Transfer of the tendon of latissimus dorsi for the treatment of massive tears of the rotator cuff

A NEW SINGLE-INCISION TECHNIQUE

P. Habermeyer,
P. Magosch,
T. Rudolph,
S. Lichtenberg,
D. Liem

From The ATOS Clinic, Heidelberg, Germany

We describe 14 patients who underwent transfer of latissimus dorsi using a new technique through a single-incision. Their mean age was 61 years (47 to 76) and the mean follow-up was 32 months (19 to 42).

The mean Constant score improved from 46.5 to 74.6 points. The mean active flexion increased from 119° to 170°, mean abduction from 118° to 169° and mean external rotation from 19° to 33°. The Hornblower sign remained positive in three patients (23%) as did the external rotation lag sign also in three patients (23%). No patient had a positive drop-arm sign at follow-up. No significant difference was noted between the mean pre- and post-operative acromiohumeral distance as seen on radiographs. An increased grade of osteoarthritis was found in three patients (23%). Electromyographic analysis showed activity of the transferred muscle in all patients.

The treatment of massive tears of the rotator cuff continues to be controversial. Despite improvement in arthroscopic repair,[1-5] open procedures remain the treatment of choice if the size of the tear prevents direct re-insertion of the tendon and if the quality of the tendon is poor. A number of different operative techniques has been introduced to address the problem of massive tears of the rotator cuff and as yet there has been no consensus.[6-13] Transfer of the tendon of latissimus dorsi for the treatment of irreparable posterosuperior tears was introduced by Gerber et al.[8] They compared the functional impairment of posterosuperior tears with that of brachial plexus palsy. In order to provide containment of the head of the humerus and to regain control of external rotation, they introduced a technique using two incisions for the transfer of the tendon of latissimus dorsi. A dorsal approach was used for mobilisation of the latissimus dorsi muscle flap; a second, transacromial approach provided access to the greater tuberosity of the humerus.

An anatomical study by Herzberg et al[14] showed that re-insertion of the latissimus dorsi flap at the site of insertion of infraspinatus gave superior rotational movement compared with that at other sites. On this basis we have introduced a modified technique for transfer of the tendon of latissimus dorsi. A single dorsal incision is used to mobilise the latissimus dorsi muscle flap and to re-insert it at the site of the attachment of infraspinatus on the greater tuberosity.

We have assessed the clinical and functional outcome of the single-incision technique and compared the results with those reported in the literature concerning transfer of latissimus dorsi.

Patients and Methods

Between 2001 and 2002, 17 consecutive patients underwent a transfer of latissimus dorsi for massive posterosuperior tears of the rotator cuff by the same surgeon. The diagnosis was made on the basis of clinical examination and MRI. All patients showed weakness of external rotation and had a complete tear of supraspinatus and infraspinatus which was demonstrated on MRI with a grade-3 retraction according to the classification of Patte.[15] Muscle atrophy was of grade 3 using the classification of Thomazeau et al.[16] The decision to perform latissimus transfer instead of repair of the rotator cuff was based on these findings. An intact subscapularis was verified by clinical testing and MRI. The patients were treated using a modified single incision (Fig. 1); there were 14 available for follow-up. Their mean age was 61 years (47 to 76) and the mean follow-up was 32 months (19 to 42).

The single-incision technique. The patient was placed in the lateral decubitus position. Before the tendon transfer we carried out a diagnostic arthroscopy on all patients and tenotomy of

■ P. Habermeyer, MD, Professor, Orthopaedic Surgeon
■ P. Magosch, MD, Medical Information Specialist
■ T. Rudolph, MD, Resident
■ S. Lichtenberg, MD, Orthopaedic Surgeon
■ D. Liem, MD, Resident
Shoulder and Elbow Service
ATOS Clinic, Bismarckplatz 9-15, 69115 Heidelberg, Germany.

Correspondence should be sent to Dr P. Habermeyer; e-mail: Habermeyer@atos.de

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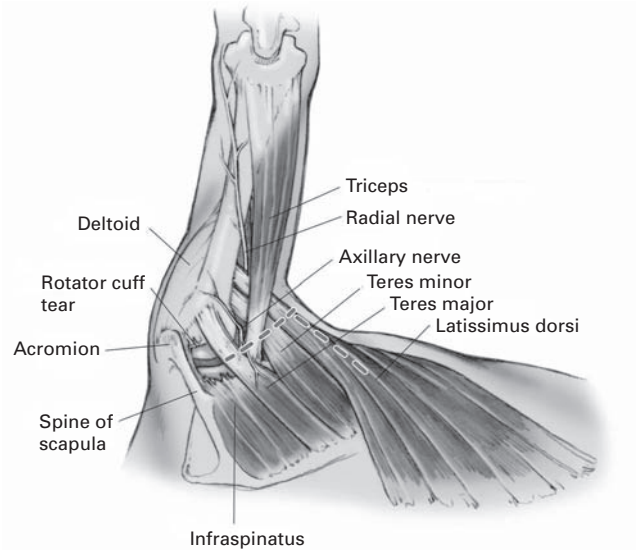

