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Isolated traumatic full-thickness supraspinatus tear with intact glenohumeral capsule: a case report

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Supraspinatus tendon is the most affected tendon in rotator cuff traumatic lesions.[1,16,19,23] Due to its intimate connection to the superior glenohumeral capsule,[2,4,6] the cases of isolated full-thickness supraspinatus tear with an intact capsule are rare. This report deals with a case of isolated full-thickness supraspinatus tear with intact glenohumeral capsule managed with arthroscopic triple-row repair. The patient was informed that data concerning his case would be submitted for publication, and he provided written consent. Institutional review board approval was not required for this case report.

Case report

On April 2022, a 67-year-old manual working patient with history of right adhesive capsulitis in 2019 came to our Orthopedics and Traumatology department at Saint-Loup Hospital (Saint-Loup, Pompaples, Switzerland), complaining of nine months long right shoulder pain, discomfort and loss of strength after a fall on his right shoulder. The patient stated pain worsened with physical activities and by night. He underwent several (31) sessions of physiotherapy without any benefit and two subacromial cortisone injections, with transitory effect. He did not use painkillers. On physical examination, active right shoulder range of motion consisted of 90° of forward flexion, 90° of abduction, 20° of external rotation at 0° of abduction (ER1), and internal rotation at 0° of abduction (IR1) to buttock. Magnetic Resonance Arthrography (Arthro-MRI) performed in March 2022 demonstrated a full-thickness supraspinatus tear with supraspinatus tendon retraction at the glenoid level (stage 3 according to Patte classification[22]), severe acromioclavicular osteoarthritis and subacromial impingement. On the preoperative Arthro-MRI it was possible to discern the intact glenohumeral capsule with its insertion on the great tuberosity, but this is a finding we made reviewing Arthro-MRI images after the arthroscopy. In fact, as the capsule layer is very thin, it can barely be distinguished on the images. Preoperative 4 dimentions (4D) code (Lafosse et al[15]) we attributed to the patient's right shoulder was: RD-0BN300AC (Fig. 1, *A* and *B*). Given the patient's pain, loss of strength, traumatic nature of the tear, patient's high-demand activities and young age, the option of an arthroscopic tendon repair was discussed with the senior author and it was accepted by the patient. The surgical procedure was performed on April 13, under general anesthesia and interscalene nerve block, with the patient in semisitting position. Diagnostic arthroscopy[13] findings were: long head of biceps brachii tendon superior labrum anterior to posterior (SLAP) I lesion and tenosynovitis (Fig. 2, *A* and *B*); isolated L-shaped full-thickness supraspinatus tear with intact glenohumeral capsule (Fig. 2, *C*), chronic subacromial bursitis with subacromial impingement (Fig. 2, *E*) and acromioclavicular osteoarthritis. Regarding supraspinatus tendon tear, it was only visible from the subacromial view and not from intra-articular view (Fig. 2, *C*): when we entered the scope into glenohumeral joint, no lesion was visible, because glenohumeral capsule was inserted to the greater tuberosity. Once the scope was introduced into the subacromial space, the presence of a rare, isolated,

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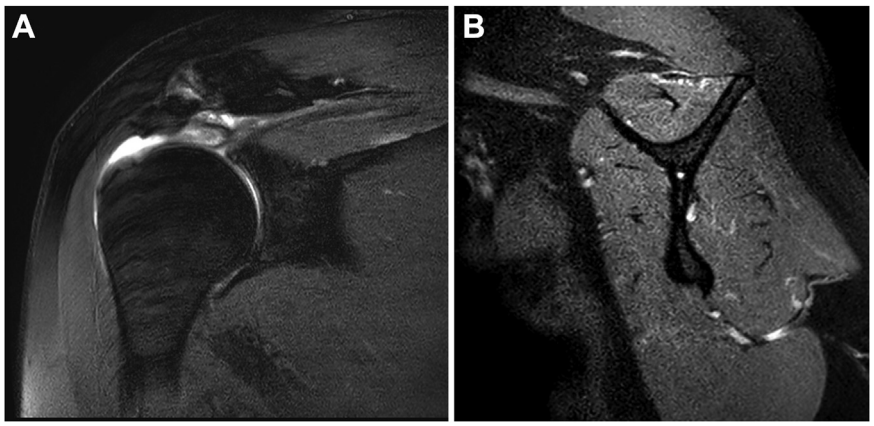

Figure 1 Arthro-MRI (coronal (**A**); parasagittal (**B**) plane) T2-weighted, preoperative. *Arthro-MRI*, magnetic resonance arthrography.

