Repaired Rotator Cuff Injuries: Magnetic Resonance Imaging Evaluation

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Conflict of interest: None declared

Funding: No funding sources

Abstract

The repaired rotator cuff frequently appears abnormal on magnetic resonance imaging (MRI). Recent studies have shown that while the tendons typically normalize, they can demonstrate clinically insignificant abnormal imaging appearances for longer than 6 months. Features of capsular thickening or subacromial-subdeltoid bursal thickening and fluid distension were found to decrease substantially in the first 6-month postoperative period. MRI was found to be highly comparable in the postoperative assessment of the rotator cuff, although they had a lower sensitivity for partial thickness tears. Imaging evaluation of newer techniques such as patch augmentation and superior capsular reconstruction needs to be further investigated.

Keywords: Repaired Rotator Cuff Injuries, MRI

Tob Regul Sci. ™ 2023;9(1): 5619-5628
DOI: doi.org/10.18001/TRS.9.1.391

Introduction

The rotator cuff plays an important role in shoulder abduction and rotation, with the supraspinatus aiding in abduction [1] and the infraspinatus and subscapularis functioning as the main external and internal rotators, respectively [2]. After repair of rotator cuff tendon tears, approximately 25% of patients may experience persistent or new pain and disability [3]. In the symptomatic patient after rotator cuff repair, the primary etiologies to consider include, but are not limited to, rotator cuff re-tear, impingement, and postoperative synovitis. Hardware dislodgement can also be an unexpected finding on imaging, which may cause significant pain and impairment [4, 5].

The rate of re-tears reported in the literature varies tremendously, ranging from 9 to 94% [6–8], with re-tears typically occurring within the first three postoperative months [9]. The risk of re-tear increases with patient age [6] and size of the preoperative rotator cuff tear [7]. Additional risk factors associated with re-tears include preoperative fatty infiltration of the rotator cuff musculature [4] and double-row repairs [8]. Magnetic resonance imaging (MRI) and ultrasound (US) are both used in evaluating pathology after rotator cuff repair. Our goal is to highlight both expected postoperative and abnormal findings on MRI, while underscoring the use of static and dynamic ultrasound as a complementary exam, particularly when a high likelihood of re-tear is suspected clinically.

Go to:

MRI Evaluation of the Postoperative Rotator Cuff

After clinical and physical examination, radiographs are typically obtained for first-line evaluation [4, 10•]. If radiographs do not answer the clinical question, MRI can be performed to evaluate the rotator cuff integrity and assess for complications such as re-tear of the tendon or displacement of suture anchors. A recent study by Collin et al. found inter-observer agreement regarding MRI interpretation of the postoperative rotator cuff to range from 0.76 to 0.90 [11•]. At our institution, MRI of the repaired rotator cuff is acquired on a 1.5-T (Tesla) system (GE Healthcare, Waukesha, Wis) with our imaging parameters described in Table Table1.1. To overcome artifacts from metallic shavings, the bandwidth can be increased to 80 kHz. In our experience, 3-T magnets have not provided additional diagnostic benefit over 1.5-T units in assessing the postoperative shoulder, while accentuating susceptibility artifact from metal [12].

Table 1

MRI protocol for imaging of the shoulder

PPlane/sequence	FOV (cm)	Matrix (frequency × phase)	Slice thickness/gap (mm)	TE (msec)	TR (msec)	TI (msec)	Bandwidth (kHz)	NEX
3 plane localizer SS FSE	20	256 × 128	7/0	Min	Min	–	31	1
Oblique coronal IR FSE	17	288 × 288	3.5/0	17	4000	150	31	2
Oblique coronal PD FSE	16	512 × 384	3/0	24	4000	–	31	2
Axial PD FSE	15	512 × 384	3/0	24	4000	–	31	2
Oblique sagittal PD FSE	15	512 × 320	4/0.5	24	4000	–	31	2

FOV field of view, *TE* time to echo, *TR* time to repetition, *TI* inversion time, *NEX* number of excitations, *ETL* echo train length, *SS FSE* single shot fast spin echo, *IR* inversion recovery, *FSE* fast spin echo, *PD* proton density

