

Achillon Mini-Open Achilles Tendon Repair: Early Outcomes and Return to Duty Results in U.S. Military Service Members

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The purpose of this article is to report short-term outcomes and return to duty rates in a cohort of active duty U.S. military personnel who underwent repair of acute Achilles tendon ruptures using the Achillon mini-open technique. Between October 2009 and March 2012, 15 consecutive patients underwent mini-open repair of acute Achilles tendon ruptures using the Achillon device by a single surgeon. Minor and major complications were recorded, and American Orthopaedic Foot and Ankle Society (AOFAS) and pain visual analog scores were recorded at regular follow-up intervals. At mean latest follow-up of 16.7 months postoperatively, all 15 patients had returned to full active duty status without major complications. Specifically, no patient experienced major wound complication, infection, or rerupture. Mean AOFAS score in 9 of 15 patients was 94.1; mean pain visual analog score in 12 of 15 patients was 1.4. The Achillon mini-open technique can be used for treatment of acute Achilles tendon ruptures in appropriately selected high-demand patient populations with the expectation of minimal adverse outcomes. (Journal of Surgical Orthopaedic Advances 22(1):23–29, 2013)

Key words: Achilles tendon, Achillon, military, mini-open, rupture

Acute Achilles tendon rupture is a relatively common orthopaedic injury, the incidence of which is increasing as the population continues to participate in high-demand recreational activities well into late adulthood (1–3). One study reported an incidence of 18 Achilles tendon ruptures per 100,000 people in a single population, and the authors noted a rising trend at that time (3). The mechanisms of Achilles tendon ruptures include sudden forced plantarflexion of the foot, unexpected dorsiflexion of the foot, and violent dorsiflexion of a plantarflexed foot (4, 5). Achilles tendon ruptures are thought to occur in previously abnormal tendons (4, 6), and a variety of causative factors have been linked to spontaneous ruptures, including use of systemic and topical corticosteroids (7, 8), fluoroquinolone antibiotic use (9, 10), and mechanical abnormalities of the hindfoot and forefoot (11).

Optimal treatment of acute Achilles tendon ruptures is controversial, with some authors advocating early acute repair to reduce risk of rerupture and others proposing nonoperative treatment with early functional rehabilitation to minimize the risk of complications associated with surgical management. A recent multicenter prospective, randomized controlled trial by Willits et al. demonstrated similar functional outcomes and minimal risk of rerupture with nonoperative treatment and accelerated functional rehabilitation for acute Achilles tendon ruptures compared to traditional open operative repair followed by an identical accelerated functional rehabilitation protocol (12). However, the authors only compared nonoperative treatment to standard open repair. A 2005 meta-analysis of randomized, controlled trials by Kahn et al. demonstrated decreased relative risks of rerupture, overall complications, and wound infections for percutaneous techniques compared to standard open repairs (5). The authors also reported a relative risk of rerupture with all forms of operative treatment of 0.27 compared to nonoperative treatment, with overall rerupture rates of 3.5% versus 12.6%, respectively. Given these findings, some authors have noted that despite the encouraging results with nonoperative treatment followed by accelerated functional rehabilitation, there is not currently sufficient empirical evidence to dismiss operative treatment followed by accelerated functional rehabilitation as a management option for acute

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Achilles tendon ruptures in appropriately selected patients (13, 14).

Despite the lack of consensus regarding operative versus nonoperative treatment for acute Achilles tendon ruptures, percutaneous and minimally invasive (mini-open) treatment techniques have become increasingly popular, offering the historically reported advantages of standard open repair in terms of decreased rerupture rates but without the increased risk of wound complications (15–17). Compared to classic percutaneous repair techniques, mini-open repair minimizes risk of sural nerve injury and allows for direct visualization and tensioning at the repair site (17–19). Recently, a new mini-open technique using an instrument known as the Achillon device (Integra Life Sciences Corporation, Plainsboro, NJ) has emerged, offering such advantages (18) (Fig. 1). The device permits direct visualization of the torn tendon ends through a small transverse or vertical incision at the rupture site, allowing appropriate repair tensioning. Furthermore, the sural nerve lies outside the repair site, ostensibly eliminating the risk of sural nerve entrapment inherent to typical percutaneous techniques. Cadaveric biomechanical studies have demonstrated that the strength of the Achillon repair is equal to or greater than that obtained using standard open Krackow or Kessler repair techniques (19–21). Results of several clinical series using this mini-open technique have likewise been encouraging, with some authors reporting significant reduction in complications compared to standard open techniques (18, 21–24).

