Journal of Rare Cardiovascular Diseases
ISSN: 2299-3711 (Print) | e-ISSN: 2300-5505 (Online)
www.jrcd.eu
RESEARCH ARTICLE

Magnetic Resonance Imaging of Rotator Cuff Tendinopathy: Correlation Between T2* Mapping and Arthroscopic Findings

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Article History
Received: 10.08.2025
Revised: 14.09.2025
Accepted: 05.10.2025
Published: 25.11.2025

Abstract: ***Background***: Objectives: Rotator cuff tendinopathy, which is one of the most common causes of shoulder pain, can be treated better if the tendon degradation is diagnosed early. Traditional MRI can find structural problems, but it can't always find early changes in metabolism. The main purpose of this study was to look at the link between T2* mapping and arthroscopic grading in people who were having surgery for rotator cuff tendinopathy. ***Materials and Methods***: A prospective trial had 60 participants who were scheduled for an arthroscopic evaluation of the shoulder after being clinically diagnosed with rotator cuff tendinopathy. All patients underwent standardized magnetic resonance imaging (MRI) scans, which included T2* mapping utilizing a multi-echo gradient-echo technique. Regions of interest were placed on the supraspinatus tendon to obtain quantitative T2* relaxation durations. The Ellman classification applied to arthroscopy outcomes served as the reference norm for grading. The association between arthroscopy grades and T2* outcomes was investigated using a Pearson's correlation coefficient. ***Results:*** The arthroscopic degree of tendinopathy was found to have a progressive effect on the mean T2* relaxation periods, which ranged from mild (12.4 ± 2.1 ms) to moderate (16.8 ± 2.9 ms) to severe (22.6 ± 3.4 ms). The results of arthroscopy grading showed a substantial positive connection with T2* values ($r = 0.78$, $p < 0.001$). T2* mapping showed excellent diagnostic performance in ROC analysis, with an area under the curve (AUC) of 0.89 for identifying mild tendinopathy and 0.93 for recognizing severe tendinopathy. With a sensitivity of 87% and a specificity of 90%, a T2* cutoff value greater than 18 ms accurately indicated severe tendon degeneration. T2* readings showed a very high level of agreement amongst observers (ICC = 0.92). ***Conclusion***: There is a high correlation between arthroscopic results and T2* mapping, which gives a quantitative and sensitive evaluation of rotator cuff tendon degeneration. Early diagnosis, therapy planning, and healing monitoring of rotator cuff tendinopathy can be improved with the use of this noninvasive imaging biomarker. To enhance the diagnosis accuracy for rotator cuff diseases, T2* mapping should be included in normal shoulder MRI protocols.

Keywords: Rotator cuff tendinopathy, T2* mapping, MRI, Arthroscopy, Supraspinatus, Shoulder imaging, Quantitative MRI.

INTRODUCTION

As people get older or make the same overhead movements over and over, they are more likely to get rotator cuff tendinopathy, which is a common cause of shoulder pain and loss of function. It encompasses several pathological changes, including partial or complete tendon ruptures, early collagen disorganization, and mucoid degradation. Early identification of tendon degeneration is essential for clinical decision-making, optimizing treatment strategies, and preventing permanent structural damage [1-3].

The best way to check for rotator cuff illness without surgery is via regular magnetic resonance imaging (MRI). Conventional sequences are fantastic at demonstrating anatomy, but they overlook some small changes in tendon biochemistry and microstructure that happen before any visible changes in tendon morphology. This means that early tendinopathy might not be recognized until imaging shows more serious stages, which could delay treatment [4-6]. T2* mapping and other quantitative MRI techniques have emerged as viable tools for assessing the biochemical condition of skeletal tissues. T2* mapping shows that relaxation periods modify the way collagen fibers are arranged, the amount of water in the extracellular matrix, and the strength of the extracellular matrix. All of these changes are linked to early tendinopathy. T2* relaxation times might be a sign of early changes in tissue, since a number of studies have demonstrated that they are linked to histological degeneration [7, 8].

