Long-Term Follow-up After Latissimus Dorsi Transfer for Irreparable Posterosuperior Rotator Cuff Tears

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**Background:** Irreparable posterosuperior rotator cuff tears are treated in several ways. Transfer of the latissimus dorsi is an alternative with acceptable mid-term results, but long-term results have rarely been published.

**Methods:** The cases of 108 consecutive patients with 115 shoulders treated with latissimus dorsi transfer between 2000 and 2005 were reviewed clinically and radiographically. Ninety-three shoulders in eighty-six patients were included in the follow-up analysis. The mean duration of follow-up was 9.3 years (range, 6.6 to 11.7 years), and the mean age at the operation was fifty-six years (range, forty to seventy-two years). Outcome measures included the Constant-Murley score (Constant score), American Shoulder and Elbow Surgeons (ASES) index, and visual analog scale (VAS) for pain. The progress of cuff tear arthropathy was determined with radiographic evaluation according to the system described by Hamada et al.

**Results:** The mean relative Constant score improved from 44% preoperatively to 71% at the time of follow-up (p < 0.0001, effect size = 0.6), excluding the clinical failures. Similarly, the mean ASES index improved from 30 to 70 (p < 0.0001, effect size = 0.7), and the mean VAS score decreased from 7.8 to 2.4 (p < 0.0001, effect size = 0.8). A pain-free outcome was reported in only eighteen shoulders (19%). Active shoulder movement improved significantly (p < 0.05). The mean Hamada radiographic grade of cuff tear arthropathy increased from 1.7 (range, 0 to 2) preoperatively to 2.2 (range, 1 to 5) (p < 0.0001, effect size = 0.2). The rate of clinical failure of latissimus dorsi transfer was 10%, and the rate of shoulder prosthetic replacement after latissimus dorsi transfer was 4%.

**Conclusions:** Pain relief and improvement of shoulder function were maintained a mean of 9.3 years after latissimus dorsi transfer for irreparable posterosuperior cuff defects. The younger the patient, the better the outcome.

**Level of Evidence:** Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

The retear rate after successful rotator cuff repair has been as high as 44% in recent reports. Although some massive tears can be adequately repaired with reasonable results, poor tissue quality and an inability to mobilize chronically retracted cuff tissue often preclude successful repair and transform the tear into an irreparable one. Shoulders with a debrided cuff appear to deteriorate with time, and the degenerative changes in the glenohumeral joint tend to progress.

Irreparable posterosuperior rotator cuff tears have been addressed with numerous types of procedures, including debridement and subacromial decompression, margin convergence, combined subscapularis and teres minor transposition, teres minor transfer, latissimus dorsi transfer, deltoid flap reconstruction, and defect closure with tendon allograft or autograft and synthetic graft material. The main problem with most of these options is failure of active centralization of the cuff.

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humeral head in the glenoid as a fulcrum during motion, which is a biomechanical prerequisite for normal motion of the arm in space, in addition to the lack of completely satisfying results. Therefore, the value of these procedures remains uncertain.

Latissimus dorsi transfer is an acceptable option that was introduced by Gerber et al. in 1988. Latissimus dorsi transfer was intended to act as a head depressor and active external rotator. However, some authors have had concerns regarding latissimus dorsi transfer, including the lack of active coordinated synchronous contraction with elevation of the arm when it is performed in adults. The procedure has shown acceptable early to mid-term results, even though it does not restore normal function. However, we are not aware of any previous study describing the long-term results of this technique.

The purpose of the current study was to review the long-term clinical and radiographic outcomes in a consecutive series of patients who had undergone latissimus dorsi transfer to the humeral head for the treatment of irreparable posterosuperior rotator cuff defects. We sought to determine whether the improvements demonstrated after this procedure in short and mid-term studies persisted over the long term.

