Comparison between percutaneous and open repair in acute tendon Achilles rupture in active young patients

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Abstract---Background; the Achilles tendon is the strongest and yet most commonly ruptured tendon, in the human body, its rupture is known to be increasing. It occurs more commonly in men in the third or fourth decade of life and more frequently on the left side. Most ruptures occur during sports activities. Aim and objectives; to compare between percutaneous and open repair of acute tendon Achilles rupture in active young patients who are willing to resume sports activity after the repair. Subjects and methods; This prospective comparative study was conducted, including 30 patients divided randomly into two groups A and B (each consists of 15 patients). Group A underwent percutaneous repair while group B were managed by open repair. The study was conducted at Al-Azhar university hospitals (Al-Hussien and Sayed Galal). The duration of the study ranged from 6-12 months. Result; No statistically significant difference was detected between the two techniques regarding functional results (full weight-bearing, return to activity, muscle strength, and AOFAS score) at last follow-up. However, patients in the percutaneous group were able to achieve significantly larger degrees of ankle plantar flexion compared to the open group. Conclusion; there is no difference between percutaneous and open repair of Achilles tendon at the long-term follow up. Both groups had equal functional outcomes however the percutaneous repair of Achilles tendon was associated with less wound complications than open repair.
Introduction

The Achilles tendon is the strongest and yet most commonly ruptured tendon, in the human body, its rupture is known to be increasing. It occurs more commonly in men in the third or fourth decade of life and more frequently on the left side. Most ruptures occur during sports activities. Moller et al. suggested the incidence is increasing, perhaps due to an increase of sport activities in the population. Management options include open repair, percutaneous repair, and non-operative techniques, depending on the preferences of the surgeon and patient. Re-rupture rate is less frequent following surgery. There is a lack of agreement of the optimal treatment for the acute Achilles tendon rupture (AATR). Reports in the literature are equivocal or even contradictory. Currently, there are four different types of interventions, including two types of surgical repair, (1) open, or (2) minimally invasive procedures, and two types of nonoperative conservative management, (3) simple immobilization, or (4) functional bracing. 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. Many studies were done to achieve a definite optimum treatment for acute Achilles tendon rupture but no conclusive result was given. Moreover, no studies were done to detect the efficacy of different surgical methods of repair for the young active patients who will resume their activity postoperatively.

Subjects and Methods

This prospective comparative study was conducted at Al-Azhar university hospitals (Al-Hussien and Sayed Galal) on 30 patients with acute tendon Achilles rupture. Patients were divided randomly into two groups: Group A (15 patients): underwent percutaneous repair. Group B (15 patients): was managed by open repair.

Inclusion criteria

Age group from 15 to 40 years old with acute Achilles tendon rupture, active personnel or sports player, acute rupture of Achilles tendon, isolated Achilles tendon injury and first time injury.

Exclusion criteria

Age group below 15 or above 40 years old, comorbid diseases, patients who intend to stop practicing exercises, chronic Achilles tendon rupture, polytrauma patients and/or associated ipsilateral fractures and rerupture.
Methods

All patients included in the study were subjected to the following:

- Detailed history taking including: Personal history (Name, age and sex), time of trauma, mood of trauma, medical comorbidities as (DM, Rheumatoid...etc.) and past history of previous operative procedure.
- General examination: Vital signs (Blood pressure, Temperature, Heart rate, Respiratory rate) and signs of (Pallor, Cyanosis, Jaundice, and Lymph node enlargement).
- Investigations: Liver function tests (AST, ALT, ALP, serum bilirubin, serum albumin, Prothrombin time and I.N.R, serum creatinine and complete blood count (CBC).
- Subjective assessment through: Patient satisfaction through a questionnaire with a scale from 1 to 5 given to every patient asking for their satisfaction about both function of the limb and cosmetic look as following: 1- Very dissatisfied, somewhat dissatisfied satisfied, neither satisfied nor dissatisfied, somewhat satisfied and very satisfied. Doctor satisfaction through the same scale given to both the surgeon and other orthopedic surgeons.