Fig. 1a

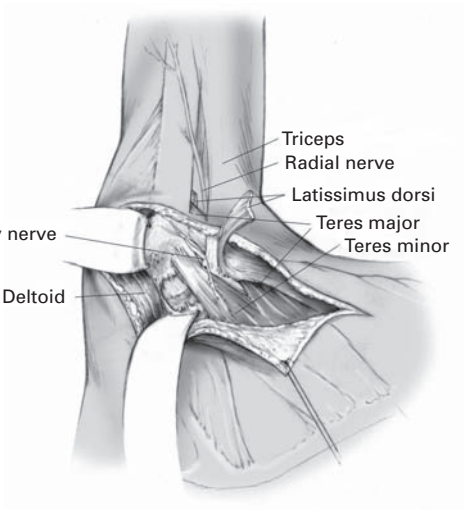

Fig. 1b

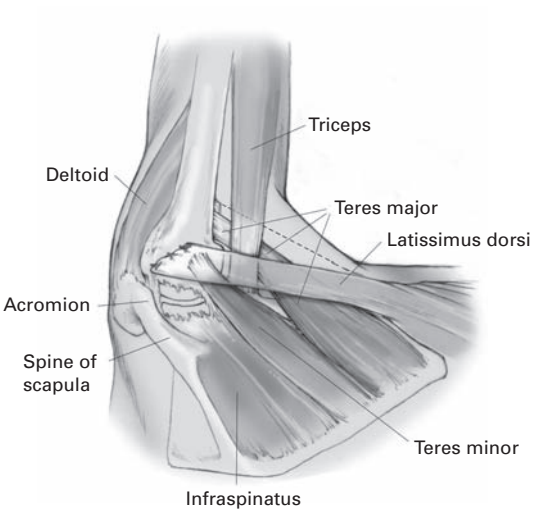

Fig. 1c

Diagrams showing a) the pre-operative line of incision, b) visualisation of the defect of the rotator cuff and preparation of the latissimus flap and c) the transferred latissimus flap at the site of insertion of infraspinatus.

the long head of biceps if necessary. A triangular incision was made from the axillary pouch to its apex and from the lateral border of the scapula to the inferior scapular angle (Fig. 1a). Latissimus dorsi and teres major were identified and defined. The infraspinatus was approached through the interval between deltoid and teres minor. With the arm in 90° of flexion and maximum external rotation the back of the greater tuberosity was identified. The posterosuperior rotator cuff and glenohumeral joint were then evaluated. An acromioplasty was not carried out but the tuberosity was modified to create more space. An area 3 cm wide on the posterosuperior aspect of the greater tuberosity was prepared and three titanium corkscrew suture anchors (Arthrex Inc., Naples, Florida) armed with two pairs of No 2 fibrewires were inserted 1 cm apart from each other (Fig. 2).

Fig. 2

A post-operative anteroposterior radiograph showing the position of the suture anchors.

Latissimus dorsi was then separated from teres major. The tendon of latissimus dorsi was carefully detached from the shaft of the humerus and thoracic wall for a length of approximately 12 cm (Fig. 1b), taking care to avoid damage to the radial nerve. The thoracodorsal vessels and nerve were identified. The arm was held in 90° of abduction and maximum internal rotation. The tendon of latissimus dorsi tendon then transposed to the prepared bony bed at the site of insertion of infraspinatus and attached using the fibrewire sutures from the anchors with Mason-Allen stitches. The stability of the reconstruction and the vitality of the muscle flap were controlled (Fig. 1c). Reconstruction of the posterosuperior rotator cuff was then achieved restoring the biomechanical force couple in association with the intact tendon of subscapularis.

Post-operative rehabilitation. The patients were immobilised for 48 hours in a sling and then in an abduction pillow for a further three weeks. In this period passive movement was restricted to 30° of abduction, 30° of flexion, 60° of internal rotation and 0° of external rotation. From weeks four to six 60° of abduction, 90° of flexion, 60° of internal rotation and 0° of external rotation were allowed and after six weeks a free range of movement. Strengthening exercises were begun after eight weeks when a full passive range of movement was established.