**Materials and Methods**

We retrospectively reviewed the data on 115 consecutive shoulders in 108 patients who had undergone latissimus dorsi transfer in our hospital between March 2000 and January 2005. (Along with the 400 repairable cuff tears that we operate on per year, we operate on nearly 100 irreparable ones.) Latissimus dorsi transfer was performed in twenty to thirty cases a year. Nearly 60% of our patients who underwent latissimus dorsi transfer had been referred to our department by other shoulder surgeons. All patients had signed an informed consent form for the procedure. Direct repair of the torn tendon was performed on only forty-one shoulders (44%) preoperatively, we had to rely on intraoperative criteria for our decision about whether to perform the operation. Tears were confirmed intraoperatively by the presence of friable or scarred tendon retracted to the glenoid edge that could not be mobilized to the footprint in ≤60° of abduction as defined by Gerber et al. Other criteria included pain and subjective loss of function in a biologically young active individual.

We excluded latissimus dorsi transfers that had been performed in the same session as, or had been followed by, other surgical procedures in the shoulder (pectoralis major transfer, shoulder replacement, etc.). Other exclusion criteria were shoulder instability; inflammatory arthritis such as rheumatoid arthritis; insufficient subscapularis function detected clinically with a positive lift-off and/or lift-up test, bear hug test, and belly press test; fatty degeneration of the subscapularis with a grade higher than II according to the system of Fox and Romeo, and an intraoperative finding of a subscapularis tear that was greater than grade II according to the system of Fox and Romeo. Other contraindications included an axillary nerve lesion, obvious deltoid muscle atrophy from a previous large incision, rotator cuff arthropathy of grade III or higher according to the system of Hamada et al., and limited passive movements of the shoulder joint (passive elevation and abduction of <80°).

The preoperative data were obtained directly from the patients’ hospital files (shoulder questionnaire, including the American Shoulder and Elbow Surgeons [ASES] index, Constant-Murley score, and visual analog scale [VAS] for pain, as well as radiographic scores). Initially, patients were informed about the study in a telephone call. Each interested patient was then sent a detailed questionnaire and invited to sign the informed consent form to participate in the study. Included in the questionnaire were questions about shoulder pain and function and patient satisfaction, a VAS, the ASES index, and the Constant score. Patients were then invited to come to our hospital for clinical and radiographic evaluation. At the clinical assessment visit, the range of shoulder motion was measured with a goniometer and the strength of the abducted shoulder was assessed with an IsobeX digital strength analyzer (Medical Device Solutions, Oberburg, Switzerland).

Standard radiographs (anteroposterior, axial, and outlet “Y” views) were made of the operatively treated shoulders. The radiographic evaluation included...

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**TABLE I Description of the Excluded Shoulders**

<table>
<thead>
<tr>
<th>Cause of Exclusion</th>
<th>No. of Shoulders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latissimus dorsi transfer combined with pectoralis major transfer</td>
<td>5</td>
</tr>
<tr>
<td>Received reverse prosthesis</td>
<td>5</td>
</tr>
<tr>
<td>Revised with teres major transfer</td>
<td>1</td>
</tr>
<tr>
<td>Complicated with infection, underwent multiple debridement operations, had deltoid atrophy, and refused to participate</td>
<td>1</td>
</tr>
<tr>
<td>Died (1 patient underwent shoulder arthrodesis)</td>
<td>3</td>
</tr>
<tr>
<td>Could not be located</td>
<td>3</td>
</tr>
<tr>
<td>Unable to participate in study</td>
<td>4</td>
</tr>
</tbody>
</table>