Surgical methods used in the study
Percutaneous surgical repair (modified Ma and Griffith)

A longitudinal incision of 2 cm was made directly over the rupture. The proximal and distal tendon stumps were located. Two incisions of 1 cm were made 12–15 cm above the rupture site, 4 cm medially and laterally of the dorsal midline. Dissection to the soleus fascia was made in order to avoid the sural nerve. Two incisions of 1 cm were made medially and laterally to the distal stump of Achilles tendon. A straight needle holding the surgical thread was inserted through the incisions made around the proximal stump from the lateral side towards the medial side passing through the stump itself exiting from the core of the stump at the rupture site. The same is done through the distal stump. While pulling the two intratendinous strings distally, the stumps of the ruptured tendon were approximated. The strings through the distal and the proximal stump are tied and buried making the two stumps in close contact. Ethipond is surgical thread used. The paratenon was closed with resorbable 2.0 thread and the skin with 2.0 PDS. The 1-cm incisions were closed using simple interrupted sutures. A below-knee cast was applied in the equinus position of the ankle for two weeks, the sutures are removed after two weeks. Then a below-knee cast was applied for two weeks in neutral position of the ankle, lastly a below-knee walking cast is applied for another two weeks.

Open surgical repair (krackow technique)

The patient was placed prone with a thigh tourniquet for hemostasis. The contralateral extremity also could be draped for comparison of resting length. A 6- to 8-cm longitudinal incision typically follows the medial edge of the Achilles tendon, but laterally and centrally based incisions had been advocated. Medial placement avoids the sural nerve, allows the plantaris to be accessed easily, and
minimizes postoperative skin breakdown. The subcutaneous tissue and fat were divided until the crural fascia overlying the tendon is reached. Care was taken not to undermine the skin. The ankle was plantar flexed to expose and approximate the tendon ends. The tendon ends can be left alone and approximated without debridement. In biomechanical studies, the Krackow technique had proven stronger than either the Bunnell or Kessler suture configuration but this has not been proven to have clinical significance. Newer polyester sutures had significantly higher failure strength than traditional polyester material. The paratenon may have to be divided further to expose the tendon ends. The final repair was reinforced with interrupted sutures. The foot position should match the contralateral side (resting equinus). Excessive debridement may cause overtightening and prompt the need for advancement. Closure of the paratenon layer following tendon repair reduces skin tension and prevents adhesions. Biomechanical testing also demonstrates that this paratenon closure significantly increases the strength of the final repair. The skin was then closed with an interrupted 3-0 nylon monofilament closure.

**Statistical Analysis**

Description of means and standard deviation for quantitative variables and frequencies and percentage for qualitative variables were calculated using SPSS Version 22.0 (IBM Corp, Armonk, NY). Data were found to follow a normal distribution using Shapiro-wilk test. To compare preoperative and postoperative data between groups, Chi-square test was used for categorical variables, while independentsample t-test was used for numerical variables. P value less than .05 was considered to declare statistical significance.

**Results**

A total of 30 patients (15 patients in each group) were enrolled in our study. All patients were followed up for a minimum of 12 months. As shown in Table 1, no statistically significant difference was found between groups regarding baseline demographics, including age, gender, mechanism of trauma, side of injury, time to surgical repair, and follow-up duration.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Comparing Demographic Data Between Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group A (n=15)</td>
</tr>
<tr>
<td>Age (years)*</td>
<td>27.5 ± 7.2</td>
</tr>
<tr>
<td>BMI (kg/m²)*</td>
<td>26.5 ± 3.2</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>12 (80)</td>
</tr>
<tr>
<td>Female</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Mechanism of Trauma</td>
<td></td>
</tr>
<tr>
<td>Falling from height</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Sports injury</td>
<td>12 (80)</td>
</tr>
</tbody>
</table>
Sports injury was the dominant mechanism of injury in our series, representing 80% of group A and 73% of group B. In group A, seven (47%) patients were football players, three (20%) were basketball players, and two (13%) were volleyball players. In group B, six (40%) patients were football players, four (27%) were basketball players, and one (7%) was a volleyball player. Only three (20%) patients in group A and four (27%) patients in group B injured their Achilles tendons by falling from heights (Figures 1a and 1b). No statistically significant difference was found between groups in terms of mechanism of injury (Chi-square test, \( P = .874 \)).

**Figure 1a.** Mechanism of Injury (Group A)

(Figure showing the distribution of mechanisms of injury in group A, with falling from height, football, basketball, and volleyball indicated.)

