Histological lesions of supraspinatus tendons in full thickness tears of the rotator cuff

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ABSTRACT

Purpose of the study
Iterative tears after simple tendon bone suture of transfixiant ruptures of the rotator cuff are frequent. The frequency of iterative ruptures had seemed to be correlated to the importance of the preoperative fatty degenerations of the cuff muscles. But fatty degeneration cannot account for iterative ruptures occurring with no or little preoperative muscle fatty degeneration. The authors have tried to know if iterative ruptures could also be accounted for by the presence on repaired tendinous stumps of histological lesions which are known to lower their mechanical quality, and if such was the case, they have tried to know what could be the impact of these lesions on the repairing technique by suturing cuff ruptures.

Material and method
Thirty-two distal stumps of ruptured supraspinatus, resected on more than 1 cm to eliminate macroscopic tendinous lesions (thin, lacerated, cleaved, hardened or whitish tendons) and to reach a new stump, slightly bleeding and thick enough to hold the stitches correctly, have been studied on longitudinal histological slides.

Results
All the tendinous resected stumps had histological anomalies: dilacerations lesions of the conjunctive tissue, fatty infiltrations, necrosis, scar lesions and micro calcifications were found. The histological lesions were often associated. The histological lesions were an average 4 mm shorter than those of the tendinous resection. In 18 cases however the whole of the resected tendon was histologically abnormal.

Discussion
Tendinous histological lesions found on the whole or almost the whole length of the macroscopically abnormal tendinous stumps diminish the mechanical quality of the tendons. Insufficient resection of the tendinous stumps leaving macroscopical lesions and therefore histological lesions could account for iterative ruptures in the first post operative year. Yet complete resection of the macroscopically abnormal tendinous stump does not entail that the neo tendinous stump to be repaired is histologically normal. This encourages to put the stitches well within the zone of the tendinous resection and to bury the tendinous stumps into a highly vascular bony trough. But tendinous resection although logical from the histological and mechanical point of view widens the rupture of the cuff to be repaired. It can make sutures under tension, which can entail iterative ruptures. Musculo-tendinoplasty appears then necessary to perform sutures without tension.

Conclusion
Histological lesions of tendinous stumps of cuff ruptures correspond roughly to tendinous macroscopic lesions. They could be at the origin of iterative ruptures that take place after simple tendon-bone sutures of ruptured cuffs which are not accounted for by muscular fatty degeneration. They could also partly account for iterative ruptures taking place when pre operative fatty degeneration is evident. It seems logical to resect macroscopically abnormal tendinous stumps before performing a suture. But the tendon-bone suture without tension is then often possible only with musculo-tendinoplasties.

Key words: Rotator cuff, full thickness tears, supraspinatus tendon, histological lesion.
INTRODUCTION

Recurrent tears of full thickness rotator cuff tears after bone-tendon suture are frequent, particularly with the increasing number of repair procedures performed [Bellumore et al. [1], Harryman et al. [2]]. The degree of preoperative fatty degeneration of the muscles whose tendons tear (particularly the infraspinatus muscle) and the overall degree of fatty degeneration of the shoulder [Goutallier et al. [3][4]] appeared to be predictive of repeated tears in a series of repair procedures for full thickness tears of the rotator cuff reported at the 1998 SOFCOT Symposium (directors: B. Augereau and D. Gazielly). However, the fatty degeneration factor cannot explain the 15% of iterative tears which occur in shoulders with no or very little overall fatty degeneration preoperatively nor the 28% of repeated tears noted after repair of isolated distal tears of the supraspinatus with very little fatty degeneration (scored less than 2) [Kempf et al. [5]]. These recurrent tears might be explained by suturing insufficiently resistant tendon stumps exhibiting histological anomalies [Sano et al. [6]].

The purpose of this study was to examine the histological status of the supraspinatus stumps in order to determine to what extent they exhibit anomalous features and determine the impact of such lesions on the suture technique for rotator cuff tears.