Follow-up evaluation. At follow-up the patients were clinically evaluated using the score of Constant and Murley.[17] The integrity of the muscle flap was confirmed by ultrasound. Before and after operation standard radiographs with an anteroposterior (AP) view with the arm in the neutral position, an axillary view and an outlet view were taken. The degree of glenohumeral osteoarthritis was evaluated according to the classification of Samilson and Prieto.[18] The acromiohumeral distance was measured on the AP view. In addition, electromyographic examination was performed using a Noromed MES 9000 Surface electromyographic Device (FA Myotronics Noromed Inc, Seattle, Washington). The activity of the transferred muscle was measured for isometric abduction, adduction and external and internal rotation.

Statistical analysis. This was undertaken using SPSS version 11.0 (SPSS Inc., Chicago, Illinois). The level of significance was set at $p < 0.05$. Pre- and post-operative non-parametric data from both groups were compared using the Wilcoxon signed-rank test. Comparison between two groups was performed using the Student *t*-test for independent samples.

Results

Clinical. The mean Constant score improved from 46.5 points (29.3 to 66.7) to 74.6 points (64.5 to 81.5) post-operatively. The patients showed significant improvement in pain, activities of daily living, active range of movement and strength of abduction (Table I).

Analysis of the range of movement showed significant improvement in active flexion, abduction and external rotation. The mean active forward flexion improved by 51° and mean active abduction also by 51°. The mean external rotation also improved by 14° (Table I).

Table I. Clinical details of the patients before and after operation

	Pre-operative (mean) (n = 14)	Post-operative* (mean) (n = 13)	p value
Pain (points)	8.9	14.4	0.017
Activities of daily living (points)	8.3	18.1	0.018
Range of movement (points)	23.7	34.3	0.028
Abduction strength (points)	5.6	7.8	0.016
Constant score (points; %)	46.5 (*51.4*)	74.6 (*84.2*)	0.018
Active range of movement (°)			
Flexion	119	170	0.010
Abduction	118	169	0.012
External rotation	19	33	0.006
Clinical tests			
Drop-arm sign	4	0	
External rotation lag sign	6	3	
Hornblower sign	7	3	

* one patient with complications was excluded

Table II. Radiological details of the patients

	Pre-operative (n = 14)	Post-operative* (n = 13)
Mean acromiohumeral distance (mm)	4.6	5.3
Grade of osteoarthritis[18]		
None (0)	12 (*85.7*)	8 (*61.5*)
Mild (I)	1 (*7.1*)	3 (*23.1*)
Moderate (II)	1 (*7.1*)	2 (*15.4*)
Severe (III)	0	0

* one patient with complications was excluded

Before operation four patients had a positive drop-arm sign which was resolved post-operatively in all. Six patients had a positive external rotation lag sign which remained in three after operation. Seven showed a positive Hornblower sign[19] pre-operatively, in three of whom it remained positive at follow-up.

Overall, 13 patients (92.9%) were satisfied with the post-operative result and would undergo surgery again.

Imaging. Ultrasound examination showed the latissimus flap to be intact at follow-up in all patients.

Analysis of the pre- and post-operative radiographs showed that the mean acromiohumeral distance had increased from 4.8 mm before to 5.3 mm after operation. This was not statistically significant.

Before operation two patients (15.4%) had signs of glenohumeral osteoarthritis according to the classification of Samilson and Prieto,[18] one mild, one moderate. They showed no change after operation. Three patients (23.1%) who had no signs of glenohumeral osteoarthritis before surgery had osteoarthritic changes at follow-up: two mild and one moderate (Table II).

Electromyography. Analysis of electromyographic activity of the transferred muscle was performed to evaluate the ability of latissimus dorsi to learn the new function at follow-up. At follow-up all patients showed positive findings

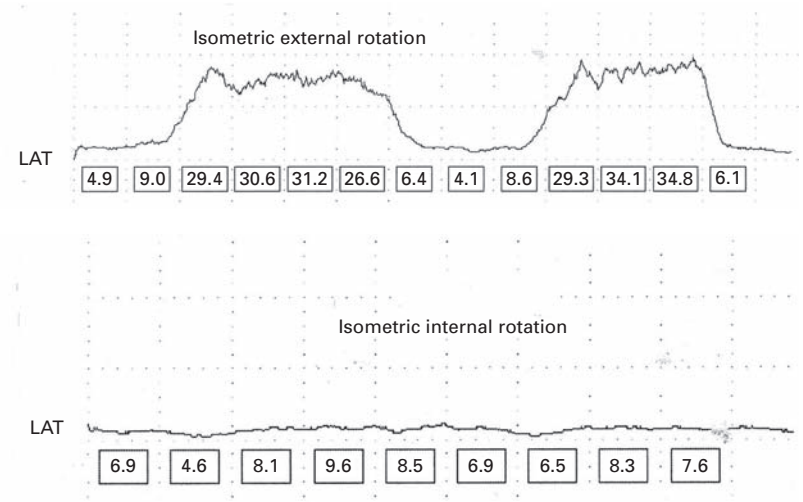

Fig. 3

Electromyograph showing higher activity for external than internal rotation.

on resisted external and internal rotation with the arm at the side indicating a functional latissimus flap. Six patients (46.2%) showed higher activity for external than for internal rotation (Fig. 3). This was not associated with a better Constant score. The other patients either showed an equally high activity for external and internal rotation or higher activity for internal rotation.

