Arthroscopic Repair of Large Subscapularis Tendon Tears: 2- to 4-Year Clinical and Radiographic Outcomes

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Purpose: The purpose of this study was to evaluate outcome and structural integrity after arthroscopic repair of large subscapularis tendon (SSC) tears at 2 to 4 years' follow-up. **Methods:** Between January 2006 and October 2008, 52 consecutive patients underwent arthroscopic repair of Lafosse type III and IV SSC ruptures. A total of 46 patients (38 men and 8 women) with a mean age of 62 years (range, 45 to 81 years) were available for final follow-up. Clinical findings were assessed for all patients preoperatively and postoperatively, including range of motion, the lift-off test, the belly-press test, the Constant score, and the modified University of California, Los Angeles score. Subscapularis muscle strength by use of the bear-hug test and external rotation were compared in both shoulders postoperatively. Patients were evaluated with plain radiographs and magnetic resonance imaging or computed tomographic arthrography before surgery. Postoperatively, radiographic examination was completed by use of magnetic resonance imaging or computed tomographic arthrography in 39 patients (85%). Patients completed the subjective shoulder value and rated their satisfaction at final follow-up. **Results:** The mean follow-up period was 35.3 ± 9.6 months (range, 23 to 57 months). An isolated lesion was detected in 13% of patients; a lesion of the SSC and supraspinatus tendon was found in 37%; and a lesion of the SSC, supraspinatus tendon, and infraspinatus tendon was detected in 50%. At latest follow-up, the mean Constant score significantly improved from 46.4 points to 79.9 points and the modified University of California, Los Angeles score improved from 15.1 points to 31.5 points ($P < .001$). Subscapularis strength was 92% and external rotation was 96% of the nonoperative shoulder. All outcome scores were similar between Lafosse type III and IV SSC ruptures. Radiographic evaluation showed a rerupture rate of 11%. The coracohumeral distance increased from 9.7 mm to 10.1 mm postoperatively ($P = .086$). The subjective shoulder value improved from 51% to 88% ($P < .001$), and 98% of patients were satisfied or very satisfied. **Conclusions:** Arthroscopic treatment of large to massive SSC ruptures results in significant clinical improvements, excellent maintenance of muscle strength, and durable tendon integrity at 2 to 4 years' follow-up. **Level of Evidence:** Level IV, therapeutic case series.

The subscapularis muscle is the largest and strongest muscle of the rotator cuff. It plays an essential role in shoulder function and stability and is an anterior stabilizer of the shoulder joint.[1,2] Arthroscopic treatment of subscapularis tendon (SSC) tears is one of the most recent techniques developed in shoulder arthroscopy.[3,4] A tear of the SSC is often traumatic, due to hyperextension or external rotation (ER) of the abducted arm in the young patient population.[4] In the elderly, SSC tears are commonly caused by an anterior shoulder dislocation.[5] Furthermore, several mechanisms leading to SSC pathology in the elderly have previously been described. These include nontraumatic/degenerative pathways[2,5,6] and an anteriorly subluxated or dislocated long head of the biceps tendon (LHBT).[7] In our clinic 4.9% of the arthroscopic rotator cuff repairs have involved an isolated repair of an SSC tear.[8] The frequency of SSC tears of any size associated with a tear of the supraspinatus tendon (SSP) and/or infraspinatus tendon (ISP) varies in the literature between 27.4% and 35.0%.[9-11] To our knowledge, no study has been published analyzing the outcomes of arthroscopic repairs of large SSC tears only.

The purpose of this study was to evaluate outcome and structural integrity after arthroscopic repair of large SSC tears at 2 to 4 years' follow-up. We hypothesized that arthroscopic repair of large SSC tears would show equivalent clinical outcome and similar rerupture rates to open surgery as reported in the literature.

