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Latissimus dorsi transfer for primary treatment of irreparable rotator cuff tears

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Abstract Transfer of the musculo-tendinous unit of the latissimus dorsi was performed in seven patients (5 men and 2 women, with a mean age of 57 years) with irreparable rotator cuff tear who had had no previous surgery for cuff repair.

Preoperatively, the mean active shoulder motion was 86° in flexion, 74° in abduction and 22° in external rotation. One patient had a positive lift-off test. The average preoperative Constant and Murley score was 44%. Diagnosis of irreparability of the cuff lesion was made preoperatively only in one case. In the remaining patients, the preoperative data only led to suspect that the tear was irreparable. At surgery, all patients had an irreparable tear of the superoinferior portion of the cuff and one patient also had a tear of the subscapularis tendon. In all cases the latissimus dorsi tendon was inserted

to the greater tuberosity and, in four cases, to the subscapularis tendon; in three patients it was sutured to the bicipital tendon. Postoperatively all patients had relief of shoulder pain. The mean improvement in active flexion, abduction and external rotation was, respectively, 39°, 29° and 10°. At the latest follow-up, the average Constant and Murley score was 64%. The results of surgery were rated as excellent in three cases, good in two, fair in one and poor in one. All patients but one returned to preoperative work. Transfer of the latissimus dorsi muscle is an effective procedure for patients in middle or early elderly age who have an irreparable tear of the supraspinatus and infraspinatus tendons.

Key words Rotator cuff • Irreparable tear • Tendon transfer • Latissimus dorsi muscle

Introduction

Massive tears of the rotator cuff are those tears that involve two or more tendons or are larger than five centimeters at the greatest diameter. Most of these lesions can be repaired with the arm at the patient's side or by abducting the arm 30°–60°. However, some tears are absolutely irreparable, because no residual tendon tissue is found or the tendon stumps are so retracted or friable that they cannot be approached and anchored to bone even with the arm abduct-

ed to more than 60°. Patients with truly irreparable cuff tears may be exceedingly difficult to manage, particularly when the irreparability of the lesion has not been diagnosed or suspected before surgery. In these cases, open subacromial decompression often relieves shoulder pain, but failure to repair the lesion may lead to no improvement in active range of motion or even deterioration of shoulder function after surgery [1].

There are several surgical options in patients with an irreparable cuff tear. These include arthroscopic subacromial decompression, hemiarthroplasty or total shoulder arthro-

plasty, the use of flaps of deltoid or trapezius muscles, and the transfer of a distant musculotendinous unit, such as the latissimus dorsi or the teres major.

Arthroscopic subacromial decompression, associated or not with section of the biceps tendon [2], may relieve pain, but no significant improvement in active shoulder motion can be expected when functional inability is related to loss of muscle function rather than pain [3]. Hemiarthroplasty and unconstrained total shoulder arthroplasty may lead to satisfactory results in terms of pain relief, but in most cases they improve moderately the active shoulder motion [4–6]. Delta inverse total shoulder prosthesis may give satisfactory results with regard to both pain and shoulder function [7, 8]. However, Delta prostheses, as well as any type of arthroplasty, are indicated in elderly patients, particularly in the presence of cuff arthropathy. Conflicting results have been reported with the use of muscle flaps of deltoid [9, 10] or trapezius [11, 12]; furthermore, flaps of these muscles cannot usually be used in truly irreparable cuff tears because in these cases there is no, or no sufficiently healthy, tendon stumps to which the muscle flaps can be anchored.

Celli et al. [13] reported the transfer of teres major muscle for infraspinatus in six patients with irreparable rotator cuff tear, associated, in one, with a neurologic deltoid deficiency. Of their patients, one was very satisfied and five were satisfied with the results of surgery. Transfer of the latissimus dorsi muscle was originally reported by Gerber et al. [14] in four patients with irreparable rotator cuff tears; subsequently, Gerber [15] evaluated the medium-term results after such a transfer in 15 patients who had no previous cuff surgery. Miniaci and MacLeod [16] reported the use of the latissimus dorsi in 17 patients who had repeat surgery after a failed operative treatment of a massive tear of the rotator cuff. Warner [12] and Aoki et al. [17] performed six

and 10 transfers, respectively, to reconstruct irreparable rotator cuff tears that had not been treated with prior surgery.

