



## Minimal Invasive Percutaneous Repair of Acute Closed Rupture of Achilles Tendon

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### Abstract

**Background:** Achilles tendon injuries are fairly common nowadays due to prevalence of comorbid conditions. The proposed lines of treatment in the literature are conservative treatment with cast immobilization, open surgical repair and minimal invasive lines of treatment with percutaneous repair. To achieve optimum return of function, surgical repair is clearly superior to non-operative treatment.

**Purpose:** The purpose of this study is to determine the results of minimal invasive Percutaneous repair of acute closed rupture of Achilles tendon with special emphasis on how to protect the sural nerve during the procedure. **Patients and methods:** Twelve patients with acute closed rupture of Achilles tendon were treated between November 2010 and 2012. Ten patients were males and two patients were females. The mean age of the patients was 35.5 years. The mean time between injury and index surgery was 8 days (range 5 to 14 days).

**Results:** The average range of ankle plantar flexion was 130° (range, 120°-140°) on the repaired side and 143° (range, 120°- 155°) on the non-injured side. The average range of ankle dorsiflexion was 17° (range, 16°-21°) on the operated side and 19° (range, 18°-22°) on the non- injured side. The mean calf diameter was 38.5 cm (range, 36-44 cm) on the operated side and 42.5 cm (range, 39-45 cm) on the non- injured side. The interval between injury and return to regular work was 17 weeks (range 16-18 weeks). The mean AOFAS score was 90 (80-98) at the most recent follow-up and 75% of patients' results were considered excellent while 25% were good. We had no re-ruptures.

**Conclusion:** Percutaneous repair of acute closed rupture of Achilles tendon is a reproducible and effective method of treatment. It results into a strong and sound tendon healing in a relatively short time that allowed for early functional rehabilitation. The only drawback of this technique is the sural nerve injury. This can be eliminated by direct visualization of the nerve by very minimal blunt dissection through the lateral stab incisions.

**Keywords:** Percutaneous repair; Achilles tendon; Closed rupture

### Introduction

Rupture of the Achilles tendon is increasingly common, and an incidence of 18 per 100,000 has been reported [1]. The Achilles tendon is the strongest tendon in the human body which takes its name from Achilles, from Homer's Iliad. Hippocrates said "this tendon, if bruised or cut, causes the most acute fevers, induces choking, deranges the mind and at length brings death". Since Ambroise Paré initially described in 1575 and reported in the literature in 1633, Achilles tendon breakage has received a lot of attention [2].

The current treatment options can be classified as non-operative (casting or functional bracing) or operative. Although some authors recommend conservative management strongly, cast immobilization may lead to elongation of the tendon with reduced strength of the calf muscles and in a high rate of re-rupture [3].

As a common concept, operative regiments present a lower re-rupture rate, early functional rehabilitation, stronger push off with lower incidence of calf atrophy. But open surgical repair of the Achilles tendon also includes potential problems like joint stiffness, muscles atrophy, tendo-cutaneous adhesions, deep venous thrombosis due to prolonged immobilization after surgical repair, infection, scarification, and wound breakdown [4].

Percutaneous repair was described in 1977 by Ma and Griffith [5] with no re-ruptures and only two minor complications; these have led some authors to develop new and alternative methods of percutaneous repair. Percutaneous or minimally invasive techniques are being used to minimize the typical complications associated with open surgery, and results are reported to be satisfactory, but an increased incidence of sural nerve injury has been reported after percutaneous repair [6].

### Patients and Methods

Between November 2010 and November 2012 we treated twelve patients with acute traumatic closed rupture of Achilles tendon at the orthopedic department, Zagazig University. Ten patients were males, two patients were females. Among male patients two of them were athletes. The mean age of the patients was 35.5 years (range 30 to 49 years). The mean time between injury and index surgery was 8 days (range 5 to 14 days). Three patients were smokers. Two patients had diabetes mellitus. None of the patients had pathologic rupture. The dominant leg was involved in 8 patients and non-dominant leg in 4 patients. Patients who had closed traumatic Achilles tendon rupture, complete rupture in the tendinous portion, a distal tendon stump of more than 2 cm within 14 days from injury were included in this study while patients with skin lesions, previous Achilles tendon or ankle surgery and distal tendon stump of smaller than 2 cm were excluded from the study.