MRI Appearance of the Repaired Rotator Cuff Tendon

Normal, native tendons on MRI should demonstrate homogenous low signal intensity without tendon thickening or attenuation, interposed fluid-intensity high signal, or discontinuity

[13]. Repaired rotator cuff tendons, on the other hand, commonly demonstrate increased signal intensity on MRI; such appearance can be attributable to postoperative granulation tissue and inflammation or preexisting tendinosis, rather than a re-tear [14]. A small study by Spielmann et al. determined that only 10% of asymptomatic patients who had undergone rotator cuff repair had a normal MRI appearance of the rotator cuff tendon [15]. Patients who are asymptomatic with good function of their rotator cuff may still demonstrate tendon thinning on imaging [10•]. The repaired tendon may continue to appear thin or hyperintense up to a year after surgery (Fig. 1a–d) [14]. At the site of debridement, the tendon may have a smooth defect that is classically wider than it is deep, which should not be mistaken for a re-tear [16, 17]. Intermediate to low signal intensity foci may be identified within the repaired tendon, typically from either suture material, granulation tissue, fibrosis, or metal artifact from instrumentation [10•, 15, 16]. After the first postoperative year, the repaired tendon will begin to have a more normal appearance, but may demonstrate abnormal characteristics even years after surgery [14]. Additionally, it is important to be aware that portions of the rotator cuff may not have been repaired secondary to poor tissue quality, therefore continuing to demonstrate features of partial or full-thickness tear similar to the prior study; these should not be mistaken for re-tears [10•].

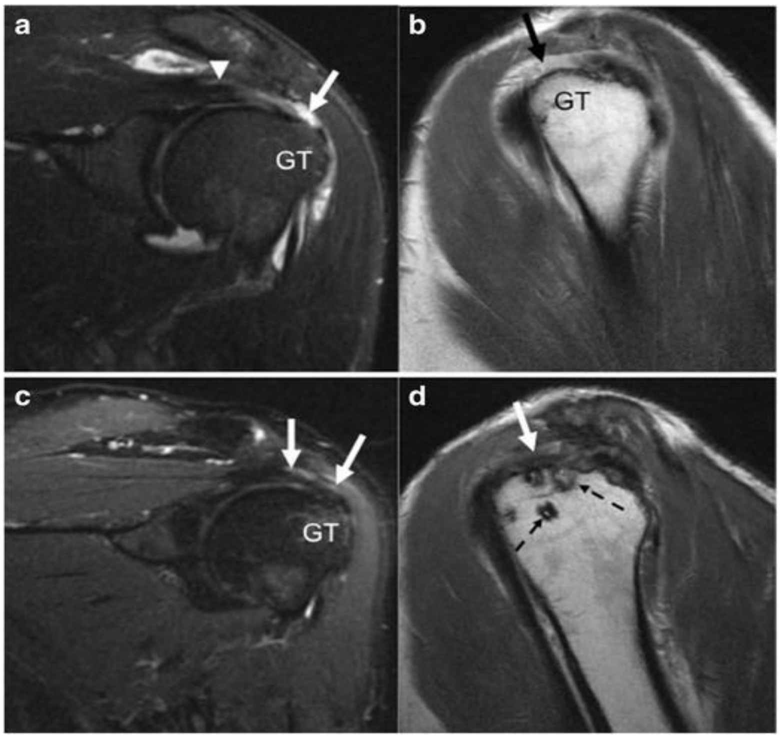

Fig. 1

a–**d** Fifty-six-year-old man initially presenting with rotator cuff tear: preoperative and postoperative imaging. Preoperative oblique coronal IR (**a**) and oblique sagittal PD (**b**) images demonstrate the supraspinatus tendon (arrowhead) with a fluid-filled gap (arrow) and no normal fibers inserting onto the greater tuberosity (GT), consistent with a full thickness tear. Ten months after rotator cuff repair, oblique coronal IR (c) and oblique sagittal PD (d) images demonstrate somewhat irregular and slightly hyperintense supraspinatus tendon fibers (arrows) inserting onto the greater tuberosity, without a fluid filled gap to suggest a re-tear. Suture anchors (dashed arrows) are noted within the greater tuberosity

