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Original article

Does partial tear repair of adjacent tendons improve the outcome of supraspinatus tendon full-thickness tear reinsertion?



C. Nich*, N. Dhiaf, M. Di Schino, B. Augereau

Department of Traumatology and Orthopaedic Surgery, Medical school Paris 5 René-Descartes, European Hospital of Paris, Assistance publique-Hôpitaux de Paris, 20-40, rue Leblanc, 75908 Paris cedex 15, France

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ABSTRACT

Background: Partial tearing of the infraspinatus and/or subscapularis tendon(s) is frequently associated with supraspinatus full-thickness tears. However, limited data regarding its influence on supraspinatus surgical repair is available.

Purpose: Our aim was to assess the functional and anatomical outcomes of open repair of supraspinatus full-thickness tears combined with adjacent partial tearing, comparatively to a control.

Methods: We retrospectively identified 22 patients (22 shoulders) with a partial tear, most of them being a delamination tear, of the infraspinatus and/or subscapularis tendons associated with a complete detachment of the supraspinatus tendon. Twenty-seven patients (27 shoulders) treated for an isolated complete detachment of the supraspinatus tendon by open repair served as controls. The mean age was 58 years. A proximalized trans-osseous reinsertion of the supraspinatus tendon was combined with a curettage-closure of the delamination tear. Patients were evaluated with standardized MRI at last follow-up.

Results: At a mean of 75-month follow-up, the presence of a partial tear of either infraspinatus or subscapularis, or both, did not influence function and healing rates of supraspinatus tendon repair. Conversely to the control, when a retear occurred, the functional score tended to worsen. Preoperatively, fatty muscular degeneration was more pronounced when a partial tear was present. Fatty degeneration worsened regardless of repair healing.

Conclusion: Open reinsertion of a supraspinatus full-thickness tear associated with a thorough treatment of partial tear of adjacent tendons led to optimal functional and anatomical mid term outcomes. Our results suggest the presence of a partial tear of adjacent tendons could be associated with poorer function in case of supraspinatus tendon re-rupture.

Level of evidence: Level III case-control study.

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1. Introduction

Rotator cuff tears are a common source of pain and dysfunction in the adult. Cuff tear size and location are variable and their impact on global shoulder function is unclear [1,2]. However, there is general consensus that surgical repair of massive tears are associated with higher failure rates [3–9] as compared to surgical repair of small to intermediate tears [5,6,9–12]. Risk factors for anatomic failure following surgical repair include age older than 65 years, number and degree of retraction of torn tendons, and fatty degeneration (FD) of the rotator cuff muscles. A proximalized tendon-bone reinsertion located at the cartilage-bone junction

allows for a tension-free repair of the torn tendons. Using this technique, we recently showed that repair of complete detachment of either superior or superior-posterior or anterior-superior cuff tears resulted in reliable improvement in function and pain in rotator cuffs with limited FD [13,14].

Partial tearing, including delamination, of adjacent tendons to the supraspinatus tendon, is a common finding. Although the exact prevalence is debated, it has been suggested that delaminated tendon tears would be present in at least 20% cases of rotator cuff full thickness tears [1,12,15–18]. The influence of partial tears on post-operative function and tendon healing is still unclear, one reason being that its frequency might have been underestimated. Specifically, detecting the presence of delamination using arthroscopy has been reported to be difficult. Recently, it was shown that delamination tearing of subscapularis and infraspinatus tendons was associated with higher failure rates of supraspinatus arthroscopic

* Corresponding author. Tel.: +33 1 56 09 32 78; fax: +33 1 56 09 23 96.
 E-mail addresses: chnich@gmail.com, christophe.niche@egp.aphp.fr (C. Nich).

repair [18]. On the other hand, open repair of tendon complete detachment with curettage of associated delamination tears provided satisfying subjective [1], functional and anatomical results [12]. Taken together, these data suggest that partial tears, notably delamination tearing, should be thoroughly assessed and treated. However, given the lack of control in most studies and short term follow-up, it is unclear whether the treatment of partial tears would result in optimal function and repair healing as observed in isolated tears of the supraspinatus tendon in the mid to long-term. Therefore, we aimed to evaluate the functional and anatomical outcome of open repair of full thickness supraspinatus tendon tear associated with partial tearing of either the infraspinatus and/or subscapularis tendon(s), comparatively to a control group of open repair of isolated full thickness tear of the supraspinatus tendon.

