Flexor Tendon Grafting Using a Plantaris Tendon with a Fragment of Attached Bone for Fixation to the Distal Phalanx: A Preliminary Cohort Study

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Purpose: Secure methods of graft attachment ensure safe early motion after flexor tendon grafting. This has been achieved at the proximal graft juncture using Pulvertaft's technique. For secure distal attachment, we investigate the results of flexor tendon grafting using the plantaris tendon with a fragment of attached bone fixed with a screw to the distal phalanx.

Methods: Thirteen digits from 10 patients with longstanding flexor tendon injuries in zone II had surgical reconstruction. A plantaris tendon-bone graft was attached to the distal phalanx using a mini-screw. This was followed by immediate active motion. At 3 and 8 months after surgery, total active motion was calculated as the sum of the degrees of active flexion in the proximal and distal interphalangeal joints minus the sum of the degrees of extension deficits for each of these joints. The results of total active motion were compared to the normal contralateral digit.

Results: Three months after surgery, the mean rate of recovery, relative to the normal contralateral finger, was 74%, whereas 8 months after surgery, this value was 70%. This difference was statistically significant. There were no failures or poor results (ie, less than 50% recovery).

Conclusions: The tendon-bone plantaris graft employed here ensured immediate active motion and early use of the involved hand in daily activities. (J Hand Surg 2007;32A: 1543–1548. Copyright © 2007 by the American Society for Surgery of the Hand.)

Type of study/level of evidence: Therapeutic IV.

Key words: Flexor tendon, flexor tendon grafting, plantaris muscle, plantaris tendon, tendon graft.

For most of the past century, flexor tendon grafting was the recommended method of treatment for all injuries in that part of the hand called *no man's land*. After reports in the 1970s that reinforced the principles of atraumatic surgery and early mobilization, primary repair gained popularity. Today, tendon grafting is considered to be a salvage surgery.[1]

Two-stage tendon reconstruction, in accordance with the protocol proposed by Hunter and Salisbury,[2] is the most commonly used method because of general dissatisfaction with the one-stage procedure. In 2005, the IFSSH Flexor Tendon Committee suggested that it probably is time to revert to single-stage grafting, because current sutures are stronger and rehabilitation more robust than in the past.[3] Early motion is a cornerstone of modern primary repair of flexor tendons. Early motion in flexor tendon grafting is controversial, however, because there are the risks of impairment in graft revascularization and of rup-

Table 1. Patient Data Summary

Case	Age (y)	Injury–Graft Placement Interval (mo)	Involved Digits	TAM (°) 3 mo PIP	TAM (°) 3 mo DIP	TAM (°) 8 mo PIP	TAM (°) 8 mo DIP	TAM Relative to Contralateral Digit (%) 3 mo	TAM Relative to Contralateral Digit (%) 8 mo
1	10	24	III	105	52	105	50	87	86
			IV	105	57	105	60	90	91
2	22	6	II	100	27	100	30	75	76
			III	100	40	100	45	77	80
3	25	18	II	100	50	105	60	88	92
4*	48	11	III	90	30	90	20	66	61
			IV	80	15	80	11	54	52
5	27	8	II	90	32	85	15	72	59
			III	90	26	85	25	70	61
6*	25	15	IV	97	30	95	31	74	70
7	32	12	II	95	33	92	30	75	72
8	36	9	III	80	30	80	20	61	56
9	29	12	IV	80	25	80	20	58	55
10*	21	10	II	92	35	70	24	69	55

*, previously operated patient

tures at the coaptation site.[4] Ruptures can be avoided by means of a solid graft attachment. This has been achieved at the graft's proximal juncture via the use of Pulvertaft's technique.[5] Secure methods for distal graft attachment remain relatively undeveloped because current methods of anchorage involve tendon-to-bone interfaces.

We have hypothesized that a tendon graft harvested with a piece of bone, fixed to the distal phalanx with a mini-screw, allows for solid fixation that will permit early active motion. In the present study, we investigated the results of flexor tendon grafting using a plantaris tendon with a fragment of bone secured with a screw to the distal phalanx in 10 patients.

Patients and Methods

We enrolled 13 patients in this prospective study. Two patients were excluded within the first week after surgery because of noncooperation with the protocol of early active motion. One other patient was deemed ineligible because, during surgery, we observed that the plantaris tendon was absent.

Thirteen digits in 7 men and 3 women underwent plantaris tendon-bone grafting. Both flexor tendons were injured in zone II. At the time of surgery, no active flexion was registered at the proximal or distal interphalangeal joint, but passive motion was full. All patients had preserved sensation at the fingertip, and no patient had difficulties with skin coverage. Six patients were engaged in office-type work and 3 in heavy manual work. The 10-year-old patient was a student. Patient data are summarized in Table 1.

Surgical Techniques

Tendon-bone plantaris harvesting. To harvest the plantaris tendon, a 7-cm long incision was made medial to the Achilles tendon and calcaneus. The plantaris tendon was located and traced distally to its insertion. A bone segment of 5 × 10 mm was outlined over the tendon-bone insertion. These bone dimensions ensured adequate screw fixation, being small enough not to be prominent at the fingertip. Using a 1.1 mm (0.043 in) K-wire and a hammer, a hole was created, slightly distal to the midpoint of the bone segment. A mini-screw with a diameter of 1.5 mm and a length of 8 to 12 mm was inserted to a depth of 3 to 4 mm. A ring that had been cut from a mini-plate was used as a washer. After screw insertion, and only after that, the bone was cut (Fig 1). A second incision, placed proximally in the calf at the medial border of the medial gastrocnemius muscle, allowed us to harvest an 18- to 25-cm long plantaris graft. After the plantaris tendon was located, the tendon was divided and a tendon stripper was passed from the proximal to distal end. In 3 patients, both plantaris tendons were harvested. The skin of the leg was sutured and the tourniquet released.

Finger dissection and graft attachment. The digits were explored through a mid-lateral approach distal to the proximal interphalangeal joint and