Technical Note

Achilles Tendon Rip-Stop SpeedBridge Repair

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Abstract: Achilles tendon injuries have been on the rise secondary to our increased participation in sports, increase in societal obesity rates, and the growing elderly population. There has been disagreement in recent years about whether to treat injuries such as Achilles tendon ruptures operatively or nonoperatively with aggressive functional rehabilitation. For those opting to surgically manage Achilles tendon ruptures, insertional Achilles tendonitis, or augment the described SpeedBridge Achilles tendon repair, we propose a modified rip-stop technique. The goal of this technique is to provide a biomechanical advantage to our current operative interventions for these injuries, a greater load-to-failure and a speedier, more reliable return to sport in our athletic populations.

The Achilles tendon complex is created by the soleus, medial, and lateral gastrocnemius muscles, which combine to form the largest and strongest tendon in the body.[1] Achilles tendon ruptures and Achilles tendinopathy make up 2 of the most common traumatic and overuse injuries, respectively, in the athletic population.[2,3] It is thought that Achilles tendon ruptures account for approximately 20% of all large tendon ruptures, and Achilles tendinopathy was found to be present in 9% of recreational runners and in 5.6% of nonathletes.[3,4] There currently exist both operative and nonoperative management strategies for both of these pathologies with the end goal of pain reduction and functional improvement. For patients electing to undergo operative intervention, we present an augmentation technique that may be performed with distal Achilles tendon ruptures, insertional Achilles tendinitis, Achilles tendon repair status post-Haglund resection, and as an augment to the SpeedBridge Achilles tendon repair technique.[5] We propose a modified Achilles rip-stop technique that incorporates the use of FiberWire stay sutures into an Achilles tendon repair to provide a further point of fixation and an additional barrier to failure.

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Surgical Technique (With Video Illustration)

Indications

This technique is to be performed for distal Achilles tendon rupture, insertional Achilles tendonitis, Achilles tendon repair status post-Haglund resection, and as an augment to the previously described SpeedBridge Achilles tendon repair technique.

Materials

Materials for performing an Achilles tendon rip-stop SpeedBridge repair include intraoperative fluoroscopy and the Arthrex Achilles SpeedBridge (Naples, FL) implant system, which includes a 3.5-mm drill bit, drill guide, tap with AO quick connect, tap with handle, two 4.75-mm SwiveLock anchors with #2 FiberWire suture and FiberTape loop with needle, and 2 additional 4.75-mm SwiveLock anchors with #2 FiberWire suture.

Patient Positioning

The patient is positioned prone on the operating table. Ensure all bony prominences are well padded. A tourniquet is placed on the thigh of the operative side and inflated to 300 mm Hg. The leg is prepped and draped in sterile fashion.

Incision and Approach

The posteromedial skin incision has been previously described, as has the use of the Arthrex Achilles

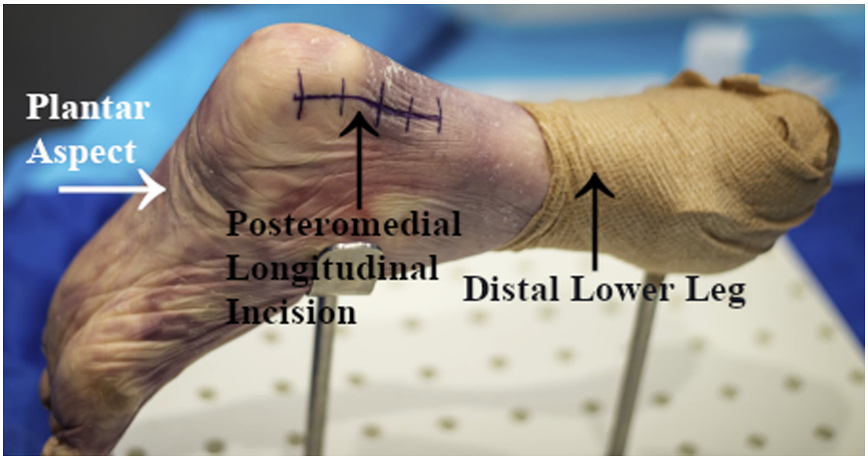

Fig 1. Cadaveric image of left foot and ankle from a medial viewpoint. A posteromedial longitudinal incision is made along the posterior calcaneal tuberosity and Achilles tendon insertion.

