Peroneus Brevis Tendon Transfer for Reconstruction of Chronic Tears of the Achilles Tendon

A Long-Term Follow-up Study

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Background: Chronic tears of the Achilles tendon can result in substantial loss of function. Those tears with a tendon gap of up to 6.5 cm can be treated surgically with use of an autologous peroneus brevis tendon graft.

Methods: At an average follow-up period of 15.5 years after the surgery, we examined sixteen of twenty-two patients who had undergone peroneus brevis tendon graft reconstruction for a chronic Achilles tendon tear. Clinical and functional assessment was performed.

Results: All sixteen patients were able to walk on tiptoe, and no patient used a heel lift or walked with a visible limp. The maximum calf circumference of the involved limb remained significantly decreased. The involved limb was significantly less strong than the contralateral one. One patient had developed a tendinopathy of the opposite Achilles tendon, one had developed a tendinopathy of the reconstructed tendon, and one had ruptured the contralateral Achilles tendon five years after the original injury.

Conclusions: The long-term results of treatment of chronic tears of the Achilles tendon by means of autologous peroneus brevis tendon grafting are encouraging. Patients retain good functional results despite permanently impaired ankle plantar flexion strength and decreased calf circumference.

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

Achilles tendon ruptures are common[1]. Even though Achilles tendon rupture can be readily diagnosed by trained health-care professionals, it may be missed by the first examining physician in >20% of cases[2-4], leading to a chronic condition. In chronic ruptures of the Achilles tendon, the tendon sheath may become thickened and adherent to the retracted ends of the tendon[5,6]. Retraction of the proximal stump produces shortening of the proximal isometric plantar flexor strength of the gastrocnemius-soleus complex with weakness of plantar flexion of the ankle and a flatfoot gait without adequate push-off[1,7-10]. In chronic injuries, the tendon ends may be thin and atrophic and, when surgical augmentation is required, tendon grafts, a turn-down flap, a transfer of local tendons, and synthetic materials have all been used for reconstruction[11-13], with no evidence that one is clearly superior to another[14]. One option involves the transfer of the flexor hallucis longus tendon, which impairs the strength of flexion of the hallux and is technically demanding. After the transfer of the peroneus brevis tendon, eversion strength of the affected ankle can be decreased[15-17]. A free autologous gracilis tendon graft has been used with excellent results[18].

We have reported the two-year results for twenty-two patients with a chronic tear of the Achilles tendon with a gap during surgery of up to 6.5 cm (with the ankle in maximum plantar flexion and traction on the Achilles tendon stumps) in whom a peroneus brevis tendon graft was used for reconstruction[17], with use of the postoperative Achilles tendon total

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rupture score, the maximum calf circumference, and isometric plantar flexion strength as outcome measures.

Materials and Methods

Patients

All of the procedures described in this article were performed after local ethical committee approval had been granted. Ethics permission was granted for the original work[17]. Ethics permission was granted for this long-term prospective study. The demographic characteristics of the whole cohort of twenty-two patients were reported in the original study[17]. Briefly, all operations were performed in the period from 1990 to 1996. In all cases, a diagnosis of closed rupture of the Achilles tendon was confirmed on clinical grounds by the authors (N.M., E.P., V.T., G.C.)[19]. At the time of the index procedure, the twenty-two patients (one thirty-two-year-old woman and twenty-one men with a mean age [and standard deviation] of 41.3 ± 7.4 years [range, twenty-five to sixty-four years]) had undergone surgery for a chronic rupture of the Achilles tendon that had occurred between forty-three days and nine months (mean, 4.8 ± 2.6 months) before the operation. Of these twenty-two patients, eleven had been seen previously for Achilles tendinopathy, and five had received one to three injections of corticosteroids into the affected tendon, with the most recent injection being administered at an average of 4.8 months (range, three to twelve months) prior to the rupture. Of the sixteen patients involved in the present study, ten patients had sustained the tear during sports activities, two had had an accident at home, and four had had an accident at work.

