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Percutaneous versus open repair of acute Achilles tendon ruptures

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Abstract

Background Controversy exists regarding the optimal treatment for acute Achilles tendon ruptures. Conservative and surgical treatments have been reported with variable results and complications rates. The purpose of this study is to compare the postoperative clinical and functional results of percutaneous versus open repair of acute Achilles tendon ruptures.

Materials and methods We present 34 patients with acute Achilles tendon ruptures treated with open and percutaneous surgical repair. There were 15 patients who had open surgical repair and 19 patients who had percutaneous repair. The mean follow-up was 22 months (range 10–24 months) for the open repair group and 20 months (range 9–24 months) for the percutaneous repair group; no patient was lost to follow-up. Postoperative rehabilitation was the same for both groups. Wound healing, complications, ankle range of motion, and patients' return to work, activity level, weight-bearing, and subjective assessment of their treatment were recorded.

Results No significant difference was observed with respect to any of the examined variables between the open and percutaneous repair groups. Tendon healing was observed in all patients of both groups by 7–9 weeks. The mean time of patients' return to work was 7 weeks for the open repair group

and 9 weeks for the percutaneous repair group. All patients were capable of full weight bearing by the 8th postoperative week time; the time to return to previous activities including non-contact sports was 5 months for both groups. All patients expressed satisfaction and graded their treatment as good. As expected, cosmetic appearance was significantly better in the percutaneous repair group. One patient who had open repair experienced skin incision pain and dysesthesia and graded his operation as fair. No patient experienced other complications such as re-rupture, infection, sural neuroma, or Achilles tendinitis within the period of this study.

Conclusions The present study showed similarly successful clinical and functional results after both open and percutaneous repair of acute Achilles tendon ruptures are similar. Cosmetic appearance is superior in the group of patients who had a percutaneous treatment.

Keywords Achilles tendon rupture · Percutaneous repair · Open repair

Introduction

The Achilles tendon is the largest and strongest tendon in the human body. However, its rupture is common in middle-aged active men, especially athletes, with a male to female ratio of 4.8:1 [1]. The cause of ruptures is multifactorial [2, 3]; 78 % of ruptures occur in athletic activities during a sudden acceleration and deceleration [2, 4]. Physical examination is diagnostic; magnetic resonance (MR) is useful for ambiguous cases, partial ruptures, and subacute or chronic injuries for preoperative planning. Although MR imaging has superior specificity compared to ultrasonography, it is time consuming, expensive and may lead to treatment delay [5].

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Controversy exists regarding the optimal treatment for acute Achilles tendon ruptures [6–12]. Conservative and surgical treatments have been reported with variable results and complications rates [6–12]. Surgical repair can be open, minimally invasive, or percutaneous [10–12]. Management often depends on the patient's activity level, age, personal preference, time interval from injury, and surgeon's preference [10]. Inappropriate treatment of Achilles tendon ruptures can lead to considerable functional impairment [11, 12]. Open surgical repair of acute Achilles tendon ruptures has been a lower risk of re-rupture with conservative treatment; the range of re-rupture after open surgical repair ranges from 1.4 to 2.8 % compared to 12 to 17 % after conservative treatment. However, open surgery has been associated with a higher cost and a higher risk of other complications including infection, adhesions, and wound healing problems such as suture reactions, hematoma formation, incisional neuromas, and granulomatous reaction; their rates range from 11.8 to 20 % [4, 13, 14].

Percutaneous surgical repair of acute Achilles tendon ruptures combines the advantages of conservative and open surgical technique, with optimum postoperative function [4, 15–18]. Re-rupture rate is significantly lower (6.4 %) compared to conservative treatment, and wound complications, cost, and cosmesis are significantly improved compared to open surgical repair [15–18]. Percutaneous repair of acute Achilles tendon ruptures has shown rapid return to full weight bearing, complete recovery of strength and full range of ankle motion due to stimulation of healing of the Achilles tendon in a more natural way compared to any treatment option [4, 15–18]. Sural nerve injury and neuroma formation is a major complication of percutaneous acute Achilles tendon repair ranging from 13 % to 60 % [4, 16–18].

This article presents a series of patients with acute Achilles tendon ruptures treated with open and percutaneous surgical repair. The purpose is to compare the postoperative clinical and functional results of these patients.

