WORKSHOPS OF THE SOO (2011, LA BAULE). ORIGINAL ARTICLE

Arthroscopic repair of large and massive rotator cuff tears using the side-to-side suture technique. Mid-term clinical and anatomic evaluation

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KEYWORDS
Arthroscopy; Shoulder; Rotator cuff repair; Ultrasound; Tendon healing

Summary
Preamble: Arthroscopic repair is our treatment of choice for massive rotator cuff tears. In order to reduce tension, we perform a side-to-side suture technique. The purpose of our work was to study the outcome of such technique by evaluating functional score and rotator cuff integrity using ultrasound at 2-year follow-up.

Hypothesis: The "side-to-side" arthroscopic repair of large and massive rotator cuff tears provides a long-term continuity of rotator cuff mechanism, enhances function and relieves pain with low morbidity.

Type of study: Retrospective monocenter study.

Material and methods: We included a continuous series of 50 patients of mean age 66.6 years (46–80), operated on between January 2007 and March 2008 for full-thickness retracted tears of the supraspinatus extending or not to the infraspinatus tendon. Management consisted of arthroscopic subacromial bursectomy, acromioplasty and side-to-side repair of the rotator cuff tendons with secure anchor fixation to the tuberosity. The relative Constant score was used for clinical evaluation preoperatively and at a minimum of 24 months after surgery. The continuity of rotator cuff mechanism was evaluated using ultrasound.

Results: The mean relative Constant score improved significantly ($p < 0.05$) from 40% (18–67) preoperatively to 91.7% (40–107) postoperatively. Fifty-six percent of the rotator cuffs from this series demonstrated continuity with a postoperative relative Constant score of 98.4% (74–121) and an increase in the shoulder strength score of 3.6 kg (1–6). Forty-four percent of the rotator cuffs had recurrent tear with an overall relative Constant score of 83.6% (4–126) and we did not observe any improvement in the strength score in this sub-group. Eighty-eight percent of the patients were satisfied or very satisfied with their outcome.

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Discussion: At a minimum 24-month follow-up, the side-to-side suturing technique reported excellent functional results with a very high satisfaction rate. For these large and massive rotator cuff tears sometimes considered as irreparable, ultrasound confirmed the continuity of the repair in 56% of the cases. Unhealed patients were not disadvantaged since they experienced pain relief and functional improvement. However, in this sub-group of patients, recovery of shoulder strength was poor.

Level of evidence: Level IV.
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Introduction

Rotator cuff tears are a common condition affecting the shoulder and their incidence increases with advancing age [1,2]. In patients unresponsive to non-operative measures, surgical treatment of distal supraspinatus tears provides satisfactory functional and anatomical outcomes [3–6].

However, surgically managed large and massive rotator cuff tears report less satisfactory results [6–14] with a higher rate of tear recurrences [8,13,14]. These large and massive defects are commonly associated with atrophy [15,16] and fatty degeneration [17] of rotator cuff muscles.

Surgical repair of rotator cuff defects focuses on recreating the anatomy of the intact rotator cuff with tension-free reinsertion of the torn tendons. [18–20] The final goal is to achieve tendon healing and painless recovery of shoulder function.

Arthroscopic repair is our treatment of choice for large or massive rotator cuff tears. We hypothesized that a tension-free side-to-side repair could provide long-term restoration of rotator cuff integrity in large and massive cuff tears.

The main purpose of our study was to evaluate the outcome of this technique by assessing the functional score, the satisfaction index of the patients and the integrity of the tendon repair using ultrasound at a minimum follow-up of 2 years.

Material and methods

Inclusion and exclusion criteria

We reviewed a series of 50 consecutive arthroscopic rotator cuff repairs (50 patients) performed by the same surgeon (O.C) between January 1st, 2007 and March 30th, 2008. The inclusion criteria of this retrospective, monocenter study were the followings:

- large rotator cuff tears: either stage III isolated tears of the supraspinatus retracted to the level of the glenoid margin according to the Thomazeau et al. classification [15] or supraspinatus tears associated with injuries to one or two rotator cuff tendons;
- arthroscopic side-to-side suture technique;
- minimum 24-month follow-up.

Patients

All patients were unresponsive to conservative therapy and continued to experience unacceptable chronic pain and weakness in the affected shoulder. Fifty-eight percent of the subjects had undertaken a preoperative physical therapy program. Twenty-four patients had one or more steroid infiltrations. After 6 months of unsuccessful conservative treatment, surgical management was recommended.