**Figure 1b.** Mechanism of Injury (Group B)

(Figure showing the distribution of mechanisms of injury in group B, with falling from height, football, basketball, and volleyball indicated.)

The mean time to surgery in group A was 28.7 ± 12.1 hours (range, 12 – 48 hours). The mean time to surgery in group B was 28.4 ± 10.3 hours (range, 10 –

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to Surgery (hours)</td>
<td>28.7 ± 12.1</td>
<td>28.5 ± 10.3</td>
<td>.962 a</td>
</tr>
<tr>
<td>Follow-up period (months)</td>
<td>18.4 ± 4.1</td>
<td>18.9 ± 5.1</td>
<td>.784 a</td>
</tr>
</tbody>
</table>

BMI: Body mass index

* Data are presented as mean ± standard deviation; ** Data are presented as number (percentage).

a Independent sample t test; b Chi-square test.
45 hours) (Figure 2). No statistically significant difference was found between groups in terms of time to surgery (Independent sample t test, \( P = .962 \)).

![Figure 2: Time to Surgery](image)

In group A, patients were followed up for an average period of 18.4 ± 4.1 months (range, 13 – 24 months). In group B, patients were followed up for an average period of 18.9 ± 5 months (range, 12 – 26 months) (Figure 3). No statistically significant difference was found between groups in terms of follow-up duration (Independent sample t test, \( P = .784 \)).

![Figure 3. Follow-up Duration](image)

In the percutaneous group, the average operating time was 28.2 ± 3.6 min (range, 23 – 37 min). On the other hand, the average operating time in the open group was 50.2 ± 8.2 min (range, 38 – 64 min). There was a statistically significant difference in surgical time between groups in favor for the percutaneous group (Independent sample t test, \( P = .000 \)) (Figure 4).
As shown in Table 2, group A demonstrated significantly better aesthetic results in comparison with group B as regards scar length and cosmetic appearance.

Table 2. Comparing Aesthetic Results Between Groups

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=15)</th>
<th>Group B (n=15)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scar Length (cm) '</td>
<td>2.8 ± 0.4</td>
<td>11.7 ± 4.5</td>
<td>.000 a</td>
</tr>
<tr>
<td>Cosmetic Appearance **</td>
<td></td>
<td>11 (73)</td>
<td>.012 b</td>
</tr>
<tr>
<td>Excellent</td>
<td></td>
<td>3 (20)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>4 (27)</td>
<td>6 (40)</td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>0 (0)</td>
<td>5 (33)</td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>0 (0)</td>
<td>1 (7)</td>
<td></td>
</tr>
</tbody>
</table>

* Data are presented as mean ± standard deviation; ** Data are presented as number (percentage).

a Independent sample t test; b Chi-square test.

As demonstrated in Table 3, no statistically significant difference was detected between the two techniques regarding functional results (full weight-bearing, return to activity, muscle strength, and AOFAS score) at last follow-up. However, patients in the percutaneous group were able to achieve significantly larger degrees of ankle plantar flexion compared to the open group.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=15)</th>
<th>Group B (n=15)</th>
<th>P value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to Full Weight-Bearing (weeks) '</td>
<td>7.1 ± 1.1</td>
<td>7.9 ± 1.4</td>
<td>.074 a</td>
</tr>
<tr>
<td>Return to Activity **</td>
<td></td>
<td></td>
<td>.666 b</td>
</tr>
<tr>
<td>Yes</td>
<td>12 (80)</td>
<td>11 (73)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (20)</td>
<td>4 (27)</td>
<td></td>
</tr>
<tr>
<td>Time to Return to Activity (months) '</td>
<td>5.3 ± 0.7</td>
<td>5.9 ± 0.9</td>
<td>.066 a</td>
</tr>
<tr>
<td>Muscle Strength **</td>
<td></td>
<td></td>
<td>.166 b</td>
</tr>
<tr>
<td>Grade V</td>
<td>8 (53)</td>
<td>3 (20)</td>
<td></td>
</tr>
<tr>
<td>Grade IV</td>
<td>4 (27)</td>
<td>7 (47)</td>
<td></td>
</tr>
<tr>
<td>Grade III</td>
<td>3 (20)</td>
<td>5 (33)</td>
<td></td>
</tr>
<tr>
<td>Plantar Flexion (degrees) '</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. Surgical Time