The purpose of the current series is to present our short-term outcomes using the Achillon mini-open technique for acute Achilles tendon rupture repair in an active duty United States military population. Active duty U.S. military personnel represent a diverse, physically active population with high occupational demands, participating



FIGURE 1 Achillon device (Integra Life Sciences Corporation, Plainsboro, NJ).

in regular organized physical fitness training programs as well as fulfilling physically demanding military occupational specialty requirements (25). No previous authors to our knowledge have described the use of this technique in this particular population. The purpose of this study is to demonstrate the Achillon mini-open repair technique as a safe option for treatment of acute Achilles tendon ruptures in this uniquely high-demand patient population.

Materials and Methods

Protocol approval for retrospective chart study was obtained from our institutional review board. Fifteen consecutive patients between October 2009 and March 2012 underwent mini-open repair of acute Achilles tendon ruptures using the Achillon device (Table 1). All patients were male active duty service members in the U.S. military with unilateral acute Achilles tendon ruptures. Mean patient age was 36.8 (range, 24–54) years, and no patients had any significant medical comorbidities or known predisposing risk factors for tendon rupture. Achilles tendon ruptures involved nine right legs and six left legs. Injuries were sustained during recreational sporting activities or in association with military occupational activities in all cases. On examination by the lead author, all patients demonstrated posterior ankle pain; a palpable defect in the Achilles tendon; increased resting dorsiflexion of the affected extremity in the prone position, with the knee flexed to 90°; absent or decreased active plantarflexion strength; and a reproducible, abnormal prone Thompson's test. Imaging studies were not typically indicated, because the diagnosis of Achilles tendon rupture was made based on patient history and physical examination; however, in all 15 cases, plain radiographs or magnetic resonance imaging of the affected extremity was ordered by the referring provider before evaluation by the lead author. In all 15 cases, imaging studies confirmed the diagnosis.

All surgeries were performed by the lead author. Mean time from initial injury to surgical repair was 4.9 (range, 0–16) days. All 15 patients underwent successful mini-open Achilles tendon repair using the Achillon repair system (Fig. 1). Mean postoperative follow-up was 16.7 (range, 5–33) months.

All 15 surgeries were performed in the prone position, utilizing a thigh tourniquet inflated to 250 mm Hg. Appropriate intravenous antibiotics were administered within 30 minutes of beginning surgery. The Achilles tendon defect was palpated (Fig. 2A), and an approximately 20- to 30-mm vertical incision was made directly medial to the defect (Fig. 2B). A vertical, rather than transverse, incision was employed in order to easily facilitate proximal and distal extension in the event that conversion to standard open repair is indicated. The torn tendon ends were delivered through the surgical incision and repaired

TABLE 1 Patient data and surgical outcomes

Patient No.	Age (years)	Follow-up (months)	AOFAS Score (months after surgery)	Pain Visual Analog Score (months after surgery)	Complications
1	34	25			None
2	49	33			None
3	36	25			None
4	26	24	100 (12)	1 (12)	None
5	39	29	85 (6)	1 (6)	None
6	54	6	100 (6)	0.75 (6)	None
7	39	25	97 (9)	0 (9)	Delayed wound healing
8	40	21	100 (9)	0 (9)	None
9	35	19			None
10	39	6	85 (6)	2 (6)	None
11	34	6	90 (8)	1 (8)	None
12	36	6	100 (6)	0.5 (6)	None
13	39	5		4 (3)	None
14	30	5	90 (3)	1 (3)	None
15	24	15		4 (14)	Noninsertional Achilles tendinopathy

utilizing the Achillon device as described by previous authors (18) (Fig. 3). All 15 repairs were performed using three No. 2 nonabsorbable braided sutures in each tendon end. Wounds were closed in a layered fashion with the skin reapproximated using interrupted nylon sutures.

Postoperatively, all patients were non-weight bearing in a 20° equinus postoperative splint for 10 to 14 days. At the initial 2-week postoperative appointment, sutures were removed and the patient was placed in a removable walking boot with a 1.5-inch heel lift and permitted to bear full weight as tolerated. A standardized postoperative accelerated functional rehabilitation program was initiated at that time (26). The heel lift was reduced by 0.5 inches every 2 weeks, at postoperative weeks 4 and 6. At the 8-week postoperative visit, the patient was transitioned into regular comfortable footwear with a 0.5-inch heel lift and continued use of the 0.5-inch heel lift until postoperative week 12. At 12 weeks postoperatively, all patients resumed wear of normal comfortable footwear without heel lift support and began a walk-to-run program. All patients were protected with restrictive military profiles during the initial 6-month postoperative rehabilitation course and were released to unrestricted recreational and military activities thereafter.