MATERIAL AND METHOD

This was a prospective study of 32 distal stumps of torn supraspinatus tendons. Macroscopically, the tendon stumps appeared excessively thin, lacerated or cleaved and whitish. The macroscopically abnormal portion of the tendon was resected before reinserting it in a bony groove of the trochanter. The resected portion measured more than 1 cm. The tendon was cut at a point where the new stump appeared macroscopically healthy (free of laceration or cleavage, slightly bleeding, thick enough to allow solid stitching. The length of the resection was measured on its superficial aspect. The orientation of the resection specimens were marked by the operator. Specimens were examined histologically on longitudinal slides (fig. 1). Specimens were obtained from 15 men and 17 women who underwent surgery between October 1997 and October 1999. This was a consecutive series. Mean age at surgery was 59.5 years (range 47-72). The position of the torn supraspinatus stump was measured from the superior aspect of the humerus and the number of torn tendons was noted on arthroscans performed preoperatively.

The supraspinatus tendon stump was in a distal position (near the greater tubercle) in 17 patients, in an intermediary position in ten (facing the superior pole of the humeral head), and at the level of the glenohumeral space in five. The full thickness tear of the supraspinatus was an isolated tear in one patient and was associated with an infraspinatus tear in 13 (extending to the teres minor in two). The full thickness supraspinatus tear was associated with infraspinatus and subscapularis tears in 15 patients and with a subscapularis tear in three.

Mean length of the resection was 2.2 cm (range 1-3.5). It was greater than 2.8 cm in six cases. None of the tendons were histologically normal. Mean length of the abnormal histological zone was 1.8 cm (range 0.4-6). However the entire length of the resected tendon was abnormal in 18 cases (table I).

The length of the tendon resection and the extent of the histological lesions on the resection specimens were statistically similar, irrespective of the position of the tendon in the frontal plane. For the tendon stumps which were in a more proximal situation, the chances the cut passed through an abnormal histological zone were greater (p < 0.045) while the extent of the tendon resections was statistically comparable.

Histological lesions were seen as lacerations of the connective tissue (n = 26) (fig. 2), fatty infiltrations (n = 7) (fig. 3), and necrosis (n = 6) (fig. 4). Twenty-two scar formations were noted and seven microlacelizations. Nine tendons exhibited a single histological lesion (scar tissue = 1, laceration of connective tissue = 5, fatty infiltration = 2, necrosis = 1). Twelve tendons exhibited two types of histological lesions and eleven had three. Disorganization of the connective tissue and scar forma-
HISTOLOGICAL LESIONS OF SUPRASPINATUS TENDONS IN FULL THICKNESS TEARS OF THE ROTATOR CUFF

Table I. – Characteristic features of the tendon resections and fatty degeneration of the supraspinatus muscle as a function of the frontal position on the arthroscan of the supraspinatus tendon stumps.

<table>
<thead>
<tr>
<th>Frontal position of the tendon stump (arthroscan)</th>
<th>Preoperative fatty degeneration of the supraspinatus</th>
<th>Length of the tendon resection (mm)</th>
<th>Length of histological lesions on the tendon resections (mm)</th>
<th>Number of histologically abnormal tendon resections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal position N = 17</td>
<td>1.29 (0-2)</td>
<td>2.32 (1.7-3.5)</td>
<td>1.79 (0.8-3)</td>
<td>8 (47%)</td>
</tr>
<tr>
<td>Intermediary position N = 10</td>
<td>1.5 (0-3)</td>
<td>1.96 (1-3)</td>
<td>1.67 (0-3)</td>
<td>5 (50%)</td>
</tr>
<tr>
<td>Facing the glenohumeral interface N = 5</td>
<td>2 (1-3)</td>
<td>2.2 (1.5-3)</td>
<td>2.2 (1.5-3)</td>
<td>5 (100%)</td>
</tr>
</tbody>
</table>

NS NS NS P = 0.045

DISCUSSION

Histological lesions of the resected tendon stumps

Earlier work has been published concerning histological lesions of full thickness rotator cuff tears [Hashimoto et al. [7]]. The microscopic lesions were comparable with those observed in non-full-thickness tears [Fukuda et al. [8][9]] and tendinopathies without tendon rupture [Sano et al. [10]]. Nevertheless, there have been no reports comparing proximal extension of the histological lesions and macroscopic anomalies.

