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## Endoscopic Flexor Hallucis Longus Tendon Transfer for Reconstruction of the Achilles Tendon Rupture in High-Risk Patients: A Case Series

Jake I. Lee, DPM, FACFAS

Senior Physician, Department of Orthopedic Surgery, Kaiser Foundation Hospital, Redwood City, CA



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## ABSTRACT

The neglected Achilles tendon rupture requires surgical reconstruction for the best functional outcome. According to the current literature, there are many reconstructive options available that demonstrate acceptable functional results in most cases. These procedures require large incisions, leading to potential wound-healing complications. Therefore, these procedures may not be suitable for patients who are at high risk for wound-healing problems. A minimally invasive approach is desirable in this situation to decrease the risk of this potential complication. Endoscopic transfer of the flexor hallucis longus tendon is described in this series as an alternative to reconstruct the Achilles tendon in 2 such high-risk individuals. Both patients had a successful outcome with no wound-healing problems and regained acceptable functional status.

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An acute Achilles tendon rupture is commonly misdiagnosed. For many patients, the initial symptoms after an Achilles tendon rupture diminish quickly. In a study of 57 patients with an acute Achilles tendon rupture, 19 patients reported no pain (1). Patients with a compromised Achilles tendon will not be able to stand on the toes of the affected side. However, active non-weightbearing plantarflexion may still be intact as a result of partial ruptures, recruitment of plantarflexors, and an intact plantaris muscle. The lack of pain and no obvious loss of plantarflexion can be misleading, resulting in up to 20% to 25% of cases being initially misdiagnosed (2–4). The failure to establish the diagnosis at the initial presentation is the most common reason for delayed treatment.

Neglected Achilles tendon ruptures can heal without intervention with scar tissue formation in the rupture interval. However, the resulting working length of the muscle–tendon unit may be too long even with reestablishment of the muscle–tendon continuity with scar tissue. This leads to loss of plantarflexion power, resulting in impaired gait pattern. Furthermore, in patients with diabetes, overlengthening of the Achilles may lead to chronic heel ulceration from resulting calcaneal gait in 2% to 10% of cases (5). There are many surgical reconstructive options that result in satisfactory functional outcome, such as V-to-Y lengthening, local tendon transfers, and Achilles allograft, and others. Flexor hallucis longus (FHL) tendon transfer for Achilles reconstruction, which was first described by Sig Hansen in 1991, has been well described in the literature (6,12,13,20). The FHL tendon has good

reconstructive properties anatomically and biomechanically because the tendon is in close proximity to the Achilles, making the harvest easy. The tendon and the Achilles share the same phasic movement and ankle axis of movement, aiding in restoration of the normal ankle function. The FHL is stronger than the peroneus brevis tendon and almost twice as strong as the flexor digitorum long tendon, both of which have been described in Achilles reconstruction (7–9). The effectiveness of the FHL tendon in reconstruction of the Achilles tendon neglected ruptures and chronic tendinopathy has also been shown to be effective (10–12). Further, FHL tendon transfer has been shown to be an effective reconstructive option for patients with diabetes with chronic heel ulceration from iatrogenic overlengthening of the Achilles tendon (14).

However, open procedures require a long incision and carry a higher risk for wound healing and surgical site infections, which can be problematic for patients with certain conditions such as diabetes and rheumatoid arthritis. Minimally invasive surgical reconstruction with FHL tendon may improve function in a high-risk individual with a neglected Achilles tendon rupture, who may otherwise not have been considered as a surgical candidate. The technique for endoscopic transfer of the FHL tendon is presented here, as well as 2 case reports using this technique.

### Case Series

#### Operative Technique

Patient positioning, instrumentation, and landmarks used for endoscopic FHL tendon transfer were similar to those for posterior ankle arthroscopy. The patient was placed on the table in prone position after

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Address correspondence to: Jake I. Lee, DPM, Department of Orthopedic Surgery, Kaiser Foundation Hospital, 1400 Veterans Blvd, First Floor, Redwood City, CA 94063.