In irreparable or chronic, massive rotator cuff tears, surgical augmentation with graft may be performed to bridge the rotator cuff defect, or a superior capsular reconstruction to stabilize the humeral head [18•, 19, 20]. Dermal allograft, fascia lata autograft, or synthetic material may be used [18•, 21]. On MRI, the grafts typically demonstrate low signal intensity on proton density images; however, the literature on the MRI evaluation of rotator cuff and superior capsular reconstruction grafts is sparse [18•, 21, 22]. In patch augmentation, the two ends of the torn rotator cuff may not be in complete apposition, but the graft should bridge the rent in the rotator cuff; in superior capsular reconstruction, the graft should be continuous from the superior glenoid to the greater tuberosity for stabilization of the glenohumeral joint (Fig. 2a–f) [18•, 22, 23].

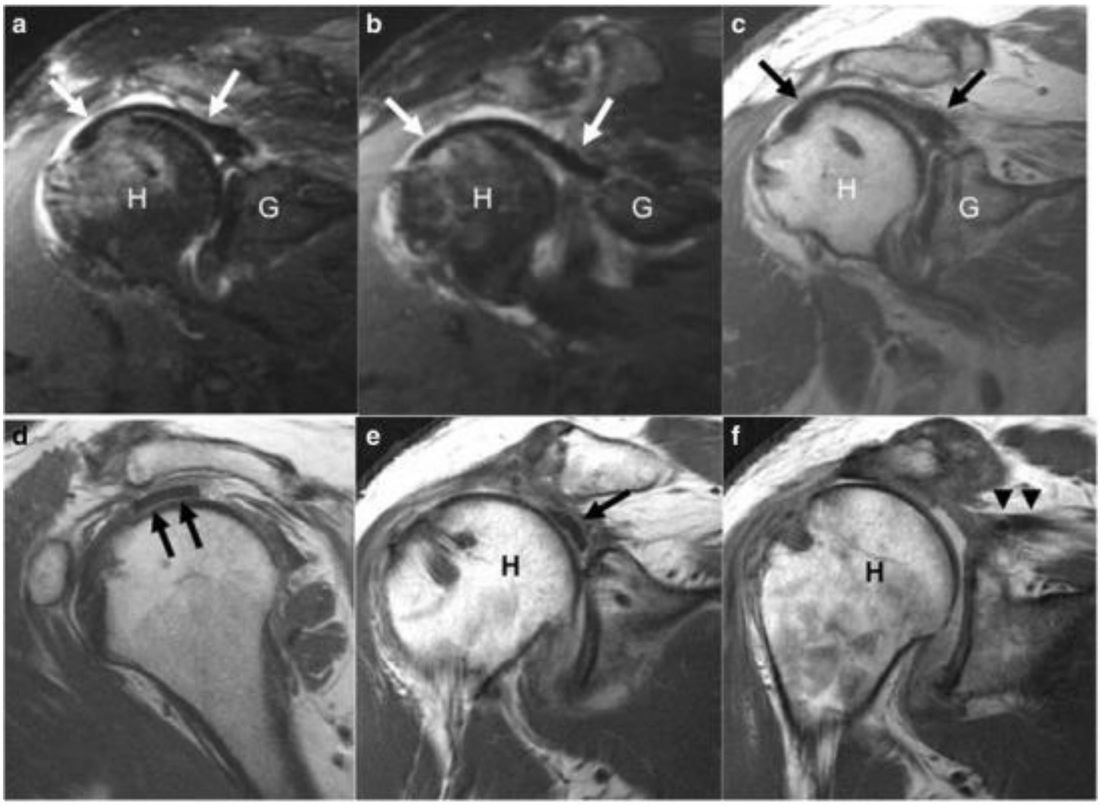

Fig. 2

a–f Sixty-year-old man, 4 months after superior capsular reconstruction. Oblique coronal IR (a, b), oblique coronal PD (c), and oblique sagittal PD (d) images demonstrate low signal intensity of the dermal allograft (arrows). The graft is closely apposed to both the greater tuberosity at the humeral head (H), as well as the glenoid (G). In a different patient (e, f), there is discontinuity of the low signal intensity graft (arrow) seen far anteriorly, with detachment from both the humeral head (H) and the medially retracted supraspinatus tendon (arrowheads). Previously, the graft had been surgically placed from the humeral head to the torn supraspinatus tendon

