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**Orthopaedics
& Traumatology**
 Surgery & Research

ORIGINAL ARTICLE

Arthroscopic repair of subscapularis tear: Surgical technique and results

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KEYWORDS

Subscapularis tear;
 Subscapularis repair;
 Rotator cuff;
 Arthroscopic repair;
 Technical procedure

Summary

Introduction: Arthroscopic management of extensive subscapularis tendon lesions was reported more recently than for the supra- and infra-spinatus tendons. Extensive tears create technical problems requiring an extra-articular approach. The few results so far reported have been encouraging.

Study design: Surgical techniques adapted to each type of tear according to our subscapularis lesion classification are described, with the preliminary results from our cohort.

Patients and methods: Between January 2006 and December 2008, 74 patients were operated on for extensive subscapularis tear. Twenty-three were assessed over a minimum 2 years' follow-up (mean, 32 months) on UCLA, ASES and Constant scores, comparative dynamometric Bear-Hug test, visual analog pain scale and self-assessed shoulder function.

Results: Postoperative clinical results for the 23 patients followed up showed an improvement in shoulder function from 58 to 86%, in UCLA score from 16.4 to 30.9 points and in weighted Constant score from 48.6 to 75.2%.

Discussion: In case of severe tear, we recommend visualizing the subscapularis tendon along its main axis from above, on a lateral approach allowing the intra- and extra-articular parts to be controlled, so as to check the reduction achieved by traction wire and anatomic fixation by anchors and sutures via an anterior access of varying height but systematically kept under tension. Biceps tenodesis is often required. Results show a clear improvement on all scores: pain, strength and function. The failure rate was 9% (two cases). There were no complications.

Level of evidence: IV (retrospective study).

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Introduction

Arthroscopic techniques for the treatment of subscapularis tear were developed and reported much later than those

for sub- and infra-spinatus tear. Isolated subscapularis tear is rare, with an incidence of 4.9% of rotator cuff tears in our own experience [1]. It is mainly found in subjects who are still active, induced by resistance to forced external rotation or by extension of the arm in abduction. It may also occur in elderly subjects, induced by shoulder dislocation. Certain patients present without trauma, suggesting a degenerative etiology [2]. In the literature, subscapularis tear was associated with rotator cuff pathology in 35% of cases according

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Figure 1 Insertion area.

to Bennet [3], 27.4% to Arai et al. [4] and 30% to Bennet [5].

The present study describes surgical technique, adapted to the type of tear, and reports results specific to arthroscopic repair of extensive subscapularis lesion of at least grade III severity [1] on 2 to 4 years' follow-up.

Anatomy and classification

The subscapularis tendon insertion to the lesser tuberosity of the humerus is triangular in shape, with a small superior base, wide above the tuberosity and thinner below (Fig. 1). Correspondingly, the superior part of the tendon is thick and resistant while the inferior third is muscular and fragile. The mean height of the insertion is 25.8 mm and the mean width 18.1 mm. The rectilinear medial edge is more or less parallel to the longitudinal axis of the humeral shaft [6].

In the light of the anatomic data and arthroscopic lesion-related findings, in 2007 we put forward a 5-type classification of subscapularis tendon lesions [7] (Table 1). Type I lesions are simple erosions of the superior third, without bone detachment (Figs. 2 and 3). Type II consists of detachment restricted to the superior third (Figs. 4 and 5). Type III involves the entire height of the tendon insertion, but without muscular detachment of the inferior third, with limited tendon retraction (Figs. 6 and 7). Type IV is complete subscapularis detachment from the lesser tuberosity of the humerus, but with the humeral head remaining well-centered, without contact with the coracoid on internal rotation on CT-scan (Figs. 8 and 9). Type V also represents complete rupture, but with anterosuperior migration of the humeral head, which comes into contact with the coracoid, with associated fatty infiltration (Figs. 10 and 11). We were able to refine lesion analysis on the basis of this classification, with a view to adapting treatment. Isolated deep layer tendon lesion is subclassified as "A", and often requires tendon elevation by the probe (Fig. 12).

Table 1 Classification of subscapularis tears, by peroperative assessment and pre-operative scan analysis and numbers per type included in the present study.

Type	Lesion	Number
I	Partial superior third lesion	0
II	Complete superior third lesion	0
III	Complete superior two-thirds lesion	15
IV	Complete tendon lesion with well-centered humeral head and fatty infiltration graded ≤ 3	5
V	Complete tendon lesion with subluxated humeral head, coracoid conflict and fatty infiltration graded ≥ 3	3

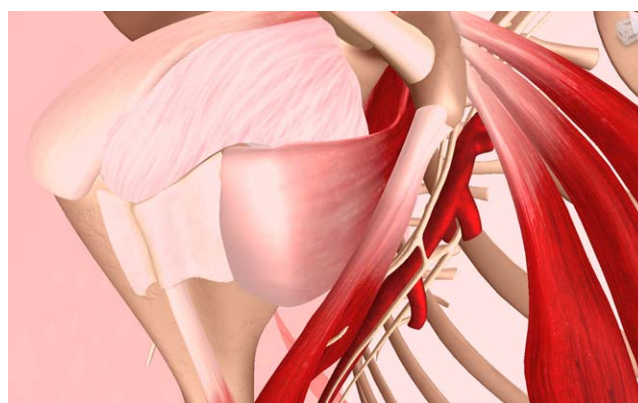


Figure 2 Type I schematic view.

