A Prospective, Quantitative MRI-Based Assessment on the Progression of Fatty Infiltration after Rotator Cuff Repair

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Summary:
IDEAL MRI offers a quantitative, reproducible method for measuring intramuscular fat and can be a valuable tool in investigating muscle quality in the setting of rotator cuff injury and repair.

Abstract:
Background: Fatty infiltration in rotator cuff muscles is a negative prognostic factor for post-surgical outcomes. Clinically, the qualitative Goutallier classification has significant intra and inter-user variability, limiting the ability to detect small changes over time. A quantitative MRI-based method using IDEAL fat measurements helps mitigate this by accurately determining the intramuscular fat fraction. The purpose of this study is to evaluate the progression of fatty infiltration before and after surgical treatment using IDEAL MRI and to correlate with tear size and integrity of repair.

Methods: 35 patients (61.5 ± 10.5 years, 17 female) were included in the study. Patients underwent a baseline MRI prior to surgical treatment and 6 months after rotator cuff repair. MR imaging sequences included sagittal proton density fast-spin echo (FSE), sagittal T2-weighted FSE, coronal-oblique T1-weighted FSE, coronal-oblique T2-weighted FSE, and sagittal six-point IDEAL based on SPGR with T2* correction and 6 peak model. Image processing was performed with in-house, Matlab-based software. The supraspinatus (SS), infraspinatus (IS), subscapularis, and teres minor muscles were segmented. Using the IDEAL fat fraction map, the intramuscular fat fraction was calculated for each muscle. Paired Student t-tests were used to compare the intramuscular fat fractions before and after rotator cuff repair. Patients were also divided into two groups: isolated supraspinatus tears and tears involving multiple tendons, with the distinction based on the intra-operative assessment. Finally, intramuscular fat fractions were compared between groups based on repair integrity at 6 month follow-up. Statistical significance was defined as p < 0.05.

Results: There were 19 patients (54.3%) with an isolated supraspinatus tear, 15 patients (42.9%) with a multi-tendon tear, and 1 patient (2.9%) with an isolated subscapularis tear. Intact repairs were present for 26 patients (74.3%) at 6 months, while a failed repair was present in 9 patients (25.7%). For the group as a whole, the follow-up fat fractions were significantly higher than baseline fat fractions for the SS (9.8 ± 7.0% vs. 8.3 ± 5.7%) and IS (7.4 ± 6.1% vs. 5.7 ± 4.4%) muscles. There was no significant difference for the fat fractions for the subscapularis or teres minor muscles. Patients with isolated supraspinatus tears showed a significant progression in the supraspinatus fat fraction from baseline to follow-up (6.8 ± 4.9% to 8.6 ± 6.8%). The infraspinatus fat fraction also increased though did not reach the level of statistical significance (5.3 ± 4.6% to 6.6 ± 6.6%, p = 0.074). Patients with multi-tendon tears showed no significant change for any of the four muscles. The baseline supraspinatus fat fractions were significantly higher in patients with eventual failed repairs as compared to those with intact repairs (11.7 ± 6.8% vs. 7.1 ± 4.8%).

Discussion: Intramuscular fat content increases significantly following rotator cuff repair. In isolated supraspinatus tears, fatty infiltration advanced over the 6 months. Eventual repair failure was related to the baseline intramuscular fat fraction as measured by IDEAL MRI. Previous work has shown that a mean fat fraction of 11%, corresponds to Grade 1 to Grade 2 on the Goutallier classification. This finding suggests that even lower levels of fatty infiltration...
than previously reported may impact post-surgical outcomes.