INTRODUCTION

Frequency of delayed reconstruction appears to be slightly increasing in recent years. As noted in the prior chapter (Chapter 21), if the host tendon can be reattached with the elbow at 90 degrees, this is possible in most instances and is preferable to reconstruction (1). The 90-degree contracture will stretch out to near-normal extension with time, and function is excellent. When the tendon has retracted to the point that it cannot be reattached directly to the tuberosity, augmentation with an Achilles tendon allograft is our technique of choice. However, we have discontinued preserving the fleck of calcaneus and simply embed the allograft tendon as noted below.

INDICATIONS/CONTRAINDICATIONS

Indications for Delayed Reconstructions

- Not all with a missed or nonoperated acute injury require reconstruction (2).
- However, chronic pain and fatigue do occur if the injury is not addressed (3).
- Hence, we offer reconstruction to patients who have chronic pain, sometimes due to tethering of the neurovascular structures or other symptoms such as cramping and fatigue due to the detached distal biceps tendon.
- Typically, selective loss of supination strength is the major problem, and rarely is flexion weakness an indication for delayed reconstruction.

Contraindications

Absence of functional impairment, either pain or weakness, even though the distal biceps tendon has been completely avulsed

DIAGNOSIS

- By definition, reconstruction implies the diagnosis has been made.
- Functional impairment is the key, not only to make the diagnosis but to determine whether reconstruction is indicated.
PREOPERATIVE PLANNING

I have had one patient 11 months after rupture who had little retraction due to an intact lacertus fibrosis, hence was able to perform a direct reattachment. Because of the uncertainty, prepare the patient for either eventuality—direct reattachment or reconstruction. Final determination is based on findings at surgery (Fig. 22-1). The recoiled tendon may be able to be teased out to a length that allows reattachment. If not, have an allograft tendon available or prep the patient for autograft harvest and reconstruct.

TECHNIQUE

Several authors have reported small series of reconstructions using various tissues including the autologous hamstring (4,5), the flexor carpi radialis (6), and the Achilles tendon allograft (7). The author has used the allograft Achilles tendon almost exclusively for this reconstruction, and the technique currently used is described in this chapter. The technique has been modified from the prior description (7) that called for retaining a fleck of the calcaneal attachment. This is felt to be no longer necessary, and hence, the calcaneus is resected, and the free end of the tubular Achilles tendon is embedded directly into the tuberosity.

Position

The patient is supine on the table, and the arm is placed on an elbow (arm) table.

Exposure

With reconstruction, the anterior exposure must be more extensive since the biceps tendon and muscle must be exposed (Fig. 22-2). We employ a Henry-type skin and deep exposure. After the tendon has been retrieved and it is determined that the biceps tendon is inadequate for reattachment even with the elbow flexed to 90 degrees (Fig. 22-3), the tuberosity is exposed by blunt dissection in the cubital fossa.

**Note:** This is one of the most important parts of the procedure; the space occupied by the biceps tendon is often scarred. Care must be taken to avoid injury to the radial nerve:

- The tuberosity is exposed by blunt dissection.
- **Tip:** Rotation of the forearm allows confirmation of the location of the radial tuberosity. A curved hemostat is used to identify the site for the forearm incision by sliding this past the tuberosity between the radius and the ulna (Fig. 22-4).
- The tuberosity is exposed by an incision over the proximal forearm. The extensor muscle and the supinator muscles are split exposing the tuberosity (Fig. 22-5).
Unlike the approach for an acute injury using a limited transverse incision, a lazy S type of incision is required both in some instances to find the tendon, but the proximal arm is always necessary in order to envelope the biceps muscle with the Achilles tendon allograft.

Patient sustained an injury 5 months prior to surgery. The biceps tendon had resorbed leaving only a small “nub” of the original tendon.

A curved hemostat is passed through the anterior incision and is directed around the radius such as to emerge at the dorsal aspect of the forearm. Care is taken not to disturb or violate the ulnar periosteum; hence, the curvature of the instruments should be directed away from the ulna.
The allograft tendon is inspected, and the length of the circular Achilles tendon is measured such that once attached to the tuberosity the flare of the aponeurosis coincides with the musculotendinous junction of the host (Fig. 22-6). Two no. 5 nonabsorbable running locked sutures are placed in the allograft tendon in a running locked pattern as in the acute rupture (Fig. 22-7).

The tuberosity is excavated in the typical fashion (Fig. 22-8) (Chapter 21). Three drill holes are placed in the margin of the tuberosity.

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FIGURE 22-5
An incision is made directly over the hemostat as it tents the skin (A). The tuberosity is exposed by a transmuscular splitting incision (B).