Surgical technique

Installation

The patient, under general anesthesia following interscalene block, is settled in a semi-seated position with the arm

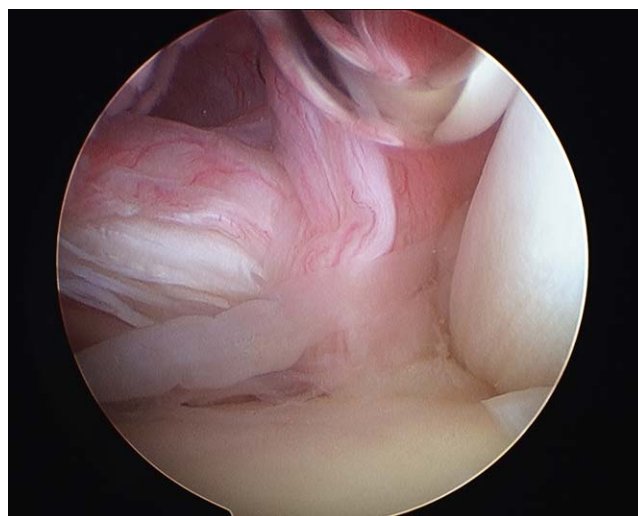


Figure 3 Type I arthroscopic view.

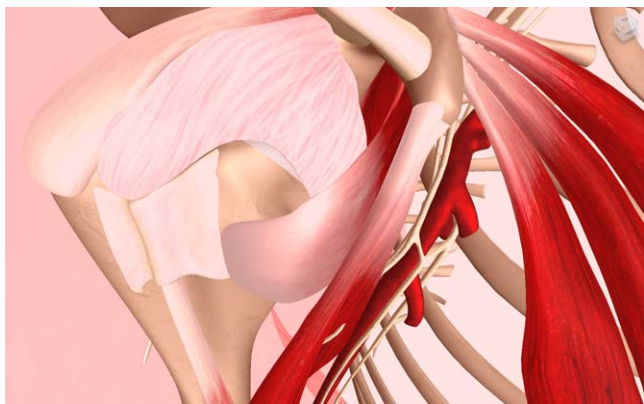


Figure 4 Type II schematic view.

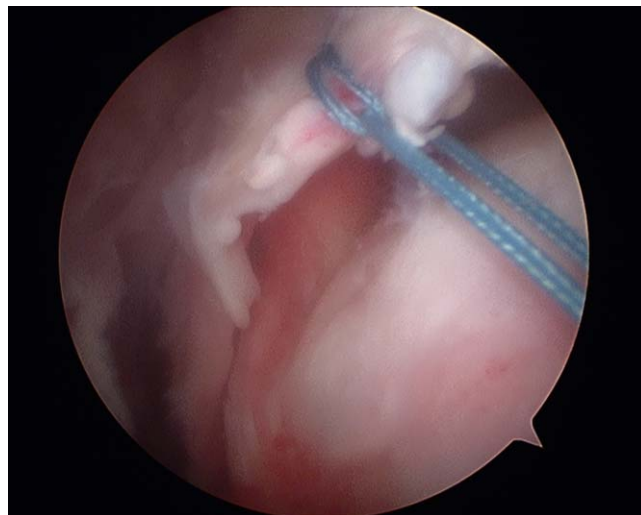


Figure 7 Type III arthroscopic view.

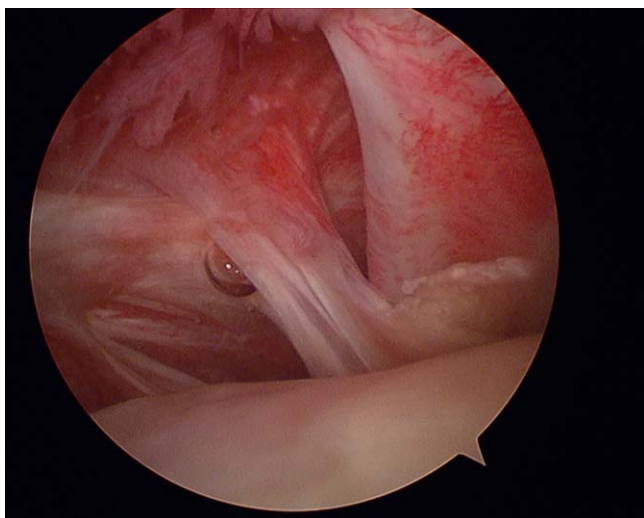


Figure 5 Type II arthroscopic view.

