CHAPTER **16**

THE FLEXOR HALLUCIS LONGUS AUGMENTATION FOR CHRONIC ACHILLES TENDINOSIS

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Achilles tendon disorders are commonly encountered by the foot and ankle surgeon. Acute ruptures are easily managed with primary repair or casting, however treatment of the chronic Achilles tendon rupture with tendinosis remains enigmatic. The growing number of aging, competitive and recreational athletes has led to an increase in the incidence of Achilles tendon injuries. The availability of magnetic resonance imaging has contributed to the identification and classification of Achilles tendinopathy.

Achilles tendinopathy can be subdivided into three distinct entities; peritendinitis, peritendinitis with tendinosis, and tendinosis. The etiologic factors are multifactorial and include inflammatory, vascular, degenerative, and biomechanic influences. Degeneration of the Achilles tendon has been described as a continuum from peritendinitis to tendinosis to rupture.[1] Chronic tendinosis is characterized by abnormal fiber structure, focal hypercellularity, and vascular proliferation. Partial tendon tears are usually present in patients who have tendinosis.[2]

Histologic examination of ruptured Achilles tendons has demonstrated hypoxic degeneration. The watershed area of the Achilles tendon has been described to be in the zone extending from 2-6 cm proximal to the insertion of the tendon to the calcaneus. Injection studies have shown that this area has a decreased blood supply compared to the more proximal and distal tendon.[3] There is evidence that suggests that the blood flow to the Achilles tendon decreases after the third decade. In addition, the overall flexibility of the collagen fibers that constitute the tendon decrease as well.

Various reconstructive surgical techniques have been developed to treat chronic Achilles watershed area tendinosis with varying degrees of success. They include tendon debridement, brisement (injecting local anesthetic under the paratenon), decompression (incision) of the paratenon, aponeurotic turndown flaps, V to Y advancement, fascia lata transplantation, synthetic augmentation (Carbon fiber), and Marlex mesh reinforcement.

Recently, much attention in the literature has been given to the role of tendon transfers or augmentation in treating chronic Achilles tendinosis. It is suggested that healing of the prerupture (tendinosis) may be enhanced by augmentation with the flexor hallucis longus tendon. This is postulated for two reasons. First, the rerouted musculotendinous unit can better revascularize the diseased tendon, and second, the in-phase tendon demonstrates sufficient length and strength to reestablish sufficient power and torque to the Achilles tendon.

TECHNIQUE

Two different techniques of the FHL transfer have been described by Hansen,[4] a short harvest and a long harvest. The short harvest sections the FHL at the distal-most aspect of the medial Achilles exposure. The long harvest utilizes a distal medial second incision that harvests the FHL at the Master Knot of Henry. The short technique is utilized to augment vascularity in cases of chronic pain and weakness caused by tendinosis, calcification or cysts where the tendon is still grossly intact. The long technique is favored in situations with previous rupture or loss of substantial tendon mass.

The short harvest uses a medial approach extending 10-12 cm proximal to the superior border of the calcaneus. The incision exposes the anterior aspect of the Achilles tendon. A longitudinal incision is made along the anterior paratenon of the Achilles tendon. Then the deep fascia enclosing the deep posterior compartment is exposed at its distal 15-20 cm exposing the muscle belly of the flexor hallucis longus. With the foot and hallux maximally plantarflexed the FHL are forcibly retracted and transected as distally as possible. The muscle belly of the FHL is brought posteriorly and while held in physiologic tension is sutured to the anterior portion of the Achilles tendon.

The tendon of the FHL is either inserted into a drill hole in the medial tubercle of the calcaneus or into a slit at the very distal aspect of the end of the Achilles tendon where it is sutured to the tendon.

The muscle belly of the FHL nearly extends the

full length of the Achilles tendon, supplying both blood supply to the tendon and providing a contacting force to augment the triceps surae.

Hansen feels that loss of strength after transferring the flexor hallucis longus are unfounded, and that most patients over thirty years of age do not miss the loss of flexion strength in the interphalangeal joint. The existing cross-attachments between the flexor digitorum communis and the distal flexor hallucis longus at the master knot of Henry are sufficient to maintain plantarflexory strength of the hallux.

