Surgical techniques for reconstruction of chronic insufficiency of the triceps

ROTATION FLAP USING ANCONEUS AND TENDO ACHILLIS ALLOGRAFT

Joaquin Sanchez-Sotelo, Bernard F. Morrey

From the Mayo Clinic, Rochester, USA

Seven patients with chronic insufficiency of the triceps were treated by either a rotation flap using anconeus (4) or an allograft of tendo Achillis (3). The latter procedure was selected for patients with a large defect in whom the anconeus muscle had been devitalised. Five disruptions were in patients who had previously undergone an elbow replacement. The patients were assessed for subjective satisfaction, pain, range of movement and strength, and the results were graded using the Mayo Elbow Performance Score (MEPS). The mean follow-up was for 33 months (9 to 63).

One rotation flap failed six months after operation. At the most recent follow-up, the remaining six patients had no or slight pain, restoration of a functional arc of movement and normal or slightly decreased power of extension. All six were satisfied with the outcome and were able to resume their daily activities with no limitations other than those imposed by the previous elbow replacement. The final MEPS was 100 points in five patients and 75 in one.

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Disruption of the extensor mechanism of the elbow most commonly follows either a traumatic rupture of the triceps or failed surgical reattachment. There is a considerable functional deficit and early reconstruction is the treatment of choice.1-3 However, the diagnosis of these uncommon lesions is usually delayed and the initial treatment often conservative. After a few weeks the muscle and tendon retract and direct reattachment may be difficult or impossible.4 The tissue may be of poor quality and further weakened when disruption occurs after a previous surgical approach which has partially compromised the extensor mechanism. Thus, reconstruction of a chronic insufficiency of the triceps frequently requires augmentation.

Reconstruction of chronic disruption of the triceps by turning down an aponeurotic flap from the area proximal to the tear or by the use of a forearm fascial flap has been described in isolated case reports.5-7 In the past, the senior author (BFM) has strengthened reconstructions of triceps with synthetic Ligament Augmentation Devices,8 but more recently has used one of two techniques depending on the underlying pathology. In elbows with moderate tissue loss, the anconeus muscle is mobilised as a local flap to fill the defect. Reconstruction by allograft of tendo Achillis is used for patients in whom either the anconeus muscle is devitalised or there is complete loss of continuity. The allograft may be used very satisfactorily for reconstruction of chronic triceps deficiency. The associated fragment of calcaneum is fixed to the olecranon, the tendinous portion is of an appropriate size to replace an absent triceps tendon, and the aponeurotic portion of the graft is wide and long enough to be securely sutured to the triceps muscle. The excellent mechanical and physical properties of this allograft in the reconstruction of other tendons and ligaments have been noted previously.9-11

We describe the surgical technique used for reconstruction of chronic ruptures of the triceps tendon by either the anconeus rotation flap or an allograft of tendo Achillis and our initial experience in seven patients.

Patients and Methods

We reviewed the medical records and radiographs of five men and two women who had undergone surgery for chronic disruption of the tendon of triceps. The reconstruction involved either a rotation flap of anconeus or an allograft of tendo Achillis (Table I). Five patients had undergone previous elbow replacement. All operations were carried out by the senior author (BFM).

The two ruptures of the tendon of triceps which occurred in patients who had not previously undergone elbow replacement followed a fall on the outstretched hand. In one, a 33-year-old woman, a professional musician, the left non-dominant arm was affected and in the other, a 31-year-
old truck-driver, who undertook occasional weight-lifting, the left dominant arm was involved. Both denied a previous history of treatment with steroids or of prodromal symptoms. They had initially been evaluated elsewhere, treated conservatively, and presented two and 21 months after the initial injury.

The remaining five disruptions occurred after replacement of the elbow. The primary diagnosis was rheumatoid arthritis in three patients and post-traumatic osteoarthritis in two. Two were traumatic, one after a fall on the outstretched hand 11 years after replacement and the other after lifting against resistance. The elbow required revision of the ulnar component and reconstruction of the proximal ulna with strut grafts. These patients presented two and five months after injury, respectively. The remaining three patients had no history of injury. One presented with progressive weakness four months after an otherwise successful primary elbow replacement. A second had undergone an uncomplicated total elbow arthroplasty for post-traumatic osteoarthritits secondary to a fracture sustained in childhood; 23 months after the operation she developed pain in the olecranon and required resection of the olecranon bursa and 0.5 cm² of degenerate tissue from the distal triceps tendon. Seven years after the initial procedure she developed progressive weakness. The third patient presented with weakness and pain four years after revision of a total elbow arthroplasty.

**Operative technique for the anconeus rotation flap.**

With the patient supine, a tourniquet was applied to the arm, which was then brought across the chest. Ideally, the elbow was exposed through a posteromedial incision. The dissection was carried proximally and the lateral margin of the triceps muscle identified and followed distally until the remnants of the tendon were seen. The ulnar nerve should be identified, but not routinely transposed. As much of the triceps muscle was mobilized as was needed.