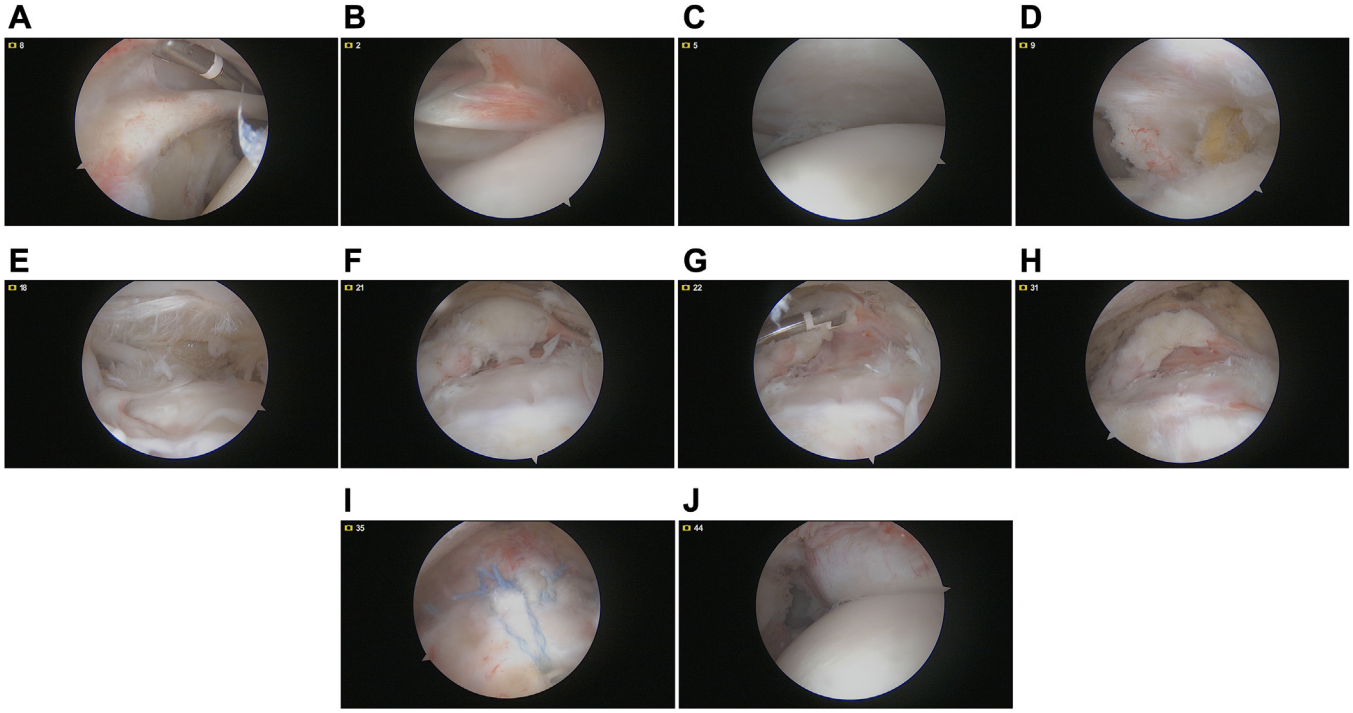

Figure 2 Intraoperative Images (posterior portal, intra-articular view: intact glenohumeral capsule, long head of biceps tendon (**A**); posterior portal, intra-articular view: intact glenohumeral capsule, long head of biceps tendon, humeral head (**B**); posterior portal, intra-articular view: intact glenohumeral capsule, humeral head (**C**); posterior portal, intra-articular view: intact glenohumeral capsule, long head of the biceps tenodesis (**D**); posterior portal, subacromial view: subacromial impingement, supraspinatus stump, intact glenohumeral capsule (**E**); lateral portal, subacromial view: supraspinatus stump, intact glenohumeral capsule (**F**); lateral portal, subacromial view: supraspinatus stump, intact glenohumeral capsule (**G**); lateral portal, subacromial view: port-débridement supraspinatus stump, intact glenohumeral capsule (**H**); lateral portal, subacromial view: bursal side supraspinatus tendon, post triple-row repair (**I**); posterior portal, intra-articular view: articular side supraspinatus tendon, post triple-row repair (**J**).