The operating surgeon followed all 15 patients, and complications were recorded (Fig. 4). Major complications considered by the authors included deep wound infection, significant wound dehiscence, iatrogenic neurovascular injury, or Achilles tendon rerupture. Minor complications considered by the authors included superficial wound infection, minor wound dehiscence, delayed wound healing, or development of symptomatic Achilles tendinopathy. Efforts were made to obtain functional outcomes data in the form of American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot and ankle scores as

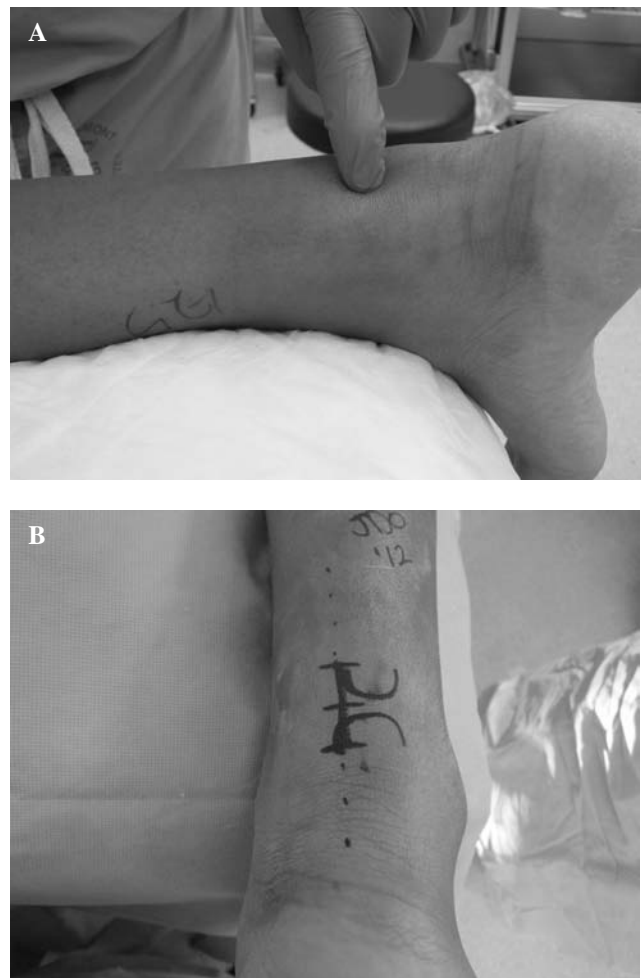


FIGURE 2 (A) Palpation of Achilles tendon defect before mini-open surgical repair. **(B)** Vertical 20- to 30-mm incision site, just medial to Achilles tendon defect, used for Achillon mini-open repair technique.

