Mini-open repair for acute Achilles tendon rupture using the ring forceps technique

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Received 12 December 2018
Accepted 27 December 2018

The Egyptian Orthopaedic Journal
2018, 53:285–291

Background
Treatment of acute closed rupture of the tendo-Achilles is a challenge for the orthopedic surgeons. The aim of this study was to assess the results of repairing the tendo-Achilles using the ring forceps technique through a mini-open approach.
Patients and methods
A total of 21 adult patients with a closed rupture of the Achilles tendon were managed in Mansoura Emergency Hospital in the period between February 2009 and January 2013 with a mini-open technique using the ring forceps. Seventeen patients were males and only four females, and the mean age was 31 years, with a range 20–48 years. Rupture was diagnosed on the basis of a clinical examination, palpation of the defect, and a positive Thompson test result. Patient assessment at follow-ups was done using the American Orthopedic Foot and Ankle Society scoring system.
Results
Patients were followed up for a mean duration of 1.8 years (range, 1–3 years). All patients returned to their full preinjury level of activity. The mean American Orthopedic Foot and Ankle Society score was 100 (range, 100–100). No patient developed reruptures, sural nerve injury, wound infection, or deep venous thrombosis.
Conclusion
The management of acute closed rupture of the Achilles tendon with a mini-open technique using the ring forceps is an excellent way of management without skin complications or hazard on the sural nerve and with excellent functional results.

Keywords:
mini-open repair, ring forceps, tendo-Achilles, Thompson test

Egypt Orthop J 53:285–291

1110-1148

Introduction

Although the Achilles tendon is the largest and strongest tendon in the body, it is the most frequently ruptured, but the etiology of Achilles tendon ruptures is still not completely explained [1–3].

Surgery is the treatment of choice, and the nonoperative management is reserved mainly for elderly or more sedentary individuals [4]. Primary hematoma and soft tissue coverage play an essential role in the healing process; the thin soft tissue envelope and hypovascularity of the injury site may contribute to the healing problems [5].

The conventional open surgical approach for the repair of acute closed Achilles tendon ruptures allows clear visualization of the tendon and ensures anatomic apposition. The functional outcomes of this open approach are favorable. However, this extensive approach has a more risk of soft tissue problems and peritendinous adhesions, and the pure percutaneous techniques solved the problem of soft tissue healing and adhesions but with increased rerupture rate [6].

The mini-open technique was developed to avoid the extensive iatrogenic disruption of the subcutaneous tissues and paratenon and to avoid peritendinous adhesions that may develop with the standard conventional approach [7,8]. Despite the minimally invasive nature of the procedure, it allows anatomic apposition of the disrupted tendon. The mini-open repair represents an attractive procedure between the nonoperative, pure percutaneous, and open surgical repair, taking the advantages and avoiding the disadvantages of each method [6–8].

Patients and methods

From February 2009 through January 2013, 26 adult patients presented to Mansoura Emergency Hospital with a closed rupture of the Achilles tendon and were managed with a mini-open technique using the ring

 DOI: 10.4103/eoj.eoj_62_18

forceps. Five patients were lost to follow-up and were excluded from the study, so only 21 patients were included.

Patients with a chronic rupture of more than 3-week duration, an open rupture, a rupture not occurring between 2 and 8 cm proximal to the tuberosity of the calcaneus, patients with previous surgery on tendo-Achilles, patients with frayed tendons or those who had local or systemic steroid use during the 6 months before the rupture were excluded from the study.

Rupture of Achilles tendon was diagnosed on the basis of a clinical examination, palpation of the defect, and a positive calf squeeze test result (Thompson test) [9]. The rupture was owing to a sports-related activity in 12 patients and activities related to work in the remaining nine patients.

Operative technique

All the patients were managed with the same operative technique. After spinal anesthesia, a tourniquet is applied and the patient is placed in a prone position. Both legs are prepared and draped so that the tension of the Achilles tendons can be compared in both sides intraoperatively.