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Methods

Patients

Between January 2006 and October 2008, 59 patients underwent primary arthroscopic repair of Lafosse classification[12] type III to V SSC tears at our institution (Table 1). Preoperative magnetic resonance imaging (MRI) or computed tomographic arthrography (CTA) and arthroscopic views were used to classify SSC ruptures. All procedures were performed by the senior author (L.L.). Only type III and IV ruptures were included in this study. All patients were invited by letter and by telephone to undergo clinical and radiographic follow-up evaluation. The minimum follow-up time was 2 years. Of the 52 patients with a type III or IV lesion of the SSC, 46 (89%) were available for final follow-up and were included in this study. Of these 46 patients, 39 were willing to undergo final evaluation by either MRI or CTA. The study group consisted of 8 women (17%) and 38 men (83%). The mean age was 62.0 ± 8.0 years (range, 45 to 81 years) at the time of surgery. The dominant arm was involved in 31 patients (67%). SSC ruptures occurred spontaneously in 35% of patients (n = 16), due to a work-related incident in 15% (n = 7), and due to a recreational accident in 50% (n = 23). The time from symptom onset until surgery varied: less than 3 months in 30% (n = 14), 3 to 6 months in 11% (n = 5), 6 to 12 months in 22% (n = 10), more than 1 year in 11% (n = 5), and more than 2 years in 26% (n = 12).

Clinical and Radiographic Evaluation

A complete chart review of preoperative appointments, preoperative data and radiographs, and operative reports was conducted for all patients. All clinical assessments were performed by a shoulder fellow and/or the senior author (L.L.). The physical examination included active range of motion, the lift-off test, and the belly-press test (BPT). Each patient underwent preoperative and postoperative evaluation with the Constant score[13] and modified University of California, Los Angeles (mUCLA) score.[14] Instead of evaluation of the SSP, the SSC was examined and used to calculate the mUCLA score. According to the UCLA score, a score of 34 to 35 points was rated as an excellent result, 29 to 33 points as a good result, and less than 29 points as a poor result.

The bear-hug test (BHT)[15] was performed on both the operative and nonoperative shoulders postoperatively. During SSC muscle strength testing using the BHT, we defined the point of maximal strength as the moment when the palm of the patient's hand was elevated from the contralateral shoulder. The force to displace the hand from the shoulder was measured with a spring gauge. The arm was positioned in 90° of flexion, and the hand was placed on the contralateral shoulder. The hand was lifted upward by use of a spring gauge as the patient resisted (Fig 1). The measured values of the healthy and operated shoulders were compared. Nine patients were found to have significant pain and pathology involving the contralateral shoulder and thus were not included. Finally, patients were asked to rate their shoulder using the subjective shoulder value[16] and to rate their overall level of satisfaction with the result of the procedure.

Preoperatively, all patients were evaluated with plain radiographs including anteroposterior, axial, outlet, and Bernageau views. All patients were asked to undergo a secondary shoulder imaging study, and at final follow-up, 39 patients (85%) agreed to undergo an examination with MRI or CTA. For these 39 patients, SSC integrity, the coracohumeral distance (CHD) according to Tan et al.,[17] and SSC fatty infiltration according to Goutallier et al.[18] (Fig 2) were evaluated. Two shoulder fellows of the senior author independently evaluated all MRI and CTA scans. Rerupture of the SSC was determined when findings of a retear were present on MRI or CTA evaluation and disability was present on clinical testing.

Operative Technique

All patients were anesthetized with both general and regional anesthesia. All procedures were performed with patients in the beach-chair position. All arthroscopic SSC repairs were performed as formerly described by the senior author (L.L.).[12] Standard arthroscopic portals were used, including posterior and lateral portals. Anterolateral, anterosuperior, and anteroinferior portals were used as working portals and for release of the subscapularis. For SSC release, anchor placement, and tendon fixation, the arthroscope was often placed in the lateral portal and the SSC was visualized through the resected rotator interval and/or the torn SSP tendon. Attention was then turned to circumferential release of the SSC and the coracohumeral ligament. When necessary, a traction suture was used to pull the tendon laterally while the surgeon was performing the release. After debridement of the tendon and the footprint, depending on the size of the lesion, 1 to 3 double-loaded suture anchors (Fastin RC metal, Spiralok, or Healix PEEK anchor; DePuy Mitek, Raynham, MA) were used. Mattress sutures were used. When possible, a lateral anchor was placed for double-row fixation of the subscapularis. In cases of combined tendon tears, the SSC repair was completed first. In 4 patients, 1 anchor was used for the SSC repair; in 37 patients, 2 anchors were used; and in 5 patients, 3 anchors were used. A proximal, arthroscopic tenodesis of the LHBT was performed in all cases in which the biceps was deemed pathologic. A suture anchor and a lasso loop stitch were used. In all patients an arthroscopic acromioplasty was performed, and in