**TABLE II Demographic Data**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range) at op. (yr)</td>
<td>56 (40-72)</td>
</tr>
<tr>
<td>Mean follow-up period (range)* (yr)</td>
<td>9.3 (6.6-11.7)</td>
</tr>
<tr>
<td>Sex (no. of patients)</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>24</td>
</tr>
<tr>
<td>M</td>
<td>62</td>
</tr>
<tr>
<td>Side affected (no. of patients)</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>57</td>
</tr>
<tr>
<td>L</td>
<td>22</td>
</tr>
<tr>
<td>Bilateral</td>
<td>7</td>
</tr>
<tr>
<td>Affected shoulder: dominant (no. of patients)</td>
<td>66 (77%)</td>
</tr>
<tr>
<td>Concurrent repair of partial subscapularis lesion (no. of shoulders)</td>
<td>13 (14%)</td>
</tr>
</tbody>
</table>

*The duration of follow-up was more than ten years for 60% of the shoulders.
Subscapularis tear (maximum grade of II according to the system of Fox and thirteen shoulders (14%) in which the transfer was combined with repair of a (after failure of a previous open rotator cuff repair).

Ultrasonographically.

The operation was performed with use of the two-incision technique described by Gerber

The three shoulders (3%) with transfer failure as well as another group of thirteen shoulders (14%) in which the transfer was combined with repair of a subscapularis tear (maximum grade of II according to the system of Fox and Romeo) were also studied as separate groups.

Operative Technique

The operation was performed with use of the two-incision technique described by Gerber after the irreparability of the posterosuperior rotator cuff tears was proved as described above. The principle is that the latissimus dorsi is raised via an axillary incision along the lateral border of the muscle. After mobilization, the tendon is armed with sutures and pulled through the space between the infraspinatus, teres minor, and deltoit onto the prepared greater tuberosity of the humeral head. The lateral edge of the tendon is sewn into the greater tuberosity with transosseous sutures. Then the medial edge of the tendon is inserted into the upper rim of the subscapularis tendon.

Postoperative Care

A thorax-abduction splint was applied and worn for five weeks. During this time, passive exercises aiming at 90° of abduction and forward flexion and 40° of external rotation were performed. Internal rotation did not exceed 0°. Following the five-week splinting period, the shoulder support was changed to a shoulder abduction pillow. At six weeks, mobilization with physiotherapeutic support was gradually started in an inpatient rehabilitation center and continued there for three weeks. Then the patient underwent outpatient physiotherapy until four months postoperatively.

Statistical Analysis

A paired Student t test was used to compare the Constant score, VAS score, and ASES index between the preoperative and postoperative evaluations. The relevance of the statistical significance was measured with use of the effect size for the different indices according to the method of Cohen, with around 0.2 defined as a “small” effect size, around 0.5 as a “medium” effect size, and around 0.8 as a “large” effect size. Bivariate correlations of quantitative data were assessed with use of a Spearman correlation coefficient (r), and the correlation was interpreted as weak when r < 0.4, moderate when r = 0.4 to 0.7, and strong when r > 0.7. All statistical tests were two-sided, and a p value of <0.05 was considered to indicate significance. All statistical analyses were performed with use of the SPSS software package (version 20; IBM, Armonk, New York).

Source of Funding

No outside funding was provided for this study.

Results

Analysis of the entire series (excluding clinical failures that were not included in the follow-up evaluation) showed improvement in clinical scores; pain scores; and active motion of the shoulder in abduction, elevation, and external rotation. However, an increase in rotator cuff arthropathy and a decrease in the acromiohumeral distance were also found (Table III).
Eighteen shoulders (19%) were pain-free with a VAS score of 0 at the time of follow-up. Twenty-seven patients (31%) were very satisfied, forty-seven (55%) were satisfied, eight (9%) were unsatisfied, and four (5%) were very unsatisfied. Fifty-two patients (60%) took no pain medications regularly, twenty-six (30%) took only on-demand pain medication, and eight (9%) took pain medication regularly. Seventy-four patients (86%) stated that they would undergo the procedure again under similar circumstances, and twelve (14%) stated that they would refuse it.