A 3-cm incision is done just medial to the gap in the tendon, and the fascia and paratenon were divided in the same line. The proximal and distal parts of the ruptured tendon are identified, and the paratenon is carefully opened.

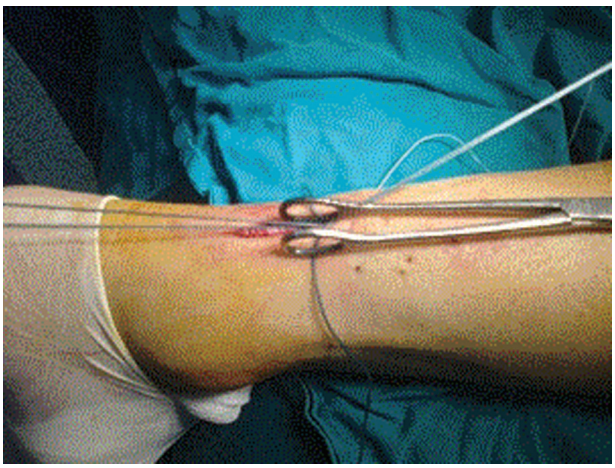
The ring forceps is introduced between the tendon and the paratenon with the tendon being positioned between both arms of the ringed forceps, which is advanced to grasp a large segment of the tendon, and then three no: 5 Ethibond sutures attached to a straight needle are passed through the skin in one stump of the tendon through the rings of the forceps at approximately 1-cm intervals. The forceps is then withdrawn pulling the sutures with it, so that the sutures lie between the tendon and the paratenon holding only the tendon, and the same maneuver is applied to the other stump.

One pair of the proximal sutures is then tightened to a pair of the distal sutures with the foot in plantar flexion taking the contralateral side as a guide to assess the tendon tension. The order of the sutures is not critical to the healing but for arrangement. We tightened the sutures near the rupture first and then go outward. The knots are better to be proximal or distal away from the rupture site (Figs 1–6).

Figure 1

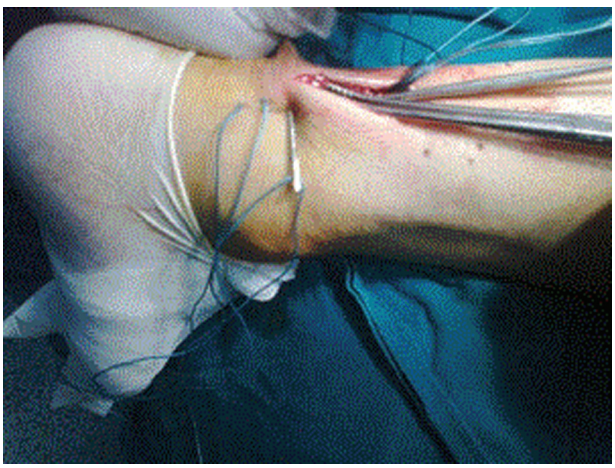
Ring forceps grasping the proximal part of the ruptured tendon and the needle passes through the rings of the forceps.

Figure 2



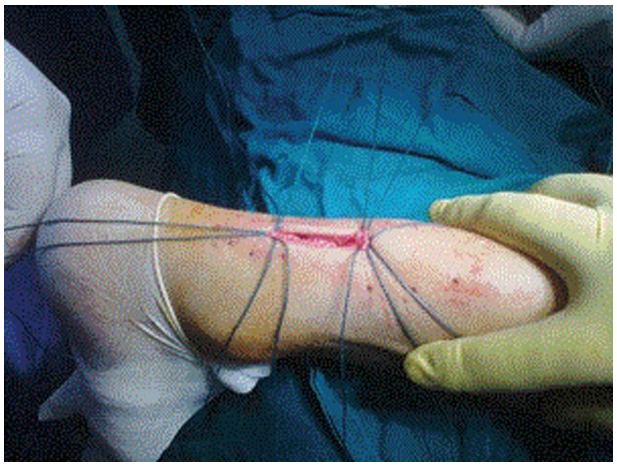
Forceps is withdrawn from the incision, pulling the sutures from the surrounding tissue leaving them through the tendon only and between it and the paratenon.