Fifty-four patients were operated on for large rotator cuff tears within the studied period: three patients met one or more exclusion criteria and one patient refused to participate in the study. Ninety-eight percent of the patients were reviewed.

Our series included 50 patients (31 females, 19 males) of mean age at surgery 66.6 years ± 6.8 years [46 years–80 years] (mean = 66 years). Seventy-six percent of patients had repairs of their dominant shoulder. Rotator cuff tear was secondary to trauma in 18 patients. Thirty-six percent of the patients from the series reported symptom worsening after recurrent trauma.

Rotator cuff tear was work-related in four patients and was classified as occupational disease in four other patients. The mean delay between the onset of symptoms and surgery was 38 months ± 7.2 months [6 months–13 years] (mean = 28.5 months). The extent of cuff tear was determined based on preoperative imaging (arthro-MRI or arthro-CT scan). All patients had involvement of the supraspinatus with associated injury to the infraspinatus in 78% of them. Most tears were retracted to the glenoid margin (56%) with a mean size of 30 mm. Fatty degeneration predominantly affected the supra- and infraspinatus. These rotator cuff tears were defined as large and massive (Table 1).

The study was conducted in accordance with the ethical principles set out in the Declaration of Helsinki of 1964. The examiner obtained the informed consent of each patient.

Evaluation of rotator cuff continuity

At last follow-up, an experienced X-ray technologist evaluated rotator cuff continuity using ultrasound. We used a Voluson E8 General Electric™ ultrasound imaging system combined with a high frequency superficial probe of 10 to 16 MHz. Rotator cuffs were classified according to their anatomic configuration: continuous, deteriorated or torn. Patients were divided into two sub-groups: those with intact repair (Group I) and those with discontinuity of the rotator cuff fibers (retear or deteriorated: Group R). The quality of tendon repair was evaluated by measuring the tendon thickness (mm). In each sub-group, the analysis was based
Table 1  Preoperative MRI and CT scan features of rotator cuff tears.

<table>
<thead>
<tr>
<th>Torn tendon</th>
<th>MRI</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraspinatus</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>78%</td>
<td></td>
</tr>
<tr>
<td>Subscapularis</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Coronal retraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>44% (22)</td>
<td></td>
</tr>
<tr>
<td>Glenoid</td>
<td>56% (28)</td>
<td></td>
</tr>
<tr>
<td>Sagittal retraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated supraspinus extending or not to the LGM</td>
<td>22% (11)</td>
<td>70% (35)</td>
</tr>
<tr>
<td>Supra + Infraspinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S + I + subscapularis</td>
<td>8% (4)</td>
<td></td>
</tr>
<tr>
<td>Tear size (mm)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long axis</td>
<td>30 [15—41]</td>
<td></td>
</tr>
<tr>
<td>Fatty degeneration&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>1.94 ± 0.6</td>
<td></td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>1.7 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>Subscapularis</td>
<td>0.72 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>Overall FD</td>
<td>1.47 ± 0.5</td>
<td></td>
</tr>
<tr>
<td>Amyotrophy&lt;sup&gt;c&lt;/sup&gt; (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>46 ± 17</td>
<td></td>
</tr>
<tr>
<td>Tear configuration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>64%</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>36%</td>
<td></td>
</tr>
</tbody>
</table>

S: supraspinus; I: infraspinus; SC: subscapularis.
<sup>a</sup> Measured on preoperative arthro-MRI or arthro-CT scan.
<sup>b</sup> Mean degree of fatty degeneration (FD) of supraspinatus, infraspinatus and subscapularis muscles according to Goutallier et al. [17].
<sup>c</sup> According to the criteria defined by Thomazeau et al. [15].

on the epidemiological data from both groups and the preoperative tear pattern.

Pre- and postoperative functional evaluation

Patients were examined preoperatively and at a minimum of 24 months postoperatively. The Constant and Murley score was used for clinical evaluation, [22] while shoulder strength was measured by means of a dynamometer (Dynamis<sup>TM</sup>). A subjective evaluation was performed during the follow-up visit to assess the degree of patient satisfaction: very dissatisfied, dissatisfied, satisfied or very satisfied with the outcome of surgery. The whole data was collected by a single examiner independent from the operator. Postoperative complications were systematically investigated.