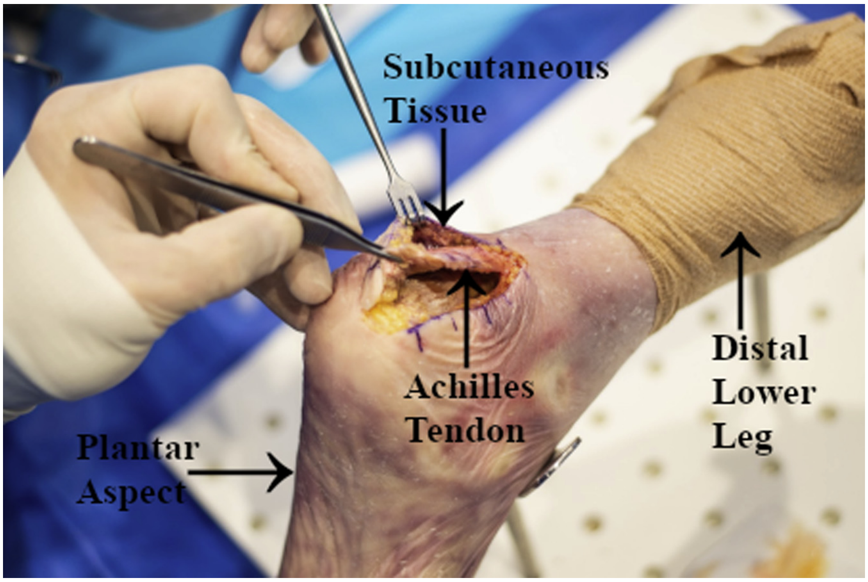

Fig 2. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. The subcutaneous tissue and a portion of the paratenon are carefully dissected off of the Achilles tendon to expose the entirety of the Achilles tendon.

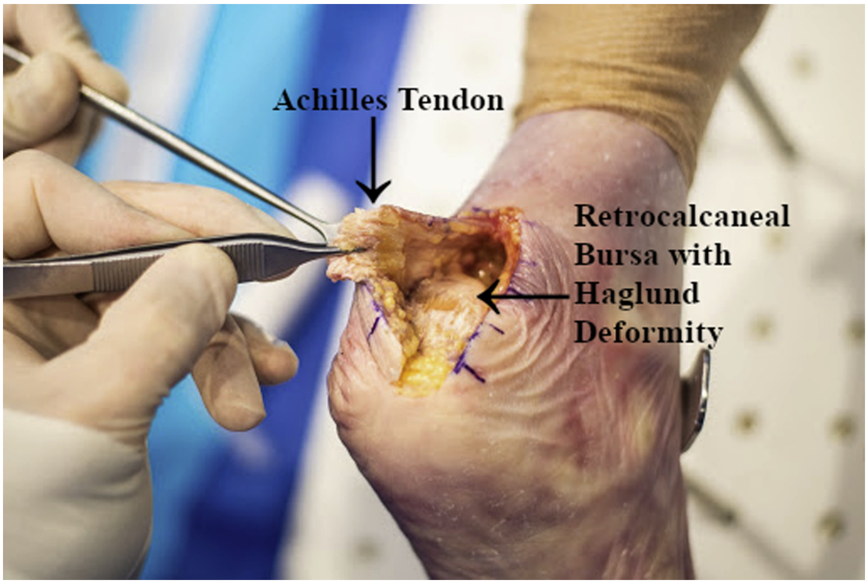

Fig 3. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. The distal attachment of the Achilles tendon is reflected off to expose the retrocalcaneal bursa.