full-thickness, reverse-L shaped supraspinatus tear was confirmed. The capsule was definitively intact and supraspinatus tendon was fully torn and retracted to glenoid (stage 3 lesion according to Patte classification,[22] Fig. 2, *F* and *G*, Video 1), confirming the Arthro-MRI results. Intraoperative 4D code was: RD0BP300AC.[15] Bicipital tenodesis in the bicipital groove[14] (Fig. 2, *D*) was performed with a 4.5 Mitek Healix Advance BR DS anchor (DePuy Synthes, Raynham, MA, USA). Supraspinatus tendon débridement, acromioplasty, and acromioclavicular resection were performed. To achieve a triple-row suture bridge supraspinatus repair, four bio-resorbable (PLGA/b-TCP) anchors were used: two 5.5 Mitek Healix Advance BR DS anchors (DePuy Synthes, Raynham, MA, USA), used as the medial row; one 4.5 Mitek Healix Advance BR DS anchor (DePuy Synthes, Raynham, MA, USA), as the middle row; one 5.5 Mitek Healix Advance Knotless anchor (DePuy Synthes, Raynham, MA, USA), as the lateral row. Medial row anchors were placed at the level of the insertion line of the glenohumeral capsule, so the capsule was not injured or disengaged in any way during the arthroscopic repair (Fig. 2, *I* and *J*). Sutures were passed through supraspinatus tendon using a Clever Hook (T.A.G. Medical Products Corporation Ltd., Ga'aton, Israel). As the tear was Reverse-L shaped, a side-to-side suture was used between supraspinatus and infraspinatus tendon. The patient was immobilized for 6 weeks post-operatively in a Bauerfeind SecuTecOmo orthosis (Bauerfeind, Zeulenroda-Triebes, Germany), in a 30° abduction, 0° external rotation position. During the period of immobilization, the only

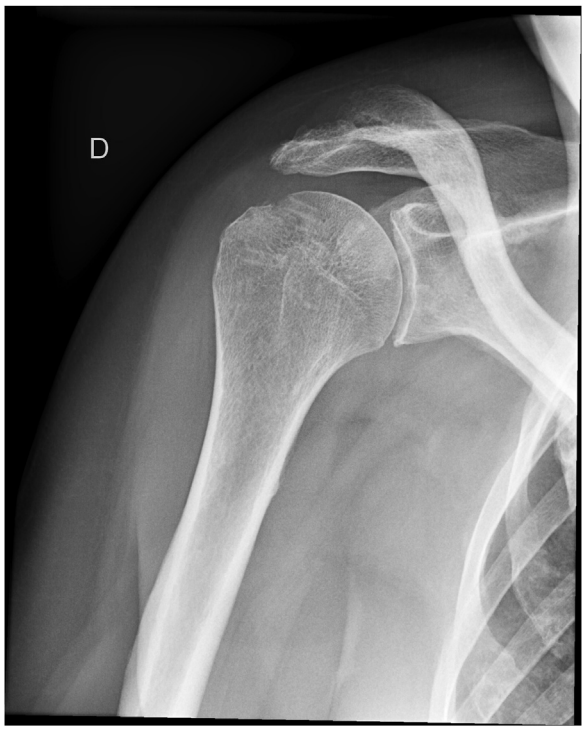

Figure 3 X-ray (AP) follow-up at 6 weeks post arthroscopic rotator cuff repair.

exercise the patient was allowed to do was the pendulum exercise. The patient started assisted active mobilization at 6 weeks postoperative. Musculation was started at 3 months after surgery. The control shoulder X-ray (Anterior Posterior Fig. 3, Neer and Zanca view,) was performed 45 days after surgery with a clinical control at the senior author consultation. Day 45 X-ray showed correct positioning of anchors tunnels, and the patient stated he was pain free on clinical control. Good clinical evolution was observed at 3 months postoperative follow-up, with good muscular strength and range of motion, and at 6 months follow-up Subjective Shoulder Value was 85%. At physical examination right shoulder active forward flexion was 150°, abduction was 140°, ER1 was 45° and IR1 was to T12, with 5/5 muscular strength according to Medical Research Council scale for resisted active forward flexion, abduction, IR1 and ER1. Arthro-MRI (Fig. 4, *A* and *B*) showed no supraspinatus retear (type-II according to Sugaya classification[25]). 6 months postoperative 4D code (Lafosse et al[15]) was RD+6M0BT000ACR. In view of the clinical and radiological evolution, no further controls were planned at the senior author's consultation.