E-mail address: [jake.i.lee@kp.org](mailto:jake.i.lee@kp.org)

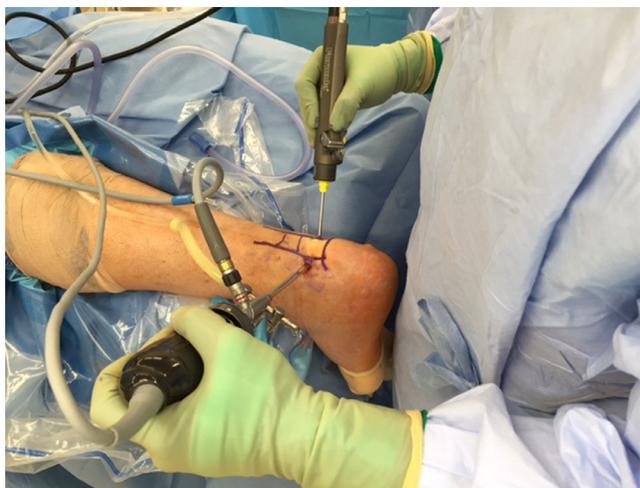
induction of general anesthesia. The patient was positioned so that the toes were hanging off the table to allow the foot to be in neutral position. A bump can be placed under the contralateral hip to help to derotate the lower body and reduce the natural external rotation of the limb. A thigh tourniquet was used for hemostasis.

An imaginary line was drawn from the tip of the fibula to the tip of the medial malleolus. The lateral and medial portals were created, respectively, immediately adjacent to the Achilles tendon. In a typical posterior ankle arthroscopy, the portals are created about 1 cm proximal to this line. However, distal placement was used for the ease of visualizing the FHL tendon and the superior surface of the calcaneus (Fig. 1). Through the lateral portal, a 4-mm scope with 30° optic was introduced. Visualization was achieved through this portal during the entire case. A shaver was inserted towards the central portion of the posterior ankle through the medial portal. This was done to protect the medial and lateral neurovascular structures. Once the shaver was visualized, debridement of the fat pad was performed to get oriented to the superior surface of the calcaneus and posterior aspect of the subtalar joint. The shaver was then moved medially, while being visualized by the scope until the FHL tendon was visualized. The correct structure was confirmed by moving the hallux intraoperatively and viewing the excursion of the tendon.

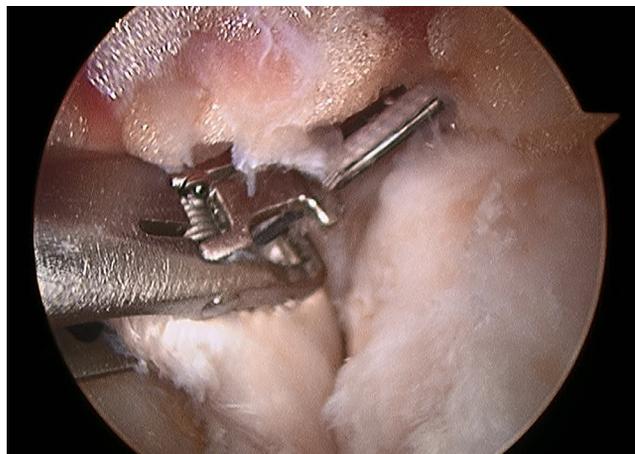
Once the tendon was visualized, the shaver was removed from the medial portal and replaced with a suture passer. To obtain the greatest length out of the FHL tendon, the foot and the hallux were maximally plantarflexed and the tendon was grabbed as distally as possible (Fig. 2). Then the passer was removed, leaving the suture tail, which was pulled through the anteromedial portal. Arthroscopy scissors were inserted through the medial portal, and the tendon was cut as distally as possible (Fig. 3). The cut end of the tendon was pulled out through the medial portal and prepared for transfer by using the whip stitch method (Fig. 4). The tendon was measured for correct sizing of the reamer.