We report our experience with the transfer of the latissimus dorsi muscle in patients with irreparable rotator cuff tears who had had no previous surgery for cuff defect.

Materials and methods

Between 1998 and 2001, transfer of latissimus dorsi musculotendinous unit was performed in 7 patients who had an irreparable rotator cuff tear and no previous cuff surgery. There were five men and two women, aged 46–68 years (mean, 57). The right, dominant shoulder was involved in five cases and the left, non-dominant shoulder, in two. All patients had shoulder pain lasting 6–18 months at the time of surgery. The active range of motion was limited in all cases, although to a variable extent (Fig. 1a, b) (Table 1). In one patient (case 3) active flexion, abduction and external rotation were considerably impaired; this was also the only patient with a positive lift-off test, indicating a tear of the subscapularis tendon. In the remaining patients, active motion averaged 86° in flexion, 74° in abduction and 22° in external rotation with the arm adducted. Atrophy of supraspinatus and infraspinatus muscles was severe in four cases, moderate in two and mild in one.

In no patient did plain radiographs show evidence of cuff arthropathy. The acromio-humeral interval was less than 7 millimeters in five cases (Table 1). Diagnosis of cuff tear was made by magnetic resonance imaging (MRI) in all cases. MR scans showed a massive lesion in all patients (Fig. 1c), and in four cases a varying degree of degeneration of the cuff muscles, as evaluated by the Goutallier grading system [18]. Only in the patient with severe loss of active shoulder motion diagnosis of irreparability of the lesion was done preoperatively, based on clinical findings and MR images, which showed an extremely large defect of the cuff and severe muscle degeneration. In the remaining cases, the preopera-

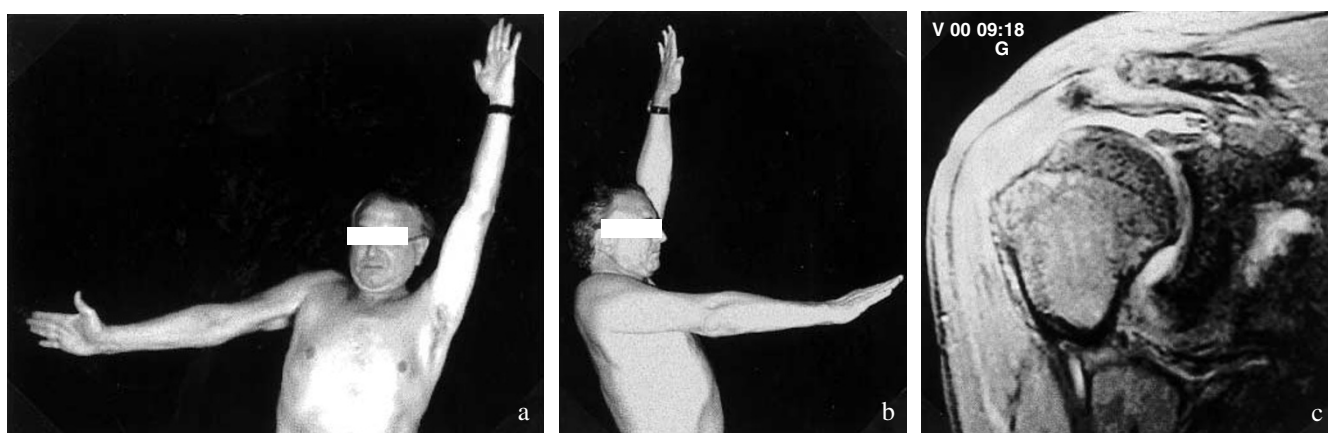


Fig. 1a-c Case 2. **a, b** A 59-year-old man with a massive rotator cuff tear of the right shoulder, involving the supraspinatus and infraspinatus tendons, and an impairment of shoulder abduction (80°) and flexion (80°). **c** MRI scan shows the massive rotator cuff and the upward migration of the humeral head

