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Lesions of the Rotator Cuff: What the Surgeon Wants to Know

Introduction

Rotator cuff pathology is common in the ageing population but may also occur amongst young athletes. While degenerative type lesions are typically found in elderly patients [1,2] and to some degree in overhead athletes, [3,4] acute traumatic injury of the rotator cuff may occur at all ages, mostly due to indirect shoulder traumas. Furthermore, acute-on-chronic lesions are a special condition which may play a role for the orthopedic surgeon when assessing the patient's disease chronologically, in particular in a medico-legal context. MR imaging may help to distinguish between acute, chronic and acute-on-chronic lesions of the rotator cuff, as described below in more detail.

Apart from helping the surgeon to assess the history of a lesion, MR imaging of the rotator cuff may provide a wide range of additional information to the clinical examination and assist the surgeon in his decision-making process (Table 1).

Rotator Cuff: Common Questions Asked by the Surgeon
Tear: size, location?
Partial-thickness vs. full thickness tear
Tendon: amount of retraction?
Tendon architecture
Muscle quality
Concomitant lesions?

Table 1: *Common questions asked by the surgeon.*

Since a surgeon has considerably more clinical information available regarding a patient than the radiologist, he is able to extract particular imaging information for the individual patient's needs. Not all pathological findings on an MRI have direct clinical implications and it is common in clinical routine to disregard certain MR findings with the assumption that they are not the cause of pain and need not be treated. Therefore, knowledge about rotator cuff (patho-)morphology in symptomatic and asymptomatic cases is crucial both for the radiologist and the orthopedic surgeon.

Considering the individual context of a patient with symptomatic rotator cuff disease, the following MR findings can help to decide whether surgical or non-surgical treatment is necessary and, in case surgery is to be performed, how the surgeon can anticipate and prepare for the intervention.

Tear Size and Location

The rotator cuff consists of four tendons: the subscapularis, supraspinatus, infraspinatus and teres minor tendon which converge to a macroscopic uniform tendon canopy inserting just lateral to the circumferential hyaline cartilage humeral head margin. Although the most distal part of the rotator cuff is a homogenous anatomical structure, the tear location can be attributed to one or several of the four tendons.

Multiple considerations have a major impact on the treatment course, including which tendon or tendons are involved, how many tendons are involved, as well as tear location. For example, small tears can often be treated non-surgically with good results or even with spontaneous healing; larger tears tend to deteriorate over time. Ruptures of two or more tendons are declared as massive tears and the treatment and outcomes are different to small tears.[5,6] In acute trauma, most patients show involvement of more than one tendon of the rotator cuff, while a lesion of an isolated tendon is only seen in about a third of acute cases. The supraspinatus tendon is the tendon most commonly injured in acute trauma, independently of whether the tear affects only a single tendon or multiple tendons (Fig. 1).[7]

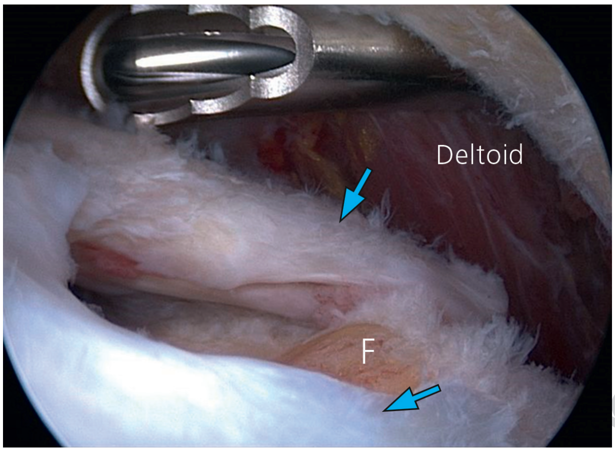

Fig. 1: Arthroscopic image showing a full thickness tear at the insertion of the supraspinatus tendon. This view from the bursa shows the anterior and posterior portions of the supraspinatus tendon (arrows) that are still intact. Between them there is a gap which allows direct visualization of the osseous footprint (F) of the greater tubercle, which would normally be hidden beneath the intact tendon. At the top of the image, the lower surface of the deltoid muscle (Deltoid) is seen next to the shaver instrument.