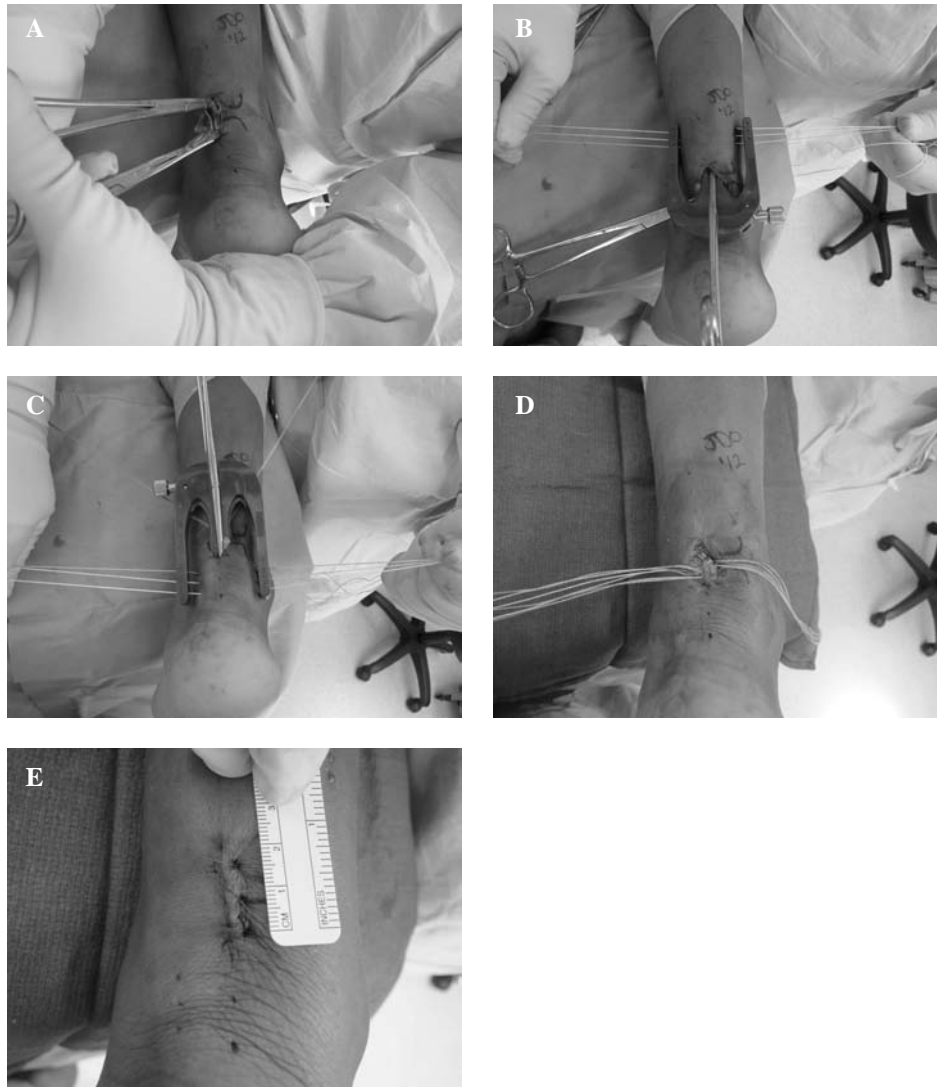


FIGURE 3 (A) Achilles tendon rupture ends exposed through vertical minimally invasive incision. (B) Three No. 2 nonabsorbable sutures passed through proximal stump of the Achilles tendon rupture using the Achillon device. (C) Three No. 2 nonabsorbable sutures passed through distal stump of the Achilles tendon rupture using the Achillon device. (D) Achilles tendon repair complete, before cutting the sutures and closing the wound. (E) Wound is closed in a layered fashion, with skin closed using interrupted nylon sutures in a tension-free manner.

well as pain visual analog scores at 3, 6, and 12 months postoperatively.

Results

At mean latest postoperative follow-up of 16.7 (range, 5–33) months, all 15 patients remained on unrestricted active duty military service. No patient underwent medical discharge from active duty service during the follow-up period for conditions related to the Achilles tendon. At latest follow-up, mean active ankle range of motion was 64.6° with mean active ankle dorsiflexion of 18.9° and mean active ankle plantarflexion of 45.7°. Follow-up AOFAS hindfoot and ankle scores were obtained in

9 of 15 patients at a mean of 7.2 (range, 3–12) months postoperatively. The mean postoperative AOFAS score in these nine cases was 94.1. Follow-up pain visual analog scores were obtained in 11 of 15 patients at a mean of 7.5 (range, 3–14) months postoperatively. The mean pain visual analog score in these 11 cases was 1.4.

There were no major complications during the follow-up period in any patient. In particular, no patient developed deep wound infection or sustained rerupture of the Achilles tendon. There were two minor complications during the follow-up period. One patient had delayed wound healing but no infection (patient 7). At 9 months postoperatively, he reported an AOFAS score of 97 with a pain visual analog score of 0.0. At latest follow-up