Physical examination revealed a palpable defect within the Achilles tendon and a positive Thompson's test. All patients underwent preoperative MRI evaluation to assure that there was a distal tendon stump at least 2 cm and an appreciable gap between the two ends of the tendon (Figure 1).

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All the subjects of this study have been evaluated clinically at 9 weeks, 3, 6 months and then annually. We used AOFAS ankle-hind foot score to evaluate the subjective satisfaction at the most recent follow-up. Results were rated as excellent (100-90 points), good (89-80 points), fair (79-70), or poor (<70) according to Kitaoka et al. [7]. A post-operative MRI was performed at 10<sup>th</sup> week after surgery.

### Surgical technique

The operation was performed with the patients in prone position under spinal anesthesia and thigh tourniquet. Antibiotic prophylaxis was given before tourniquet inflation. Before starting the procedure, the rupture site was marked. The injured foot was positioned in approximately 15° of plantar flexion. 8 micro stab incisions 4 medial and 4 lateral to the Achilles tendon, 4 proximal and 4 distal to the site of rupture. The sutures were separated by 2 cm skin interval. The length of the incision was 5 mm each. The skin only was incised then the wound was dilated with a mosquito forceps (Figure 2)

A straight needle was utilized to deliver Ethibond No. 5 suture (Ethicon Inc., Johnson & Johnson, Somerville, NJ, USA). The Achilles tendon is gently palpated between the thumb and the index finger of the opposite hand to make sure that it is caught fully by the needle. To avoid the entrapment of the sural nerve, the skin on the lateral stab incisions were incised only then blunt dissection with mosquito forceps was performed to clearly define the course of the nerve (Figure 3).

We used one suture strand through the four distal incisions in a crisscross manner (Figures 4 and 5) and then the suture was delivered

in the same crisscross manner to the four proximal incisions as well (Figure 6). Then it was brought back distally towards the medial stab incision just distal to the rupture site. The two limbs of the suture were then tied at the medial incision just distal to the rupture site to avoid the sural nerve with the ankle in a position of 10° less than full planter flexion (Figure 7). We were careful to make the final knot not so prominent and well buried away from the subcutaneous area. The tendon gap was finally reduced.

Good gap reduction was confirmed if the tendon gap was no more clinically noticed and a negative Thompson's test in which the compression of the sural triceps evoked a plantar flexion of the foot (Figure 8). No drainage was used. The skin stab incisions are closed with no 0.3 silk sutures (Figure 9).

After surgery, above-knee plaster cast was applied with the foot in 10° less than full equines to protect skin vascularity and 70° of knee flexion for 6 weeks. At 6 weeks the cast was removed and a below knee walking cast was applied for 3 weeks. At 9 weeks the cast was removed and gentle range of motion exercise was encouraged for 3 weeks. At 12 weeks we started strengthening exercises and balancing board. Strenuous activities were allowed at 6 months post-operatively.

### Complications

Three patients experienced transient hypoesthesia in the dermatome of the sural nerve for 3 months after the operation and resolved spontaneously. Two patients had superficial wound infection.



Figure 1: Pre-operative MRI scan of a 49 years old male patient who sustained a traumatic closed rupture of his Achilles tendon, the scan shows a 2cm gap (yellow arrow) and more than 2 cm distal stump.



Figure 3: Intraoperative photo showing limited exposure of sural nerve (yellow arrow), straight needle passed dorsal to the nerve.



Figure 2: Intraoperative photo showing the patient in prone position and two distal stab incisions created.



Figure 4: Intraoperative photo showing a Straight needle deliver No 5 Ethibond suture in a crisscross fashion.



**Figure 5:** Intraoperative photo showing suture passed through the four distal stab incisions



**Figure 6:** Intraoperative photo showing suture passed through the proximal four incisions.



**Figure 7:** Intraoperative photo showing sutures brought back to the medial incision just distal to the rupture site.

These patients had diabetes mellitus, strict control of diabetes was adopted along with wound irrigation and antibiotics and ultimately wound healing occurred.

The first case had a prominent knot at the medial wound that was palpable and cumbersome to the patient so we waited till the MRI scan showed complete healing of the tendon at 10 week after surgery then we took the patient to theater and we excised the knot. We were keen during the following cases to bury the final knot away from the subcutaneous area.