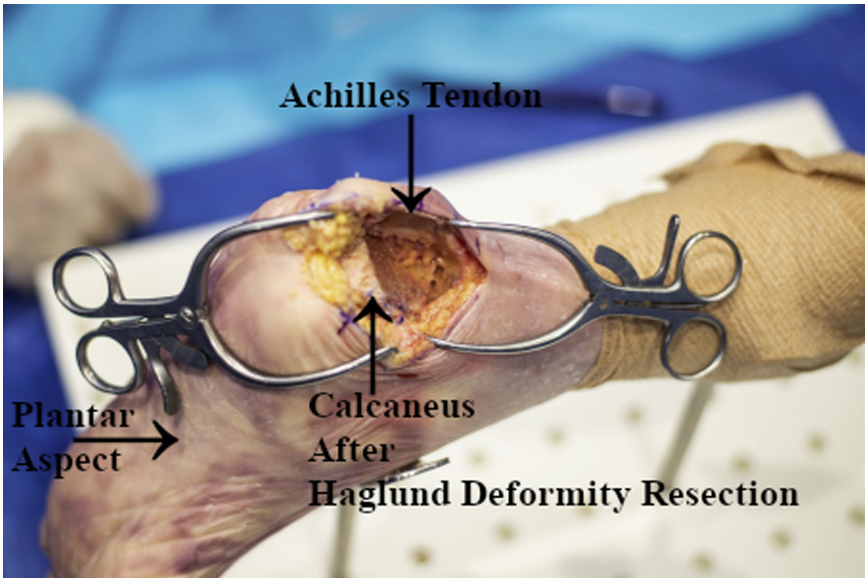

Fig 4. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. The Haglund deformity along the posterior calcaneal tuberosity is exposed and resected immediately distal to the spur and anterior to the Haglund using a microsagittal saw and osteotome.

SpeedBridge technique. We will describe the steps briefly to elaborate on some modifications that have not been previously described elsewhere. A posteromedial longitudinal incision is made along the posterior calcaneal tuberosity and Achilles tendon insertion (Fig 1). Dissection is further carried down to the medial border of the Achilles tendon. The subcutaneous tissue and a portion of the paratenon are carefully dissected from the Achilles tendon, exposing the entirety of the Achilles tendon. The subcutaneous tissue flap may be retracted laterally using a skin rake (Fig 2). At this time, all tendinopathic tissue and thickened paratenon is debrided with a fresh 10-blade. Next, the distal attachment of the Achilles tendon is reflected from the posterior calcaneal tuberosity. A baby Hohmann retractor may be placed along the mid-distal medial border of the Achilles tendon to elevate the tendon. The Achilles tendon is reflected from the posterior calcaneal tuberosity with a fresh 10-blade in a medial to lateral direction. Once the distal attachment of the Achilles tendon is reflected off, the retrocalcaneal bursa is encountered (Fig 3). This bursal tissue is sharply excised. Excision of the retrocalcaneal bursa serves 2 advantages: it reduces pain, as the retrocalcaneal bursa can be a pain generator, and creates an increased exposure to the Haglund deformity.

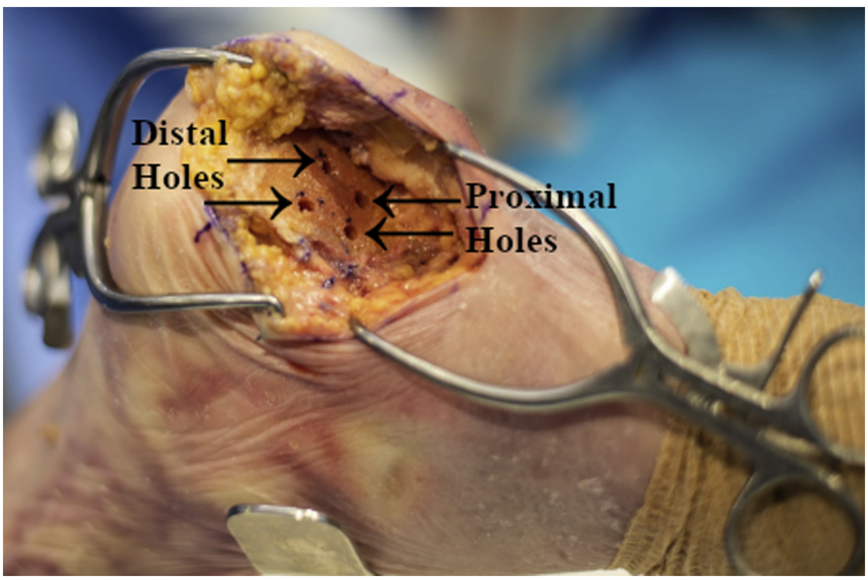

Fig 5. Cadaveric image of left foot and ankle from a posteromedial viewpoint. Two distal holes are drilled with a 3.5-mm drill distally to the previously removed spur. Two proximal holes are then drilled approximately 10 to 15 mm proximal to the distal holes.