2. Material and methods

2.1. Material

Between March 1998 and January 2005, 128 consecutive open repairs of a torn rotator cuff tear were performed by the senior surgeon (B.A.) in 119 patients. For this specific focus, we selected patients from our database, who have been reported as part of previous studies [13,14]. The criteria for inclusion in this report were:

- the presence of a chronic full thickness detachment of the supraspinatus tendon retracted on the humeral head apex associated with a partial tear of either the infraspinatus tendon or the subscapularis tendon or both;
- a cuff tear treated exclusively with use of open technique;
- an age younger than 65 years and/or the need to improve shoulder function;
- a minimum 3-year clinical and radiographic follow-up after surgery.

Patients were excluded if the rotator cuff had had a previous surgical procedure, if an irreparable tear, defined as a torn supraspinatus tendon retracted to the glenoid rim, was present, and if severe osteoarthritis according to Samilson and Prieto [19] or rheumatoid disease of the glenohumeral joint was present.

Investigational Review Board approval was not required for this study because it was a retrospective review of patients who were followed up as part of routine clinical care. Each author certifies all investigations were conducted in conformity with the ethical standards of the responsible committee on human experimentation.

2.2. Methods

All lesions were assessed on a preoperative computed tomography (CT)-arthrogram and confirmed intraoperatively. Partial tendon tears were defined either as a detachment of the superior third of the subscapularis muscle tendon or as a delamination tendon tear involving at least one third of the tendon. Delamination tear corresponded to horizontal retraction of either the bursal or articular surface of the tendon, and/or interstitial horizontal splitting of the tendon, on reconstructed CT images. Twenty-two patients (22 shoulders) met the inclusion criteria, including nine-male and thirteen female patients. All patients had chronic shoulder pain that had been treated medically, with physiotherapy and/or with subacromial injection of cortisone. The mean duration of symptoms before the surgical procedure was 26 months (range 6–144). The mean age at the time of surgery was 58.4 (± 7) years (range 47–71). The right shoulder was treated in 18 patients, and the left shoulder was treated in 4 patients. The dominant shoulder was involved in 19 cases (86%). The 22 patients were evaluated clinically and with use of standard radiographs, at a minimal 46-month follow-up (mean 75 months; range 46–108).

As determined with preoperative CT-arthrogram, a complete tear of the supraspinatus tendon was associated with a delamination tear of the infraspinatus tendon in 8 shoulders (A), with a delamination tear or a detachment of the superior third of the subscapularis tendon in 6 shoulders (B), and with a partial tear of both infraspinatus and subscapularis tendons (8 shoulders) (C). To perform a global analysis on the influence of repair of partially torn adjacent tendons on the functional and anatomical outcome of supraspinatus tendon open repair, the 3 groups (A+B+C) were pooled and constituted the “Studied Group” and were compared to a “Control Group”. The Control Group included 27 shoulders (27 patients) with an isolated complete detachment of the supraspinatus tendon operated during the same time interval. In this group, 2 patients (2 shoulders) were lost to follow-up. Therefore, the 25 remaining shoulders composed the Control Group, and were evaluated at a mean follow-up of 97.5 (± 22) months (range 59–133). Demographics are summarized in Table 1.

The surgical technique of trans-osseous reinsertion of the supraspinatus tendon through a superolateral approach has been previously described in details [13]. Briefly, an anteroinferior acromioplasty, and a release of the coracoacromial ligament were systematically associated. After excision of the abnormal bursal tissue, the degenerative supraspinatus tendon tear border was excised. The intervals between the supraspinatus and the subscapularis tendons and between the supraspinatus and the infraspinatus tendons were systematically opened, and combined with a release of the capsule-labrum junction to allow lateral mobilization of the torn tendon. Partial tears of either adjacent tendon were identified through the intervals, in accordance with

Table 1
Demographics in different groups.

