Latissimus dorsi transfer for irreparable rotator cuff tears

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Introduction
Irreparable rotator cuff tears are a challenging problem with few satisfactory treatment options. Simple subacromial decompression relieves the pain but with modest improvement in function. Reversed shoulder arthroplasty is another option for management. Latissimus dorsi transfer can help to both improve the pain and restore the function without the need for arthroplasty.

Patients and methods
This study was conducted on 12 patients with irreparable rotator cuff tears involving the supraspinatus and infraspinatus tendons and who failed to respond to subacromial decompression. The latissimus dorsi tendon was transferred to the anterior aspect of the greater tuberosity followed by programed rehabilitation.

Results
Both pain and active external rotation and abduction improved significantly at 6 and 12 months' follow-up. The average constant score improved from 28 points preoperatively to 68 points postoperatively. All these improvements were significant ($P < 0.001$).

Conclusion
Latissimus dorsi transfer to the anterior aspect of the greater tuberosity helps to improve both active external rotation and abduction with pain relief in patients with irreparable rotator cuff tears.

Keywords:
irreparable; latissimus dorsi transfer; massive; rotator cuff tears; shoulder active external rotation and abduction

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Introduction

Irreparable rotator cuff tears are those tears that cannot be repaired to the greater tuberosity of the humerus despite proper release of their superficial and deep layers [1]. They involve the supraspinatus and infraspinatus tendons that are retracted more than 5 cm; furthermore, they could be retracted medial to the glenoid rim. The shoulder function is greatly disabled in these cases.

Many options have been tried in such cases with limited success, such as autologous or synthetic tendon grafts [2], subscapulris transfer [3], deltoid flap procedures [4], and others. The use of a reversed shoulder prosthesis is another treatment option. In 1988, Gerber *et al.* [5] proposed transferring the latissimus dorsi tendon to the posterolateral aspect of the greater tuberosity to improve external rotation in such patients. Moreover, the flap stabilizes the humeral head and allows for more effective action of the deltoid muscle, leading to improved anterior elevation. However, elevation in the scapular plane (abduction) was not significantly improved by such procedure and therefore the gain was limited. A modification of such procedure that will improve both external rotation and abduction is an effective treatment option for such cases if achievable. This prospective study aims to study the efficacy of transferring the latissimus dorsi tendon to the anterior aspect of the greater tuberosity in an attempt to improve both external rotation and elevation in the scapular plane (abduction).

Patients and methods

This study was conducted between March 2009 and April 2012 on 12 patients with massive irreparable rotator cuff tear involving the supraspinatus and infraspinatus. Eight men and four women with a mean age of 62.1 (46–72) years were involved in this study. All our patients underwent subacromial decompression (acromioplasty without release of the coracoacromial ligament) as a preliminary procedure with verification of the irreparability of the tear.

This was performed arthroscopically in eight cases and through a minideltoid split approach in four cases. In six cases, biceps tenotomy was added for a clearly degenerated nonfunctioning biceps anchor to help decrease pain. They then underwent a rehabilitation program for a minimum of 3 months (up to 7 months), with a mean of 5.3 months, with stretching exercises and were unsatisfied at the completion of the rehabilitation program. Inclusion criteria for our procedure were patients with irreparable supraspinatus

and infraspinatus tears as documented either arthroscopically or through a limited deltoid split approach and who failed to improve with subacromial decompression alone.

Exclusion criteria included those with nonfunctioning deltoid or torn subscapularis muscle. We believe that the subacromial decompression performed before the procedure with the subsequent rehabilitation program is essential to restore the passive shoulder range of motion (by decreasing the pain), which is essential for the success of the procedure and helps to clarify its indication when patients remain unsatisfied.

Operative technique

All patients were operated upon in the lateral decubitus position under general anesthesia. Two incisions were always used. The first incision was made using a deltoid split approach to expose the greater tuberosity.