Furthermore, in patients older than 40 years the subscapularis tendon is also torn in acute trauma rather frequently.[8] Tears of the anterior of the supraspinatus tendon involving the anterior rotator cable seem to develop a faster fatty degeneration of the supraspinatus muscle than posteriorly located tears.[9] In contrast, large posterosuperior tears often show a massive functional impairment of the patient's shoulder.[10] Avulsion of the tendon directly off the bone is easier to treat with common surgical techniques than medial or mid-substance tears, which may be the result of an inappropriate high tension reconstruction during initial surgery.

Partial-Thickness Versus Full Thickness Tears

Other important findings in MR imaging of rotator cuff pathology apart from size and location include the differentiation between partial and full thickness tears (Fig. 2, 3). Before any tears of a tendon are visible, the degenerated or traumatized tendon usually shows tendinosis/tendinitis of different degrees, which in the majority of cases is accompanied by subacromial-subdeltoideal bursitis, responsible for the frequent shoulder pain. Partial-thickness tears are divided between articular-sided and bursal-sided tears according to their MRI appearance (Fig. 4, 5). While articular-sided partial tears are often the result of a trauma in a younger population, the bursal-sided partial tears may reflect a chronic biomechanical conflict between the rotator cuff and the acromion.[11] This, again, has an impact on surgical treatment, such as whether an acromioplasty should be performed in a bursal-sided partial-thickness tear with an acromial spur.

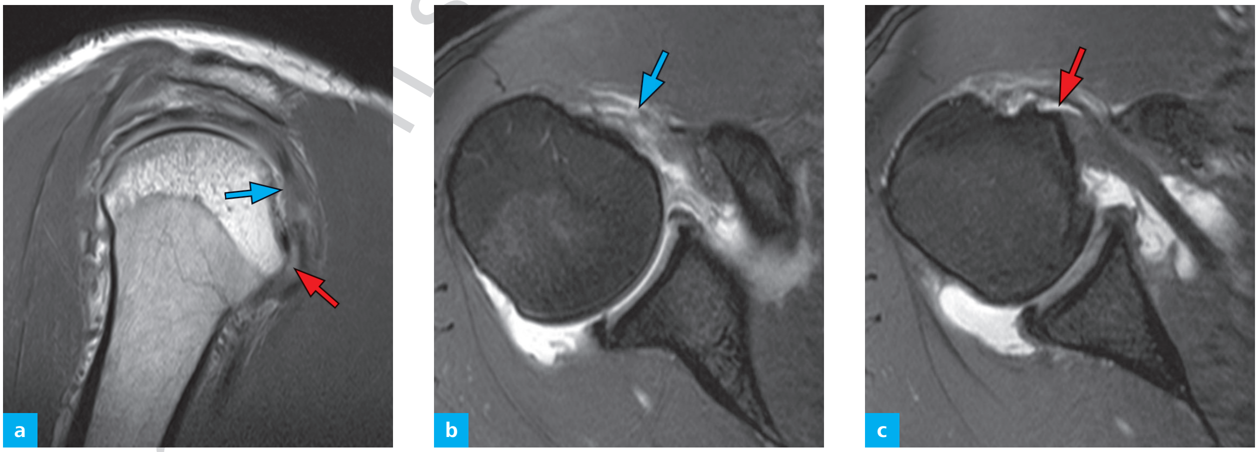

Fig. 2: Acute subscapularis tendon tear in a 24-year-old professional ice hockey player after dislocation of the right shoulder, shown at MR arthrography in (a) sagittal T1-weighted sequence, (b) axial true FISP sequence at a cranial and (c) more caudal location. A full thickness tear is present at the cranial part of the tendon (blue arrows) with uncovering of the lesser tubercle, while a partial-thickness tear (red arrows) is seen at the caudal part. Note the absence of the long biceps tendon, which is also torn.

