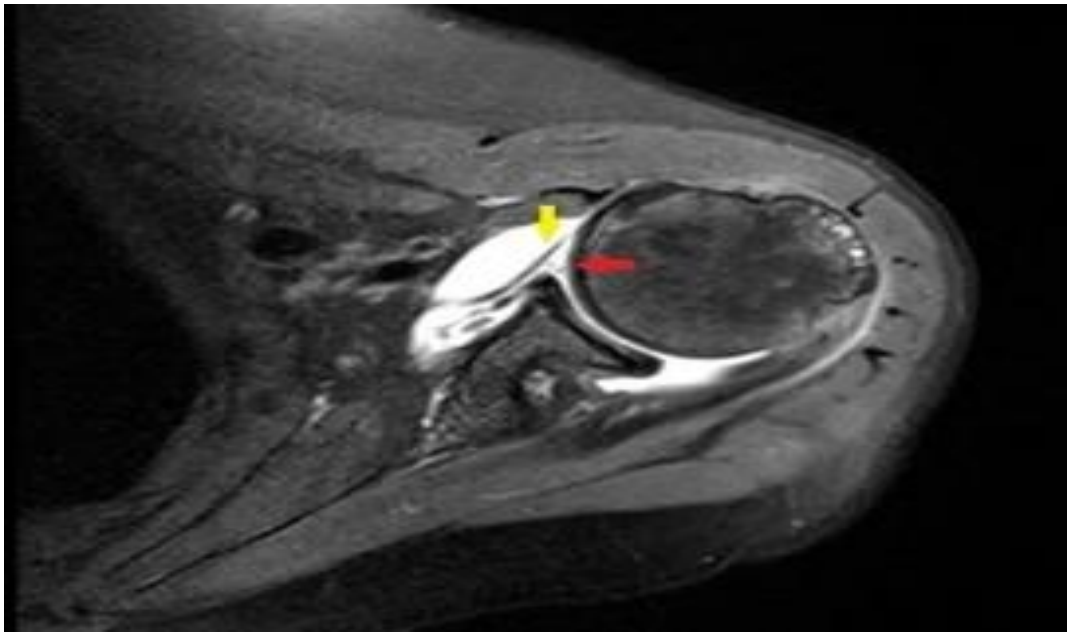

Figure 4: MRI of a 60-year-old female patient with severe left shoulder pain. Axial PDFS image shows FTT of the subscapularis tendon, with the tendon appearing diffusely and severely thinned (red arrow). Moderate shoulder joint effusion is also noted (yellow arrow).

DISCUSSION

The accuracy of MRI in diagnosing rotator cuff tears has been extensively studied in the past. But studies investigating the accuracy of MRI in specifically detecting subscapularis tendon tears are sparse in the literature. This study aimed to rectify this situation. Being the most powerful and largest muscle of the rotator cuff, the subscapularis plays a critical role in joint kinematics. A missed diagnosis of a subscapularis tendon tear can potentially result in unsuccessful rotator cuff repairs.

Tung et al. conducted a retrospective study similar to our study to evaluate the sensitivity of MRI for detecting subscapularis tendon tears with confirmation provided by arthroscopy or open surgery. Five out of the 16 patients with surgery-proven subscapularis tendon tears were identified on preoperative

MRI, resulting in poor sensitivity (31%) of MRI for detecting subscapularis tendon tears. They also stated that subscapularis tendon tears were commonly associated with subcoracoid fluid [2].Adams et al. conducted a retrospective study in which 44 patients (49 %), out of the 90 patients with both preoperative MR examinations and arthroscopy, had surgery-proven subscapularis tendon tears. Sixteen tears (36 %) were identified by preoperative MRI, resulting in sensitivity, specificity, PPV, NPV, and accuracy of 36%, 100%, 100%, 62 %, of 69 % respectively. They also suggested that MR arthrograms could potentially increase the sensitivity of subscapularis tendon tear detection [3].

A retrospective study was conducted by Pfirrmann et al. in which MR arthrography was used to identify and grade tears of the subscapularis tendon by two musculoskeletal radiologists. They compared the imaging findings with those from surgery (arthroscopy or open). The study achieved a sensitivity of 91%/91% (reader 1/reader 2). The specificity was 86%/79% (reader 1/reader 2). They also stressed the importance of assessing the tendon on axial and sagittal images [4]. Nevertheless, Foad et al. stated that MR arthrograms did not show an advantage over MRI (MR arthrography sensitivity of 36% vs. MRI sensitivity of 40%) in accurately diagnosing a subscapularis tendon tear [5].

Several classification systems have been developed for lesions of the subscapularis muscle and tendon [6,7,8]. However, no universal classification system has yet been introduced. Hence, this study simply classified the tears into PTTs and FTTs. In our study, the sensitivity, specificity, PPV, NPV, and accuracy in diagnosing subscapularis tendon tears were 72.5%, 100%, 100%, 88.82%, and 91.36%, respectively. Studies on the accuracy of MRI in detecting entire rotator cuff tendon tears are plentiful, while those reporting the sensitivity of MRI in detecting subscapularis tendon tears are few. The reported sensitivity is higher for rotator cuff tendon tears when compared to subscapularis tendon tears. No false-positive cases were present in our study. However, the ample number of false negative cases is a major drawback. Out of the 28 patients with a normal subscapularis tendon on MRI, 11 had PTTs identified during surgery. This emphasizes the need for more attention and thorough evaluation of the subscapularis and its tendon while reporting an MRI of the shoulder.

Several studies have emphasized the need for a 30° and a 70° arthroscope to adequately assess the subscapularis [3,9]. Burkhart and Brady described an algorithm that improved the identification of subscapularis tendon tears during surgery. The use of a 70° arthroscope in addition to the 30° arthroscope, the flexed and internally rotated position of the humerus, and a posterior lever push has been recommended to adequately assess the tendon [9]. The inspection of the subscapularis was undertaken with 30° and 70° arthroscopes in this study to prevent missing any tears on arthroscopy.
A 3D anatomic topography concerning the footprint of the tendon was described by Yoo et al., which may be the cause of the low sensitivity of MRI in diagnosing tears of the subscapularis tendon [10]. The fundamental limitations of our study include the small number of subscapularis tendon tears assessed and the use of the lateral decubitus position during surgery, instead of the beach chair position. Both radiologists and orthopedists will benefit from the findings of this study. There is a need to study newer imaging protocols that improve the detection of the subscapularis tendon tear. Additionally, the presented data may be utilized for future meta-analyses to strengthen existing literature.

CONCLUSION

According to this study, preoperative 1.5T MRI has high sensitivity and high PPV for the diagnosis of FTTs of the supscapularis tendon. However, it does not reliably predict PTTs of the subscapularis tendon. Hence, shoulder arthroscopy should be considered in patients with negative MRIs and continuing symptoms.

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