It starts at the midsection of the lateral border of the acromion, extending 4 cm distally. The second incision was a 10–15 cm incision and was made along the anterior border of the latissimus dorsi, extending from the scapular angle up to the posterior deltoid and passing through the axillary hollow while respecting the flexion folds (to avoid any retractile scar that could limit elevation movements) (Fig. 1).

It was separated posteriorly from the teres major (not released), anteriorly from the serratus anterior muscle.

The thin membrane-like tendon of the latissimus dorsi was released as close as possible to its insertion in the bicipital groove, reinforced by No. 2 Vicryl sutures (Ethicon Inc., Somerville, New Jersey, USA), and then used to pull on the muscle, while its distal release was performed to gain enough length to be able to pull it up to the greater tuberosity.

More dissection was always needed posteriorly than anteriorly to gain the required length. No specific dissection was performed for the neurovascular pedicle; however, as the muscle was raised, the pedicle was always clearly seen near its anterior aspect; therefore, care has been taken in the anterior dissection so as not to injure the pedicle (Fig. 2).

A long curved surgical forceps was introduced from the first deltoid split approach under the deltoid muscle to the second incision and used to pull the latissimus dorsi tendon through the attached sutures into the proximal incision. A curette was used to roughen the greater tuberosity but not to create a trough so as not to weaken it. Two 5-mm corkscrew Anchors (Arthrex Inc., Naples, Florida, USA) loaded with two strands of No. 2 Fiber Wire (Arthrex Inc.) were inserted in the anterior aspect of the greater tuberosity.

The latissimus dorsi tendon was sutured to the greater tuberosity and simultaneously sutured to the upper border of the subscapularis tendon using such anchors' nonabsorbable threads (Fig. 3).

Finally, the vitality and stability were tested and then Layered simple closure was performed for the wounds with drain applied only if there was ooze in the bed of the latissimus dorsi and removed after 24 h (in only four cases).

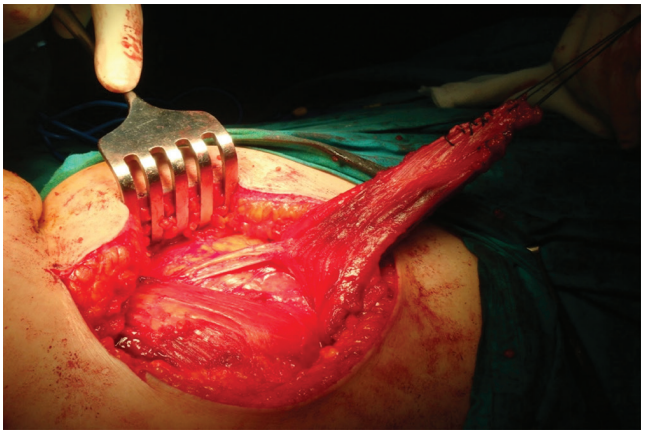
Postoperative protocol

A simple abduction arm sling was used for all cases and continued for 6 weeks.

Figure 1

Two incisions used for the latissimus transfer procedure.

Figure 2



The tendon sutured to reinforce it; the latissimus released more posteriorly than anteriorly and its neurovascular pedicle identified.

A physical therapist performed a rehabilitation protocol.

The rehabilitation program was divided into three phases.

(1) The first phase starts from the second postoperative day and lasts for 6 weeks and involves protected passive range of motion exercises (for external rotation and elevation in the scapular plane).
(2) The second phase extends for a further 6 weeks and involves active assisted and active range of motion exercise with the following aims:
    (a) Restore functional glenohumeral joint mobility into flexion (≥120°) and external rotation (≥30–40°)
    (b) Promote antigravity elevation of the upper extremity with the goal of reaching the top of the head.
    (c) Facilitate activation of the transferred muscle with biofeedback and/or facilitation techniques.
    (d) Facilitate use of the upper extremity for light activities of daily living.
(3) The third phase of rehabilitation extends until 3 months postoperatively and is the light strengthening phase/functional reintegration phase.