The second technique or long harvest are similar to the previously described technique. However, this variation is more technically demanding because of the dissection and isolation of the FHL tendon deep in the plantar musculature of the arch. This technique has been described by various authors with minimal variation.[4-6]

The second technique has been described by Wapner.[5] First the flexor hallucis longus is harvested distally using a medial incision over the navicular extending over the first metatarsal. Dissection is carried down to the abductor hallucis that is reflected plantarly with flexor brevis. The deep midfoot anatomy is exposed and the FHL is transected as far distally to allow the distal portion of the FHL to be sewn into the FDL. The proximal portion of the FHL is then tagged.

A medial incision is made along the Achilles tendon from the musculotendinous junction to below the level of the calcaneus. The paratenon is then opened longitudinally. Debridement of the diseased tendon is then performed. The fascia over the deep compartment of the leg is then opened and the FHL is exposed. The tendon is then harvested from the midfoot into the posterior incision.

A transverse drill hole from medial to lateral is made halfway across the calcaneus just distal to the Achilles insertion. A vertical drill hole is made just anterior to the Achilles insertion that intersects the original hole at 90°. A suture passer is placed through the tunnel from distal to proximal which pulls the FHL tendon through the superior calcaneus medially. The FHL is then woven from distal to proximal through the Achilles tendon using a tendon weaver. This process is repeated using the full length of the tendon back and forth across the distal 10 cm of the Achilles tendon. The weave is secured with multiple sutures of no.1 nonabsorbable braided suture. The paratenon is then repaired followed by layered closure (Figure 1).

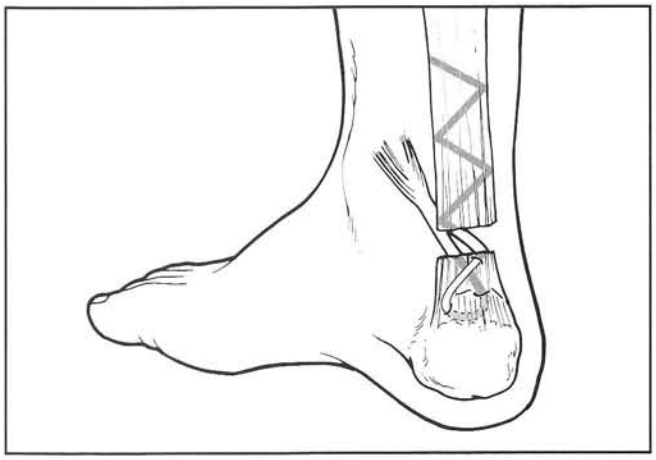

Figure 1. The flexor hallucis longus tendon has been harvested, the distal tendon is placed through a calcaneal drill hole and then woven back through the Achilles tendon across the compromised area.

Hansen's variation of this technique uses a more plantar medial incision approaching the master knot from under the plantar ligaments. The FHL tendon is harvested and rerouted in a similar fashion however a weave is not performed. Instead the distal FHL tendon is looped through a slit in the distal Achilles tendon and then sutured into the posterior, superior Achilles tendon above the compromised area.

The postoperative course entails four weeks nonweightbearing in a below knee cast at 15 degrees of plantarflexion. This is followed by a short leg walking cast or a removable cast walker for four weeks. A rehabilitation program for strengthening and range of motion is started at 8 weeks postoperatively. The patient is maintained in a cam walker until 10 degrees of dorsiflexion is obtained with muscle strength of 4/5. The patient may then progress to 7/16 heel lift in regular shoes at this time. Athletic activity is restricted for 6 months following surgery.

DISCUSSION

It is well established that active patients experiencing functional deficits with chronic Achilles tendinopathy should undergo operative treatment for optimal results. Previously reported surgical options did not go far enough to both revascularize and augment a degenerated tendon that was also in need of debridement. Wapner[5] (reported good to excellent results in 6 out of 7 patients who under-

went FHL transfer for chronic Achilles tendon ruptures. Wilcox[6] (extended the indication of the FHL transfer to Achilles tendinosis and peritendinitis with tendinosis. Of 20 patients involved in the study, 17 patients were diagnosed with tendinosis. 75% of the patients demonstrated good to excellent results whereas 10% had a poor result.

