1 Reconstruction of Achilles tendon utilizing the Perez Teuffer technique

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Introduction

Subcutaneous rupture of Achilles tendon is common (1-6). Compared with conservative treatments, surgical repair of Achilles ruptures in athletic individuals allows to shorten the rehabilitation program and earlier return to sports (7-9). In acute ruptures, endñto-end suture is our procedure of choice: it is simple and effective in most patients (10, 11). We transfer the tendon of peroneus brevis in patients in whom end-to-end suture of the injured Achilles tendon is difficult or impossible.

Case selection

We use the Peroneus Brevis tranfer procedure in three groups of patients:

A) Chronic ruptures

B) Re-ruptures

C) Acute ruptures in extensively degenerated tendons

The clinical features of the three groups of patients are summarized as follows:

A) CHRONIC RUPTURES

Achilles tendon rupture is not diagnosed in about 25% of cases. The rupture is recognised after a variable delay (from weeks to months) (8). At the time of surgery, the tendon stumps are separated by a gap of variable length, at times filled with scar tissue.

Often, patients have been treated with splints, braces and elastic bandages for several weeks. Also, a complete rupture may be misdiagnosed as a partial Achilles tendon rupture, and treated with an equinus splint for four weeks. At times, patients did not seek medical assistance.

Clinical examination

Often, these patients present with chronic swelling and oedema of the affected leg. Gait is severely affected because of the lack of appropriate propulsion. Standing on tip-toes on the affected leg is impossible. The calf muscles are atrophic. There is increased dorsiflexion of the ankle following functional or actual elongation of Achilles tendon.

At operation, there can be a fibrous callus surrounding the edges of the rupture. This scar tissue is fragile and gently adherent to the tendon. The tendon edges are rounded, and separated by a gap from the proximal retraction of the proximal stump, and distal retraction of the distal stump. At times, there are intratendinoud calcifications in the distal stump of the tendon.

B) RE-RUPTURES

The Achilles tendon may undergo a re-rupture following surgical or conservative management, generally 6 to 12 weeks after the original event. In such cases, end to end suture of the re-rupture can be problematic.

In re-ruptures, there is fibrous callus around the edges of the Achilles tendon, blood clots from an impaired blood supply, residual suture material from the former repair, retraction of the proximal stump of the Achilles tendon, and a wide gap between the two edges of the Achilles tendon.

C) ACUTE RUPTURES

Peroneus brevis transfer can be performed in acute Achilles tendon ruptures in mature athletes who show severe tendon degeneration (12-14). In these patients, end-to-end suture of the torn Achilles tendon was difficult to realize.

The severely frayed Achilles tendon rupture may be an obstacle to a firm suture, as the degenerated edges of the Achilles tendon cannot withstand the tension of the calf muscles. At the end of the operation, a below the knee cast is used to immobilize the foot and ankle in equinus.

Transfer of the peroneus brevis tendon is useful when the rupture occurs at the osteotendinous junction on the calcaneus.

Rationale for transfer of the tendon of peroneus brevis

A failed healing response with feature of tendon degeneration is found even in acute ruptures of the Achilles tendon. This is especially evident in mature athletes from the fourth decade (13, 14). Acute ruptures dramatically damage the delicate vascular network around the Achilles tendon (15, 16).

Chronic ruptures and re-ruptures result in retraction of the proximal tendon stump from the contraction of calf muscles and scar tissue between the tendon's edges.

These changes constitute the rationale to graft healthy tendon tissue into the rupture area. This is provided by the tranfer of the intact, well vascularized tendon of the peroneus brevis that acts as a biological scaffold between the Achilles tendon stumps. The transferred tendon may also withstand the tension developed by the contraction of the triceps surae while healing of the Achilles tendon proceeds.

A. Perez Teuffer originally described this technique in 1972 (17, 18). Turco and Spinella reported a series of 40 Achilles tendon reconstructions operated over a 13 year period utilizing the peroneus brevis transfer (19) when facing chronic ruptures and to fill large defect of the Achilles tendon (20).

