Technical Note

Mini-Open Achilles Repair With a Flat Braided Suture in a Low-Profile Configuration

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Abstract: Achilles repair has evolved over the past 30 years, from large open procedures with high complication rates to shorter, less-invasive procedures with better outcomes. Percutaneous repair has comparable failure rates with open repairs, fewer complications, and faster recovery. However, percutaneous Achilles repairs risk sural nerve injury. A mini-open repair fuses the gap between percutaneous and open procedures, and this approach has the potential to mitigate nerve injury while maintaining the increased efficiency in procedure time and patient recovery. The purpose of this Technical Note and accompanying video is to outline the repair of the Achilles tendon using a mini open repair using a low-profile flat braided suture.

The Achilles tendon is one of the strongest in the human body, resisting more than 9000 N in tension.[1] Interestingly, Achilles tendon tears are common, accounting for 35% of all tendon injuries in the United States.[2] Achilles rupture occurs most frequently in men between 37 and 43 years of age, especially during physical activity requiring high acceleration.[3-6] Despite being a common injury, the optimal treatment of Achilles tears is still highly debated due to improvements in both nonoperative and operative treatment.

In prospective studies of conservative and operative treatment, authors found no difference in outcomes.[7,8] However, conservative measures resulted in greater rerupture rates, tendon lengthening, and longer return-to-play time in athletes.[7,8] In contrast, an operative approach carries the inherent risk of complications related to surgery and anesthesia. More recent studies find surgical complications like superficial infections to be minor and support operative therapy to reduce time away from work and sports in younger patients.[9,10]

Open repairs have long been the gold standard in repair and range in complexity from simple tendon reapproximation to more complex procedures using grafts.[11,12] The mini-open repair sought to mitigate surgical wound complications that occurred in typical open procedures, but it has been found to reduce only superficial infections.[13] Failure rates in a retrospective review found rerupture rates to be 5.9% in minimally invasive repairs compared with 5.4% in standard open repair.[14,15]

Similarly to other minimally invasive repairs, percutaneous techniques promised a reduced infection rate and improved cosmesis at the expense of increased potential for entrapment of the sural nerve.[16,17] The Percutaneous Achilles Repair System (PARS; Arthrex, Naples, FL) was found to have a strong reconstruction with fewer complications than the open technique and quicker return-to-play time.[17,18] Similar designs such as the Achillon (Integra Lifesciences Corporation, Plainsboro, NJ) have been found to decrease tenderness, adhesions, scarring, and tendon thickness. These percutaneous techniques raise similar concerns for complications as the PARS, including both risk of sural nerve injury in addition to inaccuracies in reapproximation contributing to length discrepancies of the tendon itself.[19] However, for all such approaches, the potential for sural nerve entrapment remains high, and

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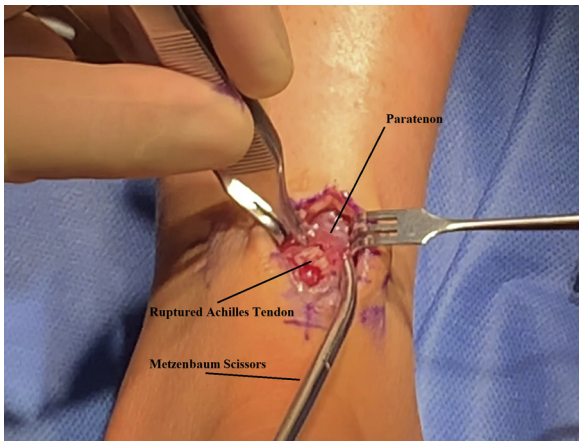

Fig 1. Operative image of the posterior leg with the Achilles paratenon being incised using Metzenbaum scissors. The patient is in prone positioning with the leg prepped and draped to above the knee.

there remains concern about the ability for the tendon to be reapproximated accurately.[20-23]

Given the high provider cost of using a percutaneous system and the anatomic concern for sural nerve injury, a mini-open technique could obviate these potential problems. The purpose of this Technical Note and accompanying video (Video 1) is to demonstrate a mini-open Achilles tendon repair using a PARS-like suture pattern with flat braided sutures in a low-profile configuration.