![Surgical Time](image.png)
Injured side & Uninjured side
---
42.3 ± 5 & 35.3 ± 2.8 & .000
42.1 ± 4.7 & 44.7 ± 2.3 & .065

P value
---
.882 & .000

Dorsal Flexion (degrees) *
---
Injured side & Uninjured side
---
24.9 ± 2.9 & 23.1 ± 2.4 & .079
25.3 ± 2.7 & 23.3 ± 2.6 & .054

P value
---
.747 & .830

AOFAS Score (points) *
---
92.5 ± 5.7 & 89.7 ± 5.6 & .195

AOFAS: American Orthopaedic Foot & Ankle Society

* Data are presented as mean ± standard deviation; ‡ Data are presented as number (percentage).

a Independent sample t test; b Chi-square test.
† Comparison between group A and group B; ‡ comparison between injured and uninjured sides within each group.

At last follow-up, the mean AOFAS score in group A was 92.5 ± 5.7 points (range, 80 – 100 points). Similar results were achieved in group B where the mean AOFAS score was 98.7 ± 5.6 points (range, 80 – 100 points). No statistically significant difference was detected between groups in terms of functional scores (Independent sample t test, P = .195) (Figure 5).

As illustrated in Figure 6, a total of seven (47%) and 10 (67%) patients developed at least one postoperative complication in group A and group B, respectively. No statistically significant difference was detected in the overall complication rate between groups (Chi-square test, P = .269).
In group A (Figure 7), 40% of patients were very satisfied, 40% were somewhat satisfied, 13% were neither satisfied nor dissatisfied, 7% were somewhat dissatisfied, and none were very dissatisfied. Regarding surgeon’s satisfaction, they were very satisfied with 53% cases, somewhat satisfied with 40%, neither satisfied nor dissatisfied with 7%, and dissatisfied with no cases. Regarding other surgeons’ satisfaction, they were very satisfied with 47% cases, somewhat satisfied with 40%, neither satisfied nor dissatisfied with 13%, and dissatisfied with no cases.
Discussion

The Achilles tendon is the primary plantar flexor of the ankle joint, and it is considered the strongest tendon in the body. The Achilles tendon rupture most commonly occurs in the third to fourth decade of life specifically in males during sports activities. Acute Achilles tendon rupture is a common injury. A variable incidence is reported, depending on the population studied, with 5.5 to 9.9 ruptures per 100,000 people in North America and six to 18 ruptures per 100,000 in reports of European communities. They occur more commonly in men in the third or fourth decade of life and more frequently on the left side. Most ruptures occur during sports activities. Moller et al. suggested the incidence is increasing, perhaps due to an increase in sport activities in the population.

As regard demographic data, there was no statistically significant difference found between groups regarding baseline demographics, including age, gender, mechanism of trauma, side of injury, time to surgical repair, and follow-up duration. Our results were supported by study of Hosny et al., as they reported that Twenty patients were included in our study. 10 patients were subjected to percutaneous repair and 10 patients were subjected to open repair. All patients were followed up for at least one year. Age ranged from 10 to 60 years. Mechanism of injury was sharp objects in 15 patients, rupture Achilles tendon while practicing sports in 3 patients and 2 patients had injury due to falling from height. 17 patients were male. The right foot was affected in 12 cases. 17 cases had open acute Achilles tendon rupture while 3 case had closed acute Achilles tendon rupture. There was no statistically significant difference between the studied groups regarding age, gender, mechanism of trauma and side of injury.

Similarly, Schrinneret al. performed surgical revisions of closed acute Achilles tendon ruptures in our hospital in 146 patients, of which 71 patients (2012-2014) received percutaneous suturing using Dresden instruments, and 75 patients (2009-2012) underwent open suturing. There was no statistically significant difference between the studied groups regarding age, gender and side of injury. The current study showed that in the percutaneous group, the average operating time was 28.2 ± 3.6 min (range, 23 – 37 min). On the other hand, the average operating time in the open group was 50.2 ± 8.2 min (range, 38 – 64 min). There was a statistically significant difference in surgical time between groups in favor for the percutaneous group (Independent sample t test, P = .000). Our results were in line with study of Haji et al., as they reported that the mean operating time was 28.5 minutes in the percutaneous group (range, 20–50 minutes), compared with 45.9 minutes (range, 18–80 minutes) in the open group. Statistical analysis using a nonparametric t test (Mann-Whitney U) showed this difference to be significant (p < .0001). A tourniquet was used in 46 (66%) open operations due surgeon's preference in achieving hemostasis. In contrast, none were used with percutaneous repair.