The lateral aspect of the triceps usually remained in continuity with the anconeus muscle and the central and medial aspects were retracted superiorly. After the integrity of the lateral margin of triceps and anconeus had been confirmed, the interval between anconeus and extensor carpi ulnaris was identified and anconeus elevated from the ulna. The distal aspect of anconeus was left intact and the anconeus-lateral triceps flap mobilized over the tip of the olecranon and reattached to the extensor mechanism in 30˚ of flexion (Fig. 1). Two crossed drill holes were placed in the olecranon and the flap secured with a non-absorbable suture. The central and medial portions of the triceps were sutured to the extensor mechanism to reinforce it. Occasionally, it was possible to reattach the medial aspect of the triceps tendon to the olecranon.

![Diagram showing that if the deficit in the extensor mechanism is not too extensive and anconeus is not devitalised and maintains its continuity with the triceps, it can be mobilised and centralised over the tip of the olecranon. The deficiency in the triceps tendon is also repaired or reinforced.](image)

**Table I.** Details of the seven patients who received either an anconeus rotation flap or tendo Achillis allograft for reconstruction of a triceps insufficiency

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender</th>
<th>Age (yrs)</th>
<th>Time to presentation (mths)</th>
<th>Mechanism of injury</th>
<th>Previous surgery</th>
<th>Reconstruction</th>
<th>Extension (degrees)</th>
<th>Flexion (degrees)</th>
<th>MEPS</th>
<th>Postoperative Results*</th>
<th>Duration of follow-up (mths)</th>
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<tr>
<td>1</td>
<td>M</td>
<td>60</td>
<td>2</td>
<td>Fall</td>
<td>TEA† Anconeus</td>
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<td>15</td>
<td>135</td>
<td>100</td>
<td>E</td>
<td>63</td>
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<tr>
<td>2</td>
<td>F</td>
<td>33</td>
<td>2</td>
<td>Fall</td>
<td>None Anconeus</td>
<td>No</td>
<td>0</td>
<td>135</td>
<td>100</td>
<td>E</td>
<td>49</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>60</td>
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<td>-</td>
<td>TEA Achillis graft</td>
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<td>150</td>
<td>100</td>
<td>E</td>
<td>41</td>
</tr>
<tr>
<td>4</td>
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<td>31</td>
<td>21</td>
<td>Fall</td>
<td>None Achillis graft</td>
<td>No</td>
<td>5</td>
<td>145</td>
<td>100</td>
<td>E</td>
<td>38</td>
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<tr>
<td>5</td>
<td>M</td>
<td>75</td>
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<td>-</td>
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<td>135</td>
<td>100</td>
<td>E</td>
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<td>6</td>
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<td>55</td>
<td>-</td>
<td>-</td>
<td>TEA Achillis graft</td>
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<td>75</td>
<td>G</td>
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<td>TEA Anconeus</td>
<td>Slight</td>
<td>30</td>
<td>135</td>
<td>75</td>
<td>G</td>
<td>9</td>
</tr>
</tbody>
</table>

*E, excellent; G, good; S, satisfactory; U, unsatisfactory
†total elbow arthroplasty
A compressive dressing was applied and the arm placed in a splint or a locked brace with the elbow in 30° of flexion and the forearm in the neutral position.

Since the distal aspect of anconeus remains attached to the ulna and the fixation to the olecranon was secure, active mobilisation was started on the third postoperative day. Active flexion was limited to 90° and active extension avoided for three or four weeks. Active flexion and extension and the previous range of movement were usually achieved by three months.

Operative technique using an allograft of tendo Achillis.
The elbow was positioned and approached in a similar fashion to that for the rotation flap. The remnants of the triceps tendon were identified and the muscle mobilised. A straight midline incision was placed over the posterior aspect of the humerus. The remaining fibres of attachment of the triceps tendon were elevated. A V-shaped osteotomy was undertaken in the proximal olecranon.

The calcaneal fragment of the allograft was fashioned in a chevron manner to fit the olecranon osteotomy and fixed with a 6.5 mm partially-threaded cancellous screw. Distal traction was applied to the mobilised triceps muscle by an Allis clamp (Fig. 2a). With the elbow in 30° of flexion, traction was applied proximally to the allograft, which was then placed over the triceps muscle and the tendon stump. A non-absorbable running locked suture was placed in the stump. The reconstruction was reinforced with multiple sutures (Fig. 2b).

When the procedure is carried out in the presence of an elbow replacement, the ulnar implant occupies the medullary canal and the proximal ulna may be deficient. In these circumstances the allograft was used to augment the ulna and fixation was achieved by circumferential wires or screws with the occasional addition of strut allografts. When the proximal ulna was not deficient, the calcaneal portion was discarded and the allograft attached by non-absorbable sutures through the dorsal aspect of the ulna.

A compressive dressing was applied and the upper arm placed in a splint or a locked brace with the elbow in 30° of flexion and the forearm in the neutral position.