The 1<sup>st</sup> case developed skin ischemic changes at the posterior ankle area that was discovered at 2 weeks postoperative during stitch removal (Figure 10). That was because we applied the plaster cast with the ankle in full planter flexion to optimize healing. So we reduced the degree of planter flexion 10 degrees and reapplied the cast. The skin condition improved greatly after two weeks (Figure 11). Later on we were keen to apply the plaster cast in 10° less than full planter flexion.



**Figure 8:** Intraoperative photo showing post-operative negative Thomson test with proper tendon repair (squeezing triceps surae planter flex the ankle).



**Figure 9:** Intraoperative photo showing skin closure.



**Figure 10:** Two weeks' post-operative photo showing skin ischemic changes (yellow arrow) due to maximal planter-flexion position in the plaster cast.



Figure 11: Four weeks' post-operative photo showing the patient in prone position and skin ischemic change resolved (yellow arrow).



Figure 14: Post-operative MRI scan at 10 weeks showing sound tendon healing and gap elimination with slight tendon hypertrophy (yellow arrow).

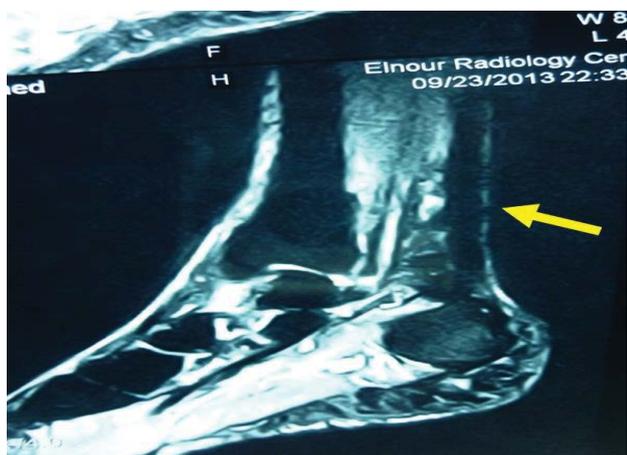


Figure 12: Post-operative MRI scan at 10 weeks showing sound tendon healing and gap elimination with no tendon hypertrophy (yellow arrow).



Figure 15: Twelve weeks' post-operative photo showing the patient with full plantar flexion.

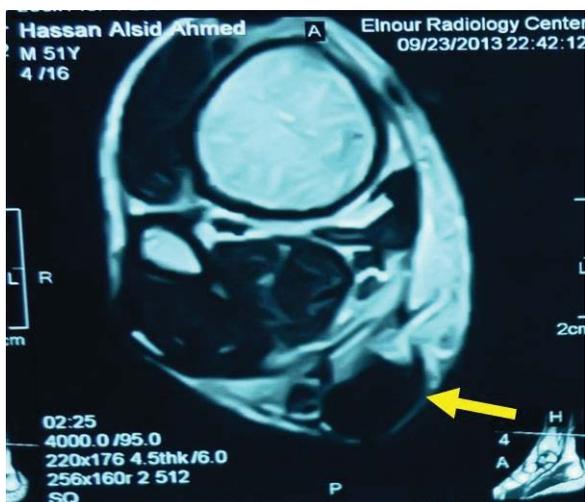


Figure 13: Post-operative MRI scan at 10 weeks showing axial cuts at the repair site showing sound tendon healing (yellow arrow).



Figure 16: Twelve weeks' post-operative photo showing the patient with full dorsiflexion.

## Results

All the patients were followed-up for 24 months after surgery. MRI scan was performed at 10 weeks after surgery for all cases. It showed that the Achilles tendon was already continuous and well defined, the



**Figure 17:** Twelve weeks' post-operative photo showing the patient is able to stand on his toes tips for 30 seconds.

fibers were clearly recognizable and longitudinally oriented and no tendon hypertrophy which is a frequent finding encountered with the other techniques (Figures 12 and 13). In two cases the post-operative MRI scan showed slight tendon hypertrophy (Figure 14).

At final follow-up the average range of ankle plantar flexion was 130° (range, 120°-140°) on the repaired side (Figure 15) and 143° (range, 120°- 155°) on the non-injured side. The average range of ankle dorsiflexion was 17° (range, 16°-21°) on the operated side (Figure 16) and 19° (range, 18°-22°) on the non- injured side. The mean calf diameter was 38.5 cm (range, 36-44 cm) on the operated side and 42.5 cm (range, 39- 45 cm) on the non- injured side. The interval between injury and return to regular work was 17 weeks (range 16-18 weeks).