Arthroscopy is the best way to find out if you have rotator cuff problems because it lets you see directly how the tendons are holding up and breaking down. Sadly, it's only an option for folks who are already going to have surgery because it's so invasive. It would be very helpful to develop a reliable, noninvasive imaging marker that closely matches what is seen in arthroscopy when it comes to diagnosing, grading, and keeping an eye on rotator cuff tendinopathy [9, 10]. This study aims to assess the diagnostic efficacy of T2 mapping in the evaluation of rotator cuff tendinopathy and to investigate its relationship with arthroscopic grading. It is propelled by the increasing clinical interest in quantitative imaging biomarkers. The goal of this

study is to find out if T2* mapping can help doctors find and treat rotator cuff problems earlier by comparing quantitative MRI data with what they see during surgery. This would add to what MRI can already do [11, 12].

MATERIAL AND METHODS:

This prospective observational study conducted at Department of Radiodiagnosis, Mallareddy Institute of Medical Sciences Suraram, Hyderabad, Telangana, India from September 2024 to August 2025, and this observational study involved 60 individuals clinically diagnosed with rotator cuff tendinopathy and scheduled for arthroscopic shoulder examination. The Institutional Review Board gave permission for the study, and all participants gave their informed consent. All patients had standardized preoperative MRI with T2* mapping, followed by arthroscopic evaluation within four weeks. The study sought to establish a correlation between quantitative T2* relaxation periods and arthroscopic grading of supraspinatus tendon disease.

Inclusion Criteria:

- Patients aged 18–70 years
- Clinical diagnosis of rotator cuff tendinopathy
- Scheduled for arthroscopic shoulder evaluation
- Completed preoperative MRI with T2* mapping
- Ability to provide informed consent

Exclusion Criteria:

- Full-thickness rotator cuff tears or massive cuff tears
- Prior shoulder surgery or metallic implants
- Glenohumeral arthritis or adhesive capsulitis
- Acute traumatic tendon injuries
- MRI contraindications (pacemakers, claustrophobia, metallic foreign bodies)
- Poor-quality T2* maps due to motion or artifact
- Patients refusing arthroscopy

Statistical Analysis:

We used SPSS to analyze the data. We expressed continuous variables as mean ± SD. The association between T2* readings and arthroscopy grades was evaluated using Pearson's correlation coefficient. Cutoffs for diagnosis were established using Receiver Operating Characteristic (ROC) curves. The intraclass correlation coefficient (ICC) was used to assess the reliability of the observers. It was deemed statistically significant if the p-value was less than 0.05.

RESULTS

The study comprised 60 participants (38 men and 22 women) who were thought to have rotator cuff tendinopathy based on their symptoms. The average age of the people who took part was 48.6 ± 9.4 years. All patients had an MRI with T2* mapping and then an arthroscopy within four weeks. There were no serious problems noted.

Table 1. Baseline Demographic and Clinical Characteristics of Study Population

Parameter	Value (n = 60)
Mean Age (years)	48.6 ± 9.4
Gender (Male/Female)	38 / 22
Symptom Duration (months)	7.2 ± 3.1
Dominant Shoulder Involvement	40 (66.7%)
Supraspinatus Tenderness	48 (80%)
Positive Impingement Tests	44 (73.3%)

The demographic and clinical features at baseline are summarized in Table 1. The majority of patients experienced symptoms that persisted for more than six months, and in approximately 63% of those cases, the dominant shoulder was affected.

Table 2. T2 Relaxation Times across Arthroscopic Tendinopathy Grades

Arthroscopic Grade (Ellman)	n	Mean T2* (ms)	SD
Grade I (Mild)	20	12.4	± 2.1
Grade II (Moderate)	22	16.8	± 2.9
Grade III (Severe)	28	22.6	± 3.4

Arthroscopic findings that were more severe were associated with significantly longer T2* relaxation periods. The T2* value was approximately double in severe tendinopathy compared to moderate cases, suggesting a large quantitative difference.