Surgical technique

A postero-lateral longitudinal approach is performed beginning from the proximal third of the affected leg and ending to the postero-lateral aspect of the heel. The torn Achilles tendon is exposed. A careful dissection of the sural nerve and of the small saphenous vein, which are isolated and protected, is performed.

In chronic ruptures, the tendon edges are debrided of scar tissue, and an end-to-end suture is attempted. Given the retraction of the proximal tendon stump, it is necessary to position the foot in full equinus achieve this.

In acute ruptures, the frayed margins of tendon are utilized for a "three bundle" repair.

A small incision at the base of the fifth metatarsal, at the level of the distal insertion of the tendon of peroneus brevis, is performed. The tendon is detached from the base of the fifth metatarsal. The posterolateral muscular septum is opened to facilitate the passage of the peroneus brevis next to the Achilles tendon stumps. The tendon of peroneus brevis is thus retrieved proximally from the base of the proximal wound, and aligned along by the lateral aspect of the Achilles tendon.

A small incision is performed in the distal stump of the Achilles tendon close to the insertion on the calcaneus (Fig. 1).

The peroneus brevis tendon is then passed, from lateral to medial, through this small incision into the distal stump. The free end of the tendon of peroneus brevis is firmly sutured to the medial aspect of proximal stump of the Achilles tendon. Given the solid anchoring to the peroneus brevis tendon, the proximally retracted aponeurosis of the calf muscles can be firmly pulled distally and secured to the distal portion of the Achilles tendon (Fig. 2). Sutures are placed on the medial and lateral aspect between the peroneus brevis tendon and the Achilles tendon. The muscle belly is used to fill the loss of tendinous substance after chronic ruptures or re-ruptures.

At the end of the operation, the gap is bridged, and the Achilles tendon is sandwiched by the peroneus brevis tendon (Fig. 3).

We normally avoid immobilization with the foot in equinus position, thus allowing the calf muscles to recover their normal tension. When the Achilles tendon is detached from the calcaneal osteotendinous junction and the distal portion is absent, the peroneus brevis tendon is passed into a tunnel drilled through the

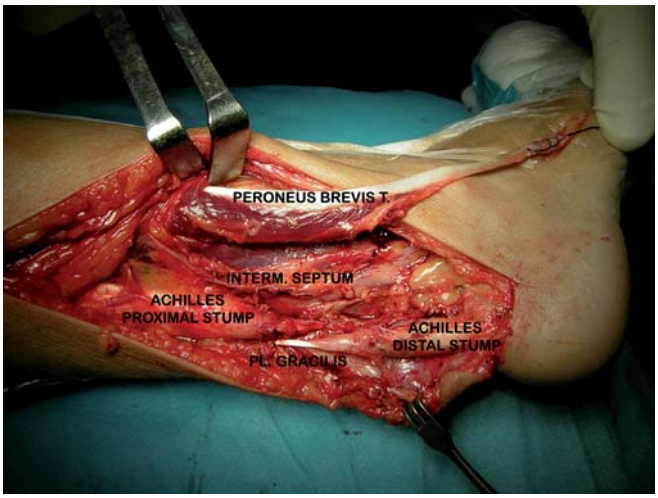


Figure 1 The picture shows the typical surgical field of a neglected rupture of Achille Tendon. The two stumps are separated, they are of round shape and are scarcely connected to the Plantaris Gracilis Tendon. The Achilles Tendon loss of substance is apparent. The fibrous septum wich divides Peronei Tendons and Muscles from Achilles Tendon is widely opened. The Peroneus Brevis Tendon was detached from its insertion on the base of fifth metatarsal bone and passed close the Achilles Tendon. The Peroneus Brevis muscle belly will be used to fill the loss of substance between the two stumps of Achille Tendon. The Peroneus Brevis Tendon is used to obtain a steady reconstruction of the Achilles tendon.