Statistical analysis

Between paired series, the variables were compared using the non-parametric Wilcoxon test (comparison of median). Between two independent series, comparison of quantitative variables was performed using the non-parametric Mann and Whitney test (comparison of median) and comparison of qualitative variables was conducted using the exact Fisher test. The significance level was set at <i>p</i> less than 0.05.

Statistical analysis of the data was performed using the NCSS software.

Surgical technique

Surgery was carried out with the patient placed in the ‘beach chair’ position under general anesthesia. A brachial plexus loco-regional anesthesia at C6 root was associated. The operated limb was placed on an articulated support to allow free motion. Five portals were used: a posterior and posterolateral portal for the arthroscope, a lateral portal, two anterior portals (antero-medial and antero-lateral) were used for passing the instruments and cannulas. The Neviser medial portal was also used for passage of suture. Tenotomy of the long head of the biceps was systematically performed. A large subacromial bursectomy and acromioplasty with release of the acromio-coracoid ligament were carried out. These procedures were associated with an extensive release of the retracted cuff tendons.

Our goal was to achieve a watertight rotator cuff repair through tension-free reduction of the anterior and posterior tendon fibers. In the presence of massive rotator cuff tears, we focused on optimizing tendon repair with use of a suture-passing device (Banana Suture Lasso™ [Arthrex®]) through the posterior, anterior, and medial portals. The suture was passed through the whole tendon substance. A side-to-side suturing technique was used to approximate the tendon edges (Fig. 1). Repairs were performed with braided non-absorbable sutures (FiberWire™ type). The entire defect was closed by means of a single row suture anchor fixed to the tuberosity (Fig. 2). Postoperatively, tendon repair was protected with an abduction brace for 6 weeks. Rehabilitation of elbow and wrist was initiated immediately. Patients were encouraged to perform daily pendulum exercises after three postoperative weeks and could resume their normal activities after six postoperative months.

Results

At a mean follow-up of 38 months ± 7 months (median 36 months) [24 months–60 months], 88% of patients were reviewed. The overall complication rate was 2%. Complications included a reflex sympathetic dystrophy syndrome that resolved spontaneously. None of the patients reported infectious or neurologic complications related to surgery. Discontinuity of rotator cuff fibers was suspected on ultrasound imaging in one patient. It was associated with major morphological changes of the subacromial bursa. This case was classified as cuff tear.

Sonographic findings

Fifty patients were reviewed and assessed using ultrasound imaging. There were signs of rotator cuff continuity in 28 of these patients. Twenty-two patients had a recurrent rotator cuff tear (that is 44% of the patients from the series). The mean rotator cuff thickness was 4.2 mm ± 1.4 mm with a median thickness of 4.
Functional results according to the Constant and Murley score [22]

Results of the whole series
At last follow-up, the relative Constant score was 91.7%±17, that is a 51.7% increase which was significant (p<0.05) compared with the preoperative status. Each of the parameters was improved (pain, activity, mobility and strength) (Table 2). Pain was significantly decreased postoperatively with a mean score of 13.5±2.8 (95% confidence interval, CI = 12 to 14, p<0.05) versus 5.5±2.9 (95% confidence interval, CI = 4.7 to 6.3, p<0.05) preoperatively. Surgical treatment allowed improved performance of daily activities by a mean of ten points (95% confidence interval, CI = 8.7 to 11.2, p<0.05). We observed a long-term restoration of mobility with a mean score of 35.6 (median 38, 95% confidence interval, CI = 34 to 37, p<0.05) This item was the one demonstrating the greatest improvement. At revision, the mean strength improvement was 1.4kg (median 1kg, 95% confidence interval, CI=0.8 to 2, p<0.05).

Results for each sub-group
The improvement in the Constant score [22] was significantly better in the rotator cuff intact repair group than in the retear rotator cuff group (p<0.05). The overall relative average Constant score in group I was 98.4%±10 (median 97.5; [74–121]) versus 83.6%±20 (median 85.5; [40–126]) in group R (Tables 3 and 4). The daily activity and mobility scores were higher in the group of patients with cuff continuity than in the other group. This difference was significant (p<0.05). A difference in strength between the pre- and postoperative status was observed in both groups. We could evidence a mean increase in strength of 3.6 kg for patients from group I. The increase in strength was 0.8 kg for group R. These differences between the two groups were considered statistically significant (p<0.05) (Table 5).