Surgical Technique[17]

Both legs, feet, and ankles were prepared and draped to allow direct comparison of the appropriate tension to be imparted to the repair. With the patient prone and both feet dangling from the end of the operating table, the involved leg was exsanguinated by elevation for four minutes and the tourniquet on the thigh of the injured limb was inflated to 250 mm Hg five minutes after the administration of a single dose of a first-generation cephalosporin. A 10 to 12-cm longitudinal skin incision was made just lateral to the lateral border of the Achilles tendon. The subcutaneous fat was penetrated by means of sharp dissection, and the sural nerve was identified and protected. The paratenon, if not disrupted, was incised longitudinally in the midline for the length of the skin incision. The Achilles tendon was thus exposed, and gentle continuous traction was applied to the proximal stump of the ruptured tendon, which was brought into the wound to create the smallest residual tendon gap. The traction was maintained by an assistant during the entire next phase of the operation.

The proximal tendon stump was retracted proximally and scar tissue was excised to reach the viable portion of the tendon. A gap ranging between 4 and 6.5 cm was created, and it was not possible to juxtapose the tendon ends even with maximum plantar flexion of the ankle. Next, the distal portion of the peroneus brevis muscle belly was exposed by accessing the peroneal compartment through a small, longitudinal incision in the lateral aspect of the floor of the Achilles tendon compartment. The proximal end of the tendon of the peroneus brevis was identified. The distal portion of the tendon of the peroneus brevis was exposed through a 2.5-cm longitudinal incision starting from the lateral aspect of the base of the fifth metatarsal. A stay suture was applied at the distal end of the tendon, which was then detached from the base of the fifth metatarsal and gently delivered proximally into the main wound. The distal end of the tendon was passed through the substance of the distal stump of the Achilles tendon in a lateral-to-medial direction. The distal end of the tendon was then pulled proximally and through the substance of the proximal stump of the Achilles tendon in a medial-to-lateral direction. The peroneus brevis tendon was sutured to the Achilles tendon at each entry and exit point with use of 3-0 Vicryl sutures (Ethicon, Johnson & Johnson, Brussels, Belgium). Sutures that secured the musculotendinous junction of the peroneus brevis to the adjacent area of the Achilles tendon were added. Finally, interrupted sutures were placed across the gap approximating the two parts of the peroneus brevis tendon (Fig. 1).