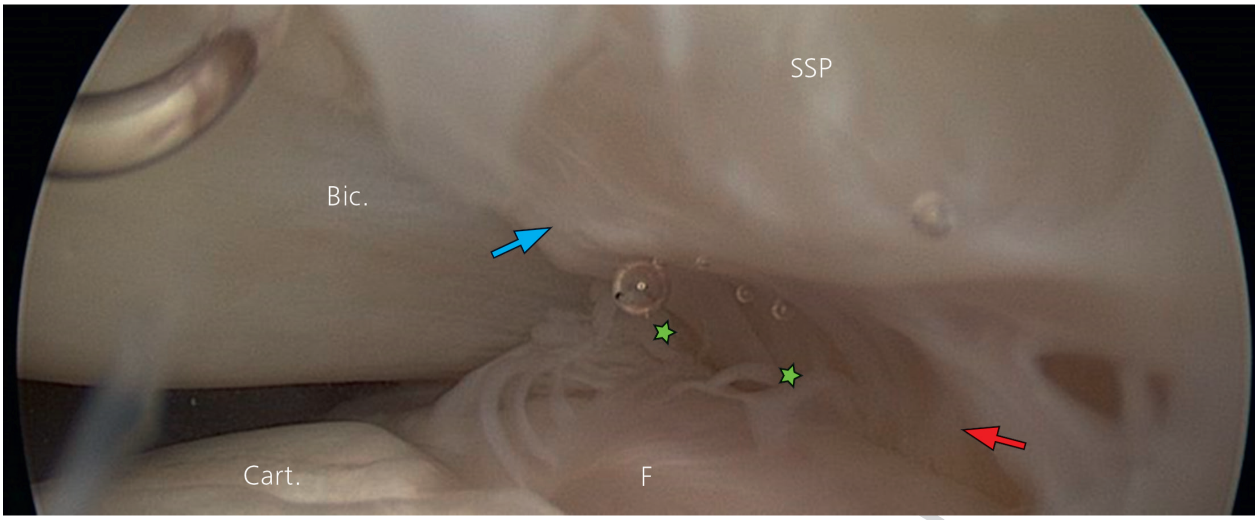

Fig. 3: *Arthroscopic image showing a partial articular supraspinatus tendon avulsion, the so-called PASTA lesion (asterisks). The deep layer of the supraspinatus tendon (SSP) that is usually attached at the footprint (F) is retracted (blue arrow), while the intact superficial layer of the supraspinatus tendon can be seen in the background (red arrow). The humerus cartilage (Cart.) is adjacent to the footprint. On the left-hand side, the long biceps tendon (Bic.) is visible next to the surgical probe.*

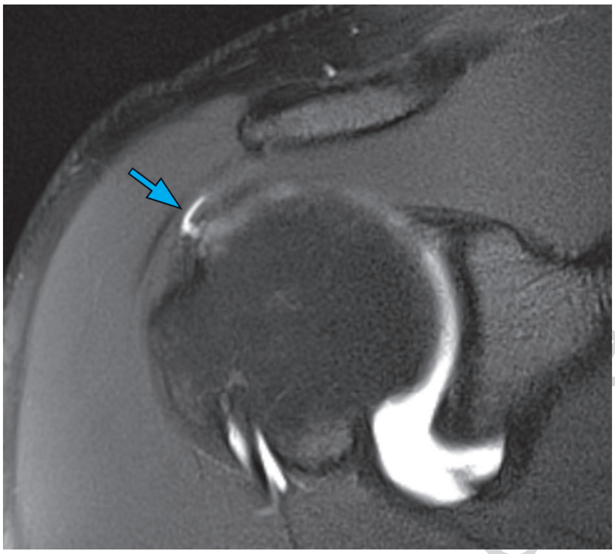

Fig. 4: *Small articular-sided partial rupture of the supraspinatus tendon (arrow) near the tendon insertion anterior portion. Coronal intermediate-weighted fat-saturated MR arthrography image of a 50-year-old man's right shoulder.*

