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CASE REPORT

Revision Achilles Reconstruction with Hamstring Autograft and FHL Tendon Transfer in an Athlete

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Introduction

Achilles tendon injuries are very common, with a reported incidence of 18 ruptures per every 100,000 people [5, 9]. While there is evidence supporting both operative and non-operative management for acute ruptures, current evidence supports operative repair as the best treatment option in young, active people, hoping to return to an active lifestyle [6]. The most common complications reported following operative treatment include re-ruptures, wound breakdown, and deep infection [4]. Among the literature, the rates of re-rupture are reported to be between 2 and 8% of patients treated operatively for Achilles ruptures [1, 6, 12, 15]. In cases of re-rupture, infection of the tissue can be present as an underlying cause that either contributed to, or caused the failure of the initial operation [7]. In one report, a 20% incidence of complications following primary Achilles repair is reported, with the majority of these complications related to wound healing [5]. Pajala et al. retrospectively reviewed 409 patients treated in one facility for primary repair of a ruptured Achilles and found that there was a 2.2% incidence of deep infection [12].

When considering revision surgery following a re-ruptured Achilles tendon, there are many possible options, including: a V-Y tendon flap, augmentation with the peroneus longus, peroneus brevis, flexor digitorum longus (FDL), flexor halluces longus (FHL), gracillis, plantaris, fascia lata, allografts, and synthetic grafts [1]. When considering these options, one must also be mindful of the associated morbidity of transferring these tendons which have important functions in normal foot and ankle mechanics. The Achilles tendon has a naturally low blood supply and thus when deciding between options during a revision procedure, one must consider how the blood supply of the grafted tendon will be [1]. If using a donor tendon, it is important to choose a tendon that is in phase with the ruptured tendon, that will involve little morbidity from the transfer, and that is strong enough to do the work that will be required of it [10]. The FHL has had successful reported clinical results and is the current gold standard. It is a biologically intact tendon that is a strong plantarflexor, has a muscle belly that extends distally into the avascular zone of the Achilles (which leads to an increased blood supply to the repaired Achilles), and does not disrupt the normal muscle balance of the ankle [7, 9].

Though the FHL has been reported most successfully for chronic Achilles reconstruction, several recent reports exist that discuss the potential benefit of using a semitendinosus autograft, in isolation, to reconstruct chronic Achilles ruptures [3, 4, 8, 11]. Furthermore, two previous reports, both by Piontek et al., present two different techniques to reconstruct the Achilles tendon using both a semitendinosus and gracilis autograft [13, 14]. These authors advocate the use of a hamstring autograft due to the weakening of the foot and decrease in hallux flexion strength that is associated with FHL tendon transfers [3, 4, 8, 11, 13].

We report a case of a re-rupture with an infection of the Achilles tendon treated with a combination reconstruction using gracilis and semitendinosus transfer and augmented with an FHL transfer. We believe that this is the first report of a case of this nature.

Work performed at Hospital for Special Surgery.

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Case Report

We present a 29-year-old female complaining of a history of left Achilles pain, lasting two and a half years. This patient was a professional triple jumper. She initially injured her ankle while running. After the initial injury, she had surgery at an outside hospital. She did report wound complication, but the wound eventually healed with local treatment. The patient never returned to sports and had persistent pain. On physical exam, she was unable to walk on her toes, but could heel walk without any difficulty. The patient had 4/5 plantarflexion strength and 25° more passive dorsiflexion on the affected side. She obtained an MRI, which showed increased signal in the Achilles, indicating partial tears and tendinosis, but no evidence of abscess or collection (Fig. 1). Due to the duration of presentation to injury, MRI findings, age, request of patient to return to sports, and exhaustion of conservative measures, including use of heel lifts and PT, we recommended surgical management. Because of the previous wound complication, the possibility of a staged procedure was discussed with the patient if intra-operative findings had necessitated it. An allograft was not considered due to increased risk of an immune response or further infection.