Data	Studied group				Control group	P value
	A	B	C	Total		
n (shoulders)	8	6	8	22	27	–
Age (mean) (yrs)	60 (SD 8)	57 (SD 6.5)	58 (SD 7)	58.4 (SD 7)	56.5 (SD 7)	0.17
M/F	4/4	1/5	4/4	9/13	11/16	0.34
Body mass index (mean)	27 (SD 5.3)	25.3 (SD 3.2)	26.8 (SD 3.6)	26.5 (SD 4)	25 (SD 3.5)	0.08
Worker compensation	1	1	1	3	3	0.3
Tobacco history	2	2	2	6	5	0.17
Trauma history	0	2	4	6	2	<0.001
Delay symptoms–surgery (mean) (mths)	35.6 (SD 45)	14.6 (SD 5.8)	24.8 (SD 20.5)	26 (SD 30)	28.5 (SD 25)	0.37

A: full-thickness tear of the supraspinatus tendon + delamination tear of the infraspinatus tendon; B: full-thickness tear of the supraspinatus tendon + delamination tear of the subscapularis tendon; C: full-thickness tear of the supraspinatus tendon + delamination tear of both infraspinatus and subscapularis tendons; control: isolated full-thickness tear of the supraspinatus tendon; yrs: years; M/F: male/female; mths: months; SD: standard deviation.

the preoperative arthrogram. No delaminated tendon was detached from its bony insertion. The delaminated tears were treated with curettage and closed using a trans-tendinous U nonadsorbable suture technique (Mersuture; Ethicon; Johnson and Johnson, Westwood, MA). Tenodesis of the long head of the biceps was performed in 11 cases in the Studied Group (2 cases in group A, 3 in group B, and 6 in group C) and in 4 cases in the Control Group, because it either was degenerated or dislocated. If detached, the superior border of the subscapularis tendon was reinserted on the lesser tuberosity using two or three nonabsorbable anchors (Quick Anchor Plus; Mitek; Norwood, MA) after local debridement. Once the supraspinatus tendon has been reinserted in its osseous proximalized trough, the different intervals were closed with nonadsorbable sutures (Mersuture) to ensure the cuff repair was watertight.

The postoperative rehabilitation protocol used in our Department has been previously reported in details [14]. Briefly, cuff repairs were protected in an abduction (60°) and neutral rotation brace for 6 weeks. All postoperative exercises were performed under the supervision of a physiotherapist in a rehabilitation unit. Passive mobilization of the shoulder above the abduction level of 60° started once a day two to three days after surgery. External rotation remained unauthorized for 6 postoperative weeks. After 6 weeks, active shoulder range-of-motion exercises and self-assisted pendulum were started. Progressive strengthening of the joint started after 12 weeks.

Patients were evaluated before surgery and with clinical examinations at 6 weeks, 3 months, 6 months, and 1 year postoperatively. Shoulder function was reported according to the score of Constant and Murley [20]. Pain was evaluated using a visual analog scale ranging from 0 (severe pain) to 15 (no pain). At last follow-up, we assessed range-of-motion and evaluated abduction strength using a digital dynamometer with the arm abducted 90°.

Standardized radiographic examinations (anteroposterior radiographs of the glenohumeral joint in internal, external, and neutral rotation, and a scapular Y view) were obtained for each patient preoperatively and at the latest follow-up. Arthritis of the glenohumeral joint was categorized according to Samilson and Prieto [19]. None shoulder was considered free of arthritis. Osteoarthritis was considered as mild in 21 shoulders, and moderate in one. No shoulder had severe osteoarthritis. Subacromial space (SAS) height was measured on plain anteroposterior radiographs of the glenohumeral joint in neutral rotation. The preoperative SAS height ranged from 5 to 12 mm with a mean of 9 (±1.5) mm.

According to the staging system of Goutallier et al. [11], the mean global fatty degeneration index (GFDI) before surgery was 0.92 (±0.5) (range 0–2). Supraspinatus muscle atrophy was measured on the most lateral image on which the scapular spine was in contact with the scapular body on the oblique and sagittal views (the Y-shaped view) as described previously [9]. We obtained the standardized muscle area (SMA) defined by the cross-sectional area of the muscle to the cross-sectional area of the fossa, using an image

analysis software. Preoperative radiologic and computed tomography data are presented in Table 2.

At the time of last follow-up, repaired tendon healing, fatty degeneration of the rotator cuff muscles, and supraspinatus muscle atrophy were evaluated with standardized MRI (Signa; GE Healthcare Technologies, Waukesha, WI), as previously described [13]. We assessed healing or re-rupture of the repaired supraspinatus or subscapularis tendon on oblique coronal fast spin echo fat-saturated T2-weighted sequences. We assessed FD according to a classification derived from Goutallier et al. [11] as adapted for use with MRI [21] on oblique parasagittal T1-weighted views.