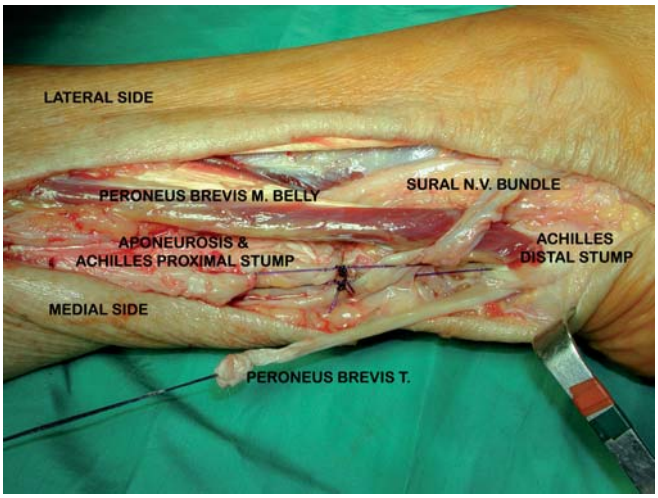


Figure 2 The picture shows the reconstruction of a neglected rupture of the Achilles tendon. The Peroneus Brevis Tendon is pulled proximally by a suture, after being passed from the lateral side of the Achilles tendon to the medial side, through a small incision within the distal stump. The injuried Achilles tendon is thus sandwiched by the Peroneus Brevis Tendon. The proximal stump of the Achille tendon and Triceps Surae aponeurosis are proximally retracted. The suture to the Peroneus Brevis Tendon allows the distal traction of the retracted Triceps Surae aponeurosis. The appropriate tension of the Triceps Surae Muscles are thus restored at the end of the procedure.

calcaneum, as originally described in Perez Teuffer's original articles (17, 18) from the lateral to the medial side, and sutured to the Achilles tendon as previously described.

Another way to achieve secure fixation of the tendon of peroneus brevis is to fix it in a calcaneal tunnel (Fig. 4) A tunnel is drilled from the proximal aspect of the bone to the plantar side. The tendon is then directed, with appropriate tension, through the tunnel with a pull-out method and secured to the calcaneum with an interference screw (Fig. 5D).

After the reconstruction, closure is accomplished in layers, and the skin is closed in the usual fashion. One or two suction drains are used. Postoperative immobilization is accomplished with a posterior splint or a Walker Donjoy ROM brace for two weeks.

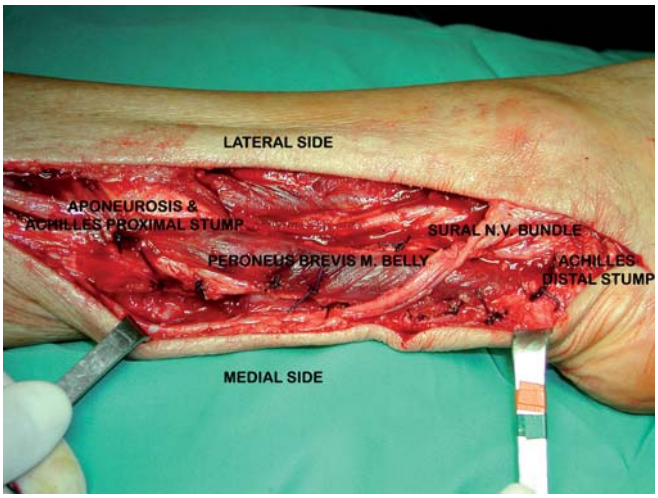


Figure 3 At the end of the reconstruction the Peroneus Brevis muscle belly fills the loss of substance and the gap between the two stumps of the injuried Achilles Tendon by means of a vascularized graft.

Postoperative protocol

Patients discharged two days after the operation. They are taught to walk with two crutches. Thromboprophylaxis treatment is started before the operation, and continued until removal of the posterior splint or the Walker Donjoy ROM brace.