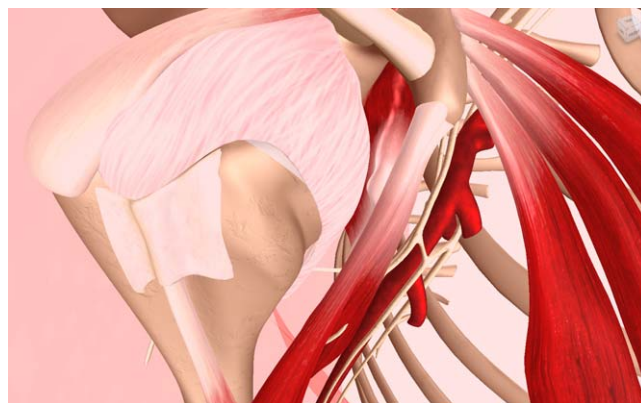


Figure 8 Type IV schematic view.

held in anterior elevation by 1.5 to 3 kg longitudinal traction, so as to position the humerus in slight flexion and neutral rotation, thereby facilitating exposure of the posterior and anterior entry edges of the bicipital groove (Fig. 13). The advantage of this position lies in the improved arthroscopic visualization of the subscapularis tendon, as described in open surgery [8]. Rotation is easy, providing optimal expo-

sure, from the posterior arthroscopic approach, of the subscapularis insertion area over a considerable height by increasing flexion in case of extensive tearing of the deep face.

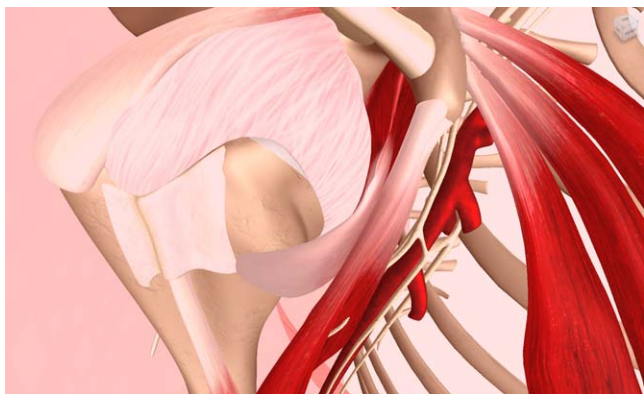


Figure 6 Type III schematic view.

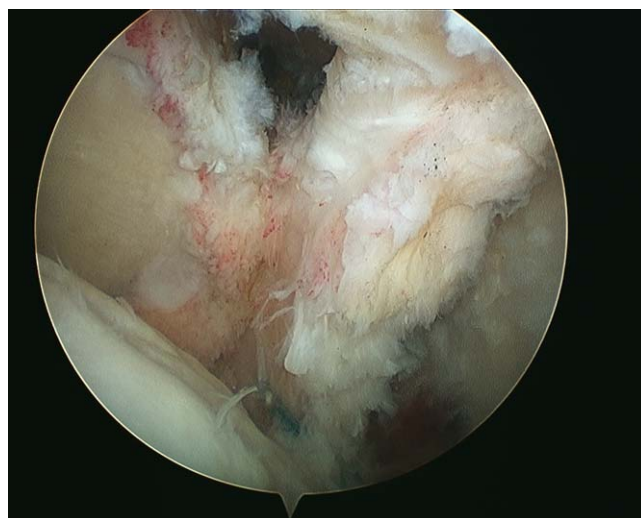


Figure 9 Type IV arthroscopic view.

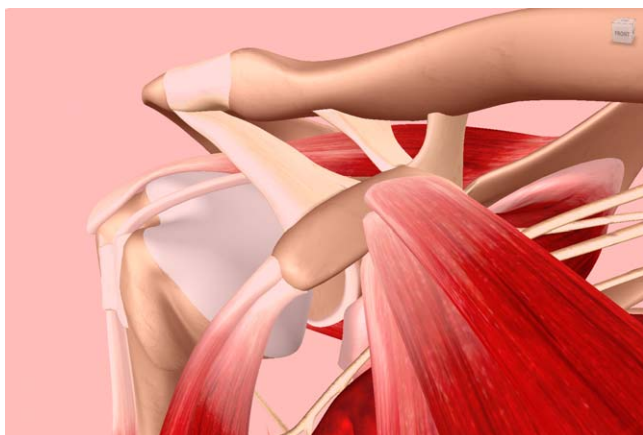


Figure 10 Type V schematic view.

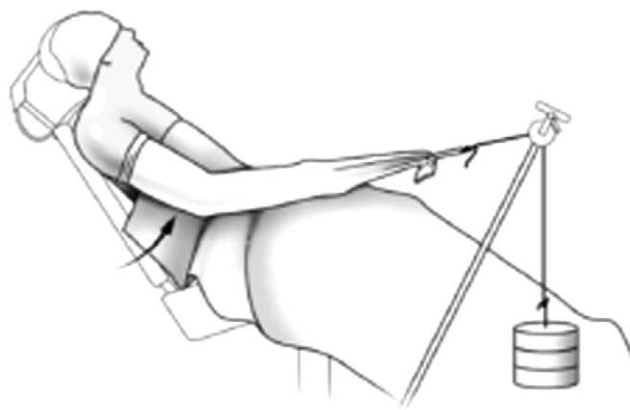


Figure 13 Operative position.