Table 1. Subscapularis Tears According to Lafosse Classification[12]

Lafosse Type	SSC Tear
I	Partial lesion of superior one-third
II	Complete lesion of superior one-third
III	Complete lesion of superior two-thirds
IV	Complete lesion of tendon but head centered and fatty degeneration classified as less than or equal to stage 3
V	Complete lesion of tendon but eccentric head with coracoid impingement and fatty degeneration classified as more than or equal to stage 3

patients with a painful acromioclavicular joint, a distal clavicle resection was performed.

Postoperative Rehabilitation

The shoulder was immobilized in 30° of abduction for 6 weeks postoperatively. Passive motion of the shoulder was permitted. Immediate internal rotation (IR) to the abdomen, but not behind the back, was allowed. Passive ER to neutral and pain-free forward flexion were permitted under the supervision of a physiotherapist during the first 6 weeks after surgery. Thereafter unrestricted active-assisted forward flexion and rotation were allowed. After 3 months, strengthening of the rotator cuff was started.

Statistical Analysis

Descriptive statistics were used to present the patients' characteristics. The paired *t* test was used to examine the difference between the preoperative and postoperative means of continuous variables. The Wilcoxon test was used to compare non–normally distributed paired preoperative and postoperative data. The Mann-Whitney *U* test was performed to compare differences in clinical outcome scores (Constant score and mUCLA score) between Lafosse types, as well as between the rupture-pattern groups. Rupture patterns were grouped according to the tendon involvement of the rotator cuff lesion into isolated SSC, anterior-superior (SSC and SSP), and massive (SSC, SSP, and ISP) rupture. By use of the independent *t* test, continuous variables were compared between the Lafosse types and between the rupture groups. χ^2 Tests were used to compare rerupture rates between the groups. Statistical significance was reported at the $P < .05$ level (2 sided).

Results

A total of 35 patients (76%) had a type III lesion, and 11 (24%) had a type IV lesion. Isolated SSC tears were seen in 13% (n = 6) of the cohort. Combined lesions involving the SSP were found in 37% (n = 17), and the SSP and ISP were involved in 50% (n = 23). The teres minor was intact in all patients. In 100% of cases (N = 46), complete repair of the SSC was achieved. At the time of arthroscopy, the LHBT was normal in 3 cases (6.5%), eroded in 3 (6.5%), anteriorly subluxated in 8 (17.4%), anteriorly dislocated in 15 (32.6%), posteriorly dislocated in 2 (4.3%), and absent in 15 (32.6%). In cases of a pathologic LHBT, a tenodesis was performed (61%). An LHBT that had undergone tenotomy, an LHBT that had undergone tenodesis, or an absent LHBT did not significantly influence the clinical outcomes compared with patients with normal LHBTs (postoperative Constant score of 80.3 ± 14.8 *v* 77.2 ± 17.5).