Patients with intact repair of the rotator cuff reported a greater decrease in pain than those from group R. In group I, the pain score was 14.1±2.3 at last follow-up versus 12.8±3.8 in group R. Such difference was not considered as significant. Even in case of recurrent rotator cuff tears, a significant increase in the Constant score at last follow-up was noted. The mean absolute improvement was 33.9 points (95% confidence interval, CI = 28 to 42, p<0.05).

Demographic data of each sub-group
The analysis of demographic data (gender, age, side of the defect) could not demonstrate any significant difference between the two groups (p>0.05) (Table 6).

Tear configuration in each sub-group
The initial size of the tear was about 5 mm larger (31 mm vs 26 mm, p<0.05) in the sub-group of patients with recurrent tears.

In this group, involvement of both the supraspinatus and infraspinatus was seen in 20 out of 22 cases (91% of the group

Table 2  Pre- and postoperative Constant scores [22] for the entire series (n = 50).

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Increase</th>
<th>p value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>5.5 ± 2.9</td>
<td>13.5 ± 2.8</td>
<td>8 ± 4.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Activity</td>
<td>6.6 ± 3.2</td>
<td>16.6 ± 3.9</td>
<td>10 ± 4.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mobility</td>
<td>17.1 ± 5.7</td>
<td>35.6 ± 5.9</td>
<td>18.5 ± 1.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Strength</td>
<td>0.8</td>
<td>3.6</td>
<td>2.8 ± 0.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Absolute total</td>
<td>30 ± 9.7</td>
<td>69.3 ± 12.3</td>
<td>39.3 ± 14.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Relative total&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40 ± 13</td>
<td>91.7 ± 17.1</td>
<td>51.7 ± 19.8</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

<sup>a</sup> Age and gender-matched values.
<sup>b</sup> According to the Wilcoxon test.

Table 3  Mean pre- and postoperative Constant scores [22] in the intact repair sub-group (n = 28).

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Increase</th>
<th>p value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>5.9 ± 2.6</td>
<td>14.1 ± 2.3</td>
<td>8.2 ± 3.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Activity</td>
<td>6.9 ± 3.4</td>
<td>18.1 ± 2.3</td>
<td>11.2 ± 4.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mobility</td>
<td>17.7 ± 5.9</td>
<td>37.9 ± 2.9</td>
<td>20.2 ± 6.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Strength</td>
<td>0.5</td>
<td>7.9</td>
<td>7.4</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Absolute total</td>
<td>31 ± 10</td>
<td>78 ± 7.4</td>
<td>47 ± 12</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Relative total&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.2 ± 12.1</td>
<td>98.4 ± 11</td>
<td>57.2 ± 16.5</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

<sup>a</sup> Age and gender-matched values
<sup>b</sup> According to the Wilcoxon test.

Table 4  Mean pre- and postoperative Constant scores [22] in the retear rotator cuff sub-group (n = 22).

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Increase</th>
<th>p value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>4.9 ± 3</td>
<td>12.8 ± 3.2</td>
<td>7.9 ± 4.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Activity</td>
<td>6.2 ± 2.9</td>
<td>14.5 ± 4.5</td>
<td>8.3 ± 4.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mobility</td>
<td>16.6 ± 5.5</td>
<td>32.7 ± 7.3</td>
<td>16.1 ± 1.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Strength</td>
<td>0.6</td>
<td>2.2</td>
<td>1.6</td>
<td>0.02</td>
</tr>
<tr>
<td>Absolute total</td>
<td>28.3 ± 8.4</td>
<td>62.2 ± 13.7</td>
<td>33.9 ± 16</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Relative total&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39 ± 14</td>
<td>83.6 ± 20.1</td>
<td>44.6 ± 22</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

<sup>a</sup> Age and gender-matched values
<sup>b</sup> According to the Wilcoxon test.

Table 5  Comparison of average Constant scores [22] at a mean follow-up of 38 months.

<table>
<thead>
<tr>
<th></th>
<th>Retear rotator cuff</th>
<th>Intact repair</th>
<th>p value&lt;sup&gt;a&lt;/sup&gt;</th>
<th>&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>32.7 [16—40]</td>
<td>37.9 [26—40]</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>2.2 [0—15]</td>
<td>7.9 [0—12]</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Absolute total</td>
<td>62.2 [33—88]</td>
<td>78 [55.5—87]</td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td>Relative total&lt;sup&gt;a&lt;/sup&gt;</td>
<td>83.6 [40—126]</td>
<td>98.4 [74—121]</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Age and gender-matched values; extreme values in brackets.
<sup>b</sup> According to the Mann et Whitney test.