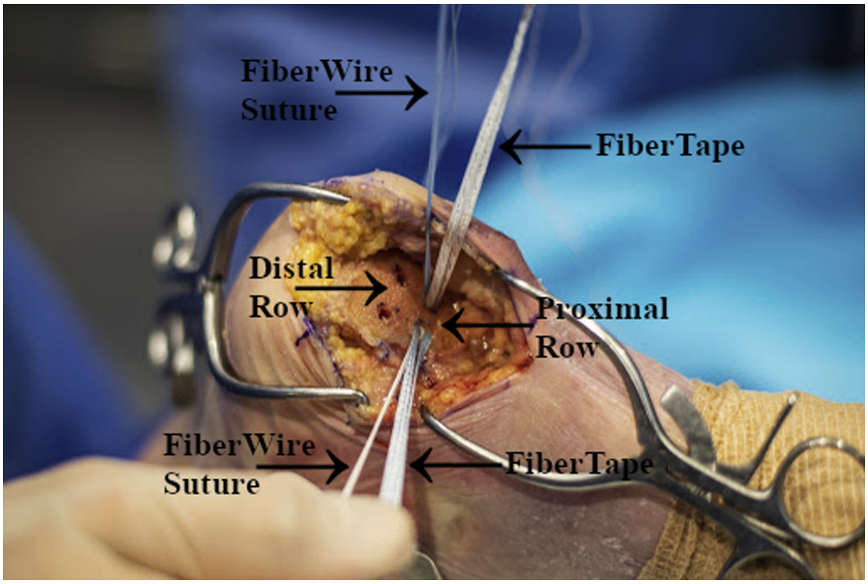

Fig 6. Cadaveric image of left foot and ankle from a posteromedial viewpoint. Two 4.75-mm SwiveLock anchors loaded with FiberWire suture and FiberTape are inserted into the proximally drilled holes.

Resection of the Haglund Deformity

At this juncture, the Haglund deformity along the posterior calcaneal tuberosity is exposed. The Haglund deformity is resected immediately distal to the spur and anterior to the Haglund using a microsagittal saw and osteotome (Fig 4). The Haglund deformity is resected in the medial-to-lateral direction. The resection is made perpendicularly to the longitudinal axis of the deformity. Medially, the neurovascular bundle is approximately 22 mm from the insertion of the Achilles tendon.[6] Laterally, care is taken to avoid injury to the dorsal cutaneous branch of the sural nerve. Following decompression of the deformity, this is confirmed with a lateral radiograph of the calcaneus. Next, the medial and lateral sides of the calcaneus are chamfered off to ensure no sharp bony prominences are palpable under the skin as these can create difficulties with shoe wear.

Table 1. Advantages and Disadvantages

Advantages
Potentially a biomechanically stronger construct that may account for improved load to failure, especially in cases in which the distal insertional fibers of the Achilles tendon are diseased
Maintaining tension on the repair may result in improved push-off strength
Potentially increases bone-to-tendon apposition, which would allow for increased tendon-to-bone healing
Disadvantages
Rip-stop suture configuration may add surgical time to the procedure
Increased risk of foreign body reactions due to double-row suture anchor constructs
Increased risk for wound complications due to open incision
Greater rates of failure may occur due to overtensioning of tissue