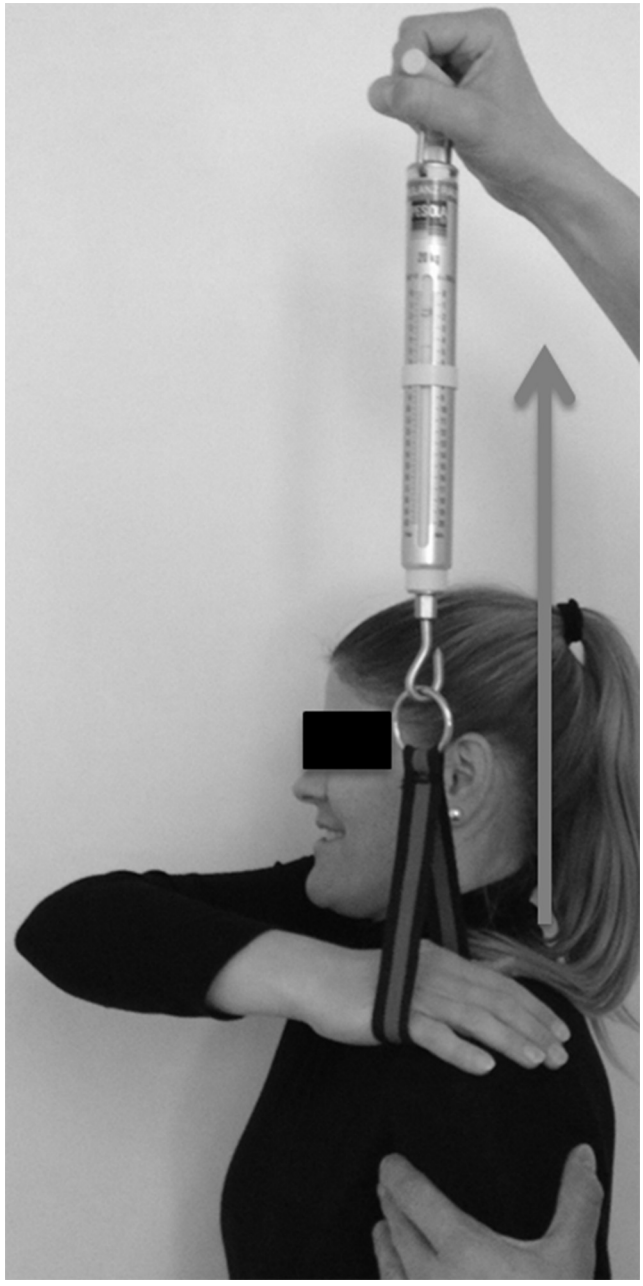

Fig 1. BHT strength measurement with a spring gauge with the arm in 90° of forward flexion and the hand placed on the contralateral shoulder.

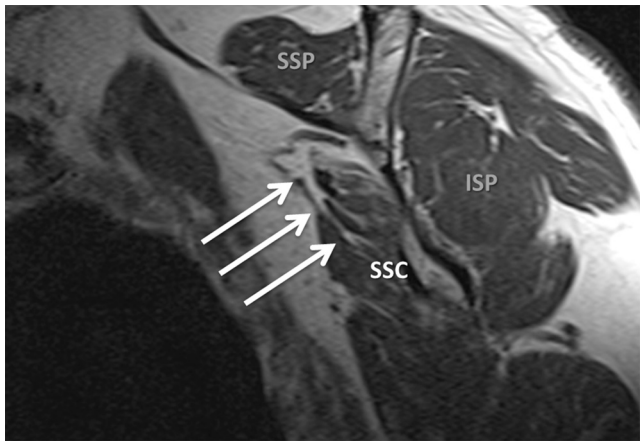

Fig 2. Sagittal T1-weighted MRI scan of a right shoulder in a 69-year-old male patient showing fatty infiltration (Goutallier stage 1) of the subscapularis muscle in the upper half of the muscle (arrows). MRI was obtained 24 months after repair of a Lafosse type III lesion.

The mean time to final follow-up was 35.3 ± 9.6 months (range, 23 to 57 months). The mean patient age was significantly higher for type III lesions compared with type IV lesions. IR was significantly lower in the retear group. Further details are listed in Table 2. Preoperatively, 31 patients had a positive lift-off test and 1 patient had a negative lift-off test. Fourteen patients had a severe IR deficit that prevented testing. Of those patients, 8 could bring their arm to the lateral thigh and 6 to the buttock in 0° of abduction. Forty-three patients had a positive BPT, and 3 patients had a negative BPT. Postoperatively, 14 patients had a positive lift-off test and 31 had a negative lift-off test. One patient was not tested because of lack of IR. Sixteen patients had a positive BPT and 30 had a negative BPT. All patients with MRI- or CTA-proven retears (n = 5) had a positive BPT and BHT.