Surgical Technique (With Video Illustration)

Preoperative Considerations

Preoperative assessment consists of patient history and physical examination to clinically diagnose and assess Achilles rupture. The patient is positioned prone on the operating table and anesthetized using general anesthesia. All bony prominences are well padded and the neck is well positioned. The operative leg is treated with skin preparation solution and then draped in sterile fashion to above the origin of the gastrocnemius muscle.

Surgical Approach to the Achilles Tendon

The approximate location of the Achilles rupture is marked with a pen and a 4-cm longitudinal incision is made over the defect. The incision is deepened to the fascia and the paratenon is incised (Fig 1). Retractors are placed for improved visualization. The tear is visualized and debrided before attaching the proximal portion to Allis clamps to retract and externalize it from the incision (Fig 2).

Suture Preparation

1.5-mm SutureTape (Arthrex) is used to make 2 transverse sutures and 1 Bunnell-type crossed suture in the proximal portion. The proximal tear is unclamped and attention is turned to the distal portion. Similarly, Allis clamps are used again to retract the tear for improved visualization through the incision. Three sets of SutureTape (Arthrex) are then used to make 2 transverse sutures and 1 crossed suture in the distal portion (Fig 3).

Achilles Reapproximation

SutureTape (Arthrex) from opposing ends of the Achilles tear are then tied in a near-near, far-far fashion to reapproximate the Achilles tendon (Fig 4). The knots are seated along the sides of the tendon creating 2 box suture configurations and 1 Bunnell configuration (Fig 5). The Achilles stumps are brought into apposition and the repair is tested for strength and range of motion before closure.

Wound Closure

The wound is closed in 3 layers using 0 VICRYL, 2-0 VICRYL, and 3-0 nylon from deep to superficial, respectively. Xeroform, 4 × 4 gauge, and Webril pad the incision. A posterior slab splint is then placed with the patient's foot in equinus and wrapped with Ace bandage. The patient is then placed in an immobilization boot.

Postoperative Rehabilitation

The patient is seen 2 weeks postoperatively for suture removal and wound assessment before being placed in a cast for 2 additional weeks before transitioning into a walking boot. At 4 weeks postoperatively, the patient is started on a rigorous physical therapy regimen to regain baseline function, strength, and range of motion. Pearls and Pitfalls for the technique are listed in Table 1.

Discussion

The technique presented in this technical paper and accompanying video (Video 1) illustrates a repair design

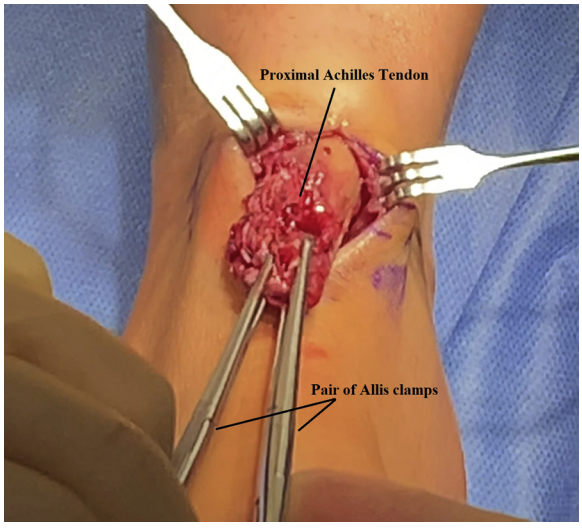

Fig 2. Operative image of the posterior leg with the proximal Achilles tendon externalized from the incision using a pair of Allis clamps. The patient is in prone positioning with the leg prepped and draped to above the knee.