Table 1 Pre-operative clinical data

Case	Gender	Age (years)	Side	Pain	Active shoulder motion			Lift-off test	Muscle atrophy	A-H interval (mm)	Constant-Murley score (%)
					Flex	Abd	Ext-rot				
1	F	52	Right	Severe	80°	70°	20°	Negative	Moderate	6	40
2	M	59	Right	Severe	80°	80°	15°	Negative	Severe	4	40
3	M	61	Right	Moderate	50°	40°	10°	Positive	Severe	4	41
4	F	62	Left	Severe	110°	100°	30°	Negative	Mild	5	53
5	M	68	Right	Moderate	90°	90°	20°	Negative	Severe	8	47
6	M	46	Right	Severe	90°	60°	30°	Negative	Severe	6	40
7	M	56	Left	Moderate	100°	80°	30°	Negative	Moderate	8	48

Flex, flexion; *Abd*, abduction; *Ext-rot*, external rotation with the arm at the side; *A-H interval*, acromio-humeral interval

tive data only led to suspect that the defect could be so large to be irreparable. In the same time period, however, irreparability of the tear was strongly suspected in four cases, in which, however, the cuff defect was found to be repairable at surgery.

The patients were examined monthly in the first five months after surgery. The latest follow-up was carried out a mean of 18 months after surgery (range, 7–34 months). The results of surgery were evaluated using the Constant and Murley system [19].

Operative technique

When the preoperative clinical or imaging findings led to suspect that the cuff tear was irreparable, the patient was placed in the lateral decubitus position on the operating table with 20° anti-Trendelenburg inclination. This position allows both the rotator cuff to be repaired if it repairable and the musculotendinous unit of the latissimus dorsi to be exposed and transferred to the greater tuberosity if the cuff lesion is irreparable.

The cuff was exposed through an anterolateral or superolateral approach. The deltoid was detached from the anterolateral border of the acromion using cutting current diathermy and split up vertically for approximately 5 centimeters in the middle part of the exposed portion. After horizontal acromioplasty, the rotator cuff was inspected to assess whether the lesion could be repaired and which tendon was intact. When no repair was found to be possible, the skin incision was temporarily closed with clamps and a second incision was done to expose the latissimus dorsi muscle. The incision was started 5 centimeters distally to the posterior corner of the acromion and continued distally and laterally to reach the posterior axillary fold. At this level, it was directed medially for a few centimeters and then continued distally with a vertical direction, parallel to the lateral profile of the trunk, for some 15 centimeters.

The latissimus dorsi was easily recognized as the large muscle crossing, with an oblique direction, the distal portion of the scapula, covered by the teres minor. The latissimus dorsi was followed laterally towards the humeral insertion and progressively dissected

from the teres major. The neurovascular bundle, running on the undersurface of the muscle, was identified and carefully preserved. By blunt dissection, proceeding along the dorsal surface of the muscle, the tendon of the latissimus dorsi was palpated with the finger and exposed as far as its insertion on the humerus, while placing the arm in adduction and internal rotation. The radial nerve, lying deep to the tendon, was never exposed, but its presence was taken in mind to avoid neural damage. The tendon was detached as close as possible to the bone surface, using scissors under direct vision of the anatomical structures (Fig. 2a). While retracting the detached tendon medially and distally, the dissection of the undersurface of the muscle was completed, avoiding tearing and stretching of the neurovascular bundle. After applying a few stay sutures at the muscle-tendon junction and in the nearest portion of the muscle belly, the musculotendinous unit was tractioned proximally. The undersurface of the posterior portion of the deltoid was separated from the triceps tendon by blunt dissection and a clamp was inserted deeply to the deltoid with a craniocaudal direction to grasp the sutures in the latissimus dorsi and bring them above the humeral head. The tendon of the latissimus dorsi was advanced as far as possible towards the greater tuberosity by both pulling the sutures and pushing upwards the muscle belly with the hands.