Discussion

Traumatic rotator cuff tendon tears represent a quite common cause of shoulder pain and disability. Among them, supraspinatus tendon is the most frequently affected tendon, either in isolated tears or in bigger tears involving infraspinatus and teres minor or subscapularis tendons.[19] Literature findings show a great variety of traumatic superior rotator cuff lesions in term of amount of torn tendon (partial-thickness, full-thickness), tear shape (C-shaped, L-shaped, U-shaped),[23] tear size, associated lesions (biceps long head tendon, SLAP lesions, infraspinatus, teres minor, subscapularis tendon).[12] Due to superior rotator cuff anatomy, full-thickness traumatic supraspinatus lesions are strongly associated to glenohumeral capsule lesions.[24] Fetal anatomical studies showed that, since 10th week of gestation, the fibers of the deep layer of supraspinatus tendon and superior glenohumeral capsule are intimately intertwined and cannot be separate at their insertion point on greater tuberosity.[6] So, in case of traumatic supraspinatus tear, superior glenohumeral capsule tears with supraspinatus tendon deep layer, explaining why it is so unusual to find an isolated full-thickness supraspinatus tear with intact glenohumeral capsule.[9] Since a biopsy for histological examination was not performed at the time of surgery, we cannot prove that the layer inserted on the greater tuberosity consisted exclusively of capsular fibers. Nevertheless, by retrospectively analyzing the coronal T2-weighted view of the Arthro-MRI, the hypointensity of the tissue layer inserted on the greater tuberosity is compatible with the glenohumeral capsule.[10] Although in our institution arthro-MRIs are done with the patient's shoulder in the neutral position, it would have been interesting to analyze images taken in the abduction and external rotation position, in order to relax the tissues to facilitate the distinction between the layers of the supraspinatus tendon and the joint capsule.[10] Some reference cadaveric studies and improved Magnetic resonance imaging showed that supraspinatus tendon is composed of two histologically different layers: the bursal-layer, mainly composed of tendon bundles with a gently decreasing muscular component toward the insertion, and the joint-side layer, that is a complex of tendon, ligament, and joint capsule without transitional areas.[5,18] This histological difference between the two layers reflects different biomechanical properties: superficial (bursal) layer is more resistant to tensile load because it elongates more than articular layer, which elongates poorly but torn more easily, and then is more vulnerable to a tensile load than the bursal layer.[4,5] A recent study based on a five-layered model of supraspinatus tendon insertion on greater tuberosity on MRI images showed that supraspinatus tendon delaminated tears usually occur between the second (densely packed parallel tendon fibers, consistent with bursal layer of supraspinatus tendon) and third (smaller fibers that cross over one another at 45° consistent with deep layer of supraspinatus tendon) layers,[11] in agreement with previous studies. According to this five-layered model, however, a second plane of cleavage exists at the level of the fourth layer, composed of loose connective tissue containing thick collagen bands running perpendicular to tendons fibers (called the "rotator cable"[3,10]). This layer contains the rotator cable and separates the deep layer of the supraspinatus tendon from the articular capsule, and could be the cleavage plane for a full-thickness supraspinatus tendon tear with intact glenohumeral capsule. In this context, in our case, the thin, smooth arthroscopic appearance of the remaining tissue really looked to be the thin capsular layer surviving from a post-traumatic cleavage between the articular capsule itself and the supraspinatus tendon. In the same way that, according to the five-layered model, in the sagittal plane there are two areas in which there is a change in the direction of the collagen fibers that could lead to cleavage, so too in the axial plane there is no homogeneity in the relationship between the tendon fibers of the supraspinatus and the glenohumeral capsule. More recent cadaveric studies have demonstrated the coexistence of areas of close contact between the articular layer of the tendon of the supraspinatus muscle, in which the glenohumeral capsule is thicker (typically at the anterior border of the supraspinatus, at the posterior border of the infraspinatus at the junction with the teres minor, and at the level of the rotator cable[17]), and areas of loose contact between the glenohumeral capsule and the articular layer of the tendon of the supraspinatus muscle, in which the glenohumeral capsule is thinner (posterior part of supraspinatus tendon, anterior part of infraspinatus tendon), and dissection between the articular layer of the tendon of the supraspinatus muscle and the