The Constant score improved from a mean of 46.4 ± 15.0 points (range, 17 to 72 points) preoperatively to a mean of 79.9 ± 14.9 points (range, 41 to 100 points) postoperatively ($P < .001$). The age- and gender-adjusted Constant score improved from 56.5% ± 19.4% preoperatively to a mean of 100.8% ± 20.8% postoperatively ($P < .001$). The mUCLA score increased from 15.1 ± 5.0 points (range, 6 to 25 points) to 31.5 ± 5.5 points (range, 11 to 35 points) ($P < .001$). According to the mUCLA score, 78% of the cases (n = 36) achieved good to excellent results after surgery. The CHD did not significantly increase from preoperatively (9.7 mm) to postoperatively (10.1 mm) ($P = .086$). Table 3 shows preoperative to postoperative changes regarding fatty infiltration in patients with intact and reruptured tendons. Retear rates were lower in patients with stage 0 and 1 fatty infiltration preoperatively compared with those with stage 2, 3, or 4 (6% *v* 33%, $\chi^2 = 5.662$, $P = .017$).

Postoperative clinical examination showed a mean strength of the SSC measured with the BHT of 92% compared with the contralateral side. Patients with type III lesions tended to have increased SSC muscle strength compared with those with type IV lesions ($P = .063$) (Table 2). ER, measured with the elbow at the side, showed no significant side-to-side difference, with the operative shoulder reaching a mean of 96% of the contralateral side. A comparison of clinical outcome measures and physical examination findings between types and rupture forms is shown in Table 4.

The overall rerupture rate was 11%. Type III and type IV tears had rerupture rates of 9% (Fig 3) and 18% ($P = .372$), respectively. Further analysis showed that the duration of symptoms before surgery, comparing less than 6 months (n = 19) and more than 6 months (n = 27), did not have a significant influence on the rerupture rate in this study (5% *v* 15%, $\chi^2 = 1.050$, $P = .305$). With the χ^2 test, we could define the achieved power post hoc, which was calculated from an effect size of 0.46 and given α (.05). Therefore we calculated a power of 88% (calculated with G*Power 3.1.3; Heinrich-Heine University, Department of Experimental Psychology, Düsseldorf, Germany).

Regarding satisfaction with the procedure, 85% of patients (n = 39) stated that they were very satisfied, 13% (n = 6) were satisfied, and 2% (n = 1) were not satisfied at final follow-up. The mean subjective shoulder value significantly improved from 51.1% ± 20.1% before surgery to 88.1% ± 15.2% after surgery ($P < .001$).

Discussion

There is a paucity of information published on arthroscopic SSC repair.[2,3,10-12,19] This study reports

Table 2. Range of Motion Between Lafosse Types III and IV and Between Intact and Reruptured Tendons

	Lafosse			Tendon Integrity by MRI or CTA at Mean Follow-up of 35 ± 9.6 mo		
	Type III (n = 35)	Type IV (n = 11)	*P* Value	Intact (n = 41)	Rerupture (n = 5)	*P* Value
Age (yr)	63.3 ± 8.1	57.8 ± 6.3	.048	62.1 ± 8.3	61.0 ± 5.7	.776
Forward flexion (°)	161.0 ± 19.6	152.7 ± 30.0	.291	159.6 ± 20.6	154.0 ± 37.1	.601
ER (°)	53.9 ± 16.2	64.1 ± 16.9	.077	56.0 ± 16.2	59.0 ± 23.0	.708
IR	T12 (glut-scap)	T12 (glut-scap)	.187	T12 (glut-scap)	SI (glut-T12)	.018

NOTE. The values are given as mean ± standard deviation.
Glut, gluteal level; scap, scapular level.

Table 3. Changes in Fatty Infiltration From Preoperatively to Postoperatively Between Intact and Reruptured Tendons

	Intact Tendons	Reruptured Tendons
Increase in fatty infiltration by 1 grade	7	1
Increase in fatty infiltration by 2 grades	1	1
No change	26	3

outcomes at 2 years' follow-up or greater after arthroscopic repair of full-thickness SSC tears involving at least two-thirds of their insertions (Table 5).