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FIGURE 22-6
The allograft is assessed referable to the anatomy. The length of the Achilles biceps tendon "D" required to attach to the tuberosity and widen at the site of the musculotendinous junction is estimated.
A running locked suture with a heavy no. 5 nonabsorbable suture is placed at the end of the allograft tendon. As with the acute repairs, we typically place two such sutures. The proper length of the allograft tendon is confirmed prior to attachment of the biceps tendon into the tuberosity.

The tuberosity is exposed, and three drill holes are placed in the margin to secure the allograft tendon. The excavation is adequate to fully seat the end of the allograft into the tuberosity.
Lead sutures are brought through these drill holes, and the lead sutures are used to bring the heavy no. 5 Ethibond sutures through the holes, thus drawing the distal aspect of the allograft into the excavated tuberosity (Fig. 22-9).

The tendon is then threaded from the anterior exposure into the dorsal forearm incision. This is facilitated by the sutures that have been placed in the tendon (Fig. 22-10) and allow the tendon to be drawn from the anterior to the posterior incision.

The sutures are firmly tied (Fig. 22-11).

**Tip:** Supination of the forearm facilitates this step.

The biceps muscle is grasped at the residual portion of the biceps tendon. The muscle is very aggressively freed both at the subcutaneous surface and its intermuscular fascial surface. All adhesions must be removed between the brachialis muscle and subcutaneous tissue to allow restoration of the excursion of the muscle.

With the elbow flexed to about 90 degrees and with distal tension on the biceps tendon and moderate proximal tension on the attached allograft (Fig. 22-12), a no. 5 nonabsorbable suture is placed through the Achilles fascia and then through the residual of the biceps tendon (Fig. 22-13).
FIGURE 22-11
A: The end of the allograft tendon is observed, and the sutures have been drawn through the bone tunnels. B: Supinating the forearm rolls the tuberosity in the direction of the allograft. Pulling the sutures draws the allograft into the prepared bed of the tuberosity, and the sutures are tied. This is the most critical step of the procedure.

FIGURE 22-12
With a secure attachment of the tuberosity, the allograft tendon is brought under tension by pulling it proximally. The elbow is placed at 90 degrees of flexion.

FIGURE 22-13
The biceps has been freed of all adhesions, and it is brought as distally as possible. At this point, the allograft is secured to the nub of the biceps tendon with a heavy no. 5 nonabsorbable suture with the elbow placed in 90 degrees of flexion. Additional stabilizing sutures are placed between the allograft and the strong tendinous portion of the distal biceps tendon.
Once the suture has been tied, the tension of the construct has been defined. With the elbow flexed to take tension off the repair, we then complete the proximal attachment with a running locked no. 1 nonabsorbable suture placed in the aponeurosis and wrapped around the medial and lateral margins of the biceps (Fig. 22-14). (Note: Care should be taken to avoid injury to the radial nerve as the graft is wrapped along the lateral aspect of the biceps muscle.)

The tension on the reconstruction is assessed to determine the initial postoperative amount of flexion to protect the reconstruction. The closure is routine.

POSTOPERATIVE MANAGEMENT

The patient is placed in a posterior splint. The recovery is delayed somewhat, and the reconstruction is protected for 3 weeks in a splint. Passive-assisted motion is begun at 3 weeks and continued for 6 weeks. Full extension is then gained from the 6th to the 9th to 10th week. Active motion for activities of daily living is allowed between 6 and 12 weeks. Activity is tolerated and progresses from the 3rd to the 9th month depending upon the circumstances.

COMPLICATIONS

There has been little written on this procedure or any of the described reconstructions, and thus there is even less regarding the complications. Kelly has pointed out that any procedure done more than 2 to 3 weeks after the original acute injury is associated with a statistically higher complication rate (8). The main potential problem of course is injury to the radial nerve. Most reports in the literature have, however, demonstrated good functional and clinical outcomes with the various techniques described for delayed reconstruction.

THE MAYO EXPERIENCE

- We have performed a delayed reconstruction using the Achilles allograft in nine patients to date.
- Of these, all nine have expressed satisfaction with the reconstruction.
- Details are currently under review.
- None has been reoperated.
- There were no complications.

FIGURE 22-14
The allograft is then deployed and wrapped around the biceps muscle. A running locked heavy nonabsorbable suture is used to secure the aponeurotic portion of the allograft to the muscle of the biceps tendon.
REFERENCES

1. Morrey ME, Abdel MP, Sanchez Sotelo J, et al.: Primary repair of retracted distal biceps tendon ruptures in high flexion. (Accepted for publication, JSES)