Materials and methods

We present 34 patients with acute Achilles tendon ruptures diagnosed and treated at the authors' institutions from January 2007 to December 2011. The diagnosis of rupture was based on a palpable tendon gap, positive Thompson test [19], and inability of plantar flexion. In ambiguous cases, ultrasonography was performed (4 patients). All patients had type II Achilles tendon rupture, which is a complete rupture with a tendinous gap ≤ 3 cm located 2–6 cm proximal to the calcaneal insertion of the tendon (Fig. 1). Fifteen patients (13 males, 2 females; mean age, 40 years; age range 28–50 years) had open surgical repair,



Fig. 1 MR imaging shows complete Achilles tendon rupture

and 19 patients (15 males and 4 females; mean age, 42 years; age range 25–58 years) had percutaneous repair. The patients were randomly allocated into the two treatment groups according to the order of their presentation (one by one); the last two patients had percutaneous repair because of the surgeon's preference. The mean follow-up was 22 months (range 10–24 months) for the open repair group and 20 months (range 9–24 months) for the percutaneous repair group; no patient was lost to follow-up.

All patients were operated within the first 48 h after their injury. Open repair was done with epidural or general anesthesia through a posteromedial ankle incision approximately 10 cm long and 1 cm medial to the tendon's edge (Fig. 2a). Suturing was done using Krackow et al. [20] technique with a non-absorbable No. 1 suture (Ethicon, Inc., Johnson & Johnson, Somerville, NJ) (Fig. 2b). Percutaneous repair was performed under local (10 patients) or spinal anesthesia (nine patients) according to Ma and Griffith's technique [21]. Depending on the length of the tendon, five or six 1-cm stab incisions were performed lateral and medial of the tendon, proximally and distally to the gap (Fig. 3). To minimize the risk of sural nerve injury, we always identified the nerve from the proximal lateral stab incisions (Fig. 4). Percutaneous suturing was done with long Keith needles (Ethicon, Inc., Somerville, NJ) using the same type of sutures with open repair. The needle was inserted transversely through the proximal stab incisions, and the suture was advanced through the proximal tendon stump (Fig. 5a). Then, the needle was advanced obliquely to the opposite middle or distal stab incision to the distal stump of the tendon (Fig. 5b, c). The suture was secured to the distal tendon by transverse advancement of the Keith needle (Fig. 5d). Finally, the suture ends were advanced to the middle stab incision and tied with the

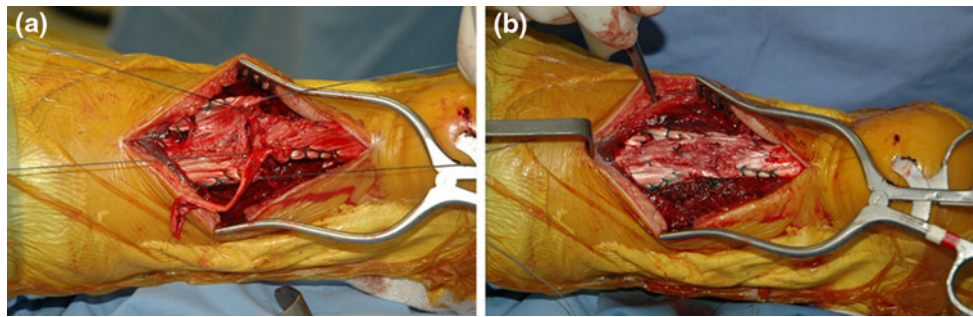


Fig. 2 Intraoperative photographs show open repair of an acute Achilles tendon rupture through a posteromedial ankle incision (a) using Krackow et al. [20] technique (b)



Fig. 3 Five or six 1-cm stab incisions were performed laterally and medially to the tendon, proximal and distal to the gap



Fig. 4 The sural nerve was identified from the proximal lateral stab incisions to minimize the risk of nerve injury

ankle in plantar flexion to close the rupture gap (Fig. 6). In both groups, the skin incisions were closed with nylon sutures No. 3–0.

Postoperative rehabilitation was the same for both groups including 3 weeks of immobilization in a non-weight-bearing cast in maximum plantar flexion, followed by gradual decrease in plantar flexion until neutral ankle position in a functional brace and progressive weight bearing within the following 3–4 weeks [22]. The skin sutures were removed within 15 days after surgery in all patients.