2.3. Statistics

Numerical data are presented as mean with standard deviation. We determined differences in the Constant-Murley score, pain scores, and strength between the preoperative and postoperative periods within each group using the nonparametric test of Wilcoxon (paired groups). Discrete variables, including sex and arthritis stage were analysed using a χ^2 test. Findings in the Studied Group were compared with those in the Control Group using the Mann-Whitney U test. The level of statistical significance was set at $P < 0.05$.

3. Results

Preoperatively, demographic parameters were similar in the Studied Group and in the Control Group, except for the item “trauma history” (χ^2 test, $P < 0.001$), indicating that the later could be associated with partial tearing of the rotator cuff. Conversely, neither age, sex, body mass index, worker compensation, tobacco history and delay between onset of symptoms and surgery were statistically associated with partial tearing (Table 1).

Preoperatively, no significant difference for the absolute and relative Constant-Murley scores was found between the Studied Group and the Control Group (Mann-Whitney U test, $P = 0.36$ and $P = 0.30$, respectively). The mean Constant-Murley scores improved postoperatively in the Studied Group and in the Control Group (Table 3). Postoperative relative Constant-Murley scores were comparable in both groups (Mann-Whitney U test, $P = 0.08$). Similar to the Control, we noted no significant improvement in active flexion, in active abduction, and in internal rotation in the Studied Group. Conversely, active external rotation improved postoperatively (Wilcoxon test, $P = 0.018$) in the Studied Group, but remained consistently lower than in the Control Group (Wilcoxon test, $P < 0.001$). In the Studied Group, abduction strength improved postoperatively (Wilcoxon test, $P = 0.008$), and ultimately reached the same level as for the Control (Mann-Whitney U test, $P = 0.17$). We noted an improvement in activities of daily living in all groups (Wilcoxon test, $P < 0.0001$), and no difference at the last follow-up for this parameter between groups (Mann-Whitney U test, $P = 0.40$). With the numbers available, postoperative functional

Table 2
Radiologic and CT characteristics before surgery.

Variables	Studied group				Control group	P value
	A	B	C	Total		
n	8	6	8	22	27	–
Standardized muscle area (mean)	0.66 (SD 0.28)	0.5 (SD 0.4)	0.56 (SD 0.32)	0.58 (SD 0.3)	0.64 (SD 0.24)	0.2
Global Fatty Degeneration Index (mean)	0.92 (SD 0.5)	0.5 (SD 0.4)	1.25 (SD 0.5)	0.9 (SD 0.5)	0.44 (SD 0.3)	<0.001
Arthritis ^a (0/mild/moderate)	0/8/0	0/5/1	0/8/0	0/21/1	7/18/2	0.02
Subacromial space height (mean) (mm)	8.75 (SD 1.1)	9 (SD 1)	9.25 (SD 2.1)	9 (SD 1.5)	10.15 (SD 1.9)	0.01

A: full-thickness tear of the supraspinatus tendon + delamination tear of the infraspinatus tendon; B: full-thickness tear of the supraspinatus tendon + delamination tear of the subscapularis tendon; C: full-thickness tear of the supraspinatus tendon + delamination tear of both infraspinatus and subscapularis tendons; control: isolated full-thickness tear of the supraspinatus tendon.

^a According to Samilson and Prieto [19].

Table 3
Functional parameters in different groups (means).

Clinical Parameters	Studied group									Control group (n = 25)		
	A (n = 8)		B (n = 6)		C (n = 8)		Total (n = 22)			Preop	Postop	P value
	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	P value			
<i>Constant-Murley score</i>												
Absolute (points)	56.5	72	62	76	55	84	57.5	82	<0.0001	56	76	<0.0001
Relative (%)	69.1	91.5	82	102	67	104	72	97	<0.0001	70	94	<0.0001
Pain score (points)	6.3	13	10	11	7.4	14.5	7.8	12.9	<0.0001	5.8	12.6	<0.0001
Activities of daily living score (points)	13.8	16	14	16.5	13	19	13.7	17.4	<0.0001	9	17	<0.0001
<i>Active motion (degrees)</i>												
Flexion	138	125.6	121	144	135.6	150	133	140	0.17	130	133	0.28
Abduction	126	114	122	134	124	148	124	132	0.16	125	124.4	0.39
External rotation	45	32	31	23	42	38	40	32	0.018	41	44	0.21
Internal rotation (thoracic level reached with thumb)	6.7	5.2	6.3	5.6	8.2	7.5	7.3	6.4	0.11	7.2	6.7	0.23
<i>Abduction strength</i>												
Kilograms	4	6.3	6.3	8	3.3	7.1	4.4	6.8	0.008	5.3	6	0.09
Points	8	12.3	12.6	16	6.8	14.3	8.9	13.7	0.008	10.7	12.1	0.09