Operative Technique

The goal of surgery was to restore the resting tension in the Achilles and to allow the patient to regain as much strength as possible. The decision was made to use both the gracilis and semitendinosus for an autograft as well as FHL for augmentation. In acute cases with tendinopothy present, solely hamstring tendons may be used for an autograft as there is usually good strength in the gastroc and the soleus and limited atrophy. Due to the chronicity of this case, and the increased muscle atrophy in the patient, the decision to also augment the Achilles with the FHL was made in order maximize strength and function in the patient.

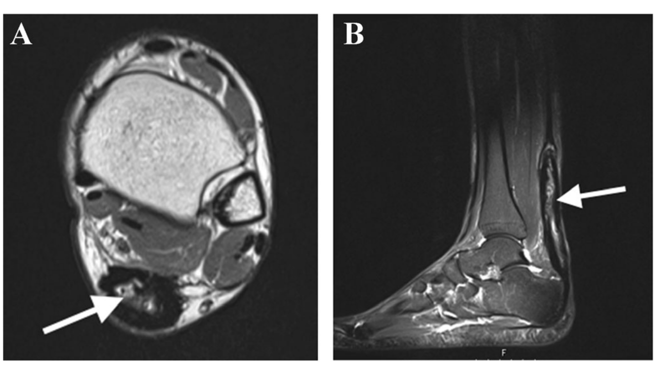

Fig. 1. MRI of patient obtained prior to surgery. No Gadolinium contrast was used. **a** Axial proton density image of ankle showing high signal in Achilles (arrow) indicative of degeneration and poor quality tissue. **b** Sagittal fat-suppressed, proton density image of Achilles indicating an approximately 10 cm area of poor remodeling (arrow) extending up to the musculotendinous junction.

Both the gracilis and semitendinosus tendons were harvested as well as FHL. The hamstrings were harvested through an anterior approach to the proximal tibia at their insertion. This was performed by flexing the knee while the patient was in a prone position (Fig. 2). The Achilles was approached with a posterior incision that was made over the patient's prior incision. The Achilles tendon appeared to be quite thick and had an area of out-pouching that appeared to be bursa and tissue. The decision was made that this tissue was dysfunctional, and a 12 cm section of the Achilles was removed in its entirety. At this point, 2.5 cm of the distal Achilles stump remained. When cut out, this tissue quality was poor with high suspicion for infection (Fig. 3).

Next, the decision was made to perform an FHL tendon transfer, in order to improve strength in the reconstructed tendon, with a posterior approach. The fascia over the FHL was incised, and the tendon was mobilized. The FHL was harvested from the tarsal tunnel with approximately 4 cm of tendon. After the FHL was mobilized, we proceeded to reconstruct the tendon with the hamstring autograft. The gracilis and semitendinosus were combined and tubularized to create a 6 mm diameter by 25 cm length graft composed of both tendons. We placed a 6-mm-drill hole in the calcaneus, just anterior to the Achilles tendon, and pulled our graft through, securing it with a 5 × 15 mm interference screw. The tubularized graft was then tunneled up to the proximal gastrocsoleus Achilles complex and, using a Pulvertaft maneuver, it was woven in and out of this area. It was secured and then tensioned in about 10° to 15° of plantarflexion. It was secured in place with #2 OrthoCord stitch in a figure eight type fashion. Once again, the graft was tunneled back down distally to create a

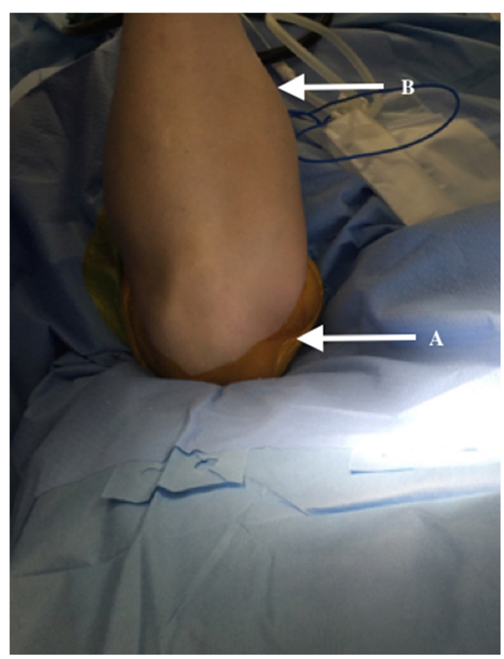

Fig. 2. An incision was made between the tibial tubercle and the posteromedial border of the tibia. The proximal (**a**) and distal (**b**) sides are labeled.