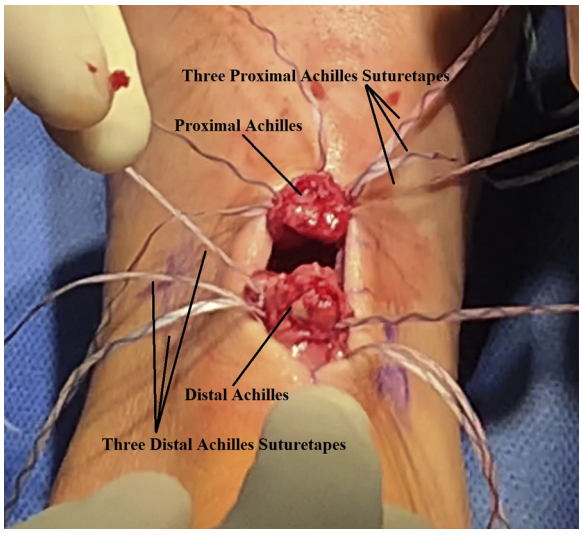

Fig 3. Operative image of 3 strands of 1.5-mm SutureTape (Arthrex) in the proximal Achilles tendon and 3 additional strands of SutureTape (Arthrex) in the distal Achilles tendon. The patient is in prone positioning with the leg prepped and draped to above the knee.

that is similar to a percutaneous system without using a proprietary jig. Simple suture passes that create the suture construct are more economical and faster than a traditional percutaneous system. While nonsurgical management is ideal for some patients, surgical management is usually considered for young athletic patients and we believe this technique offers a less invasive alternative to open repair. Added benefits of not requiring proprietary hardware and reduced theoretical risk for sural nerve injury compared with percutaneous repair strengthen the argument for this

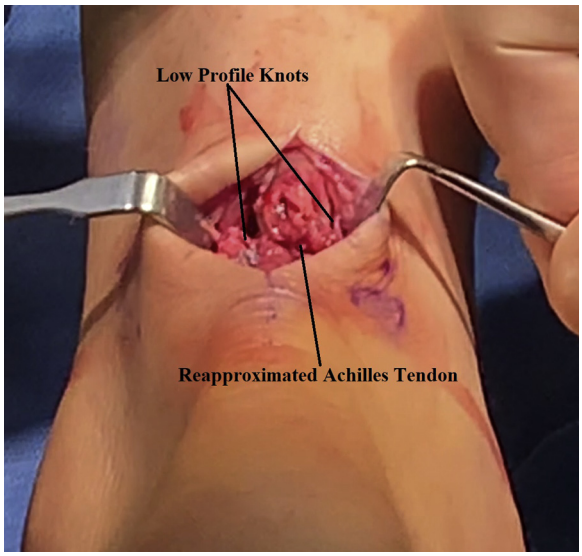

Fig 4. Operative image of the flat braid sutures tied in a low-profile configuration alongside the reapproximated Achilles tendon. The patient is in prone positioning with the leg prepped and draped to above the knee.

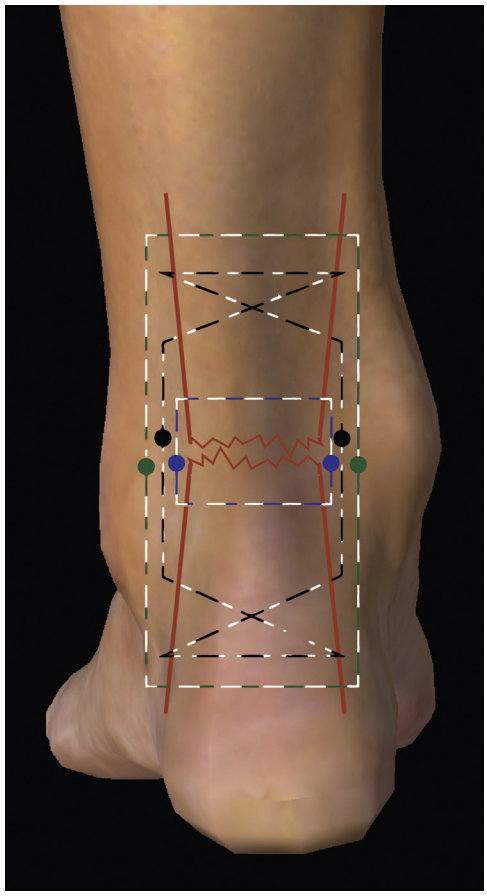

Fig 5. Diagram depicting the posterior left leg with the suture configuration using 2 box type sutures and 1 Bunnell type suture. Sutures are made using flat braid 1.5-mm SutureTape (Arthrex) and tied alongside the tendon to create a low-profile configuration.