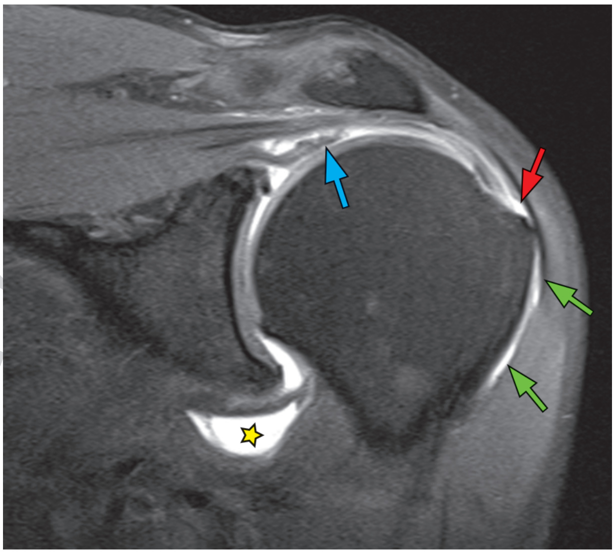

Fig. 5: *Extensive partial-thickness tear of the supraspinatus tendon with small full thickness component (red arrow) in a 60-year-old man shown on MR arthrography of the left shoulder on a T1-weighted coronal image with fat suppression. The hyperintense contrast material is visible both within the joint space (asterisk) and partial tear as well as in the bursa (green arrows) beneath the deltoid muscle, confirming the full thickness component of the tear. Note the retraction of the inner sheath of the supraspinatus tendon (blue arrow).*

Tendon Retraction

Another imaging finding which has an implication on surgical decision-making is the amount of tendon retraction in a full thickness tear (Fig. 6). Here, the shape of the retracted tendon, the direction and progression of retraction over time play a significant role. Therefore, an MR assessment at a single point in time may be insufficient to recognize the natural history of a particular tear and follow-up examinations must be obtained.

Currently it is still not fully understood why some tears retract fast and others remain constant over time. [12] There is evidence that completely retracted tears from the superior and the anterior cuff are prone to worse outcome after reconstruction, and sometimes these tears are even considered as irreparable. [13–15]

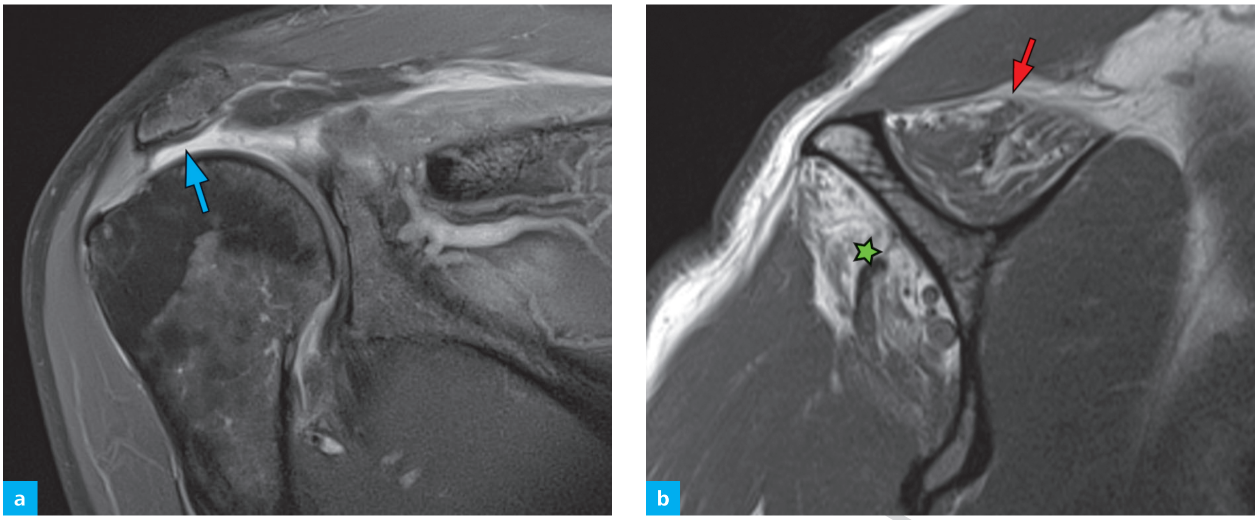

Fig. 6: *48-year-old female patient with rotator cuff tears with non-contrast MRI of the right shoulder. (a) On the coronal intermediate-weighted fat-saturated image a full thickness tear of the supraspinatus tendon (blue arrow) with tendon retraction is seen, which was contiguous with an infraspinatus tear (not shown). (b) On the sagittal T1-weighted image, a moderate atrophy of the supraspinatus muscle is seen (red arrow), with moderate fatty degeneration (Goutallier grade 2). The infraspinatus muscle (asterisk) shows moderate atrophy with substantial fatty degeneration (Goutallier grade 3–4), especially in the cranial part of the muscle.*