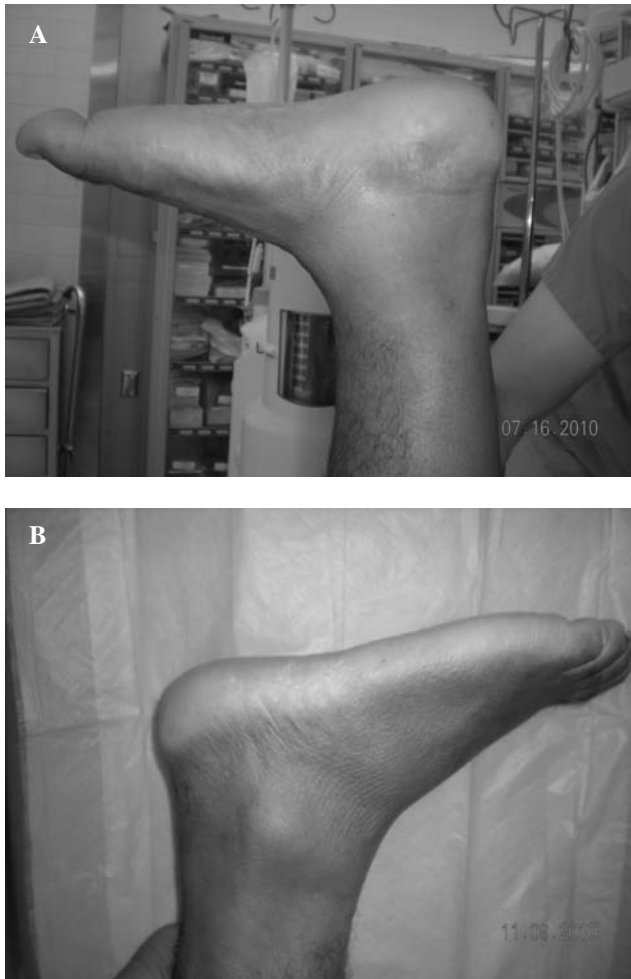


FIGURE 4 (A) Patient 8, just before mini-open repair of acute Achilles tendon rupture. Note resting dorsiflexion sag at ankle with knee flexed to 90° in prone position. (B) Same patient, 4 months after successful mini-open repair using the Achillon device. Note resting plantarflexion of ankle in same prone position with knee flexed to 90°.

of 25 months, the patient remains on unrestricted active duty military status. One other patient subsequently developed symptomatic postoperative noninsertional Achilles tendinopathy and at 15 months postoperatively is being managed nonoperatively for this condition while remaining on unrestricted active duty military status (patient 15).

Discussion

Appropriate treatment of acute Achilles tendon ruptures remains controversial (12, 13). Several randomized controlled trials comparing operative versus nonoperative treatment have reported significantly decreased rerupture rates following standard open repair but at the risk of increased complication rates (27–30). A meta-analysis

by Kahn et al. corroborated these findings and suggested that complications associated with operative treatment may be reduced by use of percutaneous repair techniques (5). Percutaneous Achilles tendon repair techniques offer the theoretical advantage of reduced disruption to the blood supply of the overlying skin and ruptured tendon, subsequently lessening the risk of wound complications; however, authors have noted the disadvantages of poor visualization of the tendon ends and an unacceptably high rate of sural nerve injury with these techniques (16, 17).

In an effort to address these concerns while maintaining the advantages of minimal invasiveness, various mini-open techniques have been developed, to include use of the Achillon device. To date, three separate biomechanical studies testing simulated Achilles tendon ruptures in cadaveric specimens have demonstrated mean loads to failure using the Achillon repair technique equal or superior to that using either a Krackow locking suture repair or Kessler suture repair (19–21), providing scientific substantiation for its use. Clinically, several authors have noted short-term functional and clinical outcomes following mini-open acute Achilles tendon rupture repair with the Achillon device to be equal or superior to historically reported outcomes following standard open repair (18, 22–24, 31). One study postulated that mini-open repair using the Achillon technique may ultimately prove cost-effective compared to standard open repair when reduction in postoperative wound complications and incisional site pain were considered (23).

Given the theoretical advantages of minimally invasive repair and concomitant reassuring biomechanical and clinical outcomes data, we have adopted the use of the Achillon mini-open technique for treatment of acute Achilles tendon ruptures in our active duty military service member population. The current series demonstrates our short-term outcomes and return to military duty success using this mini-open technique for treatment of acute Achilles tendon ruptures in a cohort of active duty U.S. military personnel. Active duty military personnel are involved in regular organized physical fitness training programs and are expected to fulfill physically demanding daily job requirements (25). Although previous authors have reported on the use of the Achillon mini-open technique in larger cohorts (18, 22–24, 31), this is the first series to our knowledge to report on its use in this unique patient population.