Figure 11 Type V arthroscopic view.

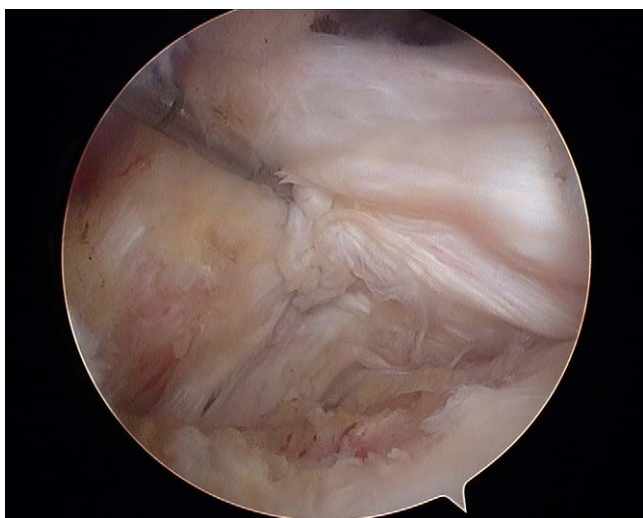


Figure 12 Type III A arthroscopic view.

Surgical approaches

The number of approaches to be used depends on the size of the subscapularis tendon lesion and of other associated lesions. Once the first approach has been performed, the others are out-to-in, under visual control, guided by needle. Skin landmarks are less important than arthroscopic landmarks (Figs. 14 and 15).

The posterior approach A allows intra-articular assessment of the subscapularis, but is used only to visualize repair of limited subscapularis lesions and biceps tenodesis and for intra-articular control of infraspinatus repair.

The lateral approach C is first used for visualization in case of associated extensive supraspinatus tear, and secondarily in case of extensive infraspinatus tear.

The anterolateral approach D and anterosuperior approach E are used as instrument channels.

The lower anteroinferior approach F is used in case of tear involving the entire height of the subscapularis, which is often retracted back to the scapula.

All these approaches, being remote from the coracoid and conjoint tendon, entail no risk of neurological lesion.

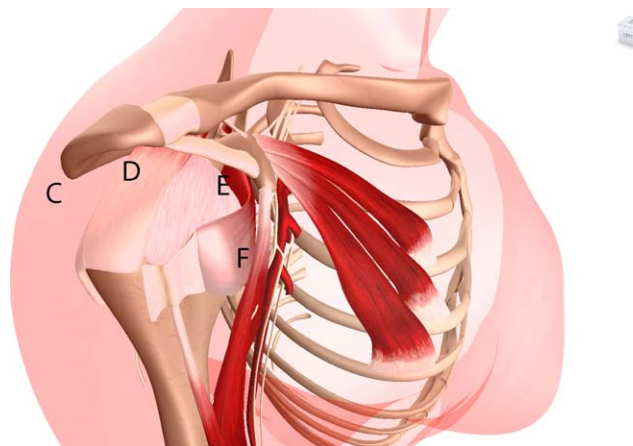


Figure 14 Ant. approaches.

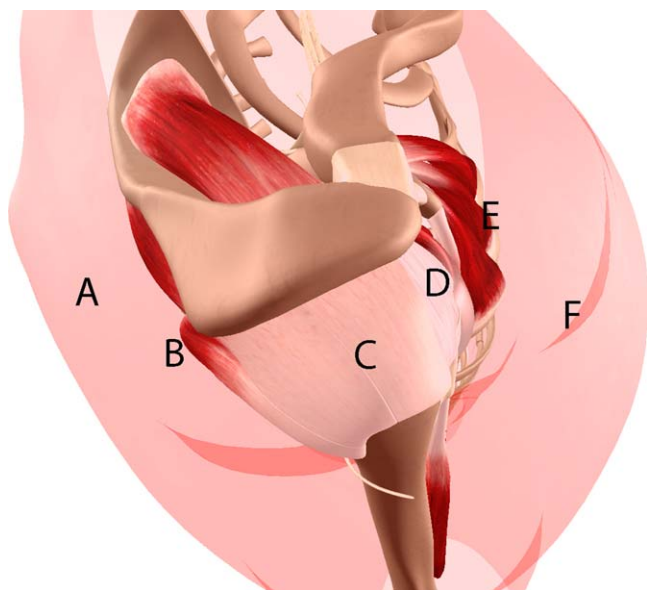


Figure 15 Approaches.

Surgical procedure

The first step consists in rigorous anatomic and lesional assessment, systematically comprising assessment of the entire glenohumeral cartilage surface, facilitated if need be by anterior translation of the head so as to expose its posterior side, and assessment of capsule status (inflammation, dystrophy); then, starting from the foot of the biceps, the anterior, inferior and posterior labrum is explored step by step, with a little circular movement, up to the posterior insertion of the biceps as far as the pulley. Pulley status and its posterior and anterior stability during internal and external rotation are examined. The edges of the rotator interval are examined, with the superior glenohumeral and coracohumeral ligaments. Then, in a wider circle, examination extends to the medial glenohumeral ligament, subscapularis tendon (examined dynamically, in internal rotation), inferior glenohumeral ligament, axillary pouch and teres minor and infra- then supra-spinatus tendons, finishing at the bicipital groove.