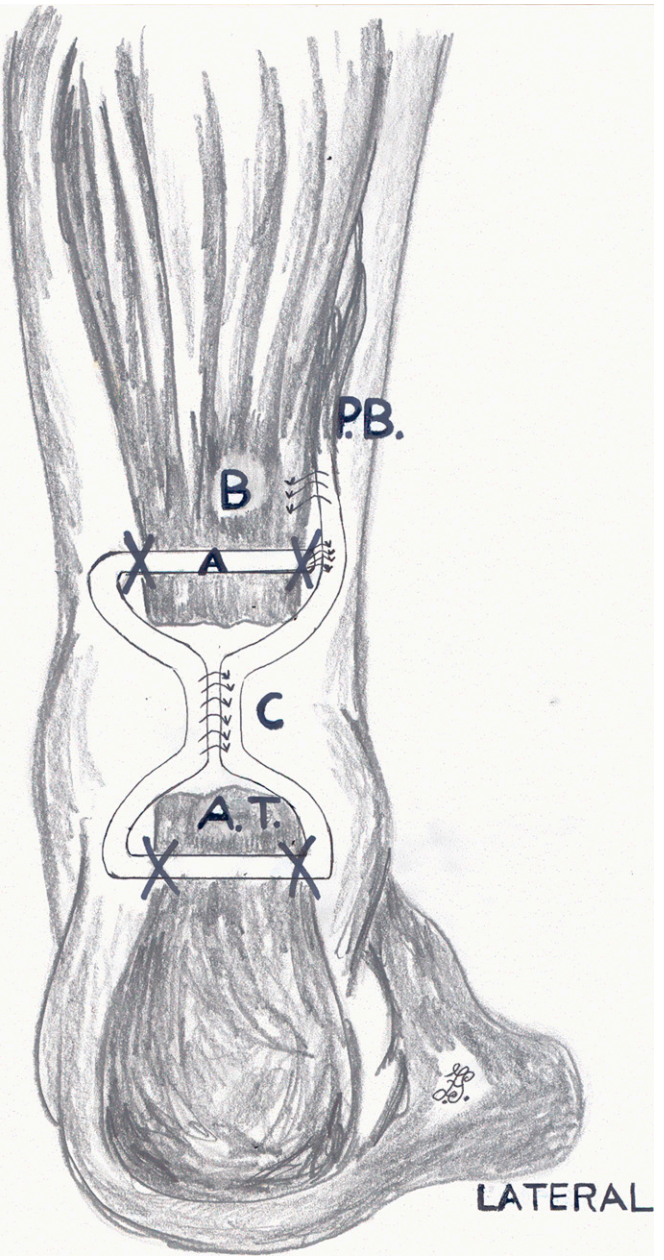

Fig. 1

Line drawing showing the surgical technique. First, the peroneus brevis (PB) tendon is passed first from lateral to medial through the distal stump of the Achilles tendon (AT) and then brought proximally and passed from medial to lateral through the proximal stump (A). Sutures are used to secure the musculotendinous junction of the peroneus brevis tendon to the adjacent area of the Achilles tendon (B). Interrupted sutures are placed in the gap to approximate the two limbs of the peroneus brevis tendon (C).

Interrupted 4-0 Vicryl reabsorbable sutures were used for the subcutaneous fat, and the skin was closed with interrupted 4.0 Ethilon sutures (Ethilon, Somerville, New Jersey). The tourniquet was deflated, and the tourniquet time was recorded. The wound was dressed, a below-the-knee cast was applied with the patient prone, and the foot was placed in gravity equinus, as described by Coughlin[20]. The cast was windowed at eight days to inspect the wound, and the skin sutures were removed on the twelfth postoperative day.

Postoperative Care

Patients were discharged the day after surgery, after having been taught to use crutches by a physiotherapist. Thromboprophylaxis was provided with 2500 units of Fragmin (deltaparin sodium; Pharmacia & Upjohn, Rome, Italy) self-administered subcutaneously once daily, starting one hour before surgery and continuing until removal of the cast. Patients were allowed to bear weight on the operatively managed limb as tolerated, but they were told to keep the limb elevated as much as possible for the first two postoperative weeks. Patients were seen on an outpatient basis at two-week intervals. The cast was changed at four weeks after the operation when the ankle was positioned plantigrade, and the cast was removed six weeks after the operation.

After removal of the cast, patients were allowed to mobilize the ankle with physiotherapy guidance. They were allowed to partially bear weight and then commenced gradual stretching and strengthening exercises, gradually proceeding to full weight-bearing eight to ten weeks after surgery. Cycling and swimming were allowed two weeks after the removal of the cast. Patients were encouraged to increase the frequency of their self-administered exercise program and were allowed to return to their primary sports activities by the fifth postoperative month.

Long-Term Follow-up

All of the patients who had been enrolled in the original study were contacted by telephone and/or letter by a research assistant who had not been involved in their earlier management. We were able to review sixteen of the twenty-two patients who had been involved in the original study; all sixteen patients were male, and the average age was 55.6 ± 8.6 years (range, forty-three to seventy-nine years). We were not able to track down three patients, one patient had died, one (the only woman in the original cohort) had experienced a stroke affecting the operatively managed side, and one refused to take part in the study because he was totally asymptomatic. Patients underwent a final assessment for the purposes of this investigation at an average of 15.5 years (range, thirteen to eighteen years) after the index operation. An orthopaedic surgeon not involved in the initial patient management (N.M.) assessed all of the patients. Strength testing was performed by a rehabilitation specialist (V.T.).

