Achilles tendon ruptures are a common tendon injury, usually occurring in middle-aged men during recreational sporting activities. The most common injury mechanism involves pushing off a planted foot with an extended knee. Other injury mechanisms include forced dorsiflexion on a plantarflexed ankle, or falls from height. Several operative and nonoperative treatment options are available. Nonoperative treatment usually consists of brief immobilization, followed by early rehabilitation and early weight bearing. Operative methods include percutaneous Achilles repair, mini-open repair, and open Achilles repair. There is still no consensus on the best method of treating these injuries, nor the best method of repair in operative management of the ruptured Achilles tendon. Some studies have reported that nonoperative management is associated with higher rerupture rates compared with operative treatment, with rates of 8.8% versus 3.6%, respectively. Nonoperative treatment is generally reserved for lower demand patients and patients with higher surgical risk, whereas operative repair is preferred for treatment in younger, healthier, and more active patients. Open repairs carry with them an increased risk of wound healing problems, whereas minimally invasive techniques are reported to have an increased risk of iatrogenic sural nerve injuries. Low complication rates, reduced operating time, improved cosmetic appearance, and favorable clinical outcomes have been reported for newer percutaneous techniques. The purpose of this Technical Note is to present our preferred technique using the Percutaneous Achilles Repair System (Arthrex, Naples, FL), which has been reported to have minimal wound and nerve complications, and early return to activity.
describe our preferred knotless technique for Achilles tendon repair using a Percutaneous Achilles Repair System (PARS) (Arthrex, Naples, FL).

**Indications**

This technique is indicated for acute Achilles tendon ruptures (less than 3 weeks) in active patients. A trial of conservative therapy consisting of temporary immobilization with early functional rehabilitation may be considered in older more sedentary patients, especially those with significant medical comorbidities that may impact wound healing.

**Operative Technique**

**Patient Positioning**

The patient is placed prone on a standard operative table after anesthesia is induced on the stretcher where a nonsterile thigh tourniquet is placed on the operative limb (Video 1). All bony prominences are well padded. An examination is performed to evaluate the location of the defect as well as the difference in carrying angle of the foot. The operative leg or both legs are prepared and draped in a routine surgical sterile fashion below the knee to allow for intraoperative assessment and proper tensioning of the Achilles rupture repair.

**Operative Technique**

**Exposure.** A small horizontal incision (approximately 3 cm) is made approximately 1 cm proximal to the distal end of the palpable defect at the tendon rupture (Fig 1). The sural nerve is defined by blunt dissection laterally and protected while the paratenon is opened horizontally and the proximal portion of the healthy...
Achilles tendon is grasped with 2 Kocher clamps (one positioned medially, and one laterally). While grasping the proximal stump of the tendon, a 1-inch (2.54-cm) ribbon malleable retractor is used to free the proximal Achilles tendon from the surrounding paratenon (Fig 2). Separation of the tendon from the paratenon facilitates proximal placement of the PARS jig and excursion of the proximal tendon stump as it is often scarred down after rupture.

**Instrumentation.** The PARS jig (Arthrex) is placed in the incision and advanced proximally between the tendon and paratenon until it is stopped by the gastrocnemius complex muscle belly (Fig 3). Advancing the device between the tendon and paratenon aids in avoiding injury to the sural nerve. The device is opened just enough to ensure that the proximal tendon is between the 2 arms of the PARS jig. Digital palpation is used to confirm that the tendon stump is captured. A 1.6-mm guide pin with a Nitinol loop (Arthrex) is placed through the No. 1 hole of the jig to secure the tendon stump to the jig (Fig 4). Another similar 1.6-mm guide pin is then placed in the No. 2 hole, and a blue No. 2 FiberWire (Arthrex) suture is shuttled through the jig (Fig 2). Subsequently, 2 white and green striped, No. 2 FiberWire (Arthrex) sutures with loops on one end are passed through the No. 3 and 4 jig holes leaving looped ends on the opposite sides of the leg. Finally, a white and black striped No. 2 TigerWire (Arthrex) suture is passed

![Fig 5. The remaining sutures are passed through the guide system while applying distal traction on the Achilles tendon. (L, lateral; M, medial.)](image)

![Fig 6. With all sutures in place and appropriately tied, the guide system is removed, pulling the suture bridge construct through the proximal incision. Of note, the sutures are also passed through the paratenon to minimize the risk of injury to the sural nerve. (L, lateral; M, medial.)](image)

![Fig 7. A 3.5-mm drill, with drill guide, is used to make holes at a 45° angle converging toward the midline within these stab incisions for cortical fixation of the proximal tendon sutures. (L, lateral; M, medial.)](image)