Achilles Tendon Reconstruction

The reconstruction of the Achilles tendon is carried out by first drilling 4 holes within the Achilles tendon footprint in a square fashion (Fig 5). We start by creating the distal row of the double-row technique. With a 3.5-mm drill, 2 distal holes are drilled distally to the previously removed spur. Next, 2 proximal holes are drilled approximately 10 to 15 mm proximal to the distal holes (reflecting the Achilles tendon footprint) with the 3.5-mm drill. Subsequently, all 4 holes are tapped using the Arthrex 4.75-mm SwiveLock tap. Next, the two 4.75-mm SwiveLock anchors loaded with FiberWire suture and FiberTape, one blue and the other white/black, are inserted into the proximally drilled holes (Fig 6). The eyelet is inserted into the drill hole until the anchor body makes contact with the bone. The driver handle is rotated in a clockwise direction until the anchor body is flush against the bone. Each SwiveLock anchor has 2 limbs of FiberWire stay sutures, one blue and the other white, and 2 limbs of FiberTape, one blue and the other white/black. An Allis clamp is applied to the distal end of the Achilles tendon to apply tension (Table 1). After adequate tension is applied to the distal end of the Achilles tendon, a free needle is used to pass one limb of the FiberWire stay suture from each of the proximal SwiveLock anchors into the most proximal aspect of the repair. These stay sutures serve as provisional fixation of the Achilles tendon. These stay sutures are not tied initially but are the first step in passing the sutures (Fig 7).

Next, we pass the FiberTape from each anchor through the Achilles tendon approximately 15 mm from its insertion site; just distal to the where the provisional sutures were passed in the previous step. At this juncture, all

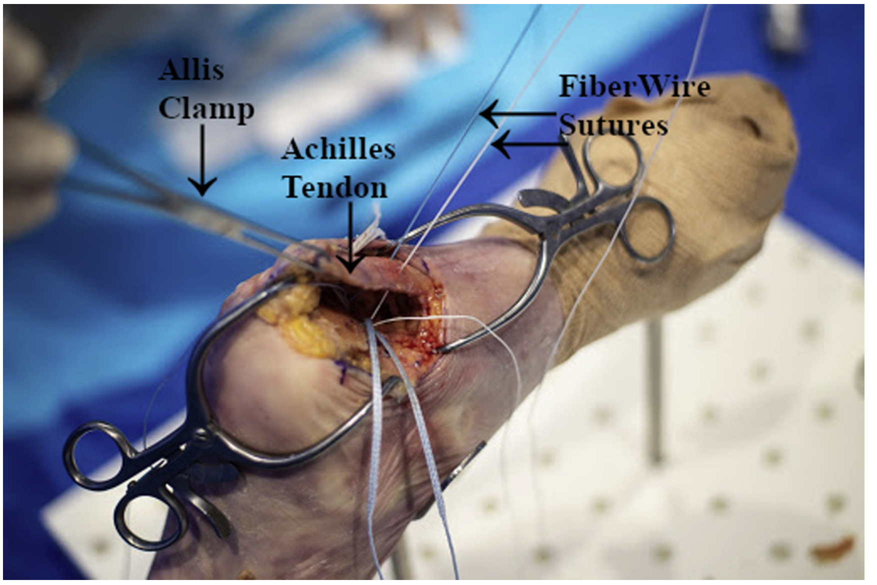

Fig 7. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. Following adequate applied tension to the distal end of the Achilles tendon, a free needle is used to pass one limb of the FiberWire stay suture from each of the proximal SwiveLock anchors into the most proximal aspect of the repair.

limbs except one limb of FiberWire stay suture from each anchor should be passed through the tendon (Fig 8). Next, one limb of the FiberWire stay suture from the medial anchor is loaded onto a free needle and passed perpendicularly to the tendon just distal to where the FiberTape was previously passed (Table 2). This is the first limb of the rip-stop suture in our reconstruction. This step is repeated in the opposite fashion with the remaining FiberWire stay suture from the lateral anchor. At this juncture, all suture limbs have been passed through the Achilles tendon in preparation of tying the initial FiberWire stay sutures that were previously placed. Adequate tension is placed on the distal end of the Achilles tendon via the Allis clamp and the initial FiberWire stay sutures are tied over the top of the tendon along the most proximal aspect of the repair. This step allows a close apposition of the Achilles tendon over the bone and prevents liftoff of the footprint (Video 1). The operative foot is held in plantarflexion. Next, one limb from each of the FiberTape ends is crossed to make an "X" configuration overlying the Achilles tendon (Fig 9). The FiberWire limbs of the rip-stop sutures are not crossed; however, each limb is incorporated into the final repair in a subsequent step. The 2 FiberTape limbs, one from each side (one blue and one white/black), along with the rip-stop suture limb is loaded through the distal SwiveLock anchor eyelet. The tension of the