Next, a guide wire was placed through the medial portal in an oblique fashion. The entry point of the guide wire was placed on the superior aspect of the calcaneus and as close to the Achilles tendon as possible at the midline of the tendon. The guide wire exited through the plantar-lateral aspect of the heel to avoid injuring the plantar nerves (Fig. 5). The correct placement of the guide wire was confirmed by intraoperative fluoroscopy for positioning. With the guide wire in place, the correct size reamer was inserted over the guide wire to create a tunnel.

Once the reaming was completed, the tendon was pulled through the osseous tunnel. This was achieved by using a guide wire with an eyelet. The wire was first inserted from the posteromedial portal and pushed through the osseous tunnel. Then the suture tails from the FHL



**Fig. 1.** Posterior portals placed adjacent to the medial and lateral aspect of the Achilles at level of the fibular tip.



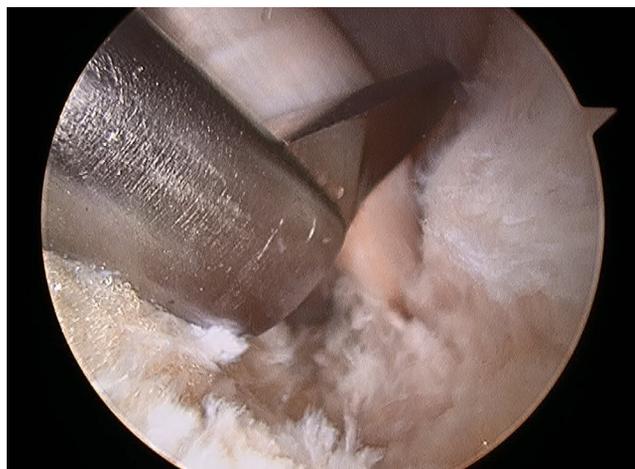
**Fig. 2.** Use of the suture passer to place a stay-suture through the flexor hallucis longus tendon.

tendon were inserted through the eyelet and the guide wire was pulled distally to pull the tendon through. This process was visualized with the scope to verify that the tendon had indeed gone through the osseous tunnel. The foot was placed in maximum plantarflexion, and the tendon was pulled through the tunnel as distally as possible (Fig. 6). Once the tendon was pulled through the tunnel, an appropriately sized interference screw was inserted through the medial portal under direct visualization and screwed into the tunnel (Fig. 7). The instruments were then removed and the portals were closed.

Postoperatively, the patient was kept non-weightbearing in a plaster splint in resting equinus position for 2 weeks. Then the patient was transitioned to a walking cast at neutral for 4 weeks. The patient then transitioned into a walking boot for an additional 2 to 3 weeks and began physical therapy.

#### Case 1

In May 2015, a 59-year-old male presented with a 3-month history of pain, swelling, and weakness to the left leg. Patient had multiple medical problems, including morbid obesity, poorly controlled type 2 diabetes with peripheral neuropathy, chronic lymphedema with history of recurrent cellulitis, and life-long anticoagulation due to factor V deficiency. Patient did not recall a specific injury and initially was treated in



**Fig. 3.** Use of arthroscopy scissors to cut the flexor hallucis longus tendon as distally as possible.



**Fig. 4.** Preparing the cut end of the flexor hallucis longus tendon with a whip-stitch method.

a walking boot in the primary care setting. On examination, the left lower extremity was diffusely edematous. Muscle-strength testing revealed a decreased ability to plantarflex against resistance. Patient was not able to perform a single heel raise on the left leg and had a positive Thompson test result. Plain radiographs were negative for acute fracture. Magnetic resonance imaging (MRI) was subsequently ordered and showed a mid-substance tear of the Achilles tendon with a 5-cm gap (Fig. 8). The patient was not considered an ideal candidate for an open reconstruction of the Achilles tendon because of his medical comorbidities. However, given his relative young age, he did not wish to be bound to a brace or a walking assistive device for the rest of his life. The patient then underwent an Achilles reconstruction with endoscopic transfer of the FHL tendon. The operative limb was placed into a gravity equinus splint, and the patient was instructed to not weight bear for the first 2 weeks postoperatively. After 2 weeks, the patient was placed into a walking cast for 4 weeks, then transitioned into a walking boot for 2 weeks, and then gradually weaned off the boot and referred to physical therapy. Follow-up examination at 3 months demonstrated 5/5 manual muscle strength testing of plantarflexion of the operative foot. He was able to walk without a brace and did not require a walking aid device. Patient returned to clinic in January 2018. He continued to walk without an assistive device and demonstrated comparative plantarflexion power as the contralateral side. No compensation was seen in his gait. However, the patient reported that the top of his