![Fig 8. Five sutures placed through the proximal Achilles tendon with the PARS jig. No. 1 suture is a FiberTape suture, which is placed last in the No. 1 hole of the jig. No. 2 suture is a blue FiberWire suture. No. 3 suture is a green and white striped suture with a loop that is pulled through and left on one side. No. 4 suture is a second green and white striped suture with a loop that is pulled through but leaves the loop on the opposite side of the first loop. No. 5 suture is a black and white striped TigerWire suture. All sutures except the FiberTape in the No. 1 hole are No. 2 FiberWire and are placed through the hole for which they are numbered. (PARS, Percutaneous Achilles Repair System.)](image)
through the No. 5 jig hole (Fig 5). A FiberTape suture (Arthrex) is then placed through the No. 1 hole. The device is then slowly removed from the leg, pulling the suture through the transverse incision site and within the paratenon, avoiding the sural nerve (Fig 6).

**Calcaneal Fixation.** At this point, attention is turned to the distal portion of the Achilles tendon. Two small stab incisions are made over the calcaneus just proximal to the Achilles insertion (approximately 1.5 cm proximal to the superior aspect of the tuberosity) on the medial and lateral sides of the tendon. A 3.5-mm drill with drill guide (Arthrex) is used to make holes at an angle converging toward the midline within these stab incisions (Fig 7). The tunnels are angled so they do not intersect. A 4.75-mm tap (Arthrex) is then used to prepare the drill holes. At this point, the No. 2 blue suture is passed under the No. 3 and 4 loop sutures on each side of the leg and back through the loop of the white and green striped looped sutures. The No. 2 suture is then pulled through the Achilles tendon to the other side by pulling on the nonlooped side of the white and green No. 3 and 4 looped sutures. The No. 2 suture is then pulled and locked in place leaving 2 transverse sutures (No. 1 and 5) and the one locked No. 2 suture with the proximal Achilles tendon. Figures 8 to 13 summarize preparation of the suture construct. Each construct is individually tested to be sure that it captures the tendon and will not pull out. A Banana SutureLasso (Arthrex) is passed through the distal Achilles tendon stump to retrieve the proximal FiberWire and FiberTape strands (Fig 14). The strands are then passed through the distal Achilles stump while a small Kocher clamp holds tension on the distal stump. The strands are secured into the calcaneus on the medial and lateral sides with a 4.75-mm SwiveLock (Arthrex) on each side, whereas the foot is held in full plantar flexion (Fig 15). When fastening these strands, careful attention is paid to the contralateral foot to ensure that appropriate tension is applied. In our experience, a carrying angle that is slightly more plantarflexed by approximately 5° to 10° when compared with the contralateral side works best.23,24
Closure and Dressing. A 3-0 Monocryl (Ethicon, Somerville, NJ) absorbable running epitenon stitch is placed. The wound is irrigated and closed in layers with 3-0 and 4-0 Monocryl sutures and Steri-Strips (3M Health Care, St. Paul, MN). A postoperative dressing is applied along with a plaster short leg splint in plantar flexion with slight tension on the Achilles tendon repair. The abbreviated steps of the operative technique can be found in Table 1. The pearls/pitfalls and advantages/disadvantages of this technique are listed in Tables 2 and 3, respectively.

Rehabilitation
An experienced physical therapist is paramount in rehabilitation after repair of acute Achilles tendon ruptures. In the immediate postoperative period, the patient is made non-weight bearing and the splint remains in place for 10 to 14 days. At that point, the patient is transitioned to a walking boot with 4 felt heel wedges (Hapad, Bethel Park, PA) measuring 7/16” each in maximum thickness and allowed to start active plantar flexion and dorsiflexion up to 5° to 10° short of neutral. The patient can begin partial weight bearing, removing 1 heel wedge per week and progressing to full weight bearing by 4 to 6 weeks postop. Formal physical therapy begins at 2 weeks with a focus on active plantar flexion and gradual dorsiflexion up to 5° short of the contralateral side. At week 7, the patient is weaned from the boot into a shoe (with wedges if necessary for comfort) over 2 weeks. As motion and strength improve, the patient starts functional physical therapy with sports progression. In weeks 12 to 16, the athletes are limited in activities as the risk of rerupture persists up to 4 months. At week 16, athletes may resume controlled practice with pain as a guide. Athletes may be able to return to full preinjury level of activity between 4.5 and 12 months postoperatively. A summary of the rehabilitation protocol is given in Table 4.