Measurements

The Achilles tendon total rupture score[21] was used to evaluate patient symptoms and physical activity outcome after Achilles tendon reconstruction. The Achilles tendon total rupture score is a patient-reported instrument with high reliability, validity[21], and sensitivity for measuring outcomes after management of patients with a complete Achilles tendon rupture[21]. The maximum score is 100 points, and the minimum score is 0 points. The ten questions of the Achilles tendon total rupture score are: (1) Are you limited because of decreased strength in the calf, Achilles tendon, or foot? (2) Are you limited because of fatigue in the calf, Achilles tendon, or foot? (3) Are you limited because of stiffness in the calf, Achilles tendon, or foot? (4) Are you limited because of pain in the calf, Achilles tendon, or foot? (5) Are you limited during activities of daily living? (6) Are you limited when walking on uneven surfaces? (7) Are you limited when walking quickly upstairs or uphill? (8) Are you limited during activities that include running? (9) Are you limited during activities that include jumping? (10) Are you limited in performing hard physical labor?

The maximum calf circumference was measured in both legs by means of a commercially available steel tape measure. Patients were asked to perform ten single-limb heel lifts on the affected side and were judged as being either able or unable to do so.

The outcome of surgical management was rated with use of the 4-point scale of Boyden et al.[22], which has been validated in our setting[15-18]. A patient with an excellent result had no pain, had no limitation of recreational or daily activities, had no footwear restrictions, and was thoroughly satisfied with the surgery. A patient with a good result had mild occasional pain, had limitation of recreational but not daily activities, had no footwear restrictions, and was satisfied with only minor reservations. A patient with a fair result had mild-to-moderate pain, had limitation of recreational and daily activities, had moderate footwear restrictions (unable to tolerate everyday shoes, with or without an insert), and was satisfied, with major reservations. A patient with a poor result had moderate to severe pain, had limitation of recreational and daily activities, had severe footwear restrictions (brace or modified shoes only), and was dissatisfied or had experienced a rerupture.

Isometric Plantar Flexion Strength of the Gastrocnemius-Soleus Complex[23]

The isometric plantar flexion strength of the gastrocnemius-soleus complex was determined bilaterally with the ankle in neutral (0°) with use of a custom-made apparatus consisting of a foot-plate, the angle of which could be varied and locked in a given position. An analogue-to-digital converter (ADC-10; Pico Technology, Cambridge, United Kingdom) connected the strain gauge on the foot-plate to a voltmeter (PicoScope; Pico Technology). In turn, the voltmeter was connected to a computer. The changes in voltage were then converted into newtons to measure strength. The apparatus was calibrated by suspending known weights from 2.5 kg to 37.5 kg before and after each patient was tested, giving a linear response. Each patient supported the leg in the leg rest, with the heel placed firmly at the top of the foot-plate and with the plantar aspect of the foot resting at ease. The patient was then asked to exert maximal isometric force onto the foot-plate for three to five seconds. The maximum result was noted. The amplifier was used each time to return the voltmeter to zero. Each patient performed two maximum attempts, and the average result was used for further analysis.

Statistic Analysis

Descriptive statistics were calculated. The groups were compared with use of the 2 × 2 contingency table test for binary outcomes and the Wilcoxon two-sample test for continuous outcomes. Comparisons between the involved limb and the contralateral, uninvolved limb from the same person were performed with use of the McNemar test to analyze binary data and the Wilcoxon test on the difference in scores for continuous data. Significance was $p < 0.05$.

Source of Funding

There was no external funding source for this study.

Results

At the 15.5-year review, all sixteen patients were able to bear weight fully on the involved limb. All patients were pleased with the appearance of the operative scars. Clinically, the operatively managed tendon was thicker than the contralateral Achilles tendon in all patients, but no patient reported an abnormal appearance of the operatively managed tendon. No patient sustained a rerupture.