**Fig. 6.** Flexor hallucis longus tendon being pulled through the osseous tunnel.

left hallux gets irritated against the shoe more easily after the surgery. On examination, his hallux was rectus on standing and weightbearing radiograph did not reveal contracture (Fig. 9).

*Case 2*

In February 2016, a 33-year-old female with a history of elective right Achilles tendon reconstruction for retrocalcaneal exostosis presented with months of weakness to the right leg. She had a history of smoking with 5 pack-year history and obesity with a body mass index of 39. The patient also reported that her immediate postoperative course from the Achilles tendon reconstruction was complicated by wound dehiscence, cellulitis, and noncompliance to immobilization. Dehiscence and cellulitis resolved with local wound care and oral antibiotic therapy. However, after the surgery, patient reported a popping sensation while walking and was unable to walk because of pain and weakness, and the symptoms persisted. Clinically, she had a palpable defect at the distal portion of the Achilles. MRI was ordered, which demonstrated detachment of the Achilles tendon from the calcaneus with proximal retraction (Fig. 10). Because of complications from the first open surgery, patient underwent an endoscopic FHL tendon transfer for reconstruction. Postoperative protocol was the same as for the first case. Follow-up examination at 4.5 months postoperatively showed that the patient was able to perform double-heel raise but unable to perform single-heel raise. The patient was able to return to work full duty and was able to walk without an assistive device or



**Fig. 5.** Guide wire placement on the superior aspect of the calcaneus.



**Fig. 7.** Interference screw placement.

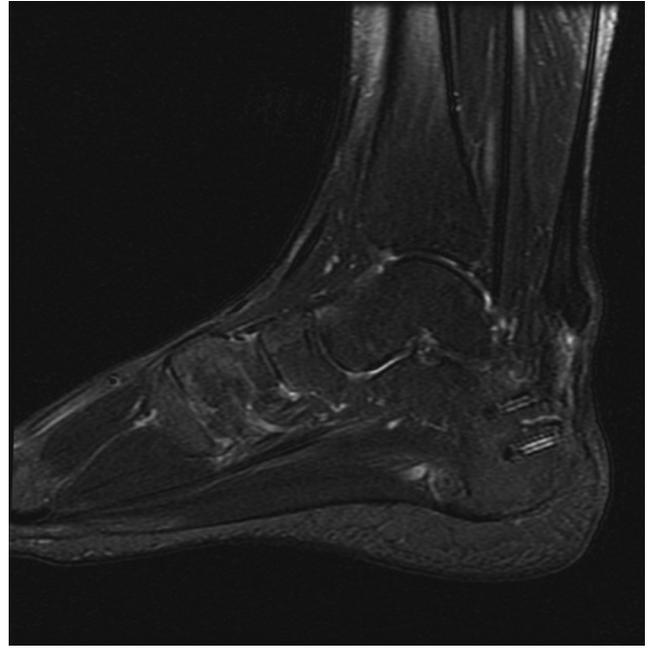


**Fig. 8.** Preoperative sagittal magnetic resonance image demonstrating a chronic mid-substance rupture of the Achilles tendon with an approximately 5-cm gap (case 1).

bracing. She returned for follow-up in October 2016 and continued to function well but complained of plantar heel pain. Examination showed 5/5 plantarflexion manual muscle strength and tenderness to palpation at the medial heel. She was diagnosed with plantar fasciitis and treated with stretching and rigid inserts. Because the patient lost insurance coverage, she was not able to return for further follow-up.