All patients returned back to their previous activities, At the most recent follow-up, all of the patients were able to stand on their toe tips for more than 30 seconds (Figure 17). Ten patients could perform repeated toe rises for 30 seconds. Nine patients were able to perform single-limb hopping. The mean AOFAS score was 90 (80-98) at the most recent follow-up and 75% of patients' results were considered excellent while 25% were good. We had no re-ruptures.

The optimal recovery of strength and endurance of the calf muscles; for regular activity was regained at 3 months and for strenuous activities at 6 months after surgery.

## Discussion

It is not uncommon to encounter cases of traumatic rupture of the Achilles tendon. Perhaps the recorded rising incidence of new cases annually in trauma centers is multifactorial i.e. prevalence of diabetes mellitus, obesity and aging athletes. Because of increasing incidence of the Achilles tendon rupture during the past decade it has been a subject of focus in many studies and meta-analyses. To achieve optimum return of function, surgical repair is clearly superior to non-operative treatment [1].

Conservative treatment has less functional results with higher re-rupture rates. It carries also the risks of prolonged immobilization such as arthro-fibrosis, joint stiffness, calf atrophy, damage of the articular cartilage and deep vein thrombosis. The high rate of re-rupture is most probably due to prolonged immobilization that leads to a weakened atrophic less vascularized tendon which is prone to re-ruptures. That is why it should be kept for elderly and low demanding patients [8].

Numerous open surgical procedures have been proposed for repairing ruptures of the Achilles tendon, but there is no single, uniformly superior technique. Delayed wound healing, necrosis, suppuration and adhesions are potential complication of open procedures which are not

rare especially in diabetic patients and smokers. Open procedures with delayed tendon healing time are not suitable also for athletes wishing to return earlier to their preinjury activity level. Augmented open procedures have to be performed for neglected or defective Achilles tendon ruptures [9].

Percutaneous repair was 1st described in 1977 by Ma and Griffith with no re-ruptures and only two minor complications [5]. This has led some authors to develop new and alternative methods of percutaneous repair. Percutaneous or minimally invasive techniques are being used to minimize the typical complications associated with open surgery, and results are reported to be satisfactory and superior to open surgical procedures. On the other hand, an increased incidence of sural nerve injury has been reported after percutaneous repair [10].

This is probably due to the blind passing of the sutures through the skin and tendon. In a comparative study by Cretnik et al., [11] a higher percent of disturbance in sensibility was reported with a percutaneous repair group compared to an open repair group. According to Halasi et al., [12] although palpation and ultrasonography (US) can assist in adaptation control, these cannot substitute for normal visualization by the surgeon. Flavin et al., [13] suggested US mapping of the sural nerve in conjunction with percutaneous Achilles tendon repairs. The authors reported that the sural nerve can be easily visualized posterior to the lateral malleolus and along the lateral border of the Achilles tendon. They also reported that US had poor sensitivity for detection of the sural nerve approximately 4 cm proximal to the insertion of the Achilles tendon due to the presence of a network of subcutaneous veins. It is clear from the work of these authors that reliance on sonographic mapping of sural nerve during the procedure is not reliable [13].

The original technique described by Ma and Griffith suggested using six skin incisions, three lateral and three medial to the ruptured tendon [5]. In their series of 18 patients, there was no injury to the sural nerve or re-rupture. However, Rowley and Scotland [14] reported injury to the sural nerve in one of ten patients using the same technique and Klein et al., [15], reported five nerve injuries in 38 patients.

Cretnik et al. [11] suggested a percutaneous repair through eight holes, which were later used for needle entry and enlarged. The procedure was begun and finished medially and distally with crisscross sutures.

This procedure is contraindicated in the following situations, Pathologic rupture, more than 14 days since injury, beyond this timeline successful repair is unlikely due to chronic muscle/tendon retraction and interposed scar tissue and if the distal stump of the ruptured tendon less than 2 cm.