Routine clinical follow-up was performed at 2, 4, 8, and 12 weeks, 6, 12, and 24 months. Wound healing, complications, ankle's range of motion, and patients' return to work, activity level, weight-bearing, and subjective assessment of their treatment were recorded. Functional evaluation was done using the ankle–hindfoot scale of the rating system developed by the American Foot and Ankle Society (AOFAS score) [23], the Thompson test [19], and the single leg rise test [11]. Subjective assessment of treatment was graded as good, fair, or poor based on the occurrence of minor, general, or major complications according to Maffulli et al. [24].

Statistical analysis was done with the Fisher's exact test for categorical variables and the Student's *t* test for comparisons between the groups. The data were recorded in a Microsoft Excel sheet (Microsoft Corporation, USA) and analyzed using SPSS[®] 20 statistical software (SPSS Inc., Chicago, IL, USA). *p* values < 0.05 were considered significant.

Results

No significant difference was observed with respect to any of the examined variables between the open and percutaneous repair groups ($p > 0.05$, Table 1). Tendon healing was observed in all patients of both groups by 7–9 weeks. The mean time of patients' return to work was 7 weeks for the open repair group and 9 weeks for the percutaneous repair group. All patients were capable of full weight bearing by the 8th postoperative week time; the time to return to previous activities including non-contact sports

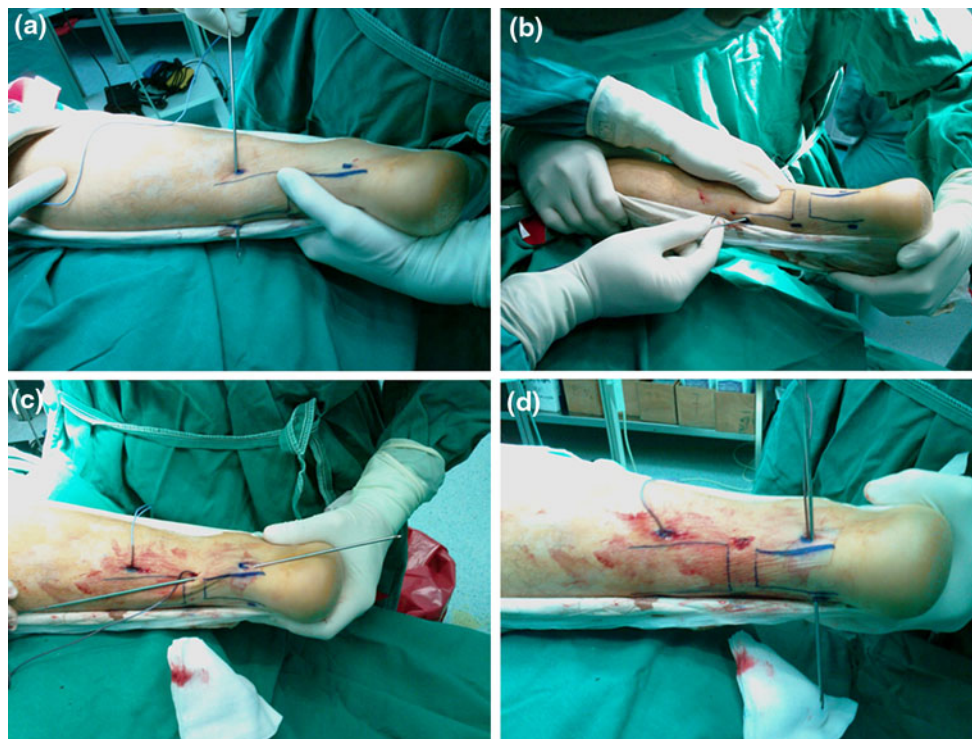


Fig. 5 A long Keith needle (Ethicon, Inc., Somerville, NJ) was inserted transversely through the proximal stab incisions and the suture was advanced through the proximal stump of the tendon (a). Then, the needle was advanced obliquely to the opposite distal (b) or

middle (c) stab incision to the distal stump of the tendon. The suture was secured to the distal tendon by transverse advancement of the Keith needle (d)



Fig. 6 The suture ends were advanced to the middle stab incision and tied with the ankle in plantar flexion to close the rupture gap

was 5 months for both groups. At the last follow-up, the mean AOFAS score was 98 points (range 89–100 points) for the open repair group and 95 points (range 84–100 points) for the percutaneous repair group. In all patients, Thompson test was negative, and all were capable of single leg rise on their toes. Less than 5 degrees loss of dorsal and plantar ankle flexion of the injured leg was observed in all patients (Fig. 7a, b).