R). Both tendons were involved in 17 patients from group I (39.3%). The proportion of patients with tear involving both tendons was higher in group R than in group I (91% versus 50%, p < 0.05). In group I, isolated tear of the supraspinatus, retracted to the glenoid margin was observed in 39.3% of the cases. This proportion was significantly higher than in group R (p < 0.05). The watertightness of the rotator cuff at last follow-up was strongly correlated with the initial size of the tear as well as the number of tendon affected. There was no significant difference between the two groups regarding the overall degree of fatty degeneration and volume of supraspinatus muscle atrophy.

Satisfaction index

Eighty-eight percent of the patients were satisfied or very satisfied with the outcome of the surgery. One female patient with recurrent tear reported dissatisfaction with treatment.

Discussion

Repair of rotator cuff defects focuses on recreating the anatomy of the tendons without tension. [18—20] The final goal is to achieve tendon healing. In large and massive rotator cuff tears, the retraction and degenerative aspect of the tendons [23] may require more complex reconstruction. The description of crescentic, U-shaped and L-shaped tears [24,25] has contributed to the development of new suturing techniques (margin convergence or side-to-side technique). [26,27] In our series, the watertight closure of the rotator cuff was achieved by means of a side-to-side suturing technique. As confirmed by St Pierre et al., [28] this technique enhanced the chances for tendon healing.

Our objective was to assess the rotator cuff integrity and evaluate the mid-term rate of recurrent tears. Our analysis was based on sonographic observations. Teefey et al. [29] have showed a 90 to 97% sensibility and 91 to 100% specificity for sonographic detection of rotator cuff tears. In our study, cuff continuity was seen in 56% of the cases at a mean follow-up of 38.6 months. The rate of recurrent tears in our study is comparable to that reported in the literature. Publications about arthroscopic repair of large and massive cuff tears report a 40% to 94% rate [8,11,13,14,30].

We used a single-row anchor configuration. However, while performing a review of the literature, Nho et al. [31] and Wall et al. [32] have reported the superior biomechanical properties of the double-row compared with single-row anchor configuration. However, level 1 and 2 studies investigating large and massive rotator cuff tears did not demonstrate any significant clinical difference between single and double row sub-groups. [33,34] The use of radioluscent anchors did not help us determine whether healing failures resulted from failed tuberosity fixation.

The study of the predictive factors for tendon healing reveals that the surgical technique is not the only contributory factor. Favard et al. [35] during the SOO symposium in 2008, highlighted the interdependence of the predictive factors for repair outcome. These factors may be related to the patient (age, [3,36,6] comorbidities [37,38]) or to the tear pattern (acromio-humeral space, [39,40] tear extent, [6,41,42] retraction and quality of the tendons, [3,6,23] amyotrophy of the supraspinatus muscle, [15] fatty degeneration [6,43]).

In our series, a significant relationship could be established between the watertightness of the repair and the initial size of the tear as well as the number of involved tendons. These findings correlate those reported by Flurin et al. [6] and de Gazielly et al. [41] The absence of infraspinatus involvement was more commonly associated with rotator cuff continuity. Twenty patients out of the twenty-two with recurrent tear had an extent to the supr-infraspinatus. They were seventeen out of twenty-eight in the sub-group with rotator cuff integrity. These results are consistent with those published in the literature. [6,41,42]

For patients unresponsive to non-operative measures, surgery positively affected the functional outcome. At more than 3-year follow-up, 88% of the patients were satisfied or very satisfied with the repair. The Constant score was significantly improved for pain, activity, mobility and strength in all patients. The overall aged and gender-matched Constant score Constant score improved from 40% preoperatively to 91.7% postoperatively. These observations correlate the functional and subjective results reported in the literature regarding arthroscopic repairs of rotator cuff tears. [7,8,10—12,14,30,35,44]

Even patients with recurrent tear experienced a significant improvement in their Constant score compared with their preoperative status. We confirmed the results reported by Jost et al. [45] according to which healing failure does not prevent long-term improvement in pain and function. Management of impingement and extended bursectomy may have largely contributed to the functional improvement. The works conducted on the absence of repair and isolated debridement of rotator cuff tears correlate these results. [46—50] The long head of the biceps brachii tendon is a well-known contributor to shoulder pain, particularly in massive rotator cuff tears. [51—53] Systematic tenotomy of the long head of the biceps brachii tendon has greatly influenced the functional results. Patients with rotator cuff intact repair at last follow-up had a functional

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Table 6 Analysis of mean demographic data for each sub-group.