The mean age in our study was slightly higher than that in previous studies.[4,20,21] The significant postoperative improvement in the mUCLA score in our study is consistent with the results of other authors[3,19,22] and further supports the notion that arthroscopic repair is a reliable technique for the treatment of SSC tears. Our study showed no age difference between the intact and rerupture groups, which is supported by the findings of Flury et al.,[4] who investigated similar sized tears treated with open surgery. On the contrary, Ide et al.[19] found the rerupture group to be significantly older (68.4 years *v* 58.1 years). In our study the patients with type IV lesions were significantly younger than those with type III lesions. At present, we do not have an explanation for this finding because we would expect the opposite to be true.

Namdari et al.[23] and Bartl et al.[24] showed that ER returns to a similar magnitude compared with the contralateral side postoperatively. In this study postoperative ER showed no significant difference compared with the contralateral shoulder. We believe that an extensive release and mobilization of the SSC and of the coracohumeral ligament are crucial for a reliable return of ER postoperatively.

IR strength after SSC repair has been measured by several authors[22,23] using the 0 to 5 scale of the Medical Research Council.[25] These authors found significantly improved strength comparing preoperative with postoperative states. Namdari et al.[23] used the contralateral shoulder as a control for the comparison of strength, and they found that the operative extremity reached 101% of the contralateral side. Instead of a scale from 0 to 5, Flury et al.[4] measured strength in kilograms using a strain gauge and found no significant difference in IR strength between the 2 sides. Our study confirms the findings of Flury et al. and Namdari et al. and further supports satisfactory recovery of IR strength after arthroscopic SSC repair.

Flury et al.[4] performed a tenodesis of the LHBT in 57% of cases. They found no significant difference in outcomes comparing tenodesis versus no tenodesis. Namdari et al.[23] described pathologies of the LHBT in 77% of cases and treated them either with tenodesis, with tenotomy, or with relocation, with no significant difference in outcome. In contrast, Bartl et al.[24] found a significantly worse Constant score in patients who were treated with recentering of the LHBT compared with those who underwent tenodesis. Kim et al.[21] found the LHBT to be pathologic in 86% of cases and performed a tenodesis in these cases, without an effect on the outcome compared with the group with an unaffected LHBT. In our study the LHBT was pathologic or absent in 94% of patients. Given the role of the LHBT in SSC tears[7] and the high rates of biceps disorders in SSC tears, we agree with Bartl et al.[24] and Burkhart and Tehrany[3] that compromise of the biceps pulley and/or a pathologic LHBT is an appropriate indication for tenodesis or tenotomy.

Subcoracoid impingement, the roller-wringer effect,[6] and a narrowed CHD[2] are described as possible causes for SSC tears. Contrarily, Nové-Josserand et al.[26] noted that the coracoid process is not the mechanical factor responsible for SSC rupture. In contradiction to Lo and Burkhart,[6] they found that the narrowing of the CHD is the consequence of a large cuff tear involving the SSC. They concluded that anterior translation of the humeral head in the horizontal plane is due to fatty infiltration and degeneration of the SSC and leads to a narrowing of the CHD.

Conversely, Adams et al.[22] found subcoracoid impingement that required coracoplasty in 43% of their patients. In our study coracohumeral impingement was not detected, and no significant difference in preoperative versus postoperative CHD was found.

Flury et al.[4] reported a 13% rerupture rate of the SSC after a mean follow-up period of 35 months. Bartl et al.[27] found a 7% rerupture rate after a mean follow-up period of 46 months in a series of open repairs for traumatic SSC ruptures. Ide et al.[19] reported a 15% rate of rerupture after a mean follow-up period of 36 months after arthroscopic repair of traumatic Lafosse type II and type III lesions. Warner et al.[28] reported residual SSC dysfunction or rupture of the tendon repair in 53% of cases. Nové-Josserand et al.[26] found a rerupture rate of 14% in their arthroscopic repair group and an 8% rate in their open repair group. In our study we found an 11% rerupture rate. Similar to Flury et al., we found significantly lower retear rates in patients with lower stages (stage 0 and stage 1) of fatty infiltration compared with those with higher stages. Unlike Flury et al., we did not find a correlation between the time from the onset of shoulder symptoms until surgery and the rerupture rate.