Fig. 3. The patient's Achilles tendon shows high suspicion for infection (arrow).

quadruple bundle type repair (two tendons in the graft now doubled over on each other) further tensioning the graft. We then turned our attention back to the FHL. The FHL was then put through the distal Achilles tendon stump. It was weaved through the Achilles and then was sutured to the other limb of the hamstring tendon. It was tensioned with 10° to 15° of ankle plantarflexion and was secured down with multiple 2–0 orthocord sutures (Fig. 4). This eliminated the Thompson test and provided good tension on the Achilles. In order to determine the correct tension, we compared it to the resting tension on the contralateral side to ensure it was symmetric. This comparison was done pre-operatively, prior to prepping and draping the patient, at which time we determined that the patient had 10° of resting plantarflexion and was able to dorsiflex to neutral on the opposite side. Following repair, the passive dorsiflexion was 15° and also symmetric bilaterally. The patient was placed in a non-weight-bearing splint.

The patient's tissues were sent off as cultures following thorough debridement and were positive for *Staphylococcus epidermidis*. A staged reconstruction was not necessary as the infection was contained within the tissue and the patient was young, healthy, and had no other comorbidities. We followed the infection closely and consulted an Infectious Disease specialist regarding post-operative treatment. Routine clinical follow-up was recommended, and reimaging was only considered necessary if the patient developed clinical symptoms. The patient was placed on oral Keflex for 6 weeks. At 7 weeks post-operatively, the patient's incision presented as healing well and there was no evidence of infection.

The patient was placed in a controlled ankle movement (CAM) walker boot at 4 weeks post-operatively and was allowed to partially weight bear (50 lbs.). She was instructed to use a heel lift in the boot for the 2 weeks and then to remove the heel lift and use the boot alone. She could plantarflex and dorsiflex to neutral without any resistance at this point. She progressed to full weight bearing in the CAM boot at 7 weeks post-operatively. The patient began to transition into a sneaker at 3 months post-operatively. The patient was able to return to running at 6 months and volleyball at 8 months post-operatively. Although she did not return to professional triple jumping, she did return to play competitive beach volleyball.

The patient returned at 28 months post-operatively for Achilles strength testing, using a Biodex Dynamometer (Shirley, NY). Her peak torque as a percentage of her non-operative leg was recorded for both plantarflexion and dorsiflexion at 60°/s as well as 120°/s. At 60°/s, her peak torque in plantarflexion was 4.7% higher on her

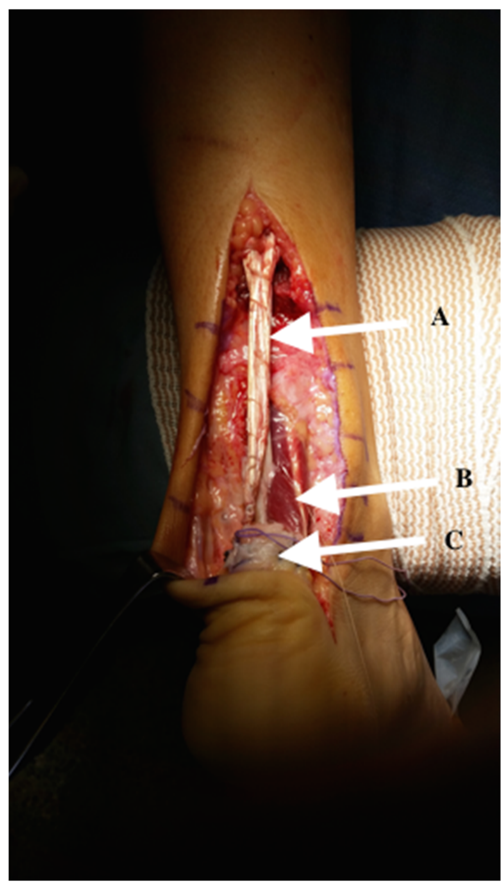

Fig. 4. The reconstructed Achilles tendon showing hamstring graft (**a**), the FHL transfer (**b**), and Achilles tendon stump (**c**). Two weaves were placed through the proximal tissue since there was still some better quality tendon available.

operative side than non-operative side and 16.5% higher on her operative side as compared to her non-operative side for dorsiflexion. She showed slight deficits at 120 degrees per second, with a 14.9% deficit in plantarflexion and a 10.2% deficit in dorsiflexion on her operative side, as compared to her non-operative side.