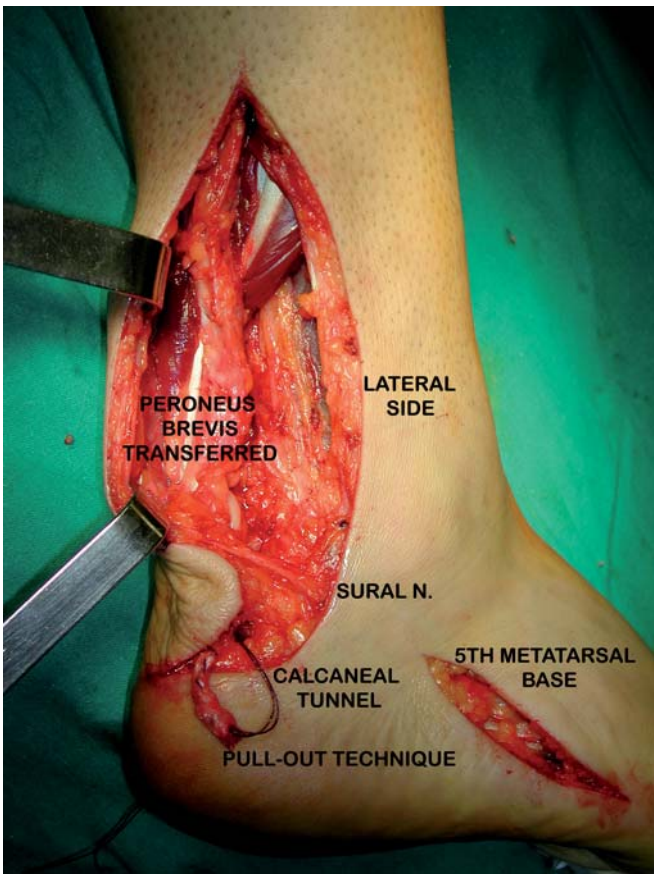
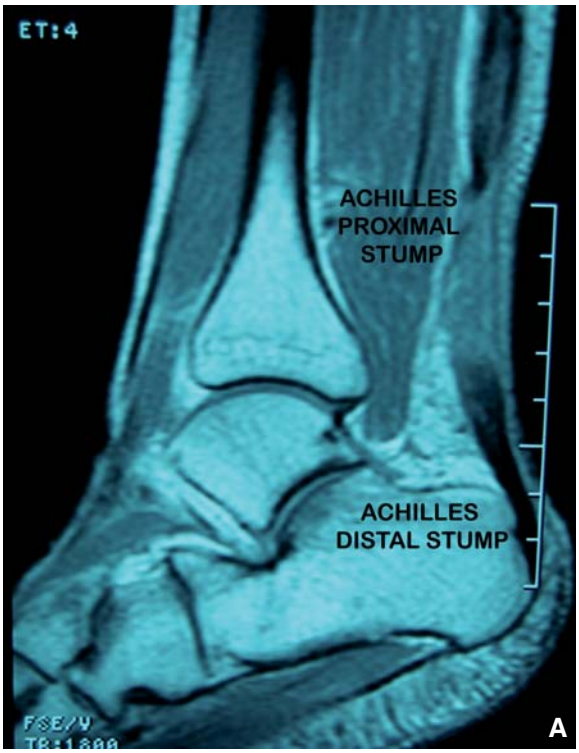
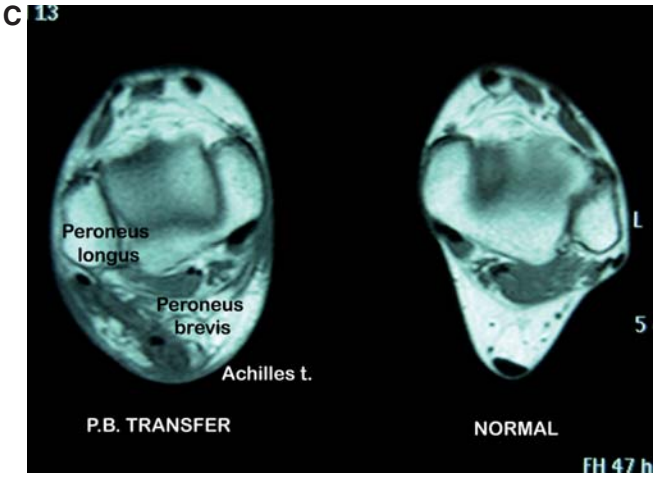


Figure 4 The picture shows the alternative method of fixation of the Peroneus Brevis to the distal portion of the injuried Achilles Tendon. A tunnel is drilled within the calcaneum close to the osteotendinous junction. The Peroneus Brevis Tendon is inserted into the bony tunnel by means of pull-out technique and maintained under tension. After the appropriate tension is obtained the tendon is firmly secured with an interference screw. The picture shows the Peroneus Brevis Tendon prepared to be routed in the calcaneal tunnel. This method is used in case of Achilles Tendon rupture at the distal osteotendinous junction.