The complementary instrumental and visualization approaches depend on the subscapular lesion type and any associated lesions.

Type I and II lesions limited to the superior third or type III limited to the deep layer

If the subscapularis lesion is isolated, without bicipital involvement, repair is performed only if biceps stability is not threatened. In case of the slightest doubt, biceps tenodesis is performed, even if the biceps tendon status is good. The rotator interval is opened above the subscapularis tendon by the anterior approach E, then the anterolateral approach D is located precisely by a needle introduced into the anterosuperior angle of the acromion up to the junction between the medial pulley of the biceps and the superior part of the subscapularis insertion area. A probe hook is introduced via approach D, to mobilize the biceps, assess pulley status and detach the subscapularis

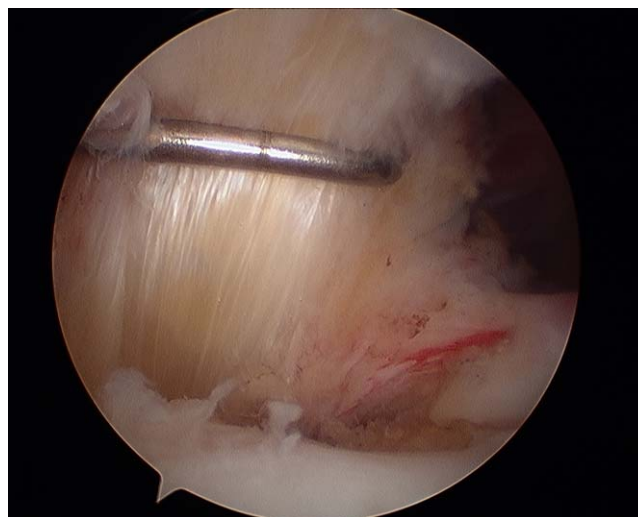


Figure 16 Type II repair: palpator under biceps.

from its insertion area so as to check the inferior extension of the deep face tear and to determine the tear type. Lesion reducibility is then assessed by lateral traction by atraumatic prehensile forceps introduced via approach D, to check whether tendon release is needed. Any adhesences are released intra-articularly, between the subscapularis and the IGHL, then on the superior edge of the subscapularis tendon, and finally forward of the subscapularis in the subcoracoid space, taking care within not to go beyond the medial subcoracoid aponeurosis, which is the outer limit of the vasculo-neural structures. The subscapular insertion area is abraded without decorticating the lesser tuberosity, so as to conserve solidity for future anchorages. The anchor, fitted with 2 double-mounted sutures (Healix BR 5.5 mm Anchor w/Orthocord, Depuy Mitek), is introduced via approach E and positioned in the lesser tuberosity at the inferior end of the tear. Either one or two anchors will be needed, depending on the inferior extension of the tear. The sutures are picked up in approach D and passed successively upward through the tendon by a "clever hook" introduced via approach E, so as to repair the subscapularis by mattress suture for the inferior sutures and by the "lasso-loop" technique (first described in 2006 [7]) for the final superior suture. The knots are then tied successively from bottom to top via approach D. In case of associated lesion or biceps instability without supraspinatus lesion, supraspinatus tenodesis is performed using one of the sutures of the uppermost anchor to reinsert the supraspinatus by the lasso-loop technique (Figs. 16–18). In case of associated supraspinatus lesion, subscapularis repair and biceps tenodesis (which is systematic in such cases) are performed before supraspinatus repair.

Type III lesion, with complete detachment of the superior two-thirds

Tendon retraction release and control of reduction are best performed with the arthroscope in the lateral approach C. This approach is made secondarily in case of isolated subscapularis lesion, after visualization in approach A and opening of the rotator interval, or, in case of extensive supraspinatus lesion, primarily. It allows good visualization

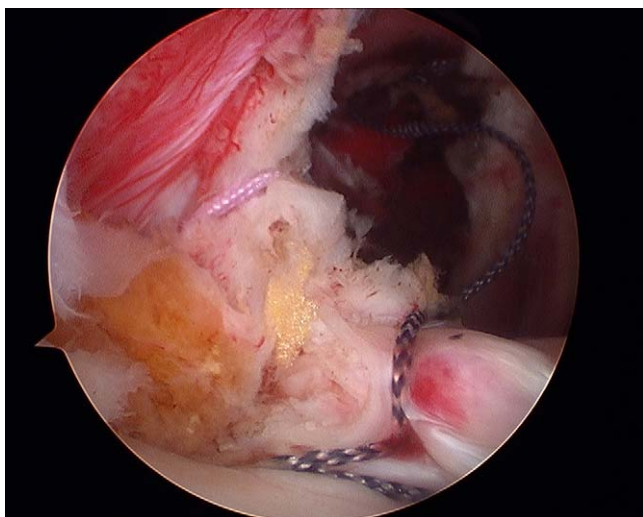


Figure 17 Type II repair: biceps tenodesis and subscapularis lasso.