A bone trough was created in the region of the greater tuberosity, where the latissimus dorsi tendon was anchored with nonabsorbable transosseous sutures. In four patients, after bone fixation, the residual free margins the latissimus dorsi tendon were sutured to the subscapularis tendon (Fig. 2b); in one of these patients the transferred tendon was also sutured to the long biceps tendon, after anchoring the distal portion of the latter to the bicipital groove. In two cases, the latissimus dorsi tendon could not be approached to the subscapularis tendon and was anchored to the long biceps tendon after tenodesis to the bicipital groove. In one patient, in whom the subscapularis tendon was torn and retracted caudally and the biceps tendon was absent, the latissimus dorsi tendon was sutured to small remnants of the superoposterior cuff. The humeral head could be completely covered with tendon tissue in four cases and partially covered in three cases

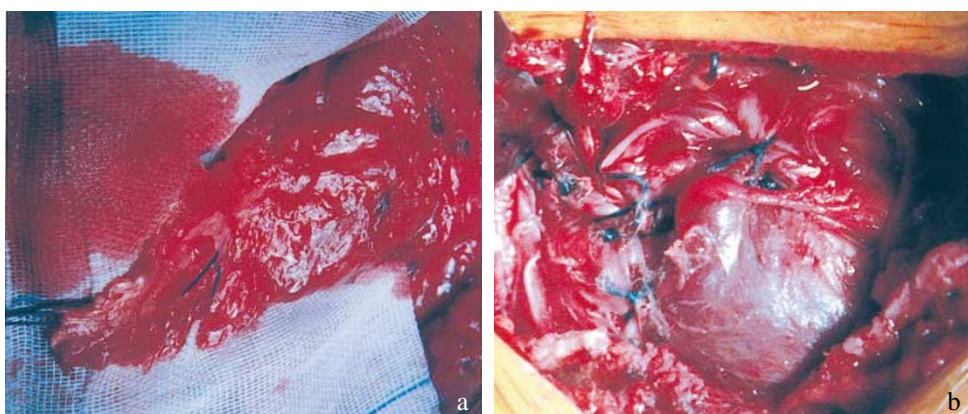


Fig. 2 a, b Case 2. **a** Latissimus dorsi musculotendinous unit which was detached from the humerus. **b** A completed transfer of latissimus dorsi tendon, sutured to the greater tuberosity and subscapularis tendon

Postoperative regimen

The shoulder was immobilized in adduction for 40 days after surgery. However, assisted exercises of passive motion were started 3–4 weeks after surgery. A rehabilitation program of active motion in flexion, abduction and external rotation was initiated 6 weeks after operation and continued for 8 weeks. Afterwards, strengthening exercises were started and usually continued for 4–8 weeks.

Results

All patients had a considerable to complete relief of shoulder pain (Table 2). Five patients had a complete or almost complete active range of motion in flexion, abduction and internal rotation (Fig. 3a–d). However, the strength in abduction and external rotation was decreased, on average, by one-fourth to one-third compared with the contralateral side. Of the remaining patients, one (case 6) obtained a partial recovery of the active range of motion and a moderate

recovery of muscle strength. This patient did not follow the recommended rehabilitation protocol, since he discontinued the assisted program two months after surgery. The other patient (case 3) had a mild improvement of active motion and strength. At surgery, this patient was found to have disinsertion of the upper portion of the subscapularis tendon from the lesser tuberosity as well as a complete rupture of the biceps tendon. The latissimus dorsi tendon, after attachment to the greater tuberosity, could not be anchored to the subscapularis, but was sutured to a few degenerate remnants of the infraspinatus tendon.

The results of surgery were rated as excellent in three patients, good in two and fair or poor in the remaining two (Table 2). Two patients were very satisfied with the result of surgery, three were satisfied and two were partially satisfied. The patient with the poor functional result (case 3), who was a manual laborer, was partially satisfied, particularly due to the complete relief of pain. Except for the latter, all patients returned to preoperative work. No patients, except for the one with poor functional result, reported to be limited in the activities of daily living. One of the two patients who played

Table 2 Post-operative clinical data

Case	Follow-up (mo)	Pain	Active shoulder motion			Result of surgery	Patient satisfaction	Constant-Murley score (%)
			Flex	Abd	Ext-rot			
1	34	Very mild	140°	120°	40°	Excellent	Satisfied	64
2	25	None	140°	145°	15°	Excellent	Satisfied	71
3	18	None	70°	60°	20°	Poor	Partially satisfied	45
4	24	None	150°	120°	50°	Excellent	Very satisfied	75
5	12	Very mild	120°	100°	30°	Good	Satisfied	62
6	9	Mild	110°	80°	30°	Fair	Partially satisfied	55
7	7	None	140°	100°	40°	Good	Very satisfied	77