Discussion

One serious complication of primary repairs of ruptured Achilles tendons are re-ruptures. The lack of blood supply and dependent location make clearing an infection often difficult. When there is an infection following primary repair, it can increase the chance of a re-rupture and can also make revision surgery much more difficult as it can necessitate the removal of a significant portion or the entire tendon [12]. This often leads to a worse clinical state than if a patient had been treated non-operatively [1, 7]. In young people, this can be a devastating injury and thorough reconstruction is necessary to help the patient return to sports and activities.

Historically, a number of different foot and ankle tendons have been used to repair re-ruptured Achilles', and the FHL has shown to be the most successful [10]. Flexor hallucis longus tendon transfer is the recommended gold standard repair because it is in phase with the Achilles tendon, it hypertrophies, and because of its proximity to the Achilles. Flexor hallucis longus muscle belly, however, is much smaller than the gastroc and the soleus, which has implications in terms of the ultimate power patients can get after this procedure [10]. Some authors have advocated using a long FHL tendon graft which would require dissection into the foot and increased morbidity [10]. Lack of toe plantarflexion strength is important in many athletes' function, including sprinters. This can sometimes be minimized by harvesting the FHL tendon from the back and by leaving the connections between the FHL and FDL tendons at the knot of henry intact, which may minimize strength deficits of the great toe [7]. In addition, while FHL transfers may allow patients to have good function in their activities of daily living and potentially even walk on their toes, there is a paucity of evidence to demonstrate how it may allow a young active athlete with this condition to return to an activity level close to that prior to their injury. In this case, we did not believe that FHL in isolation would provide our patient similar strength post-operatively as compared to her strength pre-operatively and thus we decided to do a combination reconstruction, with both an FHL tendon transfer as well as a hamstring autograft.

We believe that using the hamstring tendons helps alleviate the morbidity of primarily using a foot tendon, while allowing a more anatomical reconstruction of the Achilles tendon. This transfer of force from the gastrocsoleus complex to the calcaneus more recreates the anatomic Achilles than a standard FHL tendon alone would provide. Furthermore, there are multiple studies in the knee espousing the minimal morbidity of harvesting gracilis and semitendinosus. In a study we recently conducted regarding the use of hamstring autografts in the foot and ankle, we found that hamstring harvest led to minimal donor site morbidity affecting hamstring strength, with the exception of slightly lower peak knee flexion torque strength at higher degrees of flexion (70° and 90°) in comparison to the non-operated side [2, 16]. Due to the patient's shortened and atrophied calf muscle, we used a hamstring graft to bridge the defect and reconstruct the Achilles tendon with augmentation from an FHL transfer to provide the patient more strength than either an FHL transfer or hamstring graft in isolation. This added strength allowed her to return to sports at a high level. Additionally, as shown by her 28-month post-operative strength testing data, she recovered full plantarflexion and dorsiflexion strength at 60°/s and only had slight deficits (<15%) in plantarflexion and dorsiflexion at 120°/s.

Further study is needed to look at the use of hamstring tendons for reconstructive Achilles tendon surgery as well as augmentation in revision cases. We believe using a hamstring autograft has many advantages including using native autograft tissue instead of other tendon transfers or allograft in this high risk area. Additionally, using the hamstring tendons provides a strong and healthy replacement tendon and allows for added strength through quadruple-bundling and approaching the native Achilles tendon girth.