Discussion
Numerous techniques for the treatment of acute Achilles tendon ruptures have been published that include open, mini-open, and percutaneous repairs. Repairs have historically been performed with an open, longitudinal lateral or midline incision approach and end-to-end suture repair or graft reconstruction of the
We present a percutaneous knotless technique with distal tendon. Because of the large incision required, these techniques carry a risk of complications including deep tendon adhesions. There have been new developments in percutaneous and mini-open repairs with the aim of minimizing the risk of complications. Despite differences in biomechanical data, no method of Achilles tendon rupture repair has clearly been shown to be clinically superior.

There are limitations to the above-mentioned technique. First, incision placement is key. If the incision is placed too proximally, the epitenon suture cannot be placed and it is difficult to ensure apposition of the tendon ends. Likewise, if the incision is placed too distally, it may be difficult to capture the proximal tendon stump with the PARs jig. Second, if the tendon is particularly degenerated or of poor quality, it is difficult to capture the proximal tendon stump with the PARs jig. In this case, the incision can be elongated in an s-shape longitudinally, or an additional horizontal incision can be made proximally. In the latter case, we recommend having at least a 4-cm skin bridge. The proximal stump is then brought of the wound and a 6-core Mason-Allen construct or a Krackow construct can be performed open. The surgeon can then choose to continue with calcaneal fixation or convert to a traditional open

### Table 1. Abbreviated Operative Outline

| Basic Operative Plan |
|----------------------|
| Examination under anesthesia to locate the rupture |
| Horizontal incision 1 cm proximal to the palpable defect of the Achilles tendon rupture |
| Separation of the Achilles tendon from the paratenon using a transverse (or horizontal) incision and a ribbon mallicable retractor |
| Placement of the Percutaneous Achilles Repair System (PARs) jig in the incision and advancing it proximally until it is stopped by its hol at the handle |
| Use of a 1.6-mm guide pin with the Nitinol loop through the No. 1 hole of the jig to secure the tendon |
| Use of a 1.6-mm guide pin with the Nitinol loop through the No. 2 hole of the jig and placement of a blue No. 2 FiberWire through the No. 2 hole of the jig |
| Subsequent white and green striped, looped No. 2 FiberWire passage through the No. 3 and 4 holes of the jig using the guide pin with the loop |
| Passage of a white and black striped No. 2 TigerWire through the No. 5 hole on the jig |
| Next place a FiberTape in the No. 1 hole using the pin left there to hold the tendon |
| The jig is carefully removed |
| The blue No. 2 suture is passed under the No. 3 and 4 sutures and back through the loop of the white and green looped suture |
| Pulling the No. 2 suture through the Achilles tendon to the opposite side by pulling the nonlooped side of the No. 3 and 4 sutures (white and green) |
| Pulling and locking the No. 2 suture |
| Two stab incisions, 1.5 cm apart over the Achilles insertion on the calcaneus |
| Two 3.5-mm drill holes on the calcaneus |
| Using a SutureLasso through distal Achilles stump, retrieve the proximal FiberWire sutures |
| Fixing the sutures to the calcaneus with two 4.75-mm SwiveLocks |
| A 3-0 Monocryl absorbable running epitenon stitch is placed |
| Irrigation and closure |

### Table 2. Pearls and Pitfalls of Acute Achilles Tendon Rupture Repair With a Percutaneous Knotless Repair

| Pearls | Pitfalls |
|--------|----------|
| Be familiar with the instrumentation | Incision too distal from the rupture |
| Palpate the Achilles tendon and locate the rupture before incision | Not placing the Percutaneous Achilles Repair System jig proximal enough resulting in poor tendon capture with the sutures |
| Incision 1 cm proximal to the rupture | Sutures entangling poor suture management |
| Separate the Achilles tendon from the paratenon to enhance healing and protect the sural nerve | Undertensioning the repair using SwiveLocks |
| Passing and pulling the sutures in the right order to avoid entangling | Not inserting SwiveLocks completely into calcaneal tunnels |
| Immobilizing the ankle joint in a stirrup and posterior slab | 1-2 wk postoperatively |

### Table 3. Advantages and Disadvantages of the Percutaneous Achilles Repair System Technique

| Advantages | Disadvantages |
|------------|--------------|
| Several sutures are used for good purchase of the tendon | Many sutures may entangle |
| The tendon rupture can be visualized | The surgeon has to be familiar with the instrumentation |
| Good fixation to bone on the calcaneus with SwiveLocks | |
| Avoid wound healing problems associated with the open repair technique | |
| Avoid nerve injury problems associated with other percutaneous techniques | |
repair. Third, in a small subset of patients, the swivel lock anchors can become painful. We recommend ensuring that the swivel lock is advanced beneath the calcaneal cortex to avoid soft tissue irritation. And ensuring that the swivel lock is advanced beneath the calcaneal cortex to avoid soft tissue irritation.

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