Various factors may complicate or interfere with the overall outcome of the reconstruction. These include Achilles tendon defects, degeneration (and the associated need for debridement), retraction of the proximal portion of the triceps surae, an ischemic tendon, a lengthened tendon and problems with the Achilles insertion to the calcaneus. The FHL transfer/augmentation addresses these concerns.

First, the FHL has a low muscle belly which when stripped of its fascial covering effectively extends distally past the relative avascular zone of the Achilles and insures improved healing potential. The FHL also possesses multiple biomechanical advantages over other transferred tendons. Compared to the peroneus brevis and the flexor digitorum longus tendons, the flexor hallucis longus tendon is stronger and wider in diameter, its axis of contractile force more closely reproduces that of the Achilles tendon, it fires in phase with the triceps surae, its anatomic proximity avoids the neurovascular bundle, and its plantarflexory function is the same as the Achilles tendon.[6] (In short it is the most logical tendon to transfer to address chronic tendinpathy of the Achilles tendon.)

Disadvantages of the FHL transfer include the potential for tissue damage caused by the tendon harvest and the loss of hallux interphalangeal joint flexion strength resulting from tenotomy of the FHL. With attention to tissue planes the abductor hallucis is retracted inferiorly along with the flexor hallucis brevis. The medial plantar artery, vein and nerve are retracted plantarly as well exposing the FHL and FDL tendons. The need to suture the distal stump of the FHL to the FDL is not universally agreed upon but probably not required because of the existing interconnections. This tendon strength to the hallux can be simply tested by tugging on the FDL intraoperatively (Figure 2).

The loss of hallux plantarflexory strength following the FHL transfer remains controversial. It is felt that the muscle strength lost by the sacrifice of the FHL is minimal. The significance of the passive first metatarsophalangeal joint as well as the decrease in peak torque is compared to the contralateral side is unknown. Hansen feels that patients over thirty do not miss the loss of flexion strength at the hallux interphalangeal joint. However, the decrease if any of the hallux push off strength has not been fully documented. It may be helpful to counsel patients preoperatively that such a difference is likely to exist.

An unusual complication was reported by Monroe[7] when three of ten patients in his study experienced deep peroneal sensory nerve dysfunction following the procedure. The etiology is unknown. The most likely culprit would appear to be intraoperative dissection and retraction.

Another potential complication is hyperextension of of the hallux interphalangeal joint in patients with ligamentous laxity. This can be predicted and averted by securing one half of the extensor hallucis longus to the proximal phalanx with the interphalangeal joint in the neutral position.

CONCLUSION

The flexor hallucis longus transfer/augmentation is an effective technique for the treatment of chronic Achilles tendinosis or late rupture. This approach provides advantages over previously described procedures especially in cases that require an increase in the vascular supply and strength to a compromised Achilles tendon. Any surgery that affects the Achilles tendon function should not be taken lightly. Technical expertise is required and rehearsal with a cadaveric specimen is recommended.

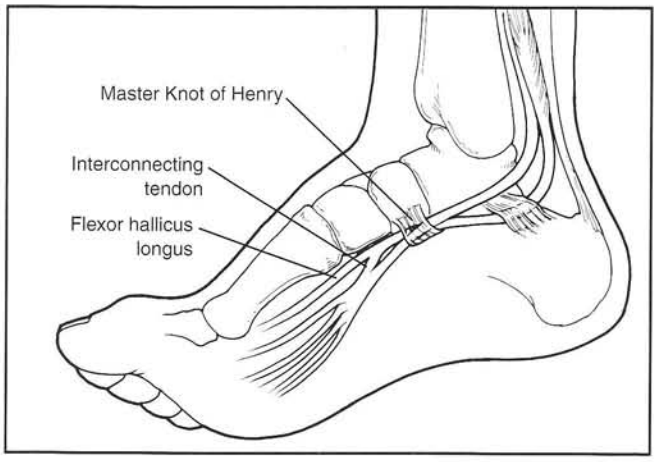

Figure 2. The FHL is connected to the FDL just distal to the Master Knot of Henry.

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