Flex, flexion; *Abd*, abduction; *Ext-rot*, external rotation with the arm at the side

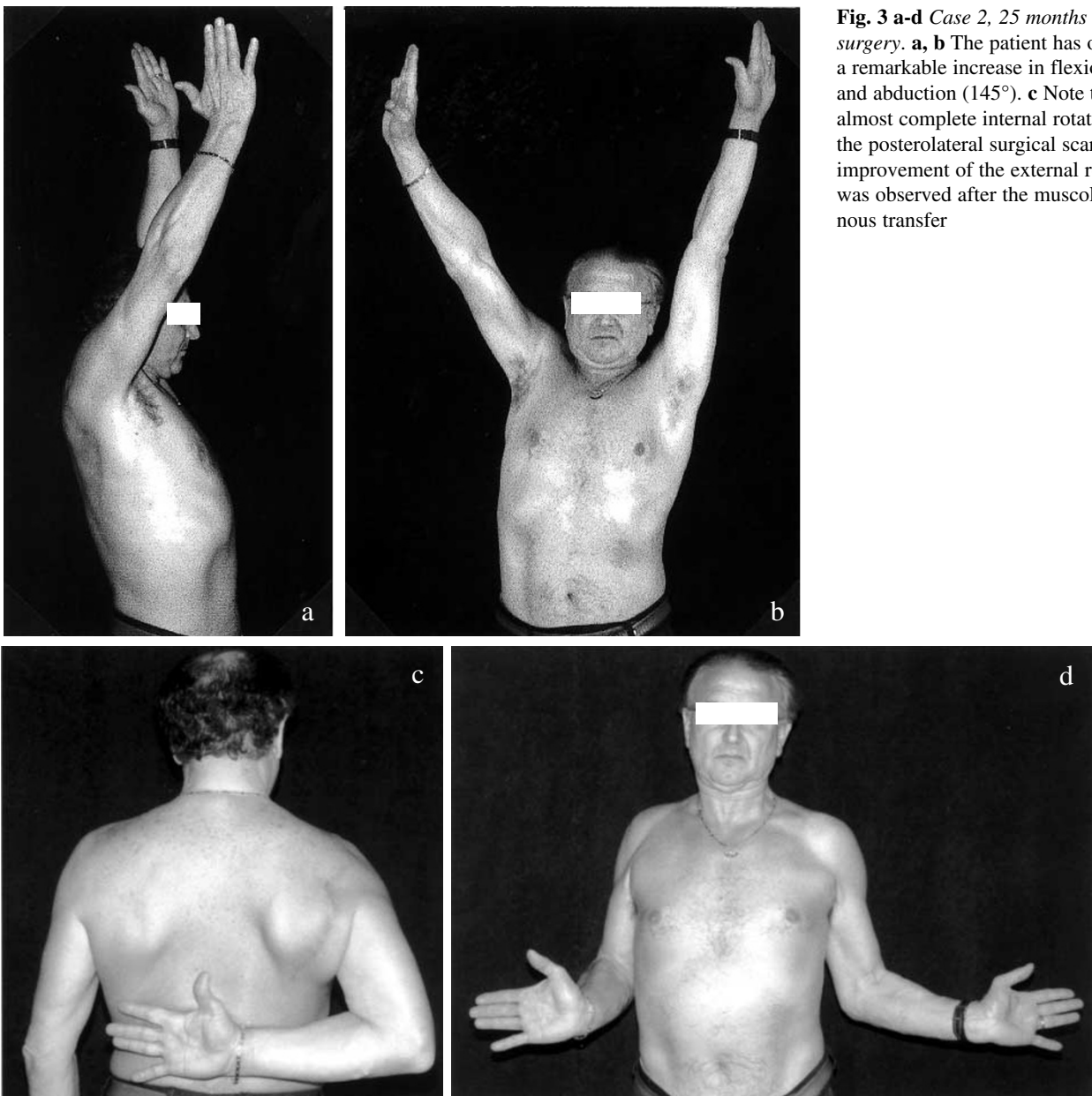


Fig. 3 a-d Case 2, 25 months after surgery. **a, b** The patient has obtained a remarkable increase in flexion (140°) and abduction (145°). **c** Note the almost complete internal rotation and the posterolateral surgical scar. **d** No improvement of the external rotation was observed after the musculotendinous transfer

sports before surgery returned to preoperative sport activities.