A: full-thickness tear of the supraspinatus tendon + delamination tear of the infraspinatus tendon; B: full-thickness tear of the supraspinatus tendon + delamination tear of the subscapularis tendon; C: full-thickness tear of the supraspinatus tendon + delamination tear of both infraspinatus and subscapularis tendons; control: isolated full-thickness tear of the supraspinatus tendon; preop: preoperatively; postop: postoperatively.

scores were similar within each group, respectively, regardless whether a biceps tenodesis had been performed.

Four patients (4 shoulders) in the Studied Group and 2 patients (2 shoulders) in the Control Group were unable to return for post-operative MRI for reasons not related to the results of the surgery. Healing of supraspinatus tendon repair was noted in 16 of the 18 shoulders in the Studied Group. No de novo detachment was observed in the other rotator cuff tendons, similar to the control. Specifically, healing of delamination tear repair was associated with a thinning of repaired tendons, and no recurrence of delamination tearing could be observed in either tendon. Healing rates of the supraspinatus tendon in the Studied Group were similar compared to the control (Table 4). All retears appeared smaller on the MRI than the preoperative tears.

In the Studied Group, standardized muscle area remained stable whether supraspinatus tendon repair had healed or not, and was similar between healed and torn rotator cuff postoperatively. Conversely, in the Control Group, when a re-tear occurred, standardized muscle area was found lower as compared to healed repairs (Table 4). Postoperatively, GFDI worsened in both groups,

regardless of repair healing. Although GFDI was worst in the Studied Group compared to the Control Group before surgery, after healing, GFDI reached similar values in both groups.

In the Studied Group, the two shoulders with tendon retears had lower Constant-Murley scores compared with those with healed repairs. Specifically, this was related to a consistent loss of strength and a decrease in activities of daily living. Conversely, in the Control Group, the four shoulders with tendon retears had similar Constant-Murley scores compared with those with healed repairs.

According to the Samilson classification, glenohumeral arthritis never worsened in any group between the pre- and the postoperative periods (K χ^2 test, $P=0.33$ in the Studied Group and $P=0.32$ in the Control Group). In the Studied Group, mean subacromial space height was stable at follow-up, from (9 ± 1.5 mm preoperatively vs 9.8 ± 2.6 mm postoperatively, Wilcoxon test, $P=0.12$), and in the Control Group (10.15 ± 1.9 mm preoperatively vs 10.7 ± 1.8 mm postoperatively, Wilcoxon test, $P=0.13$). Although mean preoperative SAS height was lower in the Studied Group compared to the Control Group (9 mm vs 10.15 mm, Mann-Whitney U test, $P=0.01$), no significant difference was found between groups at last

Table 4
Radiologic and MRI findings at last follow-up as a function of rotator cuff tendon integrity.

Variables	Studied group								Control group (n = 23)	
	A (n = 5)		B (n = 6)		C (n = 7)		Total (n = 18)		Healed	Torn
	Healed	Torn	Healed	Torn	Healed	Torn	Healed	Torn		
<i>Rotator cuff tendon</i>										
SSP (n)	3	2	6	–	7	–	16	2	19	4
IP (n)	5	–	–	–	7	–	12	–	–	–
SSC (n)	–	–	6	–	7	–	11	–	–	–
SMA (mean)	0.70	0.55	0.65	–	0.52	–	0.60	0.55	0.66	0.47
GFDI (mean)	1.55	1	0.83	–	1.52	–	1.2	1	1.5	1.4
Arthritis ^a (0/mild/moderate)	0/3/0	0/2/0	0/5/1	–	0/7/0	–	0/15/1	0/2/0	5/11/3	2/2/0
SAS height (mean) (mm)	9	6.5	10.7	–	10.7	–	10.1	6.5	10.8	10.2
FU (median) (mths)	73 (46–108)		71.5 (62–105)		77.5 (61–98)		75 (46–108)		103 (60–133)	