of the subscapularis release performed via approach D. Release begins from the joint face forward of the MGHL, then in contact with the scapula; this entails no risk of neurologic lesion, as the muscle is innervated on the anterior side. The superior edge is then released in the slide interval between the subscapularis and the coracoid, keeping away from the internal edge of the coracoid insertion, which is the suprascapular nerve notch. The anterior side of the muscle is then exposed as much as possible, releasing the conjoint tendon from the pectoralis major by sectioning the clavi-pectoro-axillary aponeurosis at the lateral edge of the conjoint tendon until the superior side of the distal part of the coracoid is exposed. Behind the conjoint tendon, the anterior side of the subscapularis often adheres to the conjoint tendon over the whole height of the tear, and needs to be released to reveal the aponeurotic veil which is the medial border of the subcoracoid bursa, a pellucid barrier forming the outer envelope of the plexus and its branches and the axillary vessels. Anatomic reduction of the

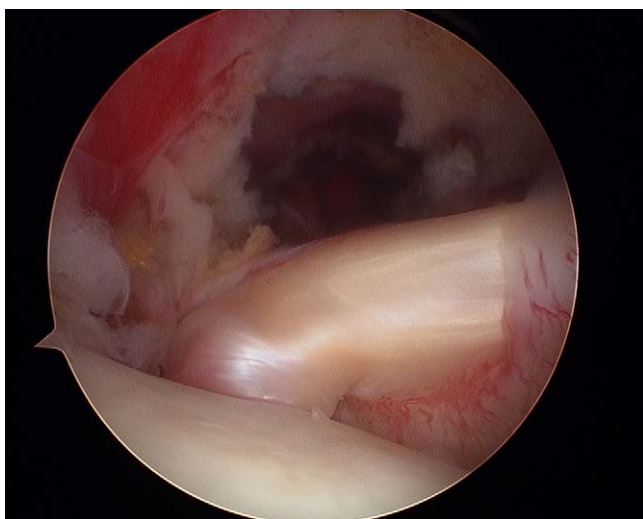


Figure 18 Type II repair: tenodesis and sutures completed.

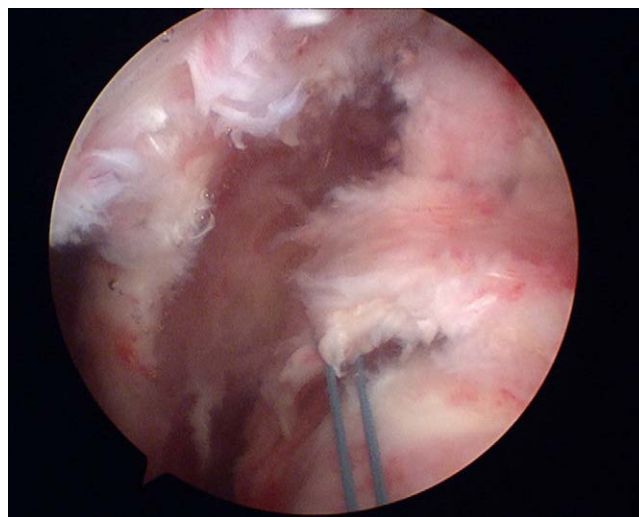


Figure 19 Type III repair: traction wire.

subscapularis tear should be performed without any traction applied to the plexus. If this is not possible, it should be released from its anterior side. The subcoracoid bursa is carefully opened using a blunt instrument, until the superior and inferior branches of the subscapular nerve appear. Dissection continues down and inward, to visualize the axillary nerve. Once the nerves are located, the subcoracoid bursa can be resected without risk of neurologic damage. This part of the procedure is often hemorrhagic, requiring alternation between shaver and a hemostasis device. Once complete reduction is achieved, the tendon is fixed as described above, with at least two anchors for the subscapularis. Associated anterosuperior supraspinatus tear may be longitudinal, conserving inter-tendon connections to the subscapularis. When the subscapularis retracts, the supraspinatus twists around the coracoid and subluxates forward. This is visualized by first opening the rotator interval, taking care not to section the supraspinatus tendon. Rather than separating them, their common insertion is conserved so as to strengthen tendon reinsertion. The coracohumeral ligament is released from its retraction around the coracoid, to allow tendon reduction. The subscapularis is then released as described above, and release is continued within the joint towards the base of the coracoid and the supraspinatus. Finally, the supraspinatus is released beyond the joint, leaving the rotator interval open after tendon repair (Figs. 19–22).

Type IV lesion, with complete retraction back to the scapula

The principle is the same, but reduction requires traction by wires in the superior and inferior parts of the torn tendon. The sutures are picked up via a dedicated approach in the axis of the reduction and fixed under tension using Kocher forceps held against the skin. This traction enables tendon release as described for type III but with greater inferior extension and adhesences that are often harder to dissect. The arthroscope is commonly placed in approach D, for better control of tendino-muscle release, with a more inferior approach F giving access to the inferior part of the subscapularis and to introduce an anchor at the infe-



Figure 20 Type III repair: reduction after tenolysis.

