Subcutaneous Achilles tendon rupture: A comparison between open technique and mini-invasive tenorrhaphy with Achillon(®) suture system

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ABSTRACT

Background: Surgical management of Achilles tendon rupture is still controversial: open techniques have a higher rate of soft tissue complications but a lower incidence of re-rupture than percutaneous tenorrhaphies. The aim of our retrospective study was to analyze and compare clinical and functional results in patients treated with either the conventional open or minimally invasive suture treatment with the Achillon® system.

Methods: A retrospective review of 140 patients was performed; 72 were treated with open tenorrhaphy, 68 with the minimally invasive Achillon® suture system.

Results: With a comparable re-rupture rate, there was a statistically significant reduction in surgical time, incidence of minor complications, time required to return to sport activities and return to work in the minimally invasive group.

Conclusions: Achillon® mini-invasive suture system is a reliable tool for the Achilles tendon ruptures, able to reduce the incidence of soft tissues complications if compared to the classic open tenorrhaphy, while maintaining strength of the suture and leading to superimposed functional outcomes.

Keywords:

Achilles Tendon Lesion, Achilles Tendon Rupture, Tenorrhaphy, Percutaneous, Minimally invasive repair, Achillon, subcutaneous

Introduction.

No epidemiologic studies were so far performed to detect the worldwide incidence of the Achilles tendon rupture. Nevertheless, the literature reports it as a frequent event in North Europe and America (18.4/100,000 per year, range 6-37.3) [1,2] that predominantly affects active men aged, on average, between 30 and 46 years [3,4,5].

The treatment of choice for the Achilles tendon rupture is still controversial. The currently available surgical techniques can be divided into three categories: open, percutaneous and minimally invasive (mini-open) tenorrhaphies. The most important post-operative complication in Achilles tenorrhaphy is re-rupture, which is quite uncommon using the open technique [6]. Nevertheless, it is well-known that classic tenorrhaphies have a high incidence of soft tissue damage, which occurs in 20% of patients [7]. In order to reduce this kind of complication, several Authors have proposed percutaneous tenorrhaphy techniques [8]. Although percutaneous techniques have excellent results with regard to soft tissue complications, some studies have shown a higher re-rupture rate with these techniques [9,10]. Percutaneous techniques are also associated with iatrogenic damage to the sural nerve, caused by entrapment in the suture [10,11,12]. Therefore, minimally invasive tenorrhaphy has been proposed in order to circumvent these limitations. The objective is to decrease the skin and wound complications of the open techniques, while at the same time maintaining the same characteristics of reliability of the suture regarding re-rupture rate [13,14,15,16,17]. The main advantages of this approach are the possibility of direct visualization of the lesion, as well as reduced surgical invasiveness. In 1996, Assal developed a device dedicated to the minimally invasive technique, called Achillon®, which is indicated when the subcutaneous rupture lies more than 2 cm or less than 8 cm from the posterior calcaneal tuberosity and when the surgery is performed within 10 days of the trauma [18]. As already reviewed, the Achillon® suture system is characterized by a low rate of re-rupture

(3.2%) and few complications on soft tissues [19], which are lower than those generally observed after open techniques [20].

Currently, a few studies have been devoted to comparing minimally invasive tenorrhaphy and other techniques [13,14,15,16,17], but these are always based on a small number of cases. The purpose of this retrospective study was to enroll a large patient cohort, compare the effectiveness of open tenorrhaphy and the Achillon® technique in treating Achilles tendon ruptures, and possibly highlight the benefits of the latter in terms of incidence of complications, rehabilitation timing, and reduction of lost working days.

Methods.

General information

Protocol approval for retrospective chart study was obtained from our Institutional Review Board. The study included patients surgically treated by open tenorrhaphy or Achillon® minimally invasive surgery for subcutaneous Achilles tendon rupture between May 2010 and August 2014 at the CTO Hospital of Turin. All patients operated with alternative techniques (percutaneous or minimally invasive device other than the Achillon® system) and patients with Achilles tendon rupture caused by an external agent or secondary to a previous tenorrhaphy were excluded. The presence of metabolic disorders, such as diabetes or hypercholesterolemia, has not been considered as and exclusion criterion. The series was thus made up of 160 patients. In order to obtain informed consent, all patients were first contacted; 20 were untraceable and were excluded. Patients were followed up to two years.

The evaluated outcomes included major complications (re-rupture, deep infection, skin necrosis, deep venous thrombosis, pulmonary embolism, death), minor complications (delayed wound healing, scar adhesion, sensation disorders in the sural nerve territory), time between the lesion

and surgery (in days), surgical time (in minutes), return to sport, post-operative sport level reached (complete skill recovery or not), time to return to work and previous sport level (in days and months, respectively). Data were gathered by consulting medical records and through direct assessments.

Surgical technique and patient groups

The 140 patients were divided into two comparison groups on the basis of their surgical treatment: open tenorrhaphy (n=72) or Achillon® technique (