A: full-thickness tear of the supraspinatus tendon + delamination tear of the infraspinatus tendon; B: full-thickness tear of the supraspinatus tendon + delamination tear of the subscapularis tendon; C: full-thickness tear of the supraspinatus tendon + delamination tear of both infraspinatus and subscapularis tendons; control: isolated full-thickness tear of the supraspinatus tendon; SSP: supraspinatus muscle tendon; IP: infraspinatus muscle tendon; SSC: subscapularis muscle tendon; SMA: standardized muscle area; GFDI: global fatty degeneration index; SAS: subacromial space; FU: follow-up; mths: months.

^a According to Samilson and Prieto [19].

follow-up (9.7 mm vs 10.7 mm, Mann-Whitney U test, $P=0.08$). We found lower postoperative SAS in the Studied Group after repair failure (6 and 7 mm), but SAS height in the Control Group was not influenced by supraspinatus tendon healing (Table 4).

In the Studied Group, two patients had postoperative reflex sympathetic dystrophy and received medical treatment. At follow-up, they both reported persistent pain and lack of motion. MRI imaging was obtained in one of these cases, and showed healing of the repair. No additional procedure was performed in this group. Three patients had postoperative reflex sympathetic dystrophy in the Control Group. In this group, an additional procedure was performed in one patient for open repair of a complete detachment of the infraspinatus tendon 29 months after the initial supraspinatus repair.

4. Discussion

Although functional and anatomical results of surgical repair of full thickness tear of the supraspinatus tendon have been extensively reported [3,4,8,13], few information regarding the impact of associated partial tear of either the subscapularis tendon, or the infraspinatus tendon, or both, is available [1,12,18]. In particular, clinical studies have suggested delamination to be a negative factor in rotator cuff arthroscopic repair [18]. We therefore aimed to evaluate the functional and anatomical results of surgical repair of partial tears, most of them characterized as delaminated, associated with a full thickness tear of the supraspinatus tendon, in comparison with a group of isolated full thickness tears of the supraspinatus tendon as a control.

We recognize that some limitations may have affected our findings, one being that patient cohorts were small. Therefore, although the study was controlled, data should be interpreted with caution given the potential lack of statistical power and need to be confirmed on larger series. Specifically, in order to increase the statistical power of our study, we combined different types of tears, with possible different pathogenesis, in the so-called “studied group”. We recognize this may introduce some confusion. However, we believe it is relevant with our surgical practice, since associated partial tears to the supraspinatus tendon are not so uncommon, and there is no consensus in the literature with regard to their treatment. Second, postoperative MRI may have underestimated small and partial-thickness recurrent cuff tears, although we employed restrictive criteria for the diagnosis of re-rupture [13]. We cannot exclude that the nature of the tear, traumatic or degenerative, may have influenced functional and anatomic pre and postoperative parameters, although preoperative structural parameters, such as supraspinatus tendon retraction degree, fatty muscular degeneration, and belly muscle atrophy were clearly defined. Last, the choice of a control group including full thickness tears of the supraspinatus tendon without associated delamination tear is debatable. Hence, the ideal control group would have been a group of full thickness tears of the supraspinatus tendon with unrepaired delamination, to highlight the interest of treating such tears. However, we believe that the behaviour of repaired partially torn tendons in the current study, similar from a functional point of view with healthy tendons, indicates that our treatment was safe and restored satisfying shoulder function.

Preoperatively, we found no association between demographic parameters such as patient age, sex, body mass index, worker compensation history, tobacco use, the delay between onset of symptoms and surgery and the presence of a partial tendon tear. This observation is in accordance with previous reports which failed to find predictive factors of delamination tearing of the cuff tendons [1,16,17]. We found a trauma history more frequently associated with the partial tear group.