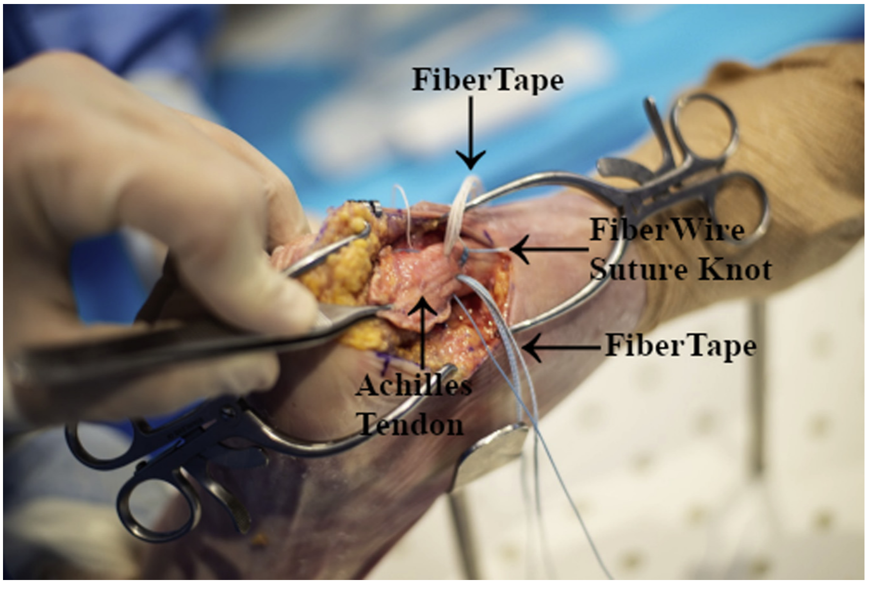

Fig 8. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. FiberTape from each anchor through the Achilles tendon is passed approximately 15 mm from its insertion site. All limbs except one limb of FiberWire stay suture from each anchor should be passed through the tendon at this point.

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Take care to elevate subperiosteally the most distal aspect of the Achilles tendon at the insertion on the calcaneal tuberosity	The Achilles tendon may be quite diseased and friable, making repair more difficult
When passing the rip-stop sutures in a crossing fashion, use the Keith needle just distal to the proximal FiberTape limbs as close as possible in the event the tissue begins to fail; the repair will share the load with the rip-stop sutures rather than continuing to lose tension	Proximal sutures may cut through the Achilles tendon and weaken repair
When placing the distal SwiveLock anchors, place the lateral anchor first to allow for better visualization for placing the medial anchor	As incision is medial, placing medial anchor first will impede visualization of lateral anchor placement
Ensure adequate decompression of the Haglund deformity, which can be confirmed on fluoroscopy	Inadequate decompression may result in recurrence and small footprint for repair

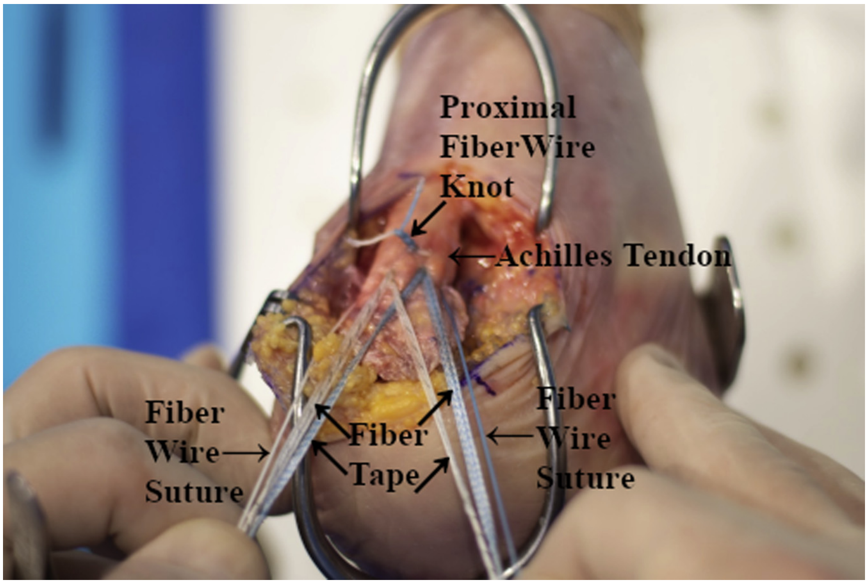

Fig 9. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. One limb from each of the FiberTape ends is crossed to make an "X" configuration overlying the Achilles tendon.