Tendon Architecture and Muscle Quality

Tendon architecture includes tendon length and thickness. While tendon lengthening of the subscapularis may indicate a partial-thickness tear, tendon shortening after supraspinatus injury is associated with worse outcome in case of repair.[14, 16] A thin lateral tendon is usually seen in degenerative tears as well as in rupture-in-continuity tears with tendon lengthening. Muscle quality, as defined by fatty infiltration and muscle atrophy, denotes a very important indicator regarding surgical treatment options and the postoperative outcome. Fatty muscle infiltration grade 3 or 4 according to the Goutallier classification [17, 18] is associated with a very high re-tear rate after reconstruction and therefore is considered to be an irreparable cuff tear. Isolated muscle edema of the infraspinatus or in combination with edema of the supraspinatus may indicate a suprascapular nerve lesion.

Concomitant Lesions

As mentioned above, MR imaging of the shoulder may provide some evidence of the acuity of a lesion. Associated soft tissues or bone marrow edema can be found in acute injuries of the rotator cuff. Further, occult greater tuberosity fractures are commonly seen in patients younger than 40 years with acute tears of the rotator cuff, indicating that the tendon is stronger than the bone in this age group.[8] In contrast, a fatty infiltrated or largely atrophic muscle as well as other degenerative findings, such as severe tendinosis demonstrate a preexisting pathology even in patients with history of a recent trauma. Altered anatomical structures adjacent to the rotator cuff, such as the medial subluxation or dislocation of the long head of the biceps tendon which is a typical sign of a subscapularis tendon tear (Fig. 7),[19] may indirectly point to cuff pathology.

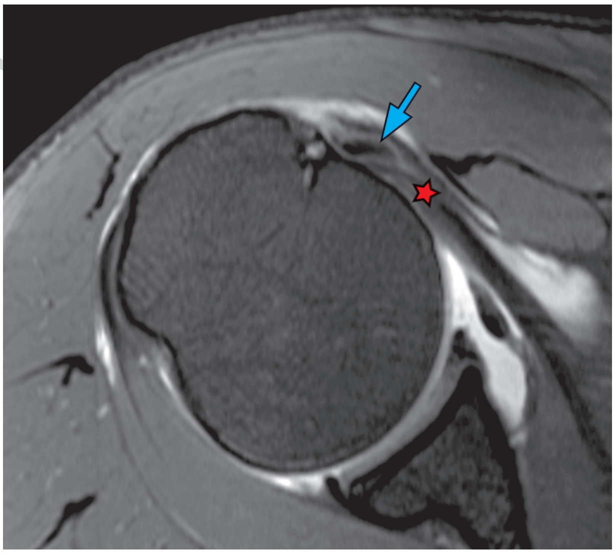

Fig. 7: *Articular-sided partial rupture of the subscapularis tendon (asterisk) with medial dislocation of the long biceps tendon (arrow) into the subscapularis tendon. MR arthrography of the right shoulder in a 50-year-old man featuring an axial true FISP image.*

Further Considerations

In the context of rotator cuff tears and subsequent surgical treatment, morphological factors of the glenohumeral joint and the glenoacromial geometry seen on MRI can provide some additional information useful for surgical planning or outcome expectation. Such factors include glenoidal inclination, acromial coverage of the humeral head, or morphology of the subacromial outlet.

Some of these parameters have shown to be associated with higher risk for the presence of a rotator cuff tear and a higher re-tear rate after reconstruction.[20, 21] Patient age is another relevant factor in acute tears of the rotator cuff: older age at trauma is associated with worse outcome at post-surgical follow up.[7]

Pitfalls

A common statement made by orthopedic surgeons is "we treat patients and not images". This somehow provocative statement is based on the fact that not every pathological finding on the MRI has its clinical correlate. A number of studies have shown that pathological MR findings of the rotator cuff can be found in completely asymptomatic patients[22] and even high-level overhead athletes, and the symptoms only correlate poorly with imaging abnormalities and findings from clinical tests, especially in the athlete.[4] For example in a study with professional handball players, only 37 % of players had shoulder symptoms, even though abnormal shoulder MRI findings were detected in 93 % of players.[4] Such knowledge is crucial for both the radiologist, who should avoid overrating and over-interpretation of certain findings, and for the treating surgeon, in order to better inform the patient and avoid unnecessary indication for surgery.

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