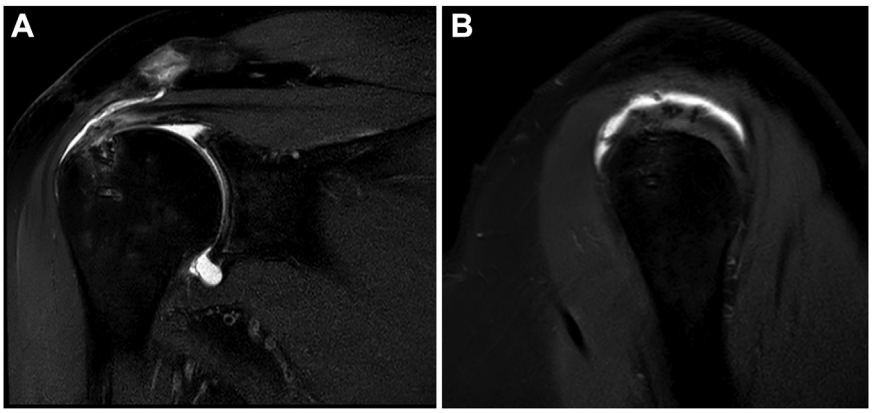

Figure 4 Arthro-MRI (coronal (**A**), parasagittal (**B**) plane) T2-weighted, 6 months post arthroscopic rotator cuff repair. *Arthro-MRI*, magnetic resonance arthrography.

capsule is possible in the areas of loose contact.[17,27] So, the assumption that the fibers of deep supraspinatus tendon layer and glenohumeral capsule are finely intertwined and cannot be dissected seems to be true only in certain regions of the glenohumeral capsule – supraspinatus muscle tendon complex where this close connection facilitates forces transmission, and is therefore a biomechanical advantage. Cooper et al in their histological study have described a four-layered model of the shoulder (from superficial to deep: layer one deltoid and pectoralis major muscle with their fascia; layer two clavipectoral fascia with conjoined tendon and coracoacromial ligament; layer three rotator cuff muscles and tendons; layer four glenohumeral capsule), of which the rotator cuff tendons represent the third layer and the joint capsule the fourth layer, independent of the third after careful dissection starting from loose contact zones between tendon and capsule.[7] The independence (anatomical and biomechanical) of the glenohumeral capsule from the deep layer of the supraspinatus tendon is furthermore justified by the fact that there is a region in the shoulder where the capsule layer exists without a tendinous layer: the rotator interval, in which the glenohumeral capsule is an indispensable element, responsible for the proprioception and stability of the shoulder itself.[8] So, when supraspinatus tendon repair is indicated superior glenohumeral capsule repair is mandatory: capsular resection would result in tendon mutilation and would significantly reduce tendon resistance and elasticity that could determine biomechanical failure. Moreover, superior capsule resection was not indicated because of its intrinsic role of dynamic shoulder stabilizer. To our knowledge, no earlier reports have described triple-row technique in order to repair an isolated full-thickness supraspinatus tear with intact glenohumeral capsule. We chose the above technique because implementation of the anchors number and rows augments bone-tendon contact points, that allows the surgeon to achieve a more anatomical supraspinatus tendon reduction on its footprint[2,21,26] and augments contact pressure between supraspinatus tendon and its humeral footprint.[20] In our case, having more fixation points also resulted in less gliding movements between torn supraspinatus tendon, intact glenohumeral capsule, and supraspinatus footprint, that could have resulted in early biomechanical failure.

Conclusion

Since the tendon of the supraspinatus muscle and the glenohumeral capsule are anatomically and biomechanically connected, a tear in the former usually leads to a tear in the latter. We report a rare case of isolated full-thickness supraspinatus tear with an intact capsule, managed with arthroscopic triple-row repair.

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Patient consent: The authors confirm that the patient was informed that data concerning his case would be submitted for publication, and he provided written consent.

Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.xrrt.2023.10.005.

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