There was a significant reduction in the mean acromiohumeral distance from 5.9 mm preoperatively to 4.9 mm at the time of follow-up (p < 0.0001) in the entire series, with a non-significant difference between the primary and secondary-transfer groups. The acromiohumeral distance was >6 mm in forty-six shoulders preoperatively but only twenty-eight shoulders at the time of follow-up. Also, there was no correlation between the clinical outcome (relative Constant score) and the radiographic grade of the shoulder according to the system of Hamada et al. (r = 0.195, p = 0.113) or between the clinical outcome and the acromiohumeral distance (r = 0.170, p = 0.219), at the time of follow-up.

The relative Constant score correlated inversely with the mean age at the time of the operation (r = −0.4) and diminished moderately with increasing age of the patient (Fig. 1).

The primary and secondary (after failed repair) latissimus dorsi transfer groups showed a significant difference regarding the absolute and relative Constant scores, but with small effect sizes (0.2
and 0.3), and nonsignificant differences with regard to the ASES index, VAS score, and cuff tear arthropathy (Table IV and Fig. 2).

The clinical failure group (three shoulders in three patients; 3%) showed significantly poorer clinical and radiographic outcomes compared with the non-failure group (Table V and Fig. 2). One of the shoulders had had a primary latissimus dorsi transfer and two, a secondary transfer.

The thirteen shoulders (14%) that underwent the latissimus dorsi transfer in combination with subscapularis repair showed no difference in the clinical outcome compared with those with an intact subscapularis (Table VI and Fig. 2). A figure in the Appendix shows a patient, nine and ten years after bilateral latissimus dorsi transfer, who had good function but developed cuff tear arthropathy. Another figure in

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**TABLE V Outcomes in Clinical Failure Group (N = 3)**

<table>
<thead>
<tr>
<th></th>
<th>Preop.*</th>
<th>At Follow-up*</th>
<th>Difference*</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute (points)</td>
<td>39.5 ± 6.4</td>
<td>23.3 ± 6.1</td>
<td>16.2 ± 3.4</td>
<td>0.07</td>
</tr>
<tr>
<td>Relative (%)</td>
<td>48.2 ± 4.2</td>
<td>32.7 ± 5.7</td>
<td>15.5 ± 3.1</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>ASES index (points)</strong></td>
<td>33.0 ± 4.6</td>
<td>34.7 ± 8.3</td>
<td>1.7 ± 11.7</td>
<td>0.827</td>
</tr>
<tr>
<td><strong>Active forward flexion (deg)</strong></td>
<td>23.1 ± 13.3</td>
<td>15.3 ± 8.8</td>
<td>7.8 ± 5.0</td>
<td>0.691</td>
</tr>
<tr>
<td><strong>Active abduction (deg)</strong></td>
<td>23.1 ± 13.3</td>
<td>20.8 ± 12.0</td>
<td>2.3 ± 5.7</td>
<td>0.184</td>
</tr>
<tr>
<td><strong>Active external rotation in 0° abduction (deg)</strong></td>
<td>2.9 ± 1.7</td>
<td>5.8 ± 3.3</td>
<td>2.9 ± 2.9</td>
<td>0.020</td>
</tr>
<tr>
<td><strong>VAS score for pain</strong></td>
<td>7.7 ± 1.5</td>
<td>6.3 ± 3.0</td>
<td>1.4 ± 4.0</td>
<td>0.625</td>
</tr>
<tr>
<td><strong>Hamada grade†</strong></td>
<td>1.7 ± 0.6</td>
<td>1.7 ± 0.6</td>
<td>0.0 ± 0.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Acromiohumeral distance (mm)</strong></td>
<td>6.1 ± 1.4</td>
<td>4.7 ± 0.6</td>
<td>1.4 ± 1.1</td>
<td>0.116</td>
</tr>
</tbody>
</table>

*The values are given as the mean and standard deviation. †Hamada grade = degree of cuff tear arthropathy according to the system described by Hamada et al.*

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**Fig. 2**
Graph showing significant improvement in the relative Constant score (CS) in the different study groups. Significant differences were found between the primary (prim LDT) and secondary (second LDT) latissimus dorsi transfer groups and between the group with clinical failure and any other group.
the Appendix shows a patient who had only a slight increase in cuff tear arthropathy eleven years after the transfer.