<table>
<thead>
<tr>
<th></th>
<th>Retear rotator cuff (n = 22)</th>
<th>Intact repair (n = 28)</th>
<th>p value a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (%)</td>
<td>63.6 F/46.4 M</td>
<td>60.7 F/39.3 M</td>
<td>N.S.</td>
</tr>
<tr>
<td>Age (year)</td>
<td>69 [55—80]</td>
<td>64 [46—74]</td>
<td>N.S.</td>
</tr>
<tr>
<td>Follow-up (month)</td>
<td>37</td>
<td>39</td>
<td>N.S.</td>
</tr>
<tr>
<td>Dominant side (%)</td>
<td>81.3</td>
<td>71.4</td>
<td>N.S.</td>
</tr>
<tr>
<td>Work accident (%)</td>
<td>9.1</td>
<td>7.1</td>
<td>N.S.</td>
</tr>
<tr>
<td>Occupational disease (%)</td>
<td>9.1</td>
<td>7.1</td>
<td>N.S.</td>
</tr>
<tr>
<td>Date of onset of symptoms (month)b</td>
<td>35.5 [3—160]</td>
<td>39.5 [6—150]</td>
<td>N.S.</td>
</tr>
<tr>
<td>Post-traumatic origin</td>
<td>50%</td>
<td>25%</td>
<td>N.S.</td>
</tr>
<tr>
<td>Worsening after trauma</td>
<td>45%</td>
<td>21.40%</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

a Fischer test.
b In months; extreme values in brackets.
score significantly higher than those with retear cuff. Many authors report similar findings regarding the Constant score in case of healed rotator cuff tendons at last follow-up. [6,41,42] This difference between the two groups was significant for the whole sub-scores (pain, daily living activities, mobility and strength). Moreover, we know that muscular strength acts as a determinant parameter in the functional assessment of repair quality. [54] Debridment and biceps tenotomy do not provide sufficient restoration of muscular strength compared with rotator cuff healing. [55] According to our findings, strength was directly related to rotator cuff continuity. In view of these results, reininsertion appears as an acceptable objective in case of reparable rotator cuff tear. Rocourt et al. [56] reported over 10% of inter-observer variability when measuring the strength component of the Constant score. Our data collection was conducted by the same examiner in order to reduce measurement bias.

However, our study demonstrates limitations. Due to the small number of patients included in our series, the study lacks adequate statistical power for comparison of demographic factors between sub-groups. The retrospective aspect of our study resulted in follow-up and measurement biases. Only one patient was lost to follow-up. Despite the 100% sensitivity of ultrasound in detecting rotator cuff tears, [29] it is well admitted that rotator cuff continuity is not synonymous with cuff healing. During the SFA symposium held in 2004, [6] arthro-CT scan or arthro-MRI was suggested for assessing the healing status after arthroscopic repair of large rotator cuff tears; however, in about 30% of the tendons considered as “healed” the authors found an intratendon addition image or loss of integrity at last follow-up. Some studies such as that conducted by Charouset et al. [42] have detected on the arthro-CT scan, a type of continuous healed tendon which functional results are less satisfactory. This “partial and watertight” healing was classified as continuous in our study whereas it was probably a non-functional rotator cuff.

Conclusion

At a minimum 24-month follow-up, the side-to-side suturing technique reported excellent functional results with a very high satisfaction rate. In our study, 56% of the patients with large and massive rotator cuff tears, sometimes considered as irreparable, demonstrated a continuous rotator cuff on ultrasound.

We reported a significant increase in strength in patients with rotator cuff intact repair at last follow-up. The extent of rotator cuff tear to the infraspinatus tendon appeared as a pejorative factor for repair outcome. Unhealed patients were not disadvantaged since they experienced improved pain and function. However, in this sub-group of patients, recovery of shoulder strength was poor.

Disclosure of interest

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

References