Compliance with Ethical Standards

Conflict of Interest: Sydney C. Karnovsky, BA has declared that she has no conflicts of interest. Mark C. Drakos, MD reports other from Fast Form and Extremity Medical, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was obtained from the patient for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

References

1. Chan JY, Elliott a. J, Ellis SJ. Reconstruction of Achilles Rerupture With Peroneus Longus Tendon Transfer. *Foot Ankle Int*. 2013;34(6):898–903. doi:10.1177/1071100712473273.
2. Cody EA, Karnovsky SC, DeSandis B, Tychanski A, Deland JT, Drakos MC. Hamstring Autograft for Foot and Ankle Applications. E-Poster accepted for presentation at the American Orthopaedic Foot & Ankle Society Annual Meeting, July 12–15, 2017, Seattle WA.
3. Dumbre PSS, Dumbre PVS, Basa VR, Dombale AV. Semitendinosus Tendon Autograft for Reconstruction of Large Deficits in Chronic Achilles Tendon Ruptures. *Foot Ankle Int.* 2014;35(7):699–705. Doi:10.1177/1071100714531228
4. Ellison P, Mason LW, Molloy A. Chronic Achilles tendon rupture reconstructed using hamstring tendon autograft. *The Foot.* 2016;26:41–44.

5. Feibel JB, Bernacki BL. A review of salvage procedures after failed achilles tendon repair. *Foot Ankle Clin*. 2003;8(1):105–114. doi:10.1016/S1083-7515(03)00005-6.
6. García-Germán D, Rubio-Quevedo R, Lopez-Goenaga J, Martin-Guinea J. Achilles tendon recurrent rupture following surgical repair: Report on two cases. *Foot Ankle Surg*. 2009;15(3):152–154. doi:10.1016/j.fas.2008.09.001.
7. Gonçalves S, Caetano R, Corte-Real N. Salvage Flexor Hallucis Longus Transfer for a Failed Achilles Repair: Endoscopic Technique. *Arthrosc Tech*. 2015;4(5):e411-e416. doi:10.1016/j.eats.2015.03.017.
8. Ji JH, Kim WY, Kim YY, Lee YS, Yoon JS. Semitendinosus Tendon Augmentation for a Large Defect after Achilles Tendon Rupture: Two Case Reports. *Foot Ankle Int.* 2007;28(10):1100–1103.
9. Krahe MA, Berlet GC. Achilles Tendon Ruptures, Re Rupture with Revision Surgery, Tendinosis, and Insertional Disease. *Foot Ankle Clin*. 2009;14(2):247–275. doi:10.1016/j.fcl.2009.04.003.
10. Lin JL. Tendon Transfers for Achilles Reconstruction. *Foot Ankle Clin*. 2009;14(4):729–744. doi:10.1016/j.fcl.2009.08.007.
11. Maffulli N, Longo UG, Gougoulias N, Denaro V. Ipsilateral free semitendinosus tendon graft transfer for reconstruction of chronic tears of the Achilles tendon. *BMC Musculoskelet Disord.* 2008;9(1):100.
12. Pajala A, Kangas J, Ohtonen P, Leppilahti J. Rerupture and deep infection following treatment of total Achilles tendon rupture. *J Bone Jt Surg*. 2002;84-A(11):2016–2021.
13. Piontek T, Bąkowski P, Ciemniewska-Gorzela K, Grygorowicz M. Minimally invasive, endoscopic Achilles tendon reconstruction using semitendinosus and gracilis tendons with Endobutton stabilization. *BMC Musculoskelet Disord.* 2016;17(1):1–8.
14. Piontek T, Bakowski P, Ciemniewska-Gorzela K, Naczk J. Novel Technique of Achilles Tendon Reconstruction Using Semitendinosus and Gracilis Tendon. Preliminary Report. *Ortopdeia Traumatol Rehabil.* 2015;17(6):619–25.
15. Rettig AC. Potential Risk of Rerupture in Primary Achilles Tendon Repair in Athletes Younger Than 30 Years of Age. *Am J Sports Med*. 2005;33(1):119–123. doi:10.1177/0363546504268720.
16. Yasuda K, Tsujino J, Ohkoshi Y, Tanabe Y, Kaneda K. Graft site morbidity with autogenous semitendinosus and gracilis tendons. *Am J Sports Med*. 1995;23(6):706–714. doi:10.1177/036354659502300613.