As mentioned, MRI was performed preoperatively for only 44% of the shoulders; therefore, we cannot provide data regarding the degree of atrophy or fatty degeneration of the rotator cuff in this series.

Complications Related to the Surgical Procedure

Axillary hematoma developed in four shoulders; it required surgical evacuation in three cases and only needle aspiration in one. A radial nerve lesion and an axillary nerve lesion (both temporary) were found in one case each, and deltoid insufficiency was present in three cases. Secondary frozen shoulder developed in two cases and improved with conservative treatment.

Discussion

The most important finding of this study is the long-lasting improvement achieved with latissimus dorsi transfer. The medium-to-large effect sizes regarding pain relief, shoulder function (ASES index and Constant score), and improvement in the range of active movements indicate that the procedure achieved clinically relevant improvements.

We decided not to include treatment failures in the calculations of the mean values of the clinical parameters as we believed that, in this way, we would enable surgeons to make a more instructive statement in their preoperative informed-consent discussions with patients. In our opinion, providing both the failure rate and the mean Constant score for successful cases is the best way to describe the postoperative outlook to the patient. We think that a lower mean Constant score based on all patients (including failures and complications) would not inform the patient about his or her prognosis to the same extent.

At about ten years postoperatively, 86% of the patients in our series were satisfied with the outcome. These findings are in line with those of Valenti et al.39, Gerber et al.37,38, Aoki et al.39, and Miniaci and MacLeod40, who found that 84%, 80%, 75%, and 82% of their patients, respectively, were satisfied. Furthermore, we can confirm this high percentage of satisfaction by the relatively large number of patients (seven) who chose to have the procedure again, on the contralateral side.

In our series, the mean active forward flexion at the time of follow-up was 133.5°, representing a mean improvement of 46.2°. These values are slightly lower than those reported by Gerber37, who found an increase of 52° after a mean duration of follow-up of four years, and Valenti et al.39, who reported an increase of 57° after about two years of follow-up. Our values are slightly higher than those of Aoki et al.39 and Weening and Willems40, who found a mean active elevation of 36° and 27°, respectively. In our series, the mean external rotation improved from 17.6° to 29.2° with a mean improvement of 11.6°. These findings are in line with those of Valenti et al.39 and Miniaci and MacLeod40.

The mean relative Constant score was improved from 44.0% to 71.4%. Our follow-up scores correspond to those of Gerber et al.37 (73%), Valenti et al.39 (63%), and Weening and Willems40 (63%). In our own previous three studies, we found mean absolute scores of 65, 69, and 78 points, respectively37,41,42.

Studies have shown the importance of subscapularis damage and that previous attempts at rotator cuff repair adversely affect the outcome of latissimus dorsi transfer.37,40 Consistent with these results, one of our earlier studies37, which included fifty-two of the ninety-three shoulders studied here, showed that, after a mean duration of follow-up of 35.7 months, patients with subscapularis involvement (Fox and Romeo grade I or II) had a mean Constant score of only 50 points as opposed to 75 points for those with an isolated posterosuperior defect. Over time, this difference diminished: after a follow-up period of 50.2 months, a mean Constant score of 72 points was found in cases of subscapularis involvement as opposed to 77 points in cases of isolated supraspinatus and infraspinatus tendon tears.13 Surprisingly, in our present series, we found the same tendency: a repaired subscapularis did not have a major impact on the long-term outcome (Table VI). However, this comparison between thirteen shoulders that underwent the transfer combined with subscapularis repair and eighty shoulders without subscapularis damage lacks statistical power. A completely insufficient subscapularis was a contraindication to latissimus dorsi transfer, as mentioned above.