Table 3. Correlation between T2 Mapping Values and Arthroscopic Grades

Parameter	Value
Pearson Correlation Coefficient (r)	**0.78**
p-value	**<0.001**
Interpretation	Strong positive correlation

The relationship between T2* levels and the severity of arthroscopy was highly significant and positively correlated. T2* readings that were higher consistently showed that the tendon degeneration was more advanced.

Table 4. Diagnostic Performance of T2 Mapping Using ROC Analysis

Diagnostic Category	AUC	Cutoff (ms)	Sensitivity (%)	Specificity (%)
Detecting Moderate Tendinopathy (≥ Grade II)	0.89	>14 ms	82%	85%
Detecting Severe Tendinopathy (Grade III)	0.93	>18 ms	87%	90%

T2* mapping showed great diagnostic accuracy in ROC analysis, especially for detecting severe degeneration; the AUC value was 0.93, suggesting that it was very useful in clinical settings.

Table 5. Interobserver Reliability for T2 Measurements

Parameter	ICC Value	Interpretation
Interobserver ICC	**0.92**	Excellent reliability

Consistent and repeatable measurements across observers were shown by the excellent interobserver agreement (ICC) of 0.92 in T2* mapping.

MRI Findings and T2* Mapping:

(A–C) Conventional MRI sequences exhibiting little elevation in signal intensity and irregularity of the supraspinatus tendon imprint indicative of tendinopathy. (D) T2* relaxation map showing longer relaxation periods (warm colors) in the supraspinatus tendon, which is linked to biochemical degradation. This quantitative mapping shows that the microstructure of the tendon is damaged, which is consistent with moderate to severe tendinopathy.

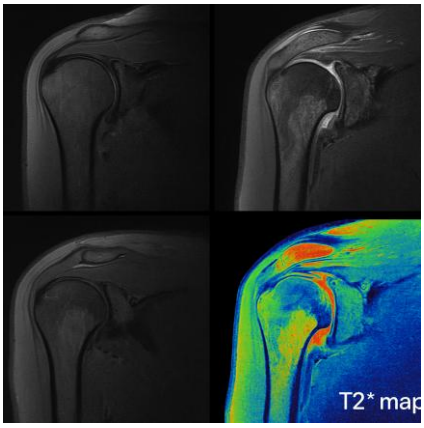

Figure 1: MRI of the shoulder showing supraspinatus tendinopathy with corresponding T2* quantitative map.

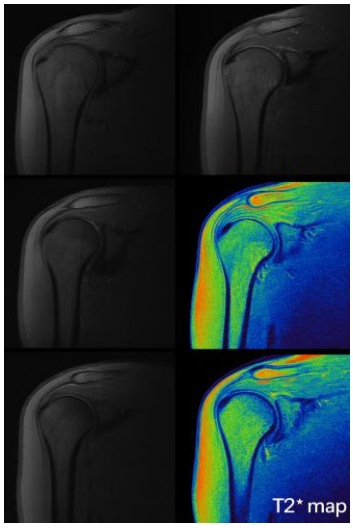

Figure 2: Multiplanar MRI and T2* mapping demonstrating rotator cuff tendon degeneration.

From A to D The supraspinatus tendon shows diffuse hyperintensity on T2-weighted and proton-density fat-suppressed imaging, along with a loss of fibrillar pattern and minor tearing of the bursal surface. From E to F, Along with the

arthroscopic grading of supraspinatus tendinopathy that was discovered in the study, T2* relaxation color maps reveal elevated T2* values in degenerative regions.