## Discussion

In 1993, Wapner et al (13) published the first case series in FHL tendon transfer for chronic Achilles tendon rupture. They showed that FHL tendon transfer resulted in good to excellent results although some loss of plantarflexory power was observed. Since then, FHL tendon transfer has been well described in the literature as an effective reconstructive option for chronic Achilles tendon rupture, as well as chronic Achilles tendinopathy (9,11,19,21). Potential wound complications remain a concern for open Achilles tendon repairs. Wound complications have



**Fig. 10.** Preoperative sagittal magnetic resonance image showing detachment of the Achilles tendon with proximal retraction and changes in the calcaneus from the previous surgery (case 2).

been shown to occur in 10.4% of such cases, and this rate can be as high as 42.1% in patients with risk factors such as diabetes, chronic steroid use, and tobacco use (22). Furthermore, wound complications or surgical site infection have been seen in up to 17% of patients who underwent an open FHL tendon transfer (23). Using the endoscopic approach would lower these potential wound complications, thereby providing a safer option for patients with risk factors.

Posterior arthroscopy or endoscopy has been used for various pathologies, such as os trigonum syndrome, posterior ankle impingement, and posterior talar osteochondral defect. Endoscopic approaches have been shown to have less postoperative pain, a lower complication rate, and a faster return to activity compared to traditional open approaches (16–18). A systemic review of posterior endoscopic approach for hindfoot and ankle pathologies has demonstrated a low complication rate (15). Although the endoscopic approach of the posterior ankle has been shown to be safe, the surgeon should be aware of potential complications of the procedure. The mean distance of the



**Fig. 9.** Postoperative lateral radiograph showing a plantigrade hallux without dorsal contracture (case 1).

neurovascular bundle from the FHL tendon (as it enters the fibro-osseous tunnel) is 0.9 mm, and care should be taken when harvesting the FHL tendon to avoid injuring the neurovascular bundle (24). The creation of the osseous tunnel in the calcaneus can be another source of complication as improper placement can fracture the wall. Although there is no clear guideline as to the placement of the tunnel, it has been shown that the more posterior the placement, the greater is the plantarflexory power (25). Also, the tunnel should be placed centrally in the calcaneus and in an oblique angle to avoid fracturing the wall of the calcaneus during the tendon screwing portion and to avoid plantar nerve structures, respectively. This can be achieved by using a Kirschner wire as a guide and using intraoperative fluoroscopy.

Once the FHL tendon has been used to reconstruct the Achilles, loss in plantarflexory power of the hallux can be observed. However, the loss of flexion power may not have a clinical implication. In 2009, Richardson observed 22 patients for an average of 28 months after FHL tendon transfer. He measured FHL flexion power by studying the plantar pressure at the distal pulp of the hallux. He also had patients fill out American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal and interphalangeal joint scores. He found that some decrease at the distal pulp was seen but there was no significant difference in the plantar pressure of the first and second metatarsal heads. American Orthopaedic Foot and Ankle Society scores were high. Therefore, he concluded that although there was measurable loss of hallux flexion power, there was no subjective functional difference (26). However, it is unknown whether the decrease in hallux plantarflexion power after FHL tendon transfer would have a greater impact in younger, more active populations. Also, in the first case of this series, the patient complained of dorsal hallux irritation. Although clinical examination did not show dorsal contracture on static exam, it is possible that dynamically, the extensor tendon may be acting unopposed and causing dorsal irritation by hyperextending the hallux. It is unclear whether this is a true phenomenon or an isolated issue.\*

In conclusion, this case series demonstrates a technique for reconstruction of the Achilles tendon rupture in a minimally invasive endoscopic fashion to transfer the FHL tendon. Although it is limited to 2 cases, this report shows functionally acceptable outcome in both patients with no major postoperative complications. Thus, an endoscopic reconstruction can be considered in patients who are at risk for surgical site complications.

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