Figure 3



Forceps grasping the distal part of the ruptured tendon and the needle passes through the rings of the forceps.

Figure 4



The proximal and distal sutures are withdrawn from the incision.

Figure 5

The proximal and distal sutures are tightened to each other holding the proximal and distal parts of the ruptured tendon. The paratenon is still open.

Figure 6

The small incision after closure of the paratenon and skin.

Absorbable sutures, 3.0 vicryl suture, are used at the site of rupture to augment the repair and ensure anatomic tendon apposition. Paratenon is then closed with 3.0 vicryl suture, and the skin incision is then closed without drain. Ankle orthosis is applied postoperatively.

The authors followed the early functional rehabilitation program instituted by Assal *et al.* [10] as follows: in the first 2 weeks, patients are allowed partial weight-bearing with the ankle orthosis locked in 30° of plantar flexion. Sutures are removed by the end of the second week.

By the third week, gentle unloaded active flexion extension of the ankle (with extension of the ankle limited to neutral) is begun; the goal is to reach a neutral ankle position by the end of the third week.

Full weight-bearing is allowed after 3 weeks with the ankle in neutral position. The orthosis is removed by the end of 8 weeks.

Patients bear weight supported with two crutches during the first 6 weeks and one crutch for an additional 4 weeks. An intensive program of ankle motion, stretching, isometric, and proprioceptive exercises is instituted. Jogging is allowed at 3 months, and more demanding sports activity is permitted at 6 months [10].

Patient assessment at follow-ups is done using the American Orthopaedic Foot and Ankle Society scoring system (100 points; 40 for pain, 50 for function, and 10 for alignment) [11] The circumference of the calf, and range of ankle motion were also assessed. The integrity of the sural nerve was confirmed in all cases.

Results

A total of 21 patients with acute rupture of the tendo-Achilles were managed through mini-open approach using the ring forceps technique and were followed up for a mean duration of 1.8 years (range, 1–3 years) (Table 1). Seventeen patients were males and four were females. The rupture was on the right in 12 patients and on the left in nine. The mean time between the injury and repair was 5 days (range, 1–16 days). The mean age of the patients was 31 years (range, 20–48 years).

The tendon healed and the Thompson test result became negative in all patients. All patients returned

Table 1 Summery of the results of the study

Patients	Age (years)	Sex	Side	Mean range of dorsiflexion and plantar flexion on the affected side (deg.)	Mean range of dorsiflexion and plantar flexion on the healthy side (deg.)	Mean of inversion and eversion on the affected side (deg.)	Mean of inversion and eversion on the healthy side (deg.)	Calf circumference atrophy (mm)	Score
1	25	Male	Rt	70	70	60	60	8	100
2	20	Male	Rt	58	70	60	60	7	100
3	27	Male	Lt	56	60	50	55	10	100
4	48	Female	Rt	63	68	50	55	14	100
5	21	Male	Lt	58	65	60	60	12	100
6	20	Male	Rt	65	65	54	58	7	100
7	30	Male	Rt	55	55	60	60	9	100
8	22	Female	Lt	63	65	55	57	10	100
9	31	Male	Rt	70	70	51	55	7	100
10	33	Female	Rt	56	60	60	60	8	100
11	28	Male	Lt	60	60	60	60	9	100
12	30	Male	Lt	62	70	53	57	7	100
13	39	Male	Rt	63	65	60	60	7	100
14	40	Male	Lt	60	65	50	55	9	100
15	35	Male	Rt	70	70	60	60	8	100
16	29	Female	Rt	57	59	55	60	10	100
17	29	Male	Lt	64	65	50	55	8	100
18	30	Male	Rt	57	60	58	60	9	100
19	41	Male	Lt	54	60	60	60	7	100
20	37	Male	Lt	60	65	54	57	12	100
21	35	Male	Rt	60	60	54	54	11	100

Lt, left; Rt, right.

to their preinjury level of activity. No patient in this study had a rerupture of the tendon. None of the patients had sensory disturbances in the sural nerve distribution. No patient had a deep or a superficial wound infection or deep venous thrombosis.