The presence of a delamination tear adjacent to a supraspinatus tendon complete detachment had no influence neither on preoperative nor on postoperative functional scores, as compared with isolated supraspinatus full thickness tear. This observation confirms previous findings by Zilber et al. [12] who employed a similar curettage-closure technique of the infraspinatus tendon with no excision of the delamination tear. Although this study was not controlled, these authors suggested that the repaired delaminated tendon behaved like a normal tendon in the midterm. Using a curettage-suture during arthroscopically assisted mini-open repairs, McDougal et al. [17] did not show any difference in outcome between non-delaminated and delaminated rotator cuff tears. In this study, the authors underscored the need for a combined mini-open technique at the time of arthroscopy to thoroughly treat delaminated tendons. Based on our results, we believe curettage and closure of delamination tears of infraspinatus or subscapularis tendons represent a reasonable option to obtain a water tight cuff at the end of the repair, conversely to others who complete these tears to full thickness prior to repair [17]. In addition, the conservative treatment of delaminated tendon allows the preservation of tendon bony insertions, which has been suggested to be the weakest link in the chain of the tendon repair [18,22,23]. Tenodesis of the long head of the biceps restored satisfying function, similar with shoulders with spontaneously stable biceps tendons. Last, it was recently suggested that posterior delamination were hidden, and likely to be left untreated, while using solely the posterior viewing portal during arthroscopic repair [22].

Overall, our results compare favourably with anatomic failure rates of 7% to 31% observed after open repair of moderate tears at short to midterm [10,12,24–26]. We could not find any difference in supraspinatus tendon healing rates as determined with MRI whether a partial tear of adjacent tendons was present or not. This suggests the repaired partially torn tendon did not increase the risk of re-tear for the supraspinatus. Consistent with previous findings [26], we found cuff repair resulted in stabilization in supraspinatus muscular volume between the pre and the postoperative period. In contrast, repair failure was associated with a consistent worsening in supraspinatus muscle atrophy in the Control Group, as previously reported [9,26]. Globally, the degree of fatty muscular degeneration increased in both groups independent of cuff healing. This observation has already been made by others [10,11,27,28], but it is still unclear whether aging could be the main determining factor to this phenomenon. Although preoperative demographics were similar in both groups, the presence of a partial tendon tear was associated with a higher degree of fatty degeneration in the Studied Group, suggesting a more severe advancement in the degenerative disease of the rotator cuff muscles. This may also explain the incidence of infraspinatus FD observed in series of isolated full thickness tears of the supraspinatus tendon [10]. The observation that postoperative GFDI were similar after supraspinatus tendon repair healing in both groups may also be a function of longer follow-up in the Control Group, underscoring again the potential influence of aging on muscle degenerative disease.

We observed that supraspinatus tendon repair failure resulted in a decrease in shoulder function in the Studied Group, as opposed to the group of isolated supraspinatus full thickness tears, although retears were smaller in size than the initial lesions in both groups. This point may bring an explanation to the controversial results reported in the literature, suggesting, on one hand, a poor correlation between clinical outcome and anatomic integrity after open repair of full thickness cuff tears [5,25,29], and, on the other hand, that functional results tend to be better in patients with healed cuffs [6,7,10,30]. This observation also highlights the need to accurately assess preoperative partial tearing with the goal of further defining their influence on repair healing on larger series.

It has been suggested that glenohumeral arthritis and narrowing of the subacromial space correlated with the extent of rotator cuff tear [31]. In line with these observations, we found partial tendon tearing was associated with lower preoperative SAS height as compared to the control. In addition, our findings suggest the current surgical procedure provided effective stabilization of the humeral head in both shoulder groups. Again, this favours the hypothesis that the repaired partially torn tendon was as efficient as a normal tendon in preserving humeral head centering in the midterm. However, in those cases, repair failure tended to alter SAS height, suggesting a more profound degenerative disease compared to isolated complete detachment of the supraspinatus tendon.

Our data suggest that the conservative treatment of partial tearing of either the infraspinatus tendon, or the subscapularis tendon, or both, does not compromise supraspinatus trans-osseous repair outcome in the midterm. In our hands, curettage and closure of delaminated tendon lesions led to optimal shoulder function and prevented degenerative shoulder changes. The presence of a partial tear of infraspinatus and/or subscapularis tendon(s) was associated with poorer preoperative structural characteristics, such as fatty muscular degeneration and supraspinatus muscular atrophy, and a higher degree of glenohumeral arthritis. With the numbers available, our data indicates that, when a recurrent tear of the supraspinatus tendon occurred, function and structural parameters of shoulders with a partial tear could degrade consistently more than the controls. We believe partial tendon tearing adjacent to a full thickness tear of the supraspinatus tendon should be thoroughly identified and treated accordingly.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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