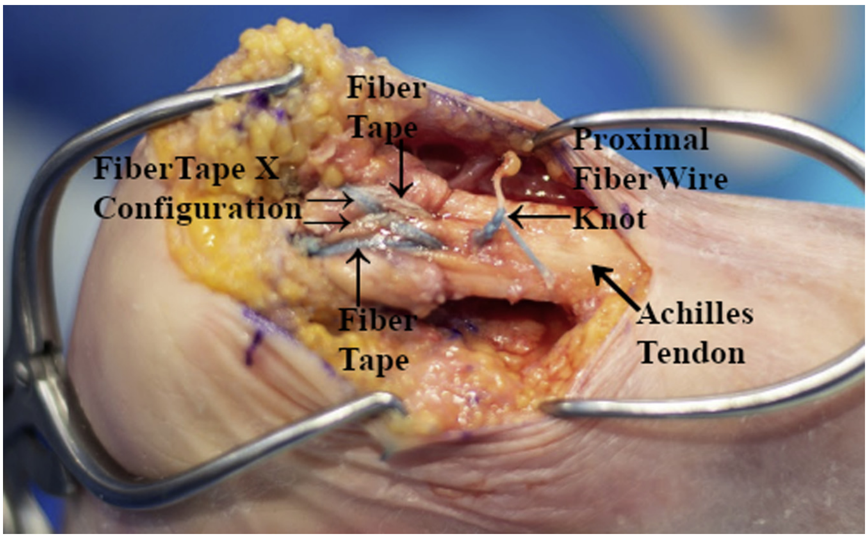

Fig 10. Cadaveric image of left foot and ankle from a posteromedial viewpoint. Following the "X" configuration, the 2 FiberTape limbs and rip-stop suture limb are loaded through the distal SwiveLock anchor eyelet.

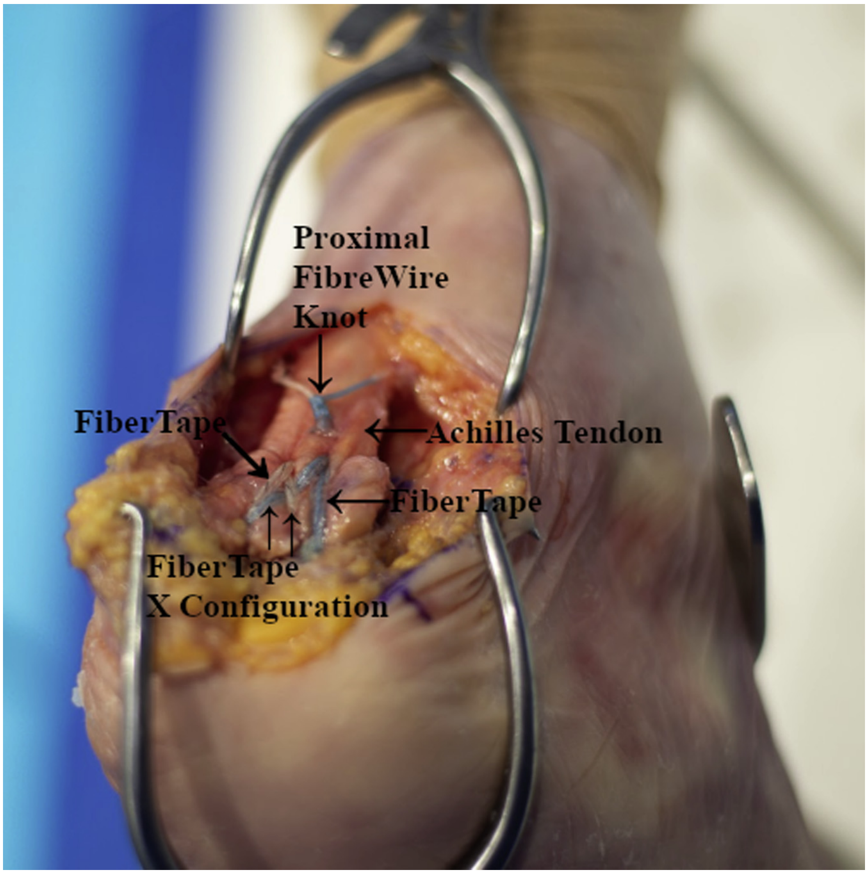

Fig 11. Cadaveric image of left foot and ankle from a posteroinferomedial viewpoint. Following insertion, the tails on the distal row are trimmed flush to the SwiveLock anchor.

