Postoperative Shoulder: widening one's knowledge in the MRI era

Award: Winner
Poster No.: P-0124
Congress: ESSR 2019
Type: Scientific Poster
Authors: A. Tereso\textsuperscript{1}, G. S. Andrade\textsuperscript{2}, S. F. A. F. Duarte\textsuperscript{3}, V. Mascarenhas\textsuperscript{4}; \textsuperscript{1}Amadora/PT, \textsuperscript{2}Amadira/PT, \textsuperscript{3}Setubal/PT, \textsuperscript{4}Lisbon/PT
Keywords: Musculoskeletal system, MR, Complications, Outcomes
DOI: 10.26044/essr2019/P-0124

This PDF document has been automatically generated from a digital poster submitted online, and is meant for personal use only. Copyright restrictions might apply. Certain materials like for example videos - or multimedia files other than images in general, are not included in this PDF.
Purpose

- Review the different surgical procedures used for the treatment of subacromial impingement, rotator cuff pathology and glenohumeral instability.
- Postoperative shoulder's Magnetic Resonance findings and complications related to subacromial decompression, rotator cuff and labrum repair, and superior capsular reconstruction (SCR) are revisited.

Magnetic Resonance Imaging (MRI) has a fundamental role in the management of the postoperative shoulder and is regarded as a pivotal imaging technique for the differentiation between postoperative complications and expected findings after shoulder surgery.

However, when we are dealing with postoperative MRI, there could be some metallic susceptibility artifacts (figure 1A). These artifacts are more prominent with shoulder prothesis, screws and staples, but they can be produced by minor particles from the surgery, like in acromioplasty (figure 1B).

The transition from the metallic hardware to bioabsorbable and bioinert suture anchors used has led to less metallic susceptibility. Also, in order to minimize these artifacts, the radiologist can change some protocol settings, such as:

1. increase the bandwidth;
2. use fast spin-echo sequences instead of conventional spin-echo sequences;
3. use short tau inversion recovery sequence (STIR) instead of fat suppression (FS) sequences, in order to achieve more homogeneous fat suppression;
4. correct the direction of the slice-encoding metal artifact. These artifacts are more pronounced in the frequency-encoding direction, which should be orientated according to the direction of lesser expected findings;
5. use new pulse sequences designed to reduced metallic artifacts: slice encoding for metal artifact correction (SEMAC), view angle tilting (VAT), multiple-acquisition with variable resonances image combination (MAVRIC) or the combination of SEMAC, VAT, and increased bandwidth, also referred to as the WARP sequence;
6. scan at a lower magnetic field strength (prefer the 1.5 Tesla scanners).

The subacromial decompression, the rotator cuff repair and the repair of glenohumeral instability are the most common surgeries of the shoulder.
Subacromial Impingement

For the treatment of subacromial impingement the most common surgical procedures are:

- arthroscopic subacromial decompression: anterior and posterior acromion resection, bursectomy and resection of acromioclavicular joint osteophytes;
- resection of the acromioclavicular joint (ARAC);
- Mumford procedure that consist on resection of the distal clavícula;
- bursectomy and coraco-acromial ligament resection.

The postoperative imaging findings expected after subacromial impingement surgery are:

- morphological and bone marrow signal changes in the acromion (figure 2);
- widening of the acromioclavicular space (figures 2 and 3);
- absence or replacement of the coraco-clavicular ligament by fibrous tissue;
- presence of acromioclavicular osteoarthritis (figure 2 and 3);
- subacromial fluid is very common in asymptomatic patients and, can sometimes communicate with the acromioclavicular joint (geyser sign).

Rotator cuff lesions

The surgical management of rotator cuff lesions depends on multiple factors like the age and the activity of the patient; the depth and the size of the rupture, and the presence of other shoulder pathology.

The surgical procedures for rotator cuff lesions can be divided in three main types:

- arthroscopic: indicated in small full-thickness tears without tendon retraction and in partial bursal-sided tears that are usually associated with some degree of subacromial impingement (ASD is also performed in these surgeries);
- mini-open repairs: the deltoid muscle is not detached from the acromion so this is a less invasive surgery (compared to open surgery). The surgical procedures can vary from side-to-side suturing of the torn ends and reattachment of the tendon to the great tuberosity using variable sutured anchors (single and double row techniques);
- open surgery: indicated in full-thickness tears with tendon retraction. In these cases, the deltoid is detached from the acromion and the tear is
repaired with tendon reinsertion to the bone by transosseous or anchored sutures.

The expected postoperative imaging findings after rotator cuff lesion surgical repair are:

- subacromial bursitis and humeral head's signal changes: can be seen years after the surgery;
- the repaired tendon can appear thin, thickened, irregular and have low or high T2 signal due to fibrous tissue (figure 4);
- in asymptomatic patients, the postoperative MRI can show the repaired tendon with high T2 signal and a considerable amount of subacromial fluid.

Glenohumeral instability

The surgical management of glenohumeral instability comprehends open and arthroscopy surgeries. The surgical procedures vary with the type of lesion and the open surgery can be anatomic or non-anatomic.

