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ORIGINAL ARTICLE

Fatty infiltration of stage 1 or higher significantly compromises long-term healing of supraspinatus repairs

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Background: Fatty infiltration (FI) compromises outcomes of rotator cuff repairs. Most clinicians consider FI of the infraspinatus, whether it is torn or intact, because it is most rapidly affected. The purpose of this study was to report long-term outcomes of isolated supraspinatus repairs and to determine their associations with FI of the infraspinatus and supraspinatus.

Methods: The records of 182 patients who underwent repair of isolated supraspinatus tears and had preoperative magnetic resonance imaging were retrieved. Of these, 147 patients were evaluated at 10 years' follow-up using the Constant score and magnetic resonance imaging scans.

Results: Preoperative FI was greater in the supraspinatus (52% stage ≥ 1) than in the infraspinatus (29% stage ≥ 1). The 10-year Constant scores were influenced by FI of the supraspinatus ($P = .006$) but not of the infraspinatus ($P = .422$). Multivariable regression confirmed that Constant scores were significantly lower for female patients, repetitive work, and stage 1 and stage 2 FI of the supraspinatus in addition to open surgery. Retear rates (Sugaya types IV-V) were also influenced by FI of the supraspinatus ($P = .001$) but not of the infraspinatus ($P = .979$). Shoulders with supraspinatus FI at stages 0, 1, and 2 had re-tear rates of 10%, 22%, and 31%, respectively. Multivariable regression affirmed that the odds of re-tears were significantly increased by both stage 1 and stage 2 FI of the supraspinatus.

The Institutional Review Board of Hôpital Privé Jean Mermoz and the Centre Orthopédique Santy approved this study in advance (IRB# 2013-A01788-37). All patients provided informed consent for their participation in this study.

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Conclusions: The Constant scores and retear rates were significantly associated with FI of the torn supraspinatus (stage ≥ 1) but not of the intact infraspinatus. The authors recommend that rapid surgical intervention be considered, before accumulation of fat, especially for young, active patients.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

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Fatty infiltration (FI) is among the most critical factors for success of rotator cuff repairs.^{2,5,6,12,13,16,19,26} Whereas fat can gradually accumulate in intact rotator cuff muscles with age,²⁹ it infiltrates far more rapidly in muscles with torn tendons.^{4,16}

The extent of FI is frequently estimated using magnetic resonance imaging (MRI) following the semiquantitative 5-stage classification of Goutallier et al,¹⁴ later modified by Fuchs et al.⁹ Numerous studies reported outcomes using this classification and noted increasing stages of FI according to tear size, tendon retraction, tear chronicity, and age of the patient.^{1,17,24,25,29} Although Goutallier et al¹⁴ originally distinguished between stage 0 (absence of any fat) and stage 1 (presence of a few fat streaks), many authors regrouped stages 0 and 1 to describe “minor” FI,^{2-4,6,8} assuming that stage 1 has little or no impact on tendon healing and functional outcomes of rotator cuff repair.²² By contrast, Barry et al¹ observed greater muscle atrophy in patients with FI at stage 1 than in those at stage 0, and Shi et al³¹ observed deterioration of tendon quality at stage 1 compared with stage 0.

Although fat can infiltrate through multiple rotator cuff muscles, most clinicians focus particularly or solely on the infraspinatus, whether it is torn or intact, because it tends to be the most rapidly affected muscle.^{1,6} Whereas it has been demonstrated that an isolated tear of the supraspinatus could cause FI in the neighboring infraspinatus,^{1,19} it remains unclear which of the 2 muscles would accumulate fat most rapidly and subsequently compromise repair integrity in the long term.

This study therefore aimed to report clinical and radiographic outcomes 10 years after surgical repair of isolated supraspinatus tears and to determine the influence of preoperative FI on tendon healing and repair integrity. The authors specifically investigated whether long-term outcomes were most significantly associated with FI of the infraspinatus vs. the supraspinatus and whether FI of stage 1 had any influence on outcomes compared with stage 0.

Material and methods

Study design

The authors retrospectively studied the records of all patients who underwent surgical repair of isolated supraspinatus tears in 2003 by 15 surgeons at 15 centers (14 centers in France and 1 center in Switzerland). The inclusion criteria were adult patients with full-thickness isolated supraspinatus tears who received complete tendon repair by either open or arthroscopic surgery and had MRI both preoperatively and 10 years postoperatively. The exclusion criteria were

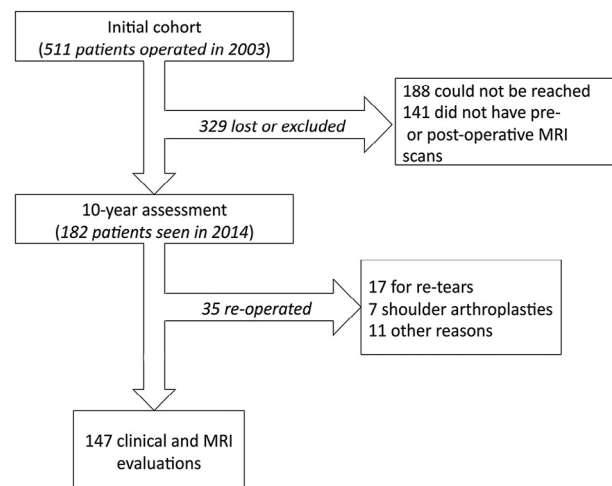


Figure 1 Flow chart detailing inclusion and exclusion of patients from the original cohort. *MRI*, magnetic resonance imaging.

partial-thickness tears, history of previous shoulder surgery, partial tendon repairs, and concomitant lesions of other rotator cuff tendons. A total of 511 patients were recalled in 2014 for evaluation at a minimum follow-up of 10 years.

Of the original cohort of 511 patients, 188 did not respond and 35 were excluded because they were reoperated on: 17 for retears, 7 for conversion to shoulder arthroplasty, and 11 for other reasons. Of the remaining 288 patients, 78 did not have preoperative MRI scans and 63 did not provide 10-year MRI scans (Fig. 1). This left a study cohort of 147 patients aged 56.0 ± 7.7 years (Table I) with both preoperative MRI that enabled assessment of FI (modified Goutallier classification^{9,15}) and 10-year postoperative MRI for assessment of tendon healing (Sugaya classification³²). All patients were also evaluated clinically with use of the Constant-Murley score,⁷ subjective shoulder value,^{10,11} and Simple Shoulder Test.

The scanning protocol included (1) T2-weighted fat suppression sequences (non-proton density weighted) in the oblique coronal, oblique sagittal, and transverse planes, including the entire scapula, used to analyze tendon healing, and (2) T1-weighted sequences in the transverse and sagittal planes, used to analyze FI and muscle conditions. Each MRI scan was interpreted by 3 central observers—a senior radiologist, a senior surgeon, and a junior surgeon—and discrepancies in classification or grading were discussed until consensus was reached. To determine intraobserver and interobserver agreement, each observer repeated the readings on 50 MRI scans after an interval of 3 weeks. The κ statistic test revealed good intraobserver agreement ($\kappa = 0.71$) and moderate interobserver agreement ($\kappa = 0.56$) for the modified Goutallier classification of FI. The κ statistic test revealed good intraobserver agreement ($\kappa = 0.74$) and moderate interobserver agreement ($\kappa = 0.68$) for the Sugaya classification of tendon healing.

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