Secondary latissimus dorsi transfer (after failed repair) with deltoid compromise seems to have an adverse effect on the outcome. This was reflected only by the Constant score

<table>
<thead>
<tr>
<th></th>
<th>Subscapularis Intact*</th>
<th>Subscapularis Repaired*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preop.</td>
<td>At Follow-up</td>
</tr>
<tr>
<td>Constant score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute (points)</td>
<td>37.8 ± 12.5</td>
<td>62.5 ± 17.9</td>
</tr>
<tr>
<td>Relative (%)</td>
<td>46.3 ± 11.3</td>
<td>71.6 ± 19.6</td>
</tr>
<tr>
<td>ASES index (points)</td>
<td>33.8 ± 20.5</td>
<td>73.2 ± 5.2</td>
</tr>
<tr>
<td>VAS score for pain</td>
<td>7.3 ± 2.5</td>
<td>1.8 ± 2.2</td>
</tr>
</tbody>
</table>

*The values are given as the mean and standard deviation. †The p values are for the difference in the postoperative values between the two groups.
and active movements of the shoulder (p = 0.04), not by the ASES index, VAS score, or cuff tear arthropathy (p > 0.05) (Table IV). This finding regarding the Constant score is in line with that of our previous comparative study and that by Warner and Parsons. The secondary-transfer group in our series also had a higher prevalence of failure compared with the primary one.

Age had an adverse effect on the outcome (Fig. 1). No correlation was found between the clinical outcome and the degree of cuff tear arthropathy or the postoperative acromiohumeral distance. This contradicts the results found by Jost et al. in their study of rotator cuff repair. It also conflicts with those of our former studies with shorter follow-up periods.

The five patients who underwent implantation of a reverse prosthesis had a mean preoperative Constant score of 34 points. Three of these patients reported an initial improvement during the first five to twelve postoperative months, followed by deterioration. The other two reported no improvement after the operation. They were identified as having transfer failure at a mean of twenty months postoperatively. They received a reverse prosthesis after different time intervals (ranging from twenty-two to sixty-two months). Two had had a primary latissimus dorsi transfer and three, a secondary transfer.

Analysis of the transfer failures and revisions to a shoulder prosthesis suggests some predictors of failure, including a secondary operation, a small acromiohumeral distance, grade-II tear arthropathy, a lower preoperative Constant score, and a reduced preoperative active range of motion. Additionally, our previous unpublished data showed a lower level of latissimus dorsi activity on superficial electromyography in the early postoperative period in those patients. However, because of the small number of patients with a failed transfer included this study, this conclusion lacks power.

Clinical failure or transplant rupture occurred within the first two years. After that we did not identify any ruptures of the transferred tendon. This finding coincides with the reruptures of the rotator cuff after repair described in the literature. We cannot provide an explanation for this finding.

Eighteen (19%) of our patients were pain-free, with a VAS score of 0. This information should be shared with future patients considering this procedure.

Limitations of our cohort study include selection bias resulting from exclusion of eight of the twelve clinical failures because the patients underwent other procedures. This can bias the study results toward a better outcome. Another major weakness of this study is its retrospective nature and lack of comparison with other procedures.

In conclusion, improvement of pain and shoulder function was maintained a mean of 9.3 years after latissimus dorsi transfer for irreparable posterosuperior rotator cuff defects. The results were better after primary than secondary repair. The younger the patient, the better the outcome. Clinical failure of the transfer occurred in only 10% of the patients, within the first two years postoperatively. This means that, on the basis of our results, 90% of treated patients can expect to have a good Constant score (mean, 71% in our series) in approximately ten years’ time. However, in 10% of cases, a failure of the latissimus dorsi transfer and consequently a significantly lower Constant score is to be expected.

Appendix

Photographs and radiographs of two cases are available with the online version of this article as a data supplement at jbjs.org. Note: The authors thank Sister Heike Luethner for her great help in organizing the patient follow-up examinations.

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References