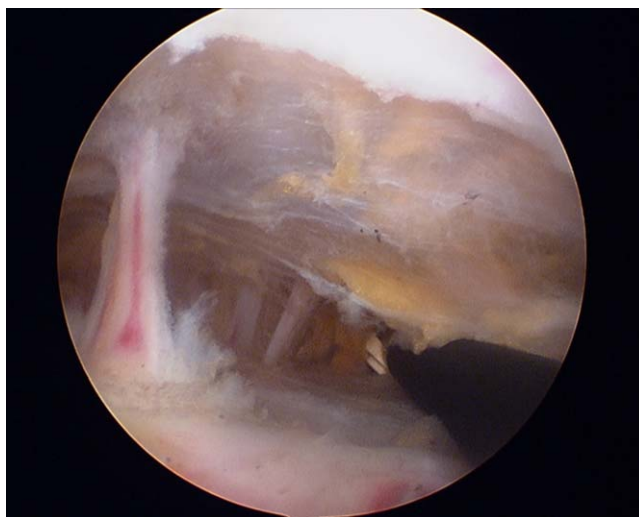


Figure 23 Subscapularis nerves.

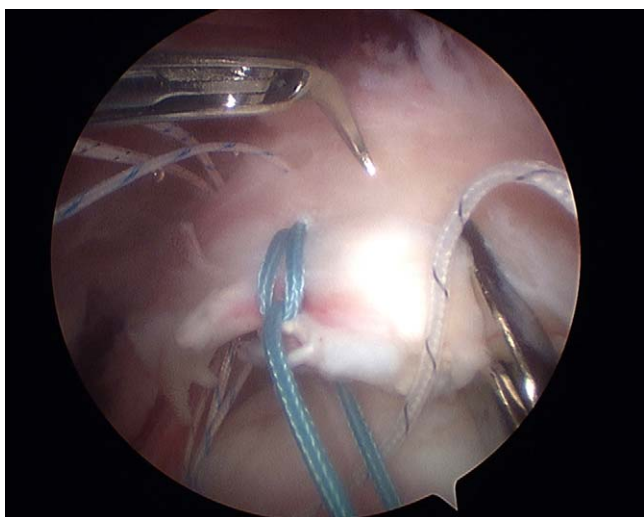


Figure 21 Type III repair: suture passage.



Figure 22 Type III repair: final fixation.

rior extremity of the lesser tuberosity. Fixation uses three anchors in a quincuncial arrangement to provide a foot print tendon application. It is essential to release the plexus nerve structures to ensure painless mobility in external rotation (Figs. 23 and 24).

Type V lesion

The anterosuperior subluxation of the humeral head, coming in contact with the coracoid, is often associated with fatty infiltration and tendon fragility, preventing complete subscapularis repair. Partial repair of the inferior part is therefore performed, followed by teres minor tendon transfer under the coracoid (Figs. 25–27).

Postoperative care

The upper limb is positioned on an abduction cushion in slight internal rotation, preventing any retroversion of the shoulder for 6 weeks: 3 weeks day and night, then 3 weeks night only. During this time, only passive mobilization is allowed, with no pendular rehabilitation, so as to avoid

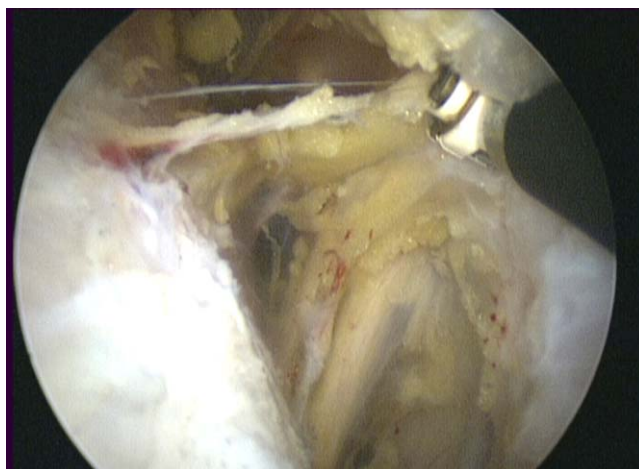


Figure 24 complete nerve release.



Figure 25 Pectoralis minor transfer: tenotomy.



Figure 26 Pectoralis minor transfer: passage under coracoid.



Figure 27 Pectoralis minor transfer: fixation on lesser tuberosity.

anterior subluxation and traction on the tendon reinsertion. Mobilization in internal rotation is restricted to the hand, on the abdomen and not behind the back. External rotation is restricted to 0°; elevation should be painless, in internal rotation under supervision by a physiotherapist. Assisted active mobilization below the pain threshold is allowed without restriction after 6 weeks, and muscle reinforcement is allowed after 3 months.

Patients and methods

Between January 2006 and December 2008, 74 patients presented with extensive type III to V subscapularis tear and underwent arthroscopic repair as described above.