We found a significant number of patients with a positive lift-off test and BPT postoperatively. We agree with Bartl et al.,[24,27] who described similar findings, and we believe that a stable transverse force couple yields a good clinical outcome despite persistently positive BHTs and BPTs.

Furthermore, we found a significant improvement in the Constant score and the mUCLA score. Similar results have been published by various authors.[4,10,24,28]

Table 4. Outcome Measures Grouped Into Lafosse Types III and IV and Into Rupture Forms

	Preoperative			Postoperative					
	Constant Score Total	mUCLA Score	Distance Between Humeral Head and Coracoid Tip	Constant Score Total	mUCLA Score	BHT Strength Comparing Operative Arm With Healthy Arm	ER Comparing Operative Arm With Healthy Arm	Distance Between Humeral Head and Coracoid Tip	No. of Patients With Rerupture/ Total No. of Patients
Lafosse									
Type III	45.6 ± 14.4 points	15.1 ± 4.9 points	9.89 ± 3.4 mm	81.7 ± 13.1 points	32.3 ± 3.3 points	96.6% ± 27.2%	97.7% ± 29.3%	10.4 ± 3.8 mm	3/35
Type IV	48.8 ± 17.3 points	15.1 ± 5.3 points	9.27 ± 2.6 mm	74.2 ± 19.1 points	29.0 ± 9.5 points	76.9% ± 25.5%	90.6% ± 16.8%	9.2 ± 2.7 mm	2/11
P value for type III *v* type IV	.538	.989	.586	.144	.840	.063	.450	.362	.372
Surgical procedure									
Isolated SSC repair	46.2 ± 19.5 points	14.2 ± 4.5 points	11.7 ± 5.4 mm	77.3 ± 20.0 points	30.0 ± 8.9 points	78.6% ± 17.1%	104.7% ± 22.9%	12.6 ± 5.5 mm	0/7
SSC + SSP repair	48.6 ± 12.1 points	16.6 ± 4.7 points	10.0 ± 3.4 mm	81.2 ± 14.6 points	32.5 ± 3.7 points	100.4% ± 33.5%	98.9% ± 33.4%	10.5 ± 4.2 mm	2/20
SSC + SSP + ISP repair	44.7 ± 16.2 points	14.3 ± 5.2 points	9.0 ± 2.2 mm	79.7 ± 14.3 points	31.2 ± 5.7 points	88.9% ± 24.2%	91.5% ± 22.2%	9.2 ± 2.0 mm	5/26
P value for isolated repair *v* SSC + SSP repair	.940	.562	.517	.852	.621	.295	.896	.470	.385
P value for isolated repair *v* SSC + SSP + ISP repair	.977	.999	.180	.941	.890	.742	.540	.098	.208
P value for SSC + SSP repair *v* SSC + SSP + ISP repair	.712	.315	.612	.943	.748	.479	.666	.526	.387

NOTE. The values are given as mean ± standard deviation.