The average postoperative Constant and Murley score was 64 points, with an increase in 20 points compared with the preoperative score.

Discussion

The definition of irreparable tear of the rotator cuff is still controversial. We consider as irreparable those tears in which, after extensive mobilization of the residual tendon

cuff, no reinsertion to the humeral tuberosities or to the nearest portion of the anatomical neck of the humerus appears to be possible, even with the arm abducted 45° – 65° . This usually occurs when no identifiable tendon tissue is found over the humeral head or when the tendon stumps are so retracted, and often so frayed and friable, that no stitches can be applied to bring the stumps to the area of insertion. In these cases transfer of a distant musculotendinous unit is indicated in patients in the middle or early elderly age, when surgery is aimed at restoring a satisfactory active range of shoulder motion and strength and there appears to be enough compliance by the patient with a long postoperative rehabilitation program.

It may be difficult, before surgery, to determine whether a massive tear of the rotator cuff can be repaired, even when excellent MRI studies are available. In these cases, when open surgery is planned, one should be able to perform any type of reconstructive surgery. The patient should be informed that a distant musculotendinous transfer may possibly be done and the operating table should be adequately positioned to allow a transfer to be performed if necessary.

The two distant musculotendinous units that are currently used for an irreparable tear of the superior cuff are the teres major and the latissimus dorsi. The latter appears to be preferable because the short tendon of the teres major may not reach the central portion of the greater tuberosity. The tendon of the latissimus dorsi, being wider and longer, can reach the greater tuberosity and cover a large portion of the humeral head; furthermore, it can be attached to a fairly large bone surface and be more easily sutured to residual tendons of the cuff. Although the functional role of the transferred latissimus dorsi is still unclear, it is conceivable that it acts not only as a passive restraint, but also as an active muscle unit which centers the humeral head in the glenoid, thus allowing the deltoid to exert its mechanical function. The fact that the transfer is functionally active is suggested by the increased range of active flexion and external rotation of the arm that was observed in previous series [15–17] as well as in most of our patients.

In some of our cases the latissimus dorsi tendon was so long, or the muscle could be brought so anteriorly, that it could be sutured to the subscapularis tendon, when this was intact. In other cases, in which the tendon could not be brought in contact with the subscapularis tendon, or only a small portion could be anchored to the latter tendon, the latissimus dorsi was

sutured to the biceps tendon, after bicipital tenodesis. All three patients in which this was done had a satisfactory functional result. This indicates that suture of the latissimus dorsi tendon to the bicipital tendon, which has not been described previously, can be a useful procedure to increase the coverage of the humeral head and give the latissimus dorsi tendon a larger insertion in the area of the rotator cuff.

All patients in the current series had a considerable relief or disappearance of shoulder pain after surgery. However, the functional result was rated as excellent or good, despite the incomplete restoration of muscle strength, only in five cases. In the case with a fair result, probably the main reason for the incomplete restoration of active shoulder motion was the inadequate and too short postoperative rehabilitation. It is known that surgical repair of a massive rotator cuff needs, to be successful, a long postoperative rehabilitation program. This is even truer for a salvage procedure, such as the transfer of a distant musculotendinous unit. The patient with a poor functional result was the only one showing a tear of the subscapularis tendon, in addition to the superior cuff. This suggests, as previously reported [15], that the latissimus dorsi muscle can be a good substitute for the superior cuff, but may fail to restore a satisfactory shoulder motion when the anterior cuff is functionally deficient.

Although the follow-up in the current series was relatively short, no patient showed deterioration of shoulder function over time. This suggests that no re-rupture of the transferred tendon occurred over time. Consistent with these findings are the results of previous studies in which no significant decrease in shoulder function was noted with increasing time from surgery [15, 16].

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