FiberTape and rip-stop suture is adjusted before the insertion of the 4.75-mm SwiveLock anchor into the distal drill hole (Fig 10). This step is repeated for the other distal 4.75-mm SwiveLock anchor using the remaining 2 FiberTape limbs and 1 rip stop limb. Lastly, the tails on the distal row are trimmed flush to the SwiveLock anchor (Fig 11). The wound is then irrigated, and subcutaneous and skin layers are closed.

Postoperative Protocol

Sterile dressings are applied, and the patient is placed in a posterior leg splint for 2 weeks to allow healing of the surgical incision site. At the 2-week postoperative visit, the patient is transitioned into a full-time CAM walker boot and is allowed partial weight-bearing to the operative extremity for 6 weeks to allow for healing of the Achilles tendon reconstruction. Physical therapy with emphasis on range of motion exercises is implemented at 4 weeks postoperatively. The patient is transitioned out of the CAM walker boot to regular footwear at 8 weeks postoperatively with full weight-bearing.

Discussion

The necessity for treating acute Achilles tendon ruptures is essential and can be managed with operative or nonoperative treatment. Operative treatment has been the gold standard for athletes and nonathletes alike due to reducing the risk of re-rupture. A meta-analysis by Deng et al.[7] demonstrated a 9.8% re-rupture rate in nonoperative treatment compared with a 3.7% rate following surgical intervention. She et al.[8] also reports a significant reduction in re-rupture but a greater complication rate with surgical intervention including deep vein thrombosis, scar adhesion to underlying tendon, sural nerve injury and infection. Minimally invasive and traditional open Achilles repairs remain controversial as to which approach provides greater patient outcome.[9] Gatz et al.[10] report that minimally invasive cases exhibited a reduction in operation time and wound complications with a greater rate of sural nerve palsy and postoperative palpable knot when compared with an open procedure. Single-row versus double-row suture anchor constructs also have been under discussion for which may provide greater strength. Although double-row repairs increase the possibility of foreign body reactions, biomechanical studies have demonstrated a larger contact area and greater resistance to failure with a double-row configuration.[11,12] Achieving greater repair strength and maximizing footprint restoration by using a rip-stop suture in addition to a double-row configuration has been previously discussed in rotator cuff repairs.[13] We presume that a rip-stop configuration using the Arthrex SpeedBridge technique may provide a stronger construct and increase bone to tendon apposition to achieve good clinical outcome in Achilles tendon repair.

The use of FiberWire limbs to augment the Achilles tendon reconstruction as presented in this technique was developed as a way to enhance already described reconstruction techniques. With minimal increase in operative time, the augmented repair potentially has a greater mechanical load to failure and more load sharing capacity than traditional reconstruction methods. This is achieved by distal fixation of the FiberWire sutures acting as an additional layer in which the FiberTape would need to pull through for the construct to fail. A disadvantage of this technique is the potential for increased operative time; however, this would be expected to be minimal, as there are few additional steps that would be added onto the planned reconstructive technique. This technique may cause an increased risk of foreign body reactions due to the application of double-row suture anchor constructs. There also may be an increased risk for wound complications due to the nature of creating an open incision when compared to percutaneous repair of the Achilles tendon. Overtensioning the tissue could lead to higher rates of failure, although there are currently no clinical outcomes or biomechanical data to our knowledge that support these possible risks and limitations (Table 1).[13] The goal of this technique was to develop a simple method to further improve Achilles reconstructive surgeries by augmenting repairs with another failsafe with the potential of increasing load to failure of the repairs. Further studies are needed to evaluate if the Achilles rip-stop technique could potentially expedite a patient's recovery with a more robust construct allowing speedier return to work and play.

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