simple technical approach. In addition, low-profile sutures along the lateral and medial aspects of the tendon likely decrease the "bowstringing effect" by removing prominent knots from under the skin.[24]

Multiple studies describe various approaches, suture constructs, and variations on techniques for the repair of the Achilles tendon. Recently, techniques using endoscopy and ultrasound also have been described with good results but increased operative time and, in some cases, increased risk for sural nerve injury.[25,26] One minimally invasive technique uses a similar

Table 1. Pearls and Pitfalls of the Mini-Open Achilles Repair With a Flat Braided Suture in a Low-Profile Configuration

Pearls
Use Allis clamps to retract Achilles for greater exposure during repair
Make incision large enough to expose tendon
Move each suture strand individually to ensure creep is removed
Pitfalls
Avoid mislabeling suture strands from proximal and distal ends
Avoid leaving the foot in neutral position when tying sutures

Table 2. Advantages and Disadvantages of the Mini-Open Achilles Repair With a Flat Braided Suture in a Low-Profile Configuration

Advantages
Design is unlikely to entrap sural nerve
Better aesthetic surgical repair—no knot bulking
Shorter operative time compared with open repair
Decreases cost associated with manufactured systems
Fewer steps and less confusing than percutaneous system setup
Fewer discrete skin wounds
Disadvantages
Inherent risk of surgery vs nonoperative treatment
Greater elongation compared with open repair
Less-reproducible suture passing compared with system

Bunnell-type suture construction was described to have a 5.9% rerupture rate and 19% sural nerve injury in a retrospective review.[15,27] A small case series used a jigless, knotless technique to reapproximate the tendon stumps and then anchored the sutures into the calcaneus with an internal bracing construct.[28] Similarly, a hybrid technique using a percutaneous and open approach proposed avoiding skin tensioning over the rupture site to decrease complications.[29] However, these and similar techniques require extra incisions, suture passing, and anchors to achieve their repair compared with open techniques.[30,31]

The main advantages of a mini-open approach are the reduced risk of both sural nerve injury and wound complications. The rate of sural nerve injury with percutaneous systems has been controversial, with the most recent literature suggesting sural neuritis in up to 10% of patients.[14,17,23] While a recent cadaveric study did not report increased sural nerve injury, 6 of 10 cadavers had needle passes within 5mm of the nerve.[23] A study of leg vasculature found the posterior leg has a poor blood supply and thin integument.[24] The smaller incision of the minimally invasive technique decreases the opportunity for wound healing complications seen with open procedures. Patient satisfaction improved with the smaller incision on average measuring 3.4 cm with the minimal invasive techniques versus 12 cm for the average open incision.[32,33] The proposed technique reduces the risk of sural nerve complications by avoiding percutaneous incisions while using a percutaneous developed suture technique in extracorporeal fashion to reduce dissection and incision size. This technique also decreases operative time associated with proprietary systems in addition to reducing cost to provider and patient.

There are some notable disadvantages to the technique used, particularly the risk of elongation and granuloma formation. One cadaver study found increased elongation with minimally invasive repair techniques; however, the failure rate was comparable to open repair.[34] This was noted to be inconsistent with current functional rehabilitation practice as the study did not permit the changes of healing to be observed, including wound and tendon contracture. In addition, polyethylene used in many common sutures, including SutureTape (Arthrex), has been reported to cause granulomatosis though this has not been well quantified.[35] A full list of advantages and disadvantages can be found in Table 2.

The technique presented in this paper describes a simple method for completing a strong repair of the Achilles tendon through mini-incision and without the need for proprietary equipment and prolonged setup needed to produce an equivocal repair. In addition, direct visualization of the Achilles tendon decreased the risk of sural nerve injury associated with percutaneous suture passing. The minimally invasive incision allowed the procedure to be carried out without difficulty and confirm appropriate tendon reapproximation and strength of repair. Finally, this technique reduced provider cost by removing the need for a manufactured surgical system and reducing surgical time associated with its set up and learning curve.

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