The mean American Orthopedic Foot and Ankle Society score was 100 (range, 100–100) as no patient in this study had pain, limitation of function, or abnormal alignment at the last follow-up [11]. Active maximum plantar flexion and dorsiflexion at follow-up were comparable to the contralateral legs. The mean on the affected side was 61° (range, 20° dorsiflexion to 50° plantar flexion) and on the healthy side was 64° (range, 20° dorsiflexion to 50° plantar flexion). There was no limitation of eversion and inversion as compared with the contralateral side. The mean in the affected side was 56° (range, 20° eversion to 40° inversion) and on the healthy side was 58° (range, 20°eversion to 40° inversion). Calf circumference was diminished in the injured leg as compared with the contralateral leg in all cases, with a mean atrophy of 9 mm (range, 7–14 mm).

Discussion

The Achilles complex has a somewhat tenuous blood supply and is continuously exposed to high-tensile repetitive stresses; hence, the Achilles tendon disorders are common complaints in Orthopedic Clinics [12].

The tendon is surrounded by a paratenon, which aids in tendon glide and supports vasculature. Blood supply to the Achilles tendon arises from the musculotendinous junction, the osseous insertion, and multiple mesotenal vessels. The mesotenal vessels supply most of the nutrition to the tendon, but a watershed area exists ~2–6 cm proximal to the calcaneal insertion [12].

The best treatment of acute ruptures of the Achilles tendon is a controversy [4].

The optimal treatment is still evolving. Most authors have favored operative over nonoperative repair. Operative repair has a lower rerupture rate but a higher risk of complications such as infection, sural nerve injury, and scar contracture [13].

The results of the nonoperative treatment are extremely variable. Wallace and colleagues reported excellent results; in contrast, Persson and Wredmark noted seven reruptures in a series of 27 patients treated nonoperatively. Nonoperative treatment results in lower calf muscle function when compared with ruptures treated operatively [4,14,15].

Conservative management may lengthen the tendon, altering its function, necessitating reconstructive surgery, which may be avoided if surgery is performed as the initial treatment [16].

Surgical repair of an Achilles tendon rupture reduces the rerupture rate but increases the risk of infection when compared with conservative management. Wong and colleagues and Lo and colleagues reported rerupture rates of 10.7 and 11.7%, respectively, for nonoperatively treated patients, and Lo and colleagues reported a rerupture rate of 2.8% for operatively managed patients [17–19].

Operative intervention allows restoration of the normal tension and length of the tendon with a lower rate of rerupture. The disadvantages of surgical intervention include morbidity from wound problems. Most authors have concluded that surgery is the treatment of choice with nonoperative management reserved mainly for elderly or more sedentary individuals [12].

Khan *et al.* [20] reported that the risk of rerupture was lower with operative (3.5%) when compared with nonoperative (12.6%) treatment.

Wilkins and Bisson in their meta-analysis study to compare the outcomes of open surgical repair of acute Achilles tendon ruptures with nonoperative management found that the rate of tendon reruptures was lower in surgical group (3.6%) compared with for nonsurgical (8.8%). The open surgery group has a higher rate of deep infection (2.36 vs. 0), noncosmetic scar (13.1 vs. 0.62%), and sural nerve sensory disturbances (8.76 vs. 0.78%). Deep vein thrombosis did not differ significantly [21].

The poor blood supply of the traumatized skin close to the tendon increases the risk of wound infection, which is more common with the open approach, and is reduced by percutaneous techniques [16].