Formation and course of the Sural nerve in the foot and ankle is well known. However, there are limited data concerning the anatomical variations in the course of the sural nerve with its relation to Achilles tendon. These variations are important and should be recognized during percutaneous Achilles repairs. Variability in Sural nerve anatomy may be an important risk factor for direct injury in percutaneous techniques [16].

The proximal course of the sural nerve is from the midline toward the lateral border of the Achilles tendon. The nerve intersects with the lateral border of the Achilles tendon approximately at half the length of the tendon, 10.4 cm (range 5.7-15.5 cm) proximal to the lateral malleolus. Sutures placed near the lateral border of the tendon at a proximal level may put the sural nerve at risk of injury. Whereas sutures put into the tendon distal to the 55% fraction may have a lesser risk of sural nerve injury [16].

We totally agree with Cretnik that the blind passing of the sutures through skin and tendon is the real cause of sural nerve injury during the procedure. Our study is designed to avoid sural nerve injury during percutaneous repair of the Achilles tendon. The idea is to make a series of small 5 mm stab incisions on both sides of the tendon. On the lateral side of the tendon where the sural nerve is at risk, careful minimal dissection is carried out to visualize the nerve before needle passage. With this technique we can make sure that the sural nerve is well protected and we had no sural nerve injury in all our cases.

Regarding functional recovery, we observed that the healing time of the tendon was around 9 weeks (range 8 to 10 w) based on MRI studies. This was a major advantage of this procedure especially for our diabetic and smoker patients. This is probably because the paratenon is not violated by this technique. Also skin healing was optimal because of the limited stab incisions especially in diabetic patients. Because of these observations we were able to start rehabilitation program at 9 weeks post-operative. The two athletes participated in our study were greatly satisfied with the early rehabilitation protocol because they were able to return to their preinjury activity level in a relatively short time. Perhaps this was the greatest advantage of this technique over the other lines of treatment.

The power of the calf muscle was greatly restored by this technique as all the patients were able to stand on their toe tips for more than 30 seconds and the two athletic patients were able to return back to their same level of pre-injury athletic activity.

The power of the calf muscle was greatly restored by this technique. This was based on the following findings proved by our study

- 1- All the patients were able to stand on their toe tips for more than 30 seconds.
- 2- Ten patients could perform repeated toe rises for 30 seconds.
- 3- Nine patients were able to perform single-limb hopping.
- 4- The mean AOFAS score was 90 (80-98) at the most recent follow-up and 75% of patients' results were considered excellent while 25% were good.
- 5- The two athletic patients were able to return back to their same level of pre-injury athletic activity.
- 6- We had no re-ruptures.

The advantage of minimally invasive procedures is that it avoids the potential complications of open procedures which are not rare especially in diabetic patients and smokers. These complications include, 1-Delayed wound healing, necrosis, suppuration and adhesions. 2-Delayed tendon healing time, it is estimated in most studies describing open Achilles tendon repair that tendon healing time is around 3 to 6 months compared to only 9 weeks in percutaneous procedures. It also carries the risks of prolonged immobilization such as arthro-fibrosis, joint stiffness, calf atrophy, damage of the articular cartilage and deep vein thrombosis. The high rate of re-rupture is most probably due to prolonged immobilization that leads to a weakened atrophic less vascularized tendon which is prone to re-ruptures. It is also not suitable for athletes wishing to return earlier to their preinjury activity level.

We had three cases reported mild occasional pains with increased activities. These are two diabetic patients who developed wound infection and one case with prominent final knot that was treated by later excision; unfortunately these three patients were also smokers.

The final AOFAS score for these three cases were 80% and their final results were rated good. Surgeons should put in mind that Diabetes and smoking delay the healing time of the tendon and the overall results are less than optimal.

The other cases included in the study had a final AOFAS score above 90 and their results were rated excellent. All patients returned back to their previous activities including the two young athletes. The overall patient satisfaction with surgery was excellent due to the relatively short recovery time and the cosmetic appearance of the surgical wound.

## Conclusion

Percutaneous repair of acute closed rupture of Achilles tendon is a reproducible and effective method of treatment. It results into a strong and sound tendon healing in a relatively short time that allowed for early functional rehabilitation. The operative scar was minimal and cosmetic that added more to the overall patient satisfaction. The only drawback of this technique is the sural nerve injury. This can be eliminated by direct visualization of the nerve by very minimal blunt dissection through the lateral stab incision.

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