There are some classic surgical procedures in glenohumeral instability surgical repair:

- labral tears: the anterior labrum, the joint capsule and the anterior band of the inferior glenohumeral ligament are attached to the glenoid rim by sutures;
- Bankart procedure: anteroinferior labral lesions with capsule tear are treated with reattachment of the anterior capsule to the glenoid in conjunction with anteroinferior labral repair;
- Remplissage technique: in Hill-Sachs lesions, the posterior capsule and the infraspinatus tendon are transferred to the Hill-Sachs lesion to prevent the lesion to be re-engaged with the glenoid rim.

The expected postoperative imaging findings in glenohumeral instability repair are:

- metallic susceptibility artifacts from the sutures, however the new bioabsorbable and bioinert anchors do not create a significant artifact (figure 5);
- irregular capsular thickening;
• truncated labrum or a labrum decreased in size.

Complications

The most common complication after shoulder surgery, usually in rotator cuff surgical repair, is a tendon retear and the diagnosis is considered when we have the following imaging findings on postoperative MRI:

1. full-thickness tear > 11 mm;
2. retracted tendon;
3. displaced or broken sutures/anchors;
4. superior displacement of the humeral head;
5. small tears not visible on preoperative MRI or on previous postoperative MRI;
6. extensive subacromial bursitis;
7. muscle atrophy.

There are other postoperative complications related to the surgical procedure:

• deltoid muscle dehiscence is a rare complication of open surgery for rotator cuff repair. Often, we can see fluid extending through deltoid muscle from the acromial attachment;
• anchors/sutures failure in rotator cuff repair that can appear when they are pull-out from the bone;
• cystic, granulomatous and osteolysis bone reaction to bioabsorbable anchors and less frequently in bioinert anchors, when they are used;
• acromial fracture, heterotopic calcification and persistency of the subacromial impingement after subacromial impingement surgery (figure 6).

Although rare, there are some complications after shoulder surgery that can emerge in all surgical procedures:

• infection, which may lead to osteomyelitis;
• axillar or subscapular nerve injury, leading to deltoid and infraspinatus atrophy (figure 7);
• adhesive capsulitis;
• shoulder arthropathy, osteolysis and free articular bodies.
Fig. 1: Examples of susceptibility artifacts due to metallic anchors (A) and after acromioplasty (B) in postoperative shoulder MRIs.

© Hospital da Luz, Lisboa

Fig. 2: Postoperative subacromial impingement normal findings: acromion's hypersignal (A) and widening of the acromioclavicular space and acromioclavicular osteoarthritis (B).

© Hospital da Luz, Lisboa
**Fig. 3:** Postoperative subacromial impingement normal findings: acromioclavicular space widening (A) and osteoarthritis (B).

© Hospital da Luz, Lisboa

**Fig. 4:** Pre (A) and postoperative (B) shoulder MRI: in (A) a supraspinatus tear is seen and in (B) the same tendon area appears hyperintense, which is a normal postoperative finding. If we compared the tendon before and after surgery at the same level, we can seen that the hyperintense signal is only due to postoperative changes and it is not a tendon retear.

© Hospital da Luz, Lisboa
Fig. 5: Postoperative shoulder MRI in a patient that underwent a glenohumeral instability repair: we can see sutures and anchors attached on the glenoid rim.

© Hospital da Luz, Lisboa
Fig. 6: Postoperative shoulder MRI in a patient that underwent a subacromial impingement decompression: persistent inferior acromial osteophyte is seen.

© Hospital da Luz, Lisboa
Fig. 7: Postoperative shoulder MRI in a patient that underwent a rotator cuff tear repair: we can seen deltoid and teres minor muscles fat infiltration probably due to axillary nerve injury.

© Hospital da Luz, Lisboa
Methods and Materials

We retrospectively reviewed forty-four surgical cases of decompression for subacromial impingement, SCR, repair for rotator cuff and labrum lesions in our institution in the last two years, that were referred with persistent postoperative shoulder pain, functional impairment or/and persistent shoulder instability. A systematically search for the postoperative Magnetic Resonance imaging findings was done.

All patients included in the study had a post-operative MRI in 1.5 or 3 Tesla (T).
Results

For this case series review, we selected patients that presented with persistent shoulder pain, functional impairment and/or persistent shoulder instability after shoulder surgery. From the forty-four patients enrolled in this study, there were twenty-eight men and sixteen women.

The pathology seen before the surgery are divided between rotator cuff tear, Bankart lesion, calcified tendinitis and acromion-clavicular fracture (table 1). In some patients the rotator cuff lesions were accompanied with glenohumeral instability, usually labrum tears.

Table 1

<table>
<thead>
<tr>
<th>Lesion prior to Shoulder Surgery</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotator Cuff Tear</td>
<td>37</td>
</tr>
<tr>
<td>Glenohumeral instability</td>
<td>9</td>
</tr>
<tr>
<td>Acromioclavicular fracture</td>
<td>1</td>
</tr>
<tr>
<td>Calcified Tendinopathy</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1. Distribution of the shoulder pathology before shoulder surgery.