Percutaneous repair results in optimal functional outcome, like that of the traditional open repair, while decreasing wound complications but with increased risk of rerupture and of damage to the sural nerve in the early reports [22].

Sural nerve damage and rerupture are the most important complications after percutaneous repair. However, the results are improving with modification of the technique. Medializing the proximal incision helps to reduce the risk of sural nerve damage [16].

Sural nerve damage can cause altered dermatomal sensation or a painful neuroma, a risk that can be minimized using the medial proximal incision [16].

Lim *et al.* [23] advocate percutaneous repair over open surgical techniques. They found no significant differences in functional results but a lower infection rate and a more cosmetic appearance with the percutaneous repair.

Cretnik *et al.* [24] found significantly fewer complications in percutaneous repairs when compared with open repair. There were, however, slightly more reruptures and sural nerve injuries in percutaneous repairs without effect on functional results.

In the purely percutaneous technique, the rupture is not directly exposed, which may limit the ability to anatomically oppose the torn tendon ends, which increases the rerupture rate.

In the mini-open procedure, anatomic tendon apposition is facilitated without the extensive exposure traditionally performed for Achilles tendon repair. This mini-open procedure combines the advantages of the open technique (anatomic apposition of the tendon stumps) and the percutaneous technique (minimal damage to blood supply and epitendon) [6].

The mini-open approach like the percuteneous technique has the benefits of less disruption of the tendon sheath, therefore more preservation of the blood supply, better tendon gliding and less risk of wound complications, while avoiding to a great extent the drawbacks of the percuteneous technique like poor purchase of tendon ends and the risk of sural nerve injury.

In this study, authors used the ring forceps technique to allow suture purchase in a longer distance of the tendon proximally and distally through a limited skin incision. Ring forceps technique used sutures with a single pass through the tendon with the free ends of the sutures lie between the tendon and paratenon; thus, on tightening these sutures, the sural nerve outside the paratenon is protected.

Huffard *et al.* [25] in their biomechanical study found that the pullout strength of three suture pairs with single passes through the tendon is superior to two suture pairs woven through the tendon. In this study, no patient had a rerupture, which supports the results of Huffard *et al.* [25].

Ring forceps technique has the same principle that of the Achillon system, with the advantage of using a simpler device available in the instrument sets in every theater [26].

Assal and colleagues, who developed the Achillon found no wound problems or nerve injuries, with only 3.7% rerupture rate when using the Achillon. However, in open repair, Rippstein *et al.* [8] reported sural nerve injuries (7%), deep infection (4%), superficial wound problems (14%), scar sensitivity (6%), and rerupture (7%) [10].

The mini-open repair had limited complications as compared with the traditional open repair.

Strauss *et al.* [27] recorded significant postoperative complications for open repair such as superficial and deep wound infections, and partial or complete rerupture in spite of end-to-end repair.

Minimally invasive Achilles tendon repair has been shown to be a safe and time-preserving procedure, although certain distinct risks associated with the minimally invasive approach continue to exist. Lansdaal *et al.* [28] in their prospective study showed a 92% satisfaction rate with 5.5% major complications requiring reoperation for reruptures deep infections and tendon necrosis, and 9.2% of their patients experienced sural nerve dysfunction.

Postoperative rehabilitation after the operative repair of Achilles tendon rupture is evolving. The classic rigid immobilization in a short-leg nonweight bearing cast for 6 weeks followed by range-of-motion and strengthening exercises is being challenged by functional protocols with early weight bearing and range of motion in a walking boot or modified orthosis [12].

Operatively treated Achilles tendon rupture followed by a weight-bearing functional rehabilitation protocol is becoming a more standard approach to care and seems to improve patient outcomes and satisfaction with a balanced acceptable risk of complications [12].

Conclusion

The management of acute closed rupture of the Achilles tendon with a mini-open technique using the ring forceps is an excellent way of management without skin complications or hazard on the sural nerve. Early functional rehabilitation program results in excellent function, and it is to be recommended as a protocol for management.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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