All patients were operated on by a single surgeon (LL). Twenty-three were followed up clinically, with complete radiological assessment, including arthro-CT in 31% of cases. There were 18 males and five females; mean age, 63 years (range, 46–78 years). All were right-handed, and the dominant side was affected in 78% of cases. Lesions were acute (less than 3 months) in 39% of cases, subacute (3–6 months) in 57% and chronic (greater than 6 months) in 4%. Lesion onset was spontaneous in 35% of cases and accident-related in the others: 39% home accidents, 26% work accidents.

Pre-operative clinical analysis was based on the Constant, UCLA and ASES scores and percentage subjective shoulder function rating. The same clinical assessments were performed postoperatively, plus dynamometric comparative bear-hug test of subscapularis strength, visual analog pain scale and 10-point satisfaction scale.

All patients underwent pre-operative radiologic analysis by arthroscan.

Statistical analysis (*t*-tests) was performed by an independent statistician, on SPSS 8.0 for Windows, with the significance threshold set at $P \leq 0.05$.

Results

Mean follow-up was 32 months (range, 18–52 months).

Twenty-six percent of the subscapularis lesions (six patients) were isolated, 35% (eight patients) associated with anterosuperior (supraspinatus) tear, and 39% (nine patients) associated with massive (supra- and infra-spinatus) tear.

Sixty-five percent of the subscapularis lesions (15 patients) were type III, 22% (five patients) type IV, and 13% (three patients) type V.

Clinical results

Clinical results showed significant postoperative improvement in UCLA and Constant scores and shoulder function and mobility (Table 2).

Postoperative UCLA scores were good or very good in 85% of cases, poor in 9% and bad in 4%.

The ASES scores showed absence of any postoperative instability.

The mean weighted Constant score was 59% (range, 18–96 points) pre-operatively, and 95% (44–121) postoperatively.

Table 2 Clinical results.

	Preoperative	Postoperative	P value
Function (%)	58 [SD 50.6–65.4]	86 [SD 77.3–94.8]	< 0.001
UCLA score	16.4 [SD 14.4–18.5]	30.9 [SD 28.5–33.2]	< 0.001
Constant score	48.6 [SD 41.4–55.7]	75.2 [SD 68.3–82.1]	< 0.001
Shoulder mobility d (Constant score joint amplitude)	25.5 [SD 21.1–29.8]	34.3 [SD 31.2–37.3]	< 0.001

Mobility analysis showed a mean 9-point post-operative gain (out of 40) in Constant mobility score.

The mean visual analog pain scale rating fell from six to two points (with 10 representing maximum pain).

Mean subjective (self-assessed) shoulder function rating rose from 58% (20–80 points) to 86% (40–100).

Biceps tenodesis

Sixty-one percent of patients (14 patients) underwent biceps tenodesis. There was no significant associated difference in postoperative pain ($P=0.874$) or joint amplitude ($P=0.869$).

Dynamometric bear-hug test of subscapularis strength

Mean postoperative resistance strength on the bear-hug test was 7 kg (range, 3–≥12 kg) on the operated side and 8 kg (2–≥12 kg) contralaterally: the operated side showed significantly less strength than the non-operated side ($P=0.031$).

Satisfaction

Mean postoperative satisfaction on the 0–10 visual analog scale was 9 (range, 3–10).

Poor results

Three patients (13%) showed non-satisfactory results: one had a secondary subscapularis tear, one a postoperative supraspinatus tear, and one a secondary subscapularis tear with associated supra- and infra-spinatus tear.

Complications

There were no complications.

Discussion

Subscapularis lesions are hard to access and require advanced surgical technique. The main key-points are, firstly, good visualization of the tendon via approach D, to see the tendon right along its axis and also the posterior, superior and anterior sides. Secondly, a traction wire fitted in the axis of the tendon allows reduction to be assessed, with the tendon applied under tension during suturing and knotting.

The extensive tendon release needed for good reduction exposes the subscapular nerves and the axillary nerve, which are conserved.

Of the postoperative tests, the dynamometric comparative bear-hug test, associated to other tests (belly-press,

lift-off), optimizes detection of the higher forms of secondary tearing, as described by Barth et al. [9].

The present study gave good results for the 23 patients seen in follow-up, with significant improvement in UCLA score (85% good and very good results; mean, 31 points), Constant score (weighted mean, 95%), mobility and function.

A review of the literature retrieved no comparable studies dedicated to type III-V severe tear.

Studies of subscapularis lesion of all types, however, reported good and very good results in 80% of cases for Adams et al. [10] (mean UCLA score, 31.6 points), 92% for Burkhart et al. [11] (mean UCLA score, 30.5 points; mean FU, 10.7 months) and 42% for Warner et al. [12] using an open surgery technique (mean UCLA score, 30.5 points).

Among the bad results, the second case, in which the patient had a postoperative supraspinatus tear, was not considered as a failure of the surgical technique, unlike the other two. The actual failure rate was thus 9% (two patients).

These good results need to be compared to those of other studies of massive type III-V subscapularis lesion.

Conflict of interest

None.

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