Thirty-six patients, that underwent surgery and had persistent symptoms after surgery, had post-surgical complications, diagnosed on the post-surgical MRI scan (table 2).

Table 2

<table>
<thead>
<tr>
<th>Postoperative Complications</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retear or new tear of the supraspinatus</td>
<td>16</td>
</tr>
<tr>
<td>Retear of the infraspinatus</td>
<td>9</td>
</tr>
<tr>
<td>Labrum lesion</td>
<td>8</td>
</tr>
<tr>
<td>Tear of the subscapular</td>
<td>5</td>
</tr>
<tr>
<td>Superior elevation of the humeral head</td>
<td>4</td>
</tr>
<tr>
<td>Articular free bodies</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 2. Distribution of the postoperative shoulder complications.

<table>
<thead>
<tr>
<th>Diagnoses</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislodged suture anchors</td>
<td>2</td>
</tr>
<tr>
<td>Glenohumeral osteoarthritis</td>
<td>1</td>
</tr>
<tr>
<td>Glenohumeral arthrosis</td>
<td>1</td>
</tr>
<tr>
<td>Humeral head fracture</td>
<td>1</td>
</tr>
</tbody>
</table>

The most common complication was tear or retear of the rotator cuff tendons (supraspinatus, infraspinatus and subscapular), followed by labrum lesions and superior displacement of the humeral head. We found one humeral head fracture, one glenohumeral arthrosis and one glenohumeral osteoarthritis (Figures 8 - 17).
Fig. 8: Postoperative shoulder MRI in a patient that underwent a glenohumeral instability repair: we can see supraspinatus and infraspinatus tears associated supraspinatus and infraspinatus muscles’ fat infiltration (an indirect sign of tendon tear).

© Hospital da Luz, Lisboa
**Fig. 9:** Postoperative shoulder MRI arthrography in a patient that underwent a Bankart lesion repair: we can still see a superior labral anterior posterior tear (SLAP). There are also some condropathic glenohumeral changes with a glenoid cystic lesion.

© Hospital da Luz, Lisboa
Fig. 10: Postoperative shoulder MRI in a patient that underwent a rotator cuff tear repair. (A) and (B) show superior displacement of the humeral head with complete cartilage defect in glenohumeral joint. (C), (D) and (E) show circumferential anterior labrum tear.

© Hospital da Luz, Lisboa
**Fig. 11:** Postoperative shoulder MRI in a patient that underwent a rotator cuff tear repair. (A) show small subscapularis tear associated with small cystic in the humeral head; (B) show small tear in the long bicipital head at the transition between extra and intra-articular portions.

© Hospital da Luz, Lisboa

**Fig. 12:** (A) and (B) preoperative shoulder MRI shows posterior labrum tear with para-labral cysts (Bankart lesion is associated). (C) and (D) two years after, the postoperative
MRI shows arthrosis of the glenoid rim. (E), (F) and (G) two years after, the postoperative MRI shows intra-articular loose bodies.

© Hospital da Luz, Lisboa

**Fig. 13:** Postoperative shoulder MRI in a patient that underwent a rotator cuff repair, shows a partial extra-osseous anchor (A), (B) and (D). In (C) we can see a retear of the supraspinatus tendon.

© Hospital da Luz, Lisboa
Fig. 14: Postoperative shoulder MRI in a patient that underwent a rotator cuff repair. (A) and (B) show important synovitis. In (C), (D), (E) and (F) we can see an anchor (red arrow) within the lesser tuberosity with important reaction associated; we can also see a free articular body (red circle).

© Hospital da Luz, Lisboa
Fig. 15: Postoperative shoulder MRI in a patient that underwent a rotator cuff repair. We can see a posterior and superior humeral head fracture, located at the infraspinatus enthesis, where we see an anchor (red circle). We also see the infraspinatus tendon insertion within the bone fragments (yellow circle), as well as tendon retraction and associated synovitis.

© Hospital da Luz, Lisboa
**Fig. 16**: Postoperative shoulder MRI in the same patient as figure 15. (A) and (B) show a fracture extra-osseous anchor that migrated through the subacromial bursa.

© Hospital da Luz, Lisboa
Fig. 17: Postoperative shoulder MRI in a patient that underwent rotator cuff repair: we can see the fat infiltration within the deltoid muscle. This complication is higher in patients that underwent open surgery for rotator cuff repair.

© Hospital da Luz, Lisboa
Conclusion

Every radiologist should know how to minimize metallic artifacts in postoperative MRI scans, regardless the surgical procedure.

Postoperative shoulder MRI can only be adequately interpreted if the radiologist thoroughly knows the surgical procedure and clinical setting in order to distinguish normal postoperative findings from postoperative complications.

In our case series, the most common complication after shoulder surgery was tear or retear of the rotator cuff tendons, namely supraspinatus and infraspinatus, followed by labrum lesions.
References