The arm was protected in a splint or locked brace for three weeks after which gentle mobilisation was started. The elbow was protected in a brace for a further three weeks using an extension-assisted orthosis which limited flexion to 100°. The patient was thereafter advised to avoid vigorous extension against resistance until three months after surgery.
On physical examination, all patients had objective weakness of extension and discontinuity of the extensor mechanism. The two with post-traumatic osteoarthritis also had pain and instability because of wear of the prosthetic bushings. One (case 3) had osteolysis of the ulna. The remaining five patients did not have pain and the passive range of movement did not change as a result of the disruption.

The technique which was used for reconstruction was decided after intraoperative assessment of the extensor mechanism. Four elbows were amenable to reconstruction with an anconeus rotation flap. The two patients with wear (cases 3 and 6) required reconstruction with a fresh-frozen allograft (Musculoskeletal Transplant Foundation, Edison, New Jersey) and exchange of the prosthetic polyethylene bushings. An allograft (AlloSource Tissue Bank, Denver, Colorado) was also required in the patient who had been treated almost two years after injury (case 4) because of substantial retraction of the triceps muscle.

The patients were evaluated by an assessment which included satisfaction, pain, range of movement and strength of extension and the results were graded using the Mayo Elbow Performance Score (MEPS).13

Results

There were no complications of surgery. The mean time of follow-up was 33 months (Table 1).

At the most recent follow-up, the two patients with an injury and no previous elbow replacement (cases 2 and 4) had no pain, full range of movement and normal strength of extension. They reported no limitation in daily activities and the MEPS was 100 points. The musician (case 2) returned to playing at the same level as before the disruption.

Two of the three patients with a previous elbow replacement for rheumatoid arthritis (cases 1 and 5) had no pain and a functional arc of movement with slightly decreased strength of extension. The remaining patient with rheumatoid arthritis (case 7) had good strength of extension for the first six months after surgery, but progressive weakness thereafter. At the most recent follow-up, nine months after reconstruction with anconeus, he was unable to extend his elbow against gravity and felt that the reconstruction had failed.

One of the patients with post-traumatic osteoarthritis and a failed elbow replacement (case 3) needed a second revision for loosening and fracture of the ulnar component two years after reconstruction of the triceps. At surgery, the reconstruction was found to be intact, the calcaneal allograft had united to the ulna and the implant used for fixation to the ulna was removed. One year later, she sustained a periprosthetic fracture of the ulna and required further revision of the ulnar component and reconstruction by strut allografts. When she was last seen, three years after the reconstruction of the extensor mechanism and six months after the most recent revision surgery, she had minimal pain, a good range of movement and slight weakness of extension. The other patient with post-traumatic osteoarthritis (case 6) had slight pain and was satisfied with the function of the elbow at the most recent follow-up.

Discussion

Reconstruction of chronic insufficiency of triceps is a technically challenging procedure with little available information to guide treatment. Retraction of the muscle-tendon unit makes it difficult to achieve reattachment to bone and there is usually a considerable gap. The quality of the tendon and muscle remnants is often poor, especially in patients who have had previous surgery with compromise of the extensor mechanism.

Some authors have described reconstruction using a flap from the proximal tricipital aponeurosis or fascia of the forearm.5-7 There is, however, no published information regarding the outcome, and the quality of the tissue used for augmentation in these procedures is unsatisfactory. The extensor mechanism, which is already compromised, may be further damaged by using the tricipital fascia. We have previously used synthetic Ligament Augmentation Devices for reconstruction of the triceps tendon, but these are no longer available and the use of a more biological repair is attractive.8

We presently favour the techniques which we describe. When the anconeus muscle is of good quality and partially maintains its continuity with the lateral aspect of the triceps, it can be elevated and centralised, providing an excellent local flap for reconstruction. In patients with a devitalised anconeus or large defects in the triceps muscle and tendon this flap does not provide enough cover and the extensor mechanism may be augmented more satisfactorily using an allograft of tendon Achill. This graft has several attractive features. First, it provides a long and broad aponeurosis which may be sutured to a wide area of the remaining muscle and tendon. Secondly, the attached fragment of calcaneum can be used for stable fixation to the olecranon and to enhance the lever arm for the extensor mechanism when there is bony deficiency of the olecranon. Thirdly, it is readily available and avoids the additional surgical time and morbidity associated with the use of autografts. Finally, its mechanical behaviour has already been tested in vivo in other sites which demand considerable stresses on the reconstruction.9-11 The possibility of achieving secure fixation of the graft both proximally and distally and the mechanical properties of the graft itself allow early postoperative mobilisation with less splintage and faster return to normal function.

One of the four anconeus rotation flaps failed six months after surgery. Because of its availability and simplicity, we still consider this procedure to be the technique of choice for the reconstruction of chronic disruptions with a moderately sized deficiency and a well-preserved anconeus. An
allograft of tendo Achillis should be used for larger defects and provides a safe and relatively easy reconstruction.

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References