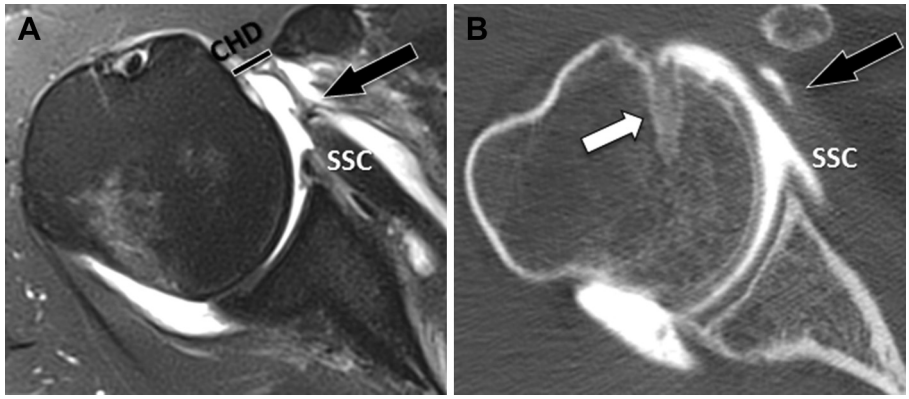

Fig 3. (A) Axial T1-weighted MRI scan of a right shoulder in a 69-year-old male patient showing a Lafosse type III SSC tear (arrow) before surgery and the CHD (line). (B) Axial view in ER of a CTA scan showing a repaired SSC (black arrow) and a resorbable anchor (white arrow) in situ at the latest follow-up in the same patient.

Table 5. Summary of Other Studies' Results and Our Results

Author	Open/ Arthroscopic	Isolated/Anterosuperior/ Massive	Tear Size (SSC)	Mean Age (yr)	Mean Follow-up (mo)	Age- and Gender-Adjusted Constant Score	IR Strength: OP *v* NOP	Rerupture Rate (SSC)
Gerber et al.[20] (1996)	Open	Isolated	100%	50	43	82%	—	0.6%
Flury et al.[4] (2006)	Open	Isolated, anterosuperior	≥66%	56	35	96%	$P > .05$	13%
Ide et al.[19] (2007)	Arthroscopic	Anterosuperior/ massive	100%	62	36	—	—	15%
Namdari et al.[23] (2008)	Open	Anterosuperior	>50%	57	56	93%	$P > .05$	Not reported
Bartl et al.[27] (2011)	Open	Isolated	33%-100%	43	46	92%	—	7%
Bartl et al.[24] (2012)	Open	Anterosuperior	25%-100%	58	50	91%	$P < .001$	4%
Current study	Arthroscopic	Isolated/ anterosuperior/ massive	≥66%	62	35	101%	$P > .05$	11%

NOTE. Isolated indicates an isolated SSC repair, anterosuperior indicates SSC repair combined with SSP repair, and massive indicates SSC repair with SSP and ISP repair.

NOP, nonoperative contralateral shoulder; OP, operative shoulder.

We had a high satisfaction rate, and we believe that this is a result of the significant functional improvements and pain relief provided by effective repair of the SSC. The only patient who was not satisfied had an SSC rerupture, shoulder pain, and a low Constant score at final evaluation.

Limitations

This study has a number of shortcomings that should be noted. First, this study involves a retrospective cohort of patients with large SSC tears. Although this may raise concerns regarding bias inherent in this study design, the patient population represents a series of consecutive patients treated by a single surgeon, and this should minimize this concern. Unfortunately, with the retrospective design, preoperative strength values were not recorded for the BPT in our study. Therefore we were not able to compare preoperative and postoperative strength in the operative extremity. As previously validated, we compared the strength of the operative extremity with that of the healthy side. We did not consider concomitant procedures including distal clavicle resection and acromioplasty as confounding factors, first because the majority of patients (78%) received a distal clavicle resection and all of them had acromioplasty. Second, we did not find residual pain in patients with previous distal clavicle resection. This study is also limited by its short-term follow-up in this patient population. Clearly, further follow-up is warranted to assess longer-term outcomes. In addition, not all patients agreed to return to undergo MRI or CTA imaging at final follow-up. As a result, the retear rate of 11% may be an underestimation of the actual rate of reruptures in this group. Although significant efforts were made to obtain imaging in all patients, the practice of the senior surgeon represents a tertiary referral center, where patients often travel long

distances for evaluation and surgery. Thus a small number of patients refused to return for imaging, citing financial and time-related reasons. Despite these limitations, this study represents the first short-term to midterm follow-up study of arthroscopically treated large SSC tears and, thus, adds considerable value to the current body of literature.

Conclusions

Arthroscopic treatment of large to massive SSC ruptures results in significant clinical improvements, excellent maintenance of muscle strength, and durable tendon integrity at 2 to 4 years' follow-up.

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