Increased signal within the greater tuberosity may also be a normal finding at the site of suture anchor placement, as this is seen even in asymptomatic patients [15]. Subacromial bursitis may be a finding after rotator cuff repair and can be seen in both symptomatic and asymptomatic patients (Fig. 3a, b) [17]. Causative factors of subacromial bursal fluid include leakage of joint fluid through a repaired tendon, synovitis inciting a bursitis, or postoperative scarring [17].

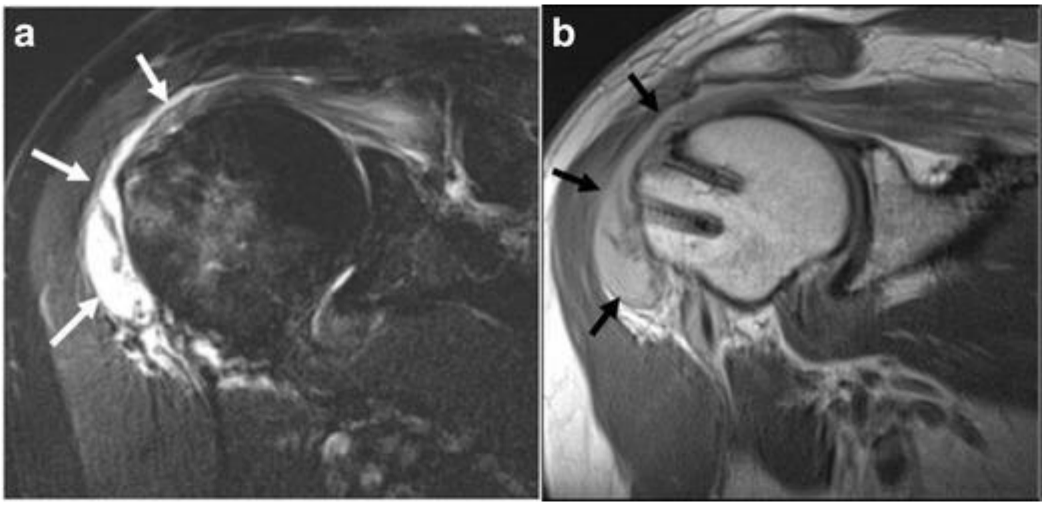

Fig. 3

a, **b** Fifty-year-old man with shoulder pain, 9 months after rotator cuff repair. Oblique coronal IR (**a**) and oblique coronal PD (**b**) demonstrate marked subacromial-subdeltoid bursitis (arrows) with fluid distension and debris

At our institution, intra-articular gadolinium is not used in the setting of prior rotator cuff repair. In our experience, optimized high-resolution noncontrast MRI on 1.5T units is accurate for identifying clinically significant re-tears of the rotator cuff. A study by Duc et al. came to a similar conclusion, as did a recent meta-analysis by Roy et al., finding that MR arthrography does not provide improved diagnostic performance when compared to standard unenhanced MRI [24, 25•].

Complications of Rotator Cuff Repair on MRI

Familiarity with the typical appearance of the postoperative tendon is important when approaching the repaired rotator cuff, as most repaired tendons demonstrate irregularity on MRI and US in the 1-year postoperative period, which should not be mistaken for a failed tendon repair or re-tear [14]. Re-tears are typically thought to be a result of failed tendon healing due to inadequate tissue quality or failure of fixation, either at the bone-tendon interface or from suture breakage [10•, 26, 27]. A re-tear typically manifests as a full-thickness discontinuity with gap of tendon fibers where there is intersecting fluid signal, reflecting a large rotator cuff defect usually occurring at the supraspinatus tendon (Fig. 4a–c) [14, 15, 17, 28]. Medial retraction of the proximal tendon and muscle edge can be seen as a secondary sign of re-tear [28]. However, as stated already, a full-thickness or partial-thickness defect of the cuff may be a normal postoperative appearance if that portion of the tear could not be successfully repaired intraoperatively. This can pose a challenge for interpretation and knowledge of the exact surgical technique as well as comparison to prior MRI becomes critical. Additionally, similar findings of discontinuity with hyperintense, fluid intensity signal within the gap indicate a failure of surgical grafts [18•].