Our short-term results treating acute Achilles tendon ruptures with the Achillon mini-open technique in active duty military personnel compare favorably with previous authors' results treating civilian populations of similar demographic makeup (18, 22–24, 31). In each of these prior studies, nearly all of the patients were recreational or high-level athletes. At a mean follow up of 16.7 months, all 15 patients in the current series remained

involved in full active duty military service without major complications. Particularly, during the follow-up period, no patient experienced major wound complication, infection, or rerupture. Although AOFAS hindfoot and ankle scores were only available in 9 of 15 patients, at a mean of 7.2 months postoperatively, the average AOFAS score was 94.1. In the 11 patients who completed postoperative pain visual analog scores, the average pain visual analog score at a mean of 7.5 months postoperatively was 1.4.

In comparison, a study by Assal et al. was the first to report on the clinical efficacy of the Achillon device (18). The authors reported no infections or wound complications in 82 patients followed prospectively after mini-open Achilles tendon repair using the Achillon technique. At a mean follow-up of 26 months, the authors noted three reruptures in their series and a mean AOFAS score of 96. The authors noted that all patients available for follow-up returned to preinjury work activities and sports. Our results, in a much smaller cohort, parallel these short-term findings. Similarly, a prospective series conducted by Calder and Saxby reported no reruptures at 1 year and a mean 6-month AOFAS score of 98 in 46 consecutive Achillon repairs (22). Aktas and Kocaoglu demonstrated a mean AOFAS score of 96.8 at a mean of 22.4 months following acute Achilles tendon repair using the Achillon device (24). The authors noted similar results compared to an age-matched cohort who underwent standard open Krackow suture repair during the same time period. Bhattacharyya and Gerber reported no wound complications, infections, or reruptures in 25 patients treated with the Achillon technique (23). Nearly all of their patients returned to preinjury work and recreational activities between 3 and 6 months. Finally, a recent study by Valente et al. reported a short-term AOFAS score of 93.4 and noted no wound complications, infections, reruptures, or sural nerve pathology in 35 consecutive patients who underwent Achillon repair. All 35 patients successfully returned to preinjury athletic levels at 6 months (31). Similar to these previous series, the patients in the current series all returned to preinjury active duty military status without any major complications. This is the first series to our knowledge to demonstrate full return to activity level in a high-demand occupation such as active duty military service members following mini-open acute Achilles tendon rupture repair using the Achillon device.

The authors acknowledge several strengths and weaknesses in the current series. First, this is a retrospective study and retains the inherent limitations of such studies. Second, this series represents a small patient sample size in a relatively unique patient population. These patients may have characteristics that limit the external validity of the current study. However, we feel that these results can be appropriately used in comparison with other physically active adult patient populations whose activity demands

are through sports or high-demand occupational activities. In addition, the results of the current series are limited by less than 2-year follow-up. The mean follow-up in the current series, 16.7 months, is similar to previous authors' follow-up periods (18, 24) and greater than outcomes data reported by another similar series (22). The critical end points when determining success or failure following treatment of Achilles tendon ruptures remain early postoperative complications, ability to return to activity level within the first year following injury, and rates of rerupture. The current series was able to address each of these critical end points during the follow-up period, as well as providing the readers with outcomes data in the form of AOFAS hindfoot and ankle scores and pain visual analog scores. The authors recognize that the AOFAS score is not validated scientifically as an outcomes measure (32). Despite this, the lead author includes this score as a routine part of his patient follow-up care because the score is conveniently obtainable during routine clinic visits and is easily understandable for patients. It is the lead author's opinion that the AOFAS score can serve as another indicator of patient outcomes despite its nonvalidated scientific status. Finally, as a case series, this study presents no comparison group. The authors recognize this weakness; however, the intent of the current study was not to demonstrate the effectiveness of the Achillon mini-open technique compared to more traditional repair techniques. Other authors have demonstrated this previously (24). The goal of the current series was to demonstrate its effectiveness in this unique patient population and, to our knowledge, this is the first series to do so. In doing so, we feel that we have succeeded in providing readers with further evidence that this technique is a reasonable option for repair of acute Achilles tendon ruptures even in their most high-demand patient populations. Finally, the major strength of the current series, as noted above, is that it is the first study to demonstrate full return to function in an active duty military population.

In conclusion, these short-term findings suggest that the Achillon mini-open technique can be used for treatment of acute Achilles tendon ruptures in select, high-demand patient populations with the expectation of minimal adverse outcomes. Our active duty military patient population experienced no reruptures or major complications, and all returned to full active duty military status during the follow-up period.

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