The maximum calf circumference remained significantly decreased in the involved leg when compared with the contralateral, uninvolved leg (mean, 41.4 ± 8.2 cm compared with 45.6 ± 7.5 cm; $p = 0.03$). This is very similar to the mean measurement of 39.3 ± 6.8 cm compared with 43.1 ± 7.4 cm reported in the original study[17]. The mean Achilles tendon total rupture score at the time of the latest follow-up examination was 89.5 ± 12.2 points[17]. With use of the Boyden score, four patients had an excellent result, nine had a good result, and three had a fair result. None had a poor result.

The duplicate measurements of isometric plantar flexion strength of the gastrocnemius-soleus complex showed a high intraobserver reliability ($r = 0.89$; $p = 0.021$). Paired sample t test results showed that the involved limb had a significantly lower peak torque than the contralateral, uninvolved limb (mean, 241.7 ± 133.2 N compared with 278.1 ± 153.1 N; $p = 0.04$), but the patients did not perceive this decrease in strength as interfering with their daily or leisure activities.

Complications

No patients experienced any surgical wound problems after harvesting of the peroneus brevis tendon. One patient had a superficial infection of the Achilles tendon surgical wound. The wound healed uneventfully by the eighteenth postoperative week with dry dressing and oral antibiotics treatment. One patient had developed a tendinopathy of the opposite Achilles tendon, one had developed a tendinopathy of the reconstructed tendon, and one had ruptured the contralateral Achilles tendon five years after the original surgery. At the sixth postoperative month, two patients reported hypersensitivity of the surgical wounds. They were counseled to rub hand cream over the wounds several times per day, and both were asymptomatic by the next visit. No patient developed a hypertrophic scar in the area of the Achilles tendon surgical wound. On clinical grounds, no patient developed a deep vein thrombosis. Also, no patient sustained a rerupture of the Achilles tendon. All patients were able to walk on tiptoe, and no patient used a heel lift or walked with a visible limp.

Discussion

We reported the long-term postoperative clinical outcome, the maximum calf circumference, the isometric plantar flexion strength, and complications in sixteen patients who had undergone peroneus brevis tendon graft treatment for a chronic Achilles tendon rupture[17]. The long-term results of the present study confirmed that an autologous peroneus brevis tendon graft can be used to reconstruct the continuity of the Achilles tendon in patients with a chronic rupture with a wide gap between the stumps.

A wide range of techniques to treat Achilles tendon ruptures has been described[14,24-28]. The harvest of the tendons of the long toe flexors carries the risk of impaired push-off strength after the procedure, which could be problematic for athletic and young people[29,30]. The major concerns about the transfer of the tendon of the peroneus brevis are the reduced strength of plantar flexion and the eversion of the ankle[17]. The peroneal muscles provide only 4% of the total work capacity in plantar flexion, and the peroneus brevis provides 28% of the eversion capacity of the hindfoot[31].

We are aware of the limitations of this study. For example, we were able to examine only sixteen of the original twenty-two patients who formed the original study cohort. However, given the length of time, an average of 15.5 years, from the original operation, this loss to follow-up should not be surprising, and we believe that the present study sample was representative of the whole cohort. The Achilles tendon total rupture score is a comprehensive outcome measure of function following an Achilles tendon rupture[21]. This patient self-administered questionnaire was only developed a few years ago and was not available when we performed the original study[17]. In that study, we measured isokinetic strength. In the present study, we were able to measure isometric plantar flexion strength. In this respect, therefore, the strength results, although valid, were not wholly comparable with those that were measured in the 2001 study. The assessment of postsurgical outcomes in this cohort study was not as strong as that which would result from a randomized controlled trial. Chronic Achilles tendon rupture is not a common injury, and a randomized controlled trial would likely be long and costly, necessitating large numbers of patients. Finally, we performed the operations in an open fashion, and it may be interesting to compare our long-term results with those of the operations currently performed with use of less invasive techniques[32].

In conclusion, reconstruction of a chronic tear of the Achilles tendon by means of an autologous peroneus brevis tendon graft affords good recovery. The patients should be warned about postoperative complications, that wasting of the calf is not likely to recover fully, and that the ankle plantar flexion strength can remain reduced. Nevertheless, satisfaction and function in these patients remained high at long-term follow-up. ■

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