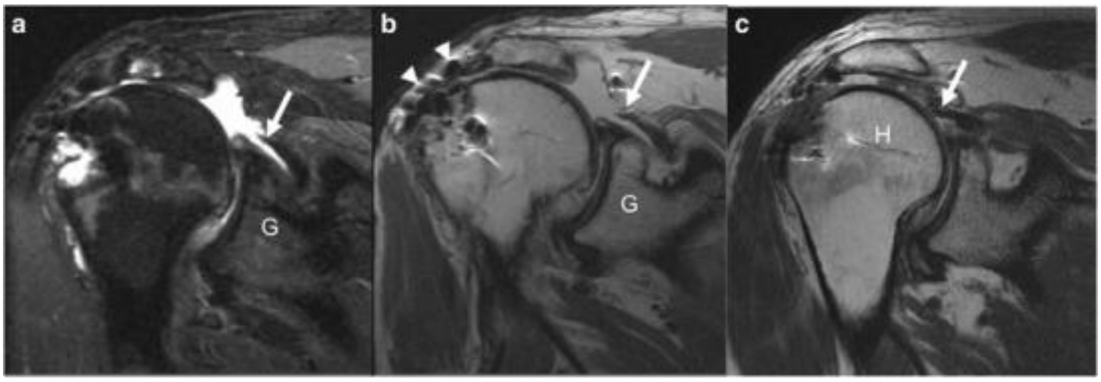

Fig. 4

a–c Forty-seven-year-old man, 5 months after most recent rotator cuff repair. Oblique coronal IR (**a**) and oblique coronal PD (**b**) images demonstrate a fluid filled defect with retraction of the supraspinatus tendon (arrow) to the level of the glenoid (G), consistent with complete rotator cuff re-tear. There is susceptibility artifact (arrowheads) from prior repair. In a different patient, oblique coronal PD (c) image demonstrates a complete tear of the repaired supraspinatus tendon (arrow) with retraction of the tendon fibers to the level of the humeral head (H)

While one of the limitations of MRI includes artifact from metallic material, bioabsorbable suture anchors are well demonstrated on MRI and result in minimal artifact in contradistinction to older metallic screws [11•, 29]. Partial or complete dislodgement of the rotator cuff anchors from the humeral head is yet another complication of the repaired cuff (Fig. 5a–b). In a small study by Magee et al., 13 of 30 patients who presented with pain after rotator cuff repair demonstrated dislodgement of the rotator cuff anchors, all presenting in the first 6-month postoperative period [30]. As bioabsorbable anchors are not visible on radiographs, MRI is important for assessing their integrity [30, 31]. Anchors displaced into the glenohumeral joint can incite a synovitis, causing new pain after arthroscopy or result in chondral injury and decreased range of motion (Fig. 6a–d) [5, 30]. If displaced into the glenohumeral joint, suture anchors can also cause a locking sensation of the shoulder [4, 5]. One case study found a suture anchor displaced into the acromioclavicular joint [29]. MRI can determine the number of anchors that are displaced and their location and can aid in surgical planning. Anchor dislodgement may or may not be accompanied by a cuff tear, and the rotator cuff tendons should be closely examined when there is identification of suture anchor failure [30].