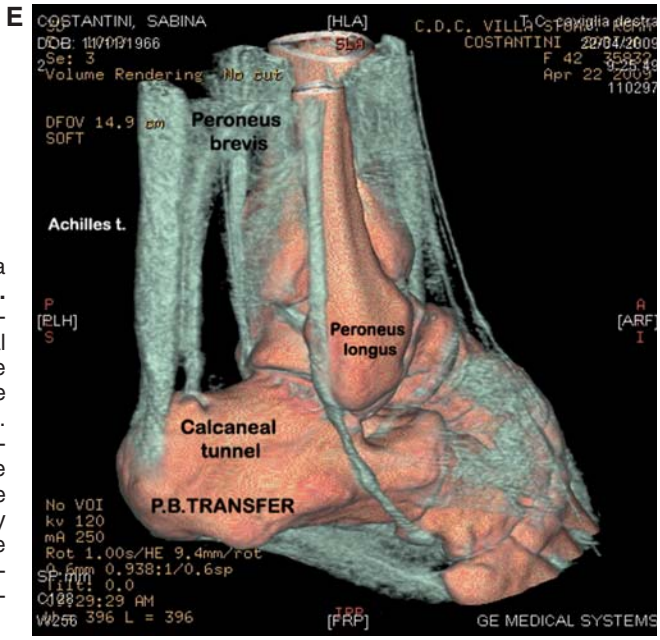


Figure 5 **A.** MRI assess the neglected rupture of the Achille Tendon in a sagittal view. The gap between proximal and distal stump is apparent. **B.** M.R.I. assesses the neglected rupture of Achilles Tendon rupture in a axial view in comparison with the normal opposite side. The two Peroneal Tendon are clearly visible within their tendon sheath behind the perone on both side. **C.** MRI after 3 months from the reconstruction shows the tranfer of the Peroneus Bevis Tendon toward the injuried Achilles Tendon. The Peroneus Brevis Tendon is close to the Achilles Tendon. The peroneus tendon sheath contains the Peroneus Longus Tendon only. The Achilles tendon collagen is immature. **D.** The MRI shows the tunnel in the calcaneum. The Peroneus Tendon is firmly secured within the tunnel by means of an interference screw. **E.** The TC scan recontruction shows the Peroneus Brevis's transfer to the injuried Achilles Tendon and the position of the calcaneal bony tunnel in which the the Peroneus Brevis is routed. The Peroneus Longus tendon is also shown.

Patients are non allowed to bear weight on the operated limb and are instructed to keep the leg elevated as much as possible for the first two week.

Skin sutures are removed after two weeks. Partial weigthbearing is then allowed with two crutches. Early plantar flexion of the ankle is made possible with the assistance of a physiotherapist and by wearing an anterior ankle splint (to avoid sudden, abrupt extension) or a restricted motion Walker Donjoy ROM brace. At the fourth post-operative week, full weightbearing is allowed. The boot is gradually discarded. Range of motion exercises (with knee flexed as well as extended), swimming holding a floating device, training into a swimming pool while wearing a life vest jacket and diving are encouraged.

During the fifth and sixth postoperative week, stationary bicycling, isometric, isotonic and isokinetic strengthtening of the calf muscle, gradual introduction of low impact stress (jogging, distance running) are commenced.

At eight weeks, high impact stress (sprinting, cutting, jumping) is introduced. After three months, return to sports participation is gradually encouraged.