Magnetic resonance imaging was performed for our patients at the end of the rehabilitation program to confirm the integrity of the transfer and show its insertion on the anterior aspect of the greater tuberosity (Fig.4).

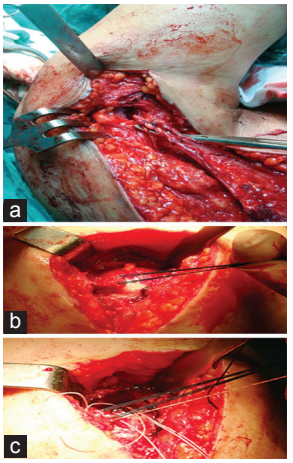
Results

There were no complications (neurologic or infectious) related to the surgical procedure in any of the patients. Follow-up was carried out for at least 12 months for all patients. The longest follow-up duration was 36 months, with a mean of 21 months.

The Constant – Murley score was used to assess the results. The assessment was carried out 6 months postoperatively after fulfillment of the postoperative rehabilitation program, and the results were reassessed at 12 months postoperatively with stabilization of the gains. The chosen level of significance (P) was set at 0.05.

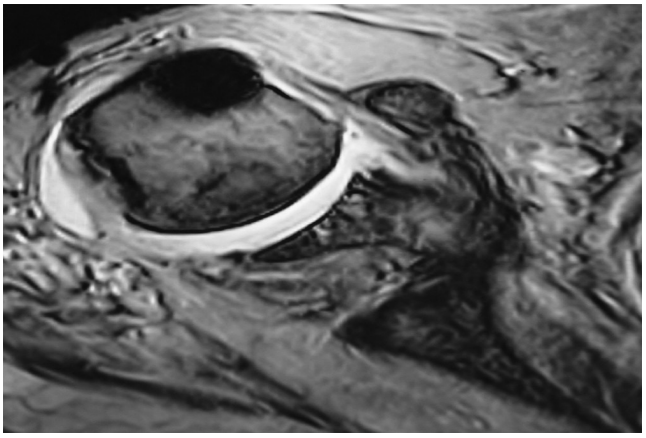
The mean constant score increased from a preoperative value of 28 to a postoperative value of 68, thus achieving an improvement of 40 points. This increase was significant ($P < 0.001$) (Fig. 5).

Figure 3



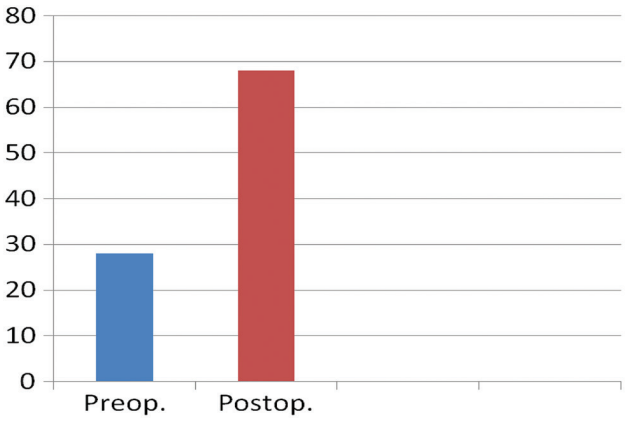
(a) The latissimus dorsi tendon pulled under the deltoid and (b) fixed to the anterior aspect of the greater tuberosity and upper border of subscapularis using (c) suture anchors.

Figure 4



Axial MRI showing the latissimus dorsi tendon attachment to the anterior aspect of the greater tuberosity and subscapularis tendon.

Figure 5



Preoperative constant score compared with postoperative, at a minimum of 12 months' follow-up.

The pain score according to constant score improved from 6.6 to 10 postoperatively, and this improvement was statistically significant ($P < 0.001$).

As regards the active external rotation, it increased from a mean of 15° preoperatively to a mean of 45° postoperatively.

This increase was significant ($P < 0.001$) (Fig. 6).