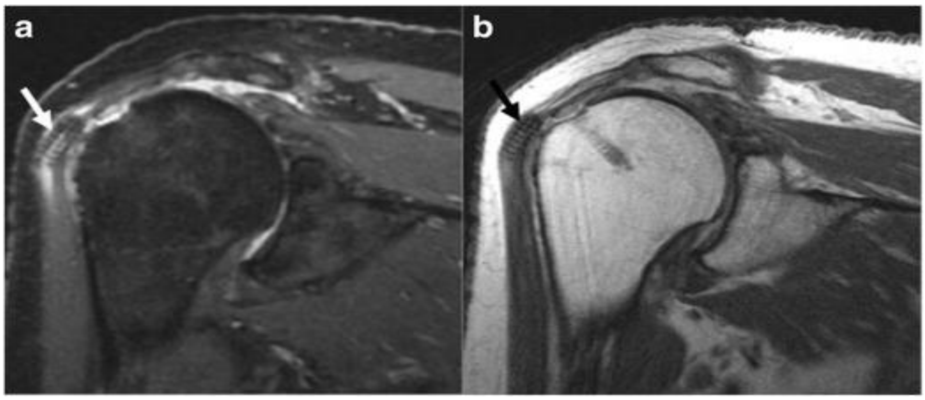

Fig. 5

a, **b** Seventy-nine-year-old woman, 6 months after rotator cuff repair, presents with clicking and soreness of the shoulder. Oblique coronal IR (**a**) and oblique coronal PD (**b**) images demonstrate a screw (arrow) displaced into the substance of the proximal deltoid muscle, inciting surrounding soft tissue edema, and subacromial-subdeltoid bursitis

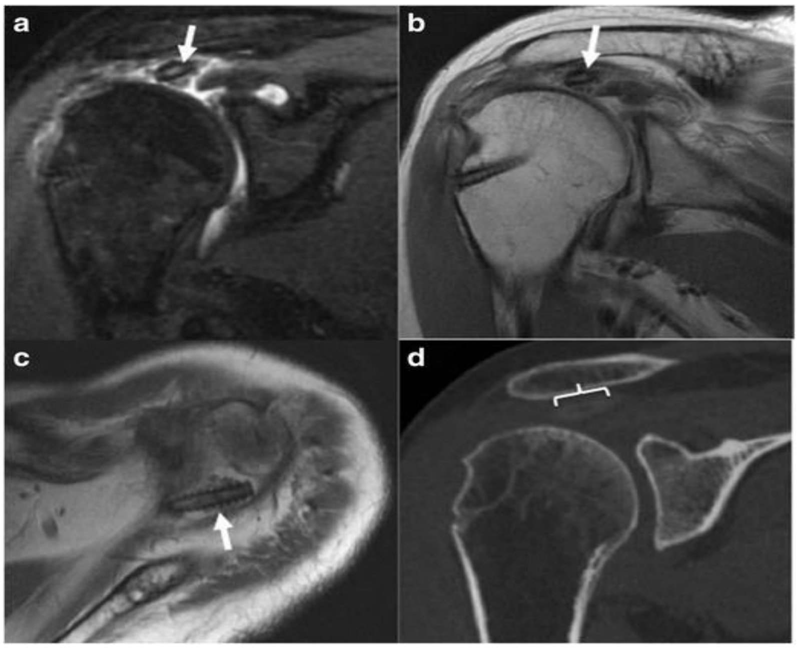

Fig. 6

a–d Fifty-six-year-old woman, 9 months after rotator cuff repair, presents with shoulder pain. Oblique coronal IR (**a**) and oblique coronal PD (**b**) images demonstrate a screw (arrow) displaced into the glenohumeral joint, generating a reactive synovitis. Axial PD (**c**) image best shows the entirety of the screw (arrow) within the joint, superior to the level of the humeral head. Oblique coronal CT image (**d**) again shows the faintly radiopaque screw (bracket) displaced superior to the humeral head

Other postoperative complications and etiologies of pain include acromial fracture, suprascapular or axillary nerve injury, deltoid dehiscence, capsular scarring, and biceps tendon subluxation or rupture [4, 10•, 28]. The glenohumeral joint should be examined for articular damage, either from dislodged suture anchors or post-arthroscopic glenohumeral chondrolysis [35–37]. Of course, other causes of pain such as labral tears and pathology unrelated to rotator cuff repair can also be identified on MRI [10•].

MRI and US are useful in the postoperative assessment of the rotator cuff, not only for evaluation of the integrity of the rotator cuff, but also for detecting hardware complications and other etiologies of shoulder pain.

No Conflict of interest.

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