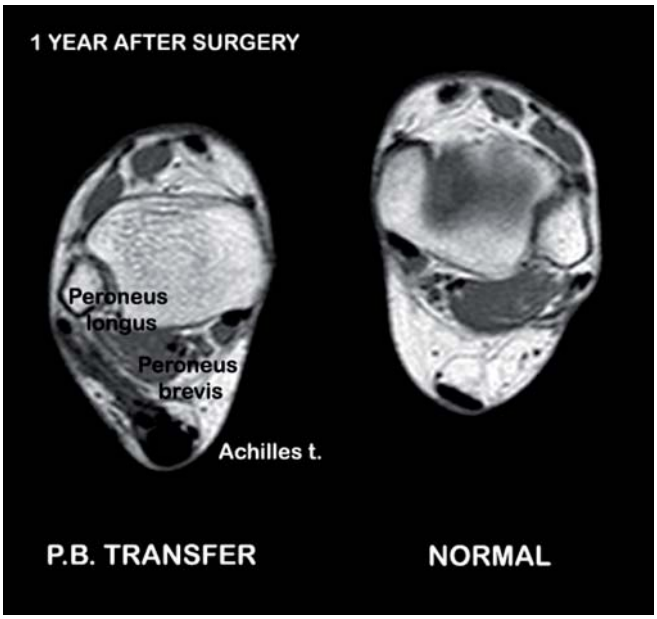


Figure 6 MRI after one year from the Peroneus Brevis Transfer shows the perfect healing of the Achilles tendon neglected rupture. The tendon appears to be formed by collagen of good quality.

Discussion

Chronic ruptures of the Achilles tendon, re-ruptures following initial repair and acute ruptures in highly degenerated tendons are challenging, as they involve compromised tendon tissue and surrounding soft tissues, which are less ideal for direct repair.

In these patients (12, 1, 2, 4, 5, 21, 22), retraction of the proximal portion of the Achilles tendon and a wide gap between the two margins of the tendon can be assessed by MRI (Fig. 5A,B) (23), and the wide gap appreciated clinically and at imaging is accompanied by weakness of the triceps surae muscles associated with a lengthened gastro-soleus-tendon complex (24). The consequent lack of physiological tension stimulation leads to calf muscle atrophy (24).

Using the ìV-Yî technique of direct reconstruction, healthy collagen tissue is not transferred in the area of the chronic rupture. Furthermore, the equinus position of the ankle is held for two months (25).

When Bosworth's technique of reconstruction is used (a fascial flap from the gastrocnemius is turned down to bridge the Achilles tendon gap and the end-to-end suture), a long legged cast is worn with the equinus of the foot and flexion of the knee for 6 weeks, followed by a short leg cast for a further 6 weeks, with the foot in neutral and gradual resumption of weightbearing (26), with long post-operative rehabilitation, sometimes several months, necessary to regain full ankle extension.

A complete and aggressive rehabilitation program is highly recommended after Achilles tendon repair, including early active range-of-motion exercises in a removable walker coupled with full weigthbearing, greatly improves early foot function with excellent recovery of plantarflection strength and motion (7, 27).

Transferring the tendon of peroneus brevis (17-19), the proximal portion of the Achilles tendon and the aponeurosis of the triceps surae is retensioned. The proximal retracted tendon stump is secured after anchoring to the peroneus brevis tendon, which sandwiches from both sides the Achilles tendon. Weakness and atrophy of the triceps surae (24) are strictly addressed. The peroneus brevis tendon bridges the tear, and acts as a biological vascularized graft (Fig. 5C), with secure fixation possible when the Achilles tendon is avulsed from the calcaneus (Figs. 5D,E, 6).

The transfer of the tendon of flexor hallucis longus, also used to reconstruct chronic Achilles tendon ruptures (28, 29), may impair the function of the hallux during walking, running and jumping.

Transfer of the peroneus brevis does not affect lateral ankle stability. Clinical and experimental data obtained by Cybex testing after lateral ligament reconstruction of the ankle using the tendon of peroneus brevis documented no significant functional loss (30).

Conclusion

Reconstruction of the Achilles tendon using a transfer of peroneus brevis procedure allows:

– immobilization of the ankle at a right angle avoiding the equinus position and restoring the physiological muscular tension;

– the peroneus brevis transfer provides active motility and adds some strength to the damaged triceps surae complex;

– early weightbearing and an aggressive rehabilitation program are allowed;

– reliable reconstruction of chronic ruptures, of re-ruptures of Achilles tendon and severely degenerated acute ruptures.

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