All patients expressed satisfaction and graded their treatment as good. As expected, cosmetic appearance was significantly better in the percutaneous repair group (Fig. 8). One patient who had open repair experienced skin incision pain and dysesthesia and graded his operation as fair. No patient experienced other complications such as re-rupture, infection, sural neuroma, or Achilles tendinitis within the period of this study.

Discussion

The goals of management of Achilles tendon ruptures are to minimize the morbidity of the injury, optimize return to full function, and prevent complications. Current evidence suggests that open compared to percutaneous repair has lower rate of re-rupture, higher rate of return to pre-injury activity level, higher complication rates, namely infection, and almost the double cost [25–28]. In 1977, Ma and Griffith [21] were the first to describe a percutaneous technique for the repair of acute Achilles tendon rupture; their technique became popular with many modifications thereafter [29–31]. In a small subset of patients, it was found that percutaneous treatment had no difference in strength and endurance in plantar flexion [32]. No

Table 1 Clinical and functional results of open and percutaneous repair of acute Achilles tendon ruptures at the last follow-up

Variables	Open repair (15 patients)	Percutaneous repair (19 patients)
Time to return to work (weeks)	7	9
Time to return to previous activities (months)	5	5
Time to full weight bearing (weeks)	8	8
AOFAS score (mean, range) [23]	98 (89–100)	95 (84–100)
Thompson test [19]	Negative	Negative
Single leg rise test [11]	Normal	Normal
Ankle range of motion (degrees)	<5 loss of dorsi/plantar flexion	<5 loss of dorsi/ plantar flexion
Subjective assessment of treatment (patients)		
Good	14	19
Fair	1	–
Poor	–	–
Complications (patients)	Skin incision pain and dysesthesia (1 patient)	–

There were no statistical significant differences between open and percutaneous groups with respect to the examined variables ($p > 0.05$)

significant differences, also, were found in a long-term retrospective study between conservative, open and percutaneous repair in terms of muscle volume, tendon's length, and days off-work [33]. However, Lim et al. [34] randomized 66 young patients to compare open and percutaneous repair of acute Achilles tendon ruptures. They found a higher rate of wound infections (21 vs. 9 %) in the open repair group, and re-ruptures and functional results comparable in both groups. These authors advocated percutaneous repair on the basis of the lower rate of complications and improved cosmetic appearance of the leg [34]. Similarly, another study [35] reported equally good results in terms of low risk of re-rupture and complications, and satisfactory clinical and functional outcomes between percutaneous and minimally invasive repair of Achilles tendon ruptures [35]. Using novel techniques such as the use of local anesthesia [38] or three midline stab incisions [17], the risk of sural nerve injury has been reduced [36, 37]. These studies concluded that percutaneous compared to open repair techniques are associated with a lower rate of complications without a significant increase in the rate of re-rupture [2, 17, 35–38]; possibly, postoperative cast immobilization followed by a functional brace may reduce the overall complications rate [13].

Relatively little information is available regarding the management of acute Achilles tendon ruptures in patients

**Fig. 7** Dorsal (a) and plantar flexion (b) 8 weeks after percutaneous repair



Fig. 8 Cosmetic appearance of the posterior ankle and leg 4 weeks after percutaneous repair

older than 65 years [24, 39]. Conservative and surgical treatment of acute Achilles tendon rupture in this age group of patients has been associated with less successful results compared to young adults, namely reduction in ankle function, and higher rate of complications including re-rupture, deep venous thrombosis, infection, sural nerve injury, and skin adhesions [39]. However, percutaneous repair in this age group has shown similarly successful results with percutaneous repair in younger patients and suggested that percutaneous method is a suitable option for patients older than 65 years [24].

In conclusion, the present study showed similarly successful clinical and functional results after both open and percutaneous repair of acute Achilles tendon ruptures. Only one patient who had open repair experienced a wound complication and graded his treatment as fair. As expected, cosmetic appearance was superior in the group of patients who had a percutaneous treatment. The major and most common complication of percutaneous repair, sural nerve injury, was controlled by direct observation of the nerve through the proximal lateral wound stab incisions.

Conflict of interest None of the authors have any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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