On average, the histological lesions extended 1.8 cm proximally, irrespective of the frontal position of the tendon stump in relation to the greater tubercle. However, when the tendon stump was facing the glenohumeral space, the histological lesions were more extensive since the resection zone was histologically abnormal in all cases.

Proximal extension of histological lesions gave a nearly equivalent measurement of the proximal extension of macroscopic tendon injury. However, resection of gross anomalies did not always leave a macroscopically normal stump, especially when the tendon stumps are at the level of the glenohumeral joint. In such cases, although we did not check out this possibility, the fear of removing the entire tendon incited surgeons to remove only the gross anomalies. It must be recalled that, measured on the MR images from the middle of the insertion facet on the greater tubercle, the length of the supraspinatus tendons is on average 2.4 cm (range 2 – 2.8) [Goutallier et al. [11]]. The six tendon resections measuring more than 2.8 cm should not have left any proximal stump. But the length of the resection was measured on the superficial aspect of the tendon, which increases the length by 0.5 cm.

Impact of histological lesions on repair technique

Sano et al. [6], demonstrated that histological lesions of the rotator cuff tendons is associated with decreased mechanical quality. Repairing a histological abnormal tendon could be the cause underlying failed repairs noted by Kempf et al. [5] and Wallace et al. [12]. Such tears could be explained by insufficient tendon resection and could be due to insufficient tension on the sutures (leading to early failure and tears before six months), or mechanical insufficiency of tendons which healed on the bone (leading to later tears more than six months after repair).

Because of the expected mechanical consequences, torn tendon stumps with histological lesions should be resected before reinsertion in order to remove macroscopically abnormal tissue. Because the tendons can present macroscopic lesions extending more proximally than the macroscopically evident anomalies, sutures should be positioned several millimeters medially from the cut line to be sure that they lie in a mechanically resistant zone. Moreover, neo-stumps, which are undoubtedly not histologically normal, should logically be pushed into a well-vascularized bony groove to favor healing. Tendon healing on cortical bone was demonstrated by Pierre et al. [13] solely for goat rotator cuff tendons which were not torn and thus probably histologically normal.
Resection of the macroscopically abnormal zone of torn tendons thus appears to be an important element for decreasing the frequency of recurrent tears. But, the loss of tendon stock makes it difficult, if not impossible, to reinsert the torn tendons without tension. But it is known that healing requires repair without tension [Burkhart et al. [14]]. Thus it is generally not possible to reinsert a resected tendon without tension unless special techniques as proposed by Debeire and Patte for the supraspinatus and by Goutallier and Patte for the infraspinatus [Goutallier et al. [15]] are applied to achieve tendinomuscular advancement. This special technique appears to be satisfactory since for comparable preoperative overall fatty degeneration, the percentage of complete cuffs after musculotendinous advancement appears to be higher than after simple suture [Goutallier et al. [3]].

Most likely, a large number of repeated tears after simple tendon-bone repair of cuff tears are due not only to muscular problems but also to lesions of the tendons which reduce their mechanical resistance and make them more vulnerable than sutures under tension.

CONCLUSION

Supraspinatus tendon stumps of full thickness tears are histologically abnormal. The extent of the histological damage is approximately the same as the length of the macroscopically apparent injury (thin, lacerated, cleaved, hardened or whitish tissue). Histological lesions of the tendon stumps could be the source of repeated tears occurring after simple tendon-bone suture and which cannot be explained by significant fatty degeneration of the muscles. Resection of macroscopically abnormal tissue appears to be a logical solution to favor tendon-bone healing. But this would lead to a longer resection, lengthening the gap and leading to tension on the suture unless a musculotendinous advancement is used.

References