The present study showed that group A demonstrated significantly better aesthetic results in comparison with group B as regards scar length and cosmetic appearance. The mean length of surgical scar in group A was 2.8 ± 0.4 cm (range, 2.2 – 3.5 cm), whereas the average scar length in group B was 11.7 ± 4.5 cm (range, 6 – 20 cm). The surgical scar was significantly smaller in the percutaneous
group compared to the open group (Independent sample t test, $P = .000$). The majority (73%) of patients in group A reported excellent cosmetic appearance of their surgical scar. In contrast, in group B, only three (20%) patients reported excellent cosmeses, and 12 (80%) reported either good (40%), regular (33%), or bad (7%) results. The difference in cosmetic appearance between groups was statistically significant (Chi-square test, $P = .012$).

In accordance with our results study of Henríquez et al., as they reported that mean scar length was greater in the open repair group (9.5 cm) than in the percutaneous repair group (2.9 cm). The largest incision (19.5 cm) was present in the same patient with wound complications who required soleus flap and augmentation. A higher number of patients in the percutaneous repair group (nine) than in the percutaneous repair group (three) qualified the cosmetic appearance as excellent. A similar number of patients qualified the incision as good in both groups. The present study showed that a total of seven (47%) and 10 (67%) patients developed at least one postoperative complication in group A and group B, respectively. No statistically significant difference was detected in the overall complication rate between groups ($P = .269$). Our results were supported by study of Henríquez et al., as they reported no statistically significant difference was detected in complication rate between groups. Three of the four postoperative complications occurred in patients from the open repair group. Two wound complications and one re-rupture were found in this group. Re-rupture and wound dehiscence occurred in the same patient. This patient needed surgical grafting and transposition of the flexor hallucis longus tendon. Another complication occurred in a patient with a dehiscence treated medically. In the percutaneous repair group, one case of deep venous thrombosis of the calf occurred. After medical treatment, the patient was discharged and had no additional complication. All of the complications presented themselves before 6 months after surgery in both groups.

Also, Hosny et al., revealed that there was no statistically significant difference in complication rate between groups. Wound infection occurred in two cases while delayed skin healing occurred in one case in patients who treated with open repair, and they were treated with antibiotics, continuous dressing and complete wound healing had been occurred with no residual complications apart from a big skin scar. These complications were not experienced in patients with percutaneous repair. Other complications as skin necrosis, wound fistula, sural nerve injury and tendon rerupture had not been experienced throughout the study in both groups. All patients were subjected to Achilles Tendon Rupture Score (ATRS) at the final follow up. The score (ATRS) yielded nearly similar results for both groups. Our results showed that in group A, 40% of patients were very satisfied, 40% were somewhat satisfied, 13% were neither satisfied nor dissatisfied, 7% were somewhat dissatisfied, and none were very dissatisfied. Regarding surgeon’s satisfaction, they were very satisfied with 53% cases, somewhat satisfied with 40%, neither satisfied nor dissatisfied with 7%, and dissatisfied with no cases. Regarding other surgeons’ satisfaction, they were very satisfied with 47% cases, somewhat satisfied with 40%, neither satisfied nor dissatisfied with 13%, and dissatisfied with no cases.
While, in the study of Karabinas et al., all patients expressed satisfaction and graded their treatment as good. 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.

**Conclusion**

There is no difference between percutaneous and open repair of Achilles tendon at the long-term follow up. Both groups had equal functional outcomes however the percutaneous repair of Achilles tendon was associated with less wound complications than open repair. We advise percutaneous Achilles tendon repair as it was associated with less wound complications and better cosmetic appearance compared to open Achilles tendon repair.

**Declarations**

**Consent for Publication**

I confirm that all authors accept the manuscript for submission

**Availability of data and material:** Available

**Competing interests:** None

**Funding:** No fund

**Conflicts of Interest**

The authors declare no conflicts of interest regarding the publication of this paper.

**References**