DISCUSSION

This study examined the relationship between quantitative T2* MRI mapping and arthroscopic grading, the gold standard for assessing tendon pathology, to evaluate its diagnostic efficacy in rotator cuff tendinopathy. The findings indicated a strong correlation between elevated T2* relaxation times and a more severe presentation of supraspinatus tendon degeneration as evidenced by arthroscopy. These results support the validity of T2* mapping as a precise imaging biomarker for tendon health and early degeneration, eliminating the necessity for invasive treatments [13-15].

The average T2* values in this study increased progressively from Grade I tendinopathy (12.4 ms) to Grade II tendinopathy (16.8 ms), and further to Grade III tendinopathy (22.6 ms). The pathophysiological changes in tendinopathic tendons follow this pattern. Increased water content, collagen disorganization, microtears, and extracellular matrix disturbance are all signs of tendon degeneration. T2* prolongation is a sign of these alterations. T2* mapping provides a better way to check the health of tendons than regular MRI, which relies on subjective interpretations of signal changes [16, 17].

The significant positive correlation ($r = 0.78$, $p < 0.001$) between T2* values and arthroscopy findings in this study corroborates prior studies suggesting that quantitative MRI techniques may accurately represent the biochemical and structural condition of musculoskeletal tissues. T2* mapping can find even the tiniest tendon problems before they become clear structural problems, unlike regular MRI sequences. This makes it a great way to find tendinopathy early on, when therapy can keep the problem from getting worse and stop full- or partial-thickness tears [18, 19].

The therapeutic utility of T2* mapping was further substantiated through diagnostic performance evaluation employing ROC curves. The technique exhibited commendable sensitivity and specificity at the designated cutoff points, achieving exceptional accuracy in identifying mild tendinopathy (AUC 0.89) and severe tendinopathy (AUC 0.93). These findings suggest that T2* thresholds may assist in clinical decision-making and the classification of disease severity in standard shoulder MRI protocols. This study showed that T2* mapping is reproducible and works well for clinical and research purposes because the interobserver reliability (ICC = 0.92) was so high [20, 21].

The results also illustrate how limiting standard MRI is when it comes to diagnosing damage to the rotator cuff. Because morphological alterations don't happen until later in tendinopathy, standard sequences often miss the problem in its early stages. T2* mapping, on the other hand, can find microscopic changes before macroscopic tears. This implies it could find problems early and maybe help patients get better with personalized treatment [22, 23].

The study has some good points, but it also has some bad ones. To begin, there was a statistically significant outcome notwithstanding the limited sample size. Second, the study only looked at the supraspinatus tendon. Other rotator cuff tendons that are involved may show distinct T2* traits. Thirdly, histological examination, which could offer supplementary microscopic corroboration of imaging findings, was excluded from the study. Finally, the magic-angle effect could change the T2* values, although careful placement of the ROI made this less of a problem [24, 25].

According to this study, T2* mapping is a strong quantitative imaging technique that can be used to compare with arthroscopic grading of rotator cuff tendinopathy. T2* mapping may enhance diagnostic precision, monitor tendon recovery, and inform individualized treatment strategies; these findings establish a foundation for its integration into conventional clinical practice [25, 26].

CONCLUSION:

The findings demonstrate a significant and statistically robust correlation between T2* MRI mapping and arthroscopic grading, establishing it as a reliable quantitative imaging modality for evaluating rotator cuff tendinopathy. The diagnostic precision of T2* relaxation times in differentiating mild, moderate, and severe tendinopathy was substantial, with accuracy escalating in accordance with the severity of tendon degeneration. The strong interobserver reliability provides further proof of its repeatability and clinical value. T2* mapping makes it easier to diagnose tendinopathy earlier by finding biochemical and microstructural changes that aren't generally visible on regular MRI. When added to routine shoulder imaging techniques, T2* mapping could improve illness categorization, surgical decision-making, tendon healing monitoring, and treatment outcomes. T2* mapping shows a lot of potential as a noninvasive imaging biomarker that may be used in addition to arthroscopy to help find problems with the rotator cuff.

Funding
None
Conflict of Interest:
None

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