Complications. One patient had a failure of the latissimus dorsi flap one week after operation. This was revised by a transfer of teres major and the post-operative assessment was not included in the analysis.

Discussion

We describe a new technique of transfer of latissimus dorsi for treatment of massive posterosuperior tears of the rotator cuff. Overall, our patients had a mean Constant score of 74.6 points with a significant gain in movement after operation. The mean flexion was 170°, abduction 169° and external rotation 33°. These clinical results are comparable with others recorded in the literature.[2,6,8,20]

In his original series Gerber[20] published the results of 16 patients with a mean follow-up of 33 months. His patients regained 73% of an age- and gender-adjusted normal Constant score. He stressed the importance of an intact subscapularis since patients in which its function was deficient had considerably inferior results. No infections or neurovascular complications were reported.

Others have described their results with the two-incision technique of Gerber. Aoki et al[21] recorded the results of 12 latissimus dorsi transfers with a follow-up of 35.6 months. Eight patients were considered to have excellent or good, and four fair or poor results. Patients were evaluated using the UCLA score[22] which improved from 11.8 to 28.0. Radiological examination showed an increase in osteoarthritic changes in five patients, but they did not have inferior clinical results. Electromyography revealed that nine of the 12 transferred muscles showed activity which was synergistic with that of supraspinatus on external rotation in abduction.

Miniaci and MacLeod[6] reported 17 patients with a follow-up of two to five years after transfer of latissimus dorsi for treatment of failed repair of the rotator cuff. They described 14 patients who had significant relief from pain and improvement of shoulder function. Three patients with impaired function and persistent pain were considered to be failures. The mean UCLA score improved from 6.8 to 16.4 post-operatively.

Warner and Parsons[23] compared the results of 16 patients who had latissimus dorsi transfer performed as a salvage procedure for failed repair of the rotator cuff with six who had undergone the operation as a primary procedure. They found better results in the group with a primary repair. The mean Constant score was 69% for the primary and 52% for the revision group. Deficiencies of the deltoid origin and poor quality of the tendon, with a high grade of fatty degeneration, were predictors of a poor outcome. In a more recent series Irlenbusch et al[24] published the short-term results of latissimus dorsi transfer as a primary procedure in 15 patients and salvage operation in seven for massive tears of the rotator cuff. They also found better results in the primary group and worse results if there was an additional rupture of subscapularis.

Experimental studies have been performed to investigate the role of tendon transfers. In a cadaver study Herzberg, Urien and Dimnet[25] compared potential excursion and relative tension in 13 different muscles of the shoulder. They showed that latissimus dorsi had the largest potential excursion of the shoulder muscles, with adequate strength.

Later, the same authors[14] presented the results of another cadaver study which modelled latissimus dorsi transfer to the insertions of different muscles of the rotator cuff. Fixation at the insertion of infraspinatus showed favourable rotational movements in comparison with attachment at the insertion of supraspinatus or teres minor.

These findings were used in the development of the single-incision technique. Moving the point of fixation further posteriorly and inferiorly allowed the use of a single incision for the preparation and fixation of the muscle flap, eliminating the need for the second transacromial incision with detachment of the deltoid muscle. Warner and Parsons[23] emphasised the negative prognostic influence of a deficient deltoid origin in their comparison of the results of primary and salvage transfer of latissimus dorsi. Electromyographic analysis was performed in several other studies to evaluate to what extent the transferred latissimus dorsi learned its new function.[21,26] Although methods of measuring electromyographic activity were different in those studies the results agree with our findings in that the transferred muscle was active post-operatively and could learn its new function.

No conclusions can be drawn from our study about the effectiveness of the single-incision technique as a revision procedure. None of our patients had undergone previous surgery on the rotator cuff. The studies by Warner and Parsons[23] and Irlenbusch et al[24] showed that in their cases the results were worse than in a primary transfer.

The number of patients included in our study was small but the results of the operation are encouraging, with a high level of patient satisfaction, and are comparable with those of the standard two-incision technique.

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