The range of active abduction increased from a mean of 25° to a mean of 120° postoperatively. This increase was significant ($P < 0.001$) (Fig. 7).

The range of forward elevation improved from 90° preoperatively to 150° postoperatively. This increase was significant ($P < 0.001$).

Discussion

The management of irreparable rotator cuff tears, especially in young patients, is therapeutically challenging with a limited number of available treatment options. The good results achieved with latissimus dorsi tendon transfer for proper restoration of elevation and external rotation in the management of obstetrical brachial plexus palsy encouraged Gerber *et al.* [5], to use this technique in the treatment of irreparable supraspinatus and infraspinatus tendon tears.

A massive cuff lesion is not an uncommon condition affecting the shoulder and is associated with persistent pain and loss of function and strength. When conservative treatment fails, surgical intervention seems to be the most appropriate method of treatment. Because of retraction and irreversible degeneration of the musculotenindenous units, reinsertion of the torn tendons is usually not possible.

In these cases transposition of the latissimus dorsi muscle can lead to satisfactory results [6–8]. According to the work of Rockwood [9] and also of Gartsman [10], subacromial decompression alone for the management of irreparable tears of the rotator cuff has been mentioned in the literature to give satisfactory results. In our study, there was some improvement in the pain (from a mean of 4.1–6.6 according to the Constant score); however, there was no improvement in the function, and our patients remained unsatisfied. This may be contributed to the fact that, contrary to their patients, eight of our 12 patients were men with the dominant hand affected in seven of them, and they required not only pain relief but also restoration of function. We believe that one of the strengths of this study compared with other studies dealing with latissimus dorsi transfer for irreparable tears is that subacromial decompression with full postoperative rehabilitation was performed for all of our patients before the procedure, emphasizing the role of such transfer in pain relief by stabilizing the head under the arch, which is the main issue behind the external impingement in such cases. To establish balanced shoulder motion, forces and moments about the glenohumeral joint must be in equilibrium. During shoulder motion, for example, the rotator cuff muscles act together to centralize the humeral head against the glenoid fossa. With massive rotator cuff tears, there may be an uncoupling of these forces that results in unstable kinematics, and the latissimus dorsi transfer may help to restore stable shoulder kinematics [11]. This explains the modest improvement with subacromial decompression alone even in terms of diffident pain relief in our series.

Figure 6

(a) Preoperative lost external rotation (b) regain of the range of external rotation 30 months postoperative.

Figure 7

(a) Preoperative deficient abduction (b) 36 months postoperatively regain of full abduction.

Good results were reported for tendon or muscle transfer in the treatment of massive rotator cuff tears as early as 1985, when Apoil and Augereau [4] obtained a 75% success rate with deltoid flap transfers.

However, use of the deltoid flap to cover cuff tears is by no means an ideal approach, as it involves an impairment of the residual abduction/flexion lever mechanism. In 1988, Gerber *et al*. [5] reported on the first use of latissimus dorsi transfer in irreparable supraspinatus–infraspinatus tears, with good clinical outcomes; since then, a number of studies have reported on the use of this tendon [6–8,12–14]. Outcomes in our series were comparable to those of Gerbers' series [1,5,7] in terms of the improvement in pain and external rotation.

Our series showed superior results as regards the improvement in active abduction, emphasizing the importance of transferring the latissimus dorsi as far anteriorly to the greater tuberosity as possible with suturing it to the upper border of subscapularis. The results obtained here indicate that latissimus dorsi transfer is a good treatment option for selected patients with massive irreparable rotator cuff tears.

We are aware that the short follow-up (mean 21 months) in our series is a limitation to this study and that further follow-up for our patients is mandatory to establish the stability of the gains of this procedure.

Conclusion

Patients with massive irreparable supraspinatus and infraspinatus tears are rarely satisfied by subacromial decompression alone.

Latissimus dorsi transfer to the anterior aspect of the greater tubersosity helps to improve both active external rotation and abduction with pain relief. Active forward flexion and passive shoulder range of motion should be present before the procedure.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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