Original article

Does preoperative subscapularis fatty muscle infiltration really matter in anterosuperior rotator cuff tears repair outcomes? A prospective multicentric study

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A B S T R A C T

Introduction: Anterosuperior (AS) rotator cuff tear describes a combined tear of the subscapularis and the supraspinatus tendons. We hypothesized that results after AS tendon repairs might be influenced by the size of the subscapularis rupture and the preoperative subscapularis muscle fatty infiltration.

Methods: A prospective multicentric study of 53 AS rotator cuff tears from five centers was performed (January 2008–January 2009). Subscapularis tendon retraction and fatty infiltration were assessed preoperatively. An ultrasonographic healing control was performed 1 year after surgery.

Results: Patients were on average 60 years (range, 43–75 years) and were operated on average 16 months (range, 2–72 months) after the beginning of their symptoms. The incidence of AS tears was found to be 18%. Average follow-up was 15 months (range, 12–24). The Constant-Murley (CM) score for the patients with AS ruptures improved significantly from 49 points (range, 35–51 points) preoperatively to 73 points postoperatively (range, 50–95 points) (P = 0.0205). CM score gains were 26 for Lafortosse group 1 ruptures and 29 for Lafortosse group 2 & 3 with pre- and postoperative P values at P < 0.000001 and P < 0.00001, respectively. The last follow-up CM score improves according to the subscapularis fatty infiltration was 70 (range, 48–95) for groups 0–1, 70 (range, 56–87) for group 2, and 56 (range, 53–88) for groups 3–4 with pre- and postoperative P values at P < 0.001, P < 0.001, and P < 0.004, respectively. The global retear rate was 6%.

Discussion: Our study showed that the CM score after repairs of AS rotator cuff tears was lower in advanced subscapularis fatty infiltration. However, gains in CM scores were similar whatever the initial subscapularis fatty infiltration. The rate of tendon healing was correlated with subscapularis fatty infiltration. Subscapularis tendon rupture size was not significantly correlated with outcomes.

Level of evidence: Level III.

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1. Introduction

Anterosuperior rotator cuff tear is a term described by Warner et al. [1] that signifies a combined tear of the subscapularis and the supraspinatus tendons. The term was used to differentiate such tears from posterosuperior tears that involve the supra- and infraspinatus tendons.

The prevalence of anterosuperior rotator cuff tears is lower than that of posterosuperior tears [2–6]. Existing publications put in evidence the fact that these ruptures are usually traumatic, show good results after open or arthroscopic repairs and stop subscapularis fatty degeneration progression [7].

The purpose of this study was to evaluate the incidence, clinical and radiological outcomes of patients who underwent arthroscopic or open repair of anterosuperior rotator cuff tears.

We hypothesized that healing and clinical results after anterosuperior tendon repairs might be influenced by the size of the subscapularis rupture and the preoperative subscapularis muscle fatty infiltration.

2. Methods

A prospective multicentric study including 312 rotator cuff repairs performed in five French hospitals between January 2008 and January 2009 was performed. Surgery was proposed only after failure of a well-guided medical treatment including rest, prescription of nonsteroidal anti-inflammatory drugs, and physiotherapy.

From the original 312 rotator cuff repairs, 53 (32 males and 21 females) involved the anterosuperior part (18%). An arthroscopic supraspinatus-subscapularis repair was performed in 44 patients (83%) and an open repair on 9 shoulders. Clinical results were quantified using the Constant–Murley score [8] while patient satisfaction was analyzed by asking if the patients were very satisfied, satisfied, or unhappy with the final functional outcome.

Preoperative magnetic resonance imaging (MRI) studies were obtained in 20 patients, injected MRI in 2 patients and injected computed tomography (CT) in 31 patients. Cross-sectional images of the cuff permitted an assessment of the supraspinatus atrophy according to the MRI classification of Thomazeau [9]. The Zanetti classification [10] was used to analyze supraspinatus muscle atrophy on injected CT scans. In all patients who performed an injected CT Scan, fatty infiltration was assessed using the Goutalier classification [11]. The extent of the supraspinatus tendon retraction was assessed using the Patte classification [12]. Subscapularis tears were classified according to the Lafosse classification: type 1 involved the superior third of the tendon, type 2 the upper two-thirds and type 3 involved the full tendon [13].

All patients who participated in the study signed an informed consent statement. The criteria for inclusion were the presence of a combined supraspinatus and subscapularis lesion, an arthroscopic or open cuff repair, a minimum of 1-year clinical follow-up, and a 1-year assessment of postoperative cuff integrity determined by ultrasonography. An experienced shoulder radiologist performed all control ultrasonographies. One control ultrasonography per patient was performed. Preoperative and control ultrasonographies were not necessarily performed by the same radiologist.

The exclusion criteria were a partial or full-thickness tear involving another rotator cuff tendon, osteoarthritides of the glenohumeral joint, and a previous cuff surgery.

3. Surgical technique

All operations were performed under interscalene block and general anesthesia. Patients were placed in the beach chair position, without continuous traction. In the nine open procedures, an anterior deltoïd-splitting approach with acromioplasty was performed. Single-row suture anchor repairs or transosseus sutures were performed in all open repairs. The arthroscopic procedure was performed as follows: a standard posterior portal was established to inspect and treat associated intra-articular pathology by use of a 30° arthroscope with an arthroscopic pump at 50 mmHg of inflow pressure. Tendon repairs were performed using a single-row suture anchor technique for the subscapularis tendon and either a single- (35.8%) or double-row (64.2%) suture anchor technique for the supraspinatus tendon. The rotator interval was always left unsutured and an acromioplasty was performed. The state of the biceps tendon was evaluated during the glenohumeral exploration. The biceps tendon was either tenotomized or tenodesed using an interference screw or a laso loop suture.

On average, 3.4 anchors (range, 1–5 anchors) were used per cuff repair, depending on the size and the shape of the tears. A single-row technique was used in 19 shoulders and the double-row technique was used in 34 shoulders.

All patients were immobilized postoperatively in a 30° abduction sling for 6 weeks. Pendulum and passive range of motion (ROM) is started immediately after surgery. Active ROM is started 6 weeks postoperatively. This protocol was continued for 6 months or until the patients had regained full ROM and strength.

Statistical analysis was performed using the t-Student test to assess the difference between the preoperative and postoperative Constant–Murley scores.

The level of significance was set at \( P \leq 0.05 \).

4. Results

Patients were on average 60 years (range, 43–75 years) at the time of surgery. Two-thirds of patients were operated on their dominant side with an average delay of 16 months (range, 2–72 months) after the beginning of the symptoms. The cause of the rupture was traumatic in 19 patients (36%). Average follow-up was 15 months (range, 12–24).

At the last follow-up, the mean CM score for the patients with anterosuperior ruptures improved significantly from 49 points (range, 35–51 points) preoperatively to 73 points postoperatively (range, 50–95 points) \( P=0.0205 \). Among the patients, 92.5% claimed that they were very satisfied, 9 patients satisfied, and four patients were unsatisfied with the final result (7.5%). Amongst the four unsatisfied patients, 3 were workers’ compensation cases. Very satisfied or satisfied patients returned to work on an average 5.5 months after surgery (range, 3–12 months).

Ultrasound imaging performed at least 1 year after surgery demonstrated that the cuff was completely healed in 50 of the 53 shoulders (94%) for the anterosuperior rupture group. A partial-thickness retear was observed in 3 shoulders (6%) and no full-thickness tears were found.

Subscapularis tears were divided into 36 tears limited to the superior 1/3 of the subscapularis (67.9%), 9 tears (17%) involving 2/3 of the tendon and 8 (15.1%) complete subscapularis tears associated with supraspinatus tears.

Patients with superior one-third subscapularis tendon (type 1) lesions were managed arthroscopically in 88.8%. At the last follow-up, the mean CM score improved from a mean of 48 points (range, 10–81 points) to 74 points (range, 31–91 points) \( P<0.000001 \). Patient satisfaction was excellent with 97.2% very satisfied patients. Ultrasound imaging performed 1 year after surgery demonstrated that the cuff was completely healed in 35 of the 36 shoulders (97%). A partial-thickness retear was observed in one patient (3%).

Patients with lesions involving two-thirds or more of the subscapularis tendon (types 2 & 3) were managed arthroscopically in 70.6%. At the last follow-up, the mean CM score improved significantly \( P<0.000001 \) from 46 points (range, 36–76 points) preoperatively to 75 points (range, 50–92 points). Among the patients, 82.3% were very satisfied or satisfied with the final result. The one-year ultrasound examination revealed a completely healed cuff in 15 of 17 shoulders (88.2%) and a partial-thickness retear in 2 shoulders (11.8%).

The biceps tendon was found to be pathological in 73.5% (Table 1) of cases thus giving a relative risk of having a biceps tendon lesion with a subscapularis tear of 1.15. Patients found to have a pathological yet intact biceps tendon benefited from tenotomy in 50.9% and tenodesis in 32.9%. The biceps tendon was left untouched when found to be normal. If the biceps was ruptured prior to surgery, no associated procedure was performed.

Subscapularis fatty infiltration analysis results are summarized in Table 2. At the last follow-up, more than 90% of patients were very satisfied or satisfied with the results regardless of the initial degree of subscapularis fatty infiltration.

Details of the anterosuperior tears with the degree of retraction of the supraspinatus tendon are illustrated on Fig. 1.

No patients were lost to follow-up. Seven patients presented with postoperative reflex sympathetic dystrophy (RSD) and two patients with superficial infections that were resolved with antibiotics. No nerve damage, suture or anchor-related complications were noted in our study.

### Table 2

<table>
<thead>
<tr>
<th>Subscapularis fatty infiltration.</th>
<th>Stages 0–1</th>
<th>Stage 2</th>
<th>Stages 3–4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age (years)</td>
<td>70 (37 patients)</td>
<td>20 (11 patients)</td>
<td>10 (5 patients)</td>
</tr>
<tr>
<td>Traumatic tear</td>
<td>58 (range, 43–72)</td>
<td>62 (range, 42–72)</td>
<td>62 (range, 52–72)</td>
</tr>
<tr>
<td>Subscapularis Lefossi type 1 rupture</td>
<td>31%</td>
<td>30%</td>
<td>60%</td>
</tr>
<tr>
<td>Subscapularis Lefossi type 2 rupture</td>
<td>74%</td>
<td>55%</td>
<td>0%</td>
</tr>
<tr>
<td>Subscapularis Lefossi type 3 rupture</td>
<td>17%</td>
<td>33%</td>
<td>40%</td>
</tr>
<tr>
<td>Preoperative CM</td>
<td>47 (range, 31–81)</td>
<td>43 (range, 41–62)</td>
<td>33 (range, 18–50)</td>
</tr>
<tr>
<td>Postoperative CM</td>
<td>70 (range, 48–95)</td>
<td>70 (range, 56–87)</td>
<td>56 (range, 53–88)</td>
</tr>
<tr>
<td>CM gain</td>
<td>23 points</td>
<td>27 points</td>
<td>23 points</td>
</tr>
<tr>
<td>P-value (CM gain)</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0004</td>
</tr>
<tr>
<td>Ultrasonographic healing percentage (%)</td>
<td>97</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Ultrasonographic partial thickness retears percentage (%)</td>
<td>3</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Ultrasonographic full-thickness retears percentage (%)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

### 5. Discussion

The anterosuperior tears constitute a less common subgroup of rotator cuff tendon tears. Previous clinical research showed that these ruptures exhibit poorer clinical results when compared to isolated subscapularis, superior or posterosuperior tears [1]. In more recent studies, the anterosuperior lesion rates were found to be as high as 25.2% and 27.4% [4,14]. In our study, anterosuperior cuff lesion rate was found to be 18%, which was closer to Ide’s [15] 17.8%.

This rupture pattern remains difficult to diagnose preoperatively. The surgeon should keep a high index of suspicion especially when faced with a positive lift off test, belly press test, bear hug test together with signs of a superior cuff tear. Even with the fast advancement in imaging techniques, radiological diagnosis of the superior part of the subscapularis tendon remains a challenge and is often missed. Unfortunately the only way to be absolutely sure of the presence of a partial or upper one-third subscapularis tendon tear is during the explorative phase of the operation.

Injuries involving the subscapularis are usually traumatic and occur in younger males [3,10]. Previous results go hand in hand with results obtained in our study as we observed subscapularis tears in young patients with a history of trauma. Superior third subscapularis tendon tears seem to be degenerative. This was confirmed in our study due to the fact that patients with type 1 subscapularis ruptures had an average age that was 4-years higher than that in types 2 & 3.

There was a high percentage of biceps tendon involvement in our study (73.5%). Recent studies detected percentages up to 85% of biceps tendon lesions when a subscapularis tendon is torn [2,14–17]. We therefore recommend performing either a biceps tenotomy or tenodesis when faced with an anterosuperior rotator cuff tear. Katthagen et al. [18] share our opinion and also stress the importance of treating concomitant biceps pathology.

Greater tendon retraction and higher grades of fatty infiltration have been previously demonstrated to be bad prognostic signs in rotator cuff tears. They were all shown to be directly proportional to worse clinical and radiological results. Gerber et al. [16,17] suggested that a delay in repairing the subscapularis tendon may produce less satisfactory results despite fatty infiltration of the muscle. Edwards et al. [19], Flury et al. [6], Ide et al. [15] and Harryman et al. [20] support the previously mentioned finding as they state that larger tears retract more and have higher degrees of fatty infiltrations thus giving rise to worse outcomes and higher retear rates.

Our study confirms results obtained by these authors as shown in Table 2.

In our study, we found no significant differences between the different sizes of subscapularis ruptures or degrees of fatty infiltration on the gain of CM score. Our results showed that the gains in the CM scores were comparable between the 3 groups of fatty infiltration with healing rates slightly higher in groups with lower fatty infiltration. Nove-Josserand et al. [21] and Toussaint et al. [22] previously reported similar results.

Having mentioned that, it is evident that even though CM score gains were somewhat comparable, the CM score in the group with the most advanced fatty infiltration was worse. The average postoperative CM score in the fatty infiltration groups 3–4 reached 56 points compared to 70 points for groups 0–1 and 2.

Anterosuperior cuff retear rate was low (6%). This retear rate was directly proportional to subscapularis muscle fatty infiltration as the percentage of retears increased as the fatty infiltration rate advanced. These results go hand in hand with results found by Goutallier et al. [11] and Flury et al. [6].

The initial subscapularis rupture size showed no consequences on the overall CM gain or the final average CM scores in our study. This was supported by Bartl et al. [23] who stated that larger subscapularis tears were not associated with worse clinical outcomes. Other publications seem to differ as they state that clinical results are worse when more than one-third of the subscapularis tendon in involved [1,2,9,24].

Preoperative analysis of the supraspinatus tendon retraction put in evidence a proportional correlation between the degree of supraspinatus retraction and subscapularis tears. Larger subscapularis tears were usually associated with more retracted supraspinatus tears. Anterosuperior ruptures usually originate around the biceps and tendon usually progress more anteriorly [7,25]. Data obtained in our study confirms these previous findings. Analysis of the supraspinatus tendon healing was not performed in our study and therefore could not be correlated with postoperative results.

There are certain limitations in our study. The retrospective, non-randomized, multi-operator, multicentric design of this study and the use of ultrasonography as a means of controlling tendon healing are considered weaknesses. Open versus arthroscopic repair analysis was not performed because the groups were heterogeneous. The lack of analysis of the supraspinatus tendon healing status at the last follow-up is also considered a limitation of this study. Measurement of force in internal rotation would have been preferable for a complete analysis of the subscapularis repairs.

In conclusion, the incidence of anterosuperior tears was found to be 18%. Our study showed that the CM score after repairs of anterosuperior rotator cuff tears was lower in advanced subscapularis fatty infiltration. Gains in CM scores were similar whatever the initial subscapularis fatty infiltration. The rate of tendon healing is correlated with subscapularis fatty infiltration with a global retear rate of 6%. Subscapularis tendon rupture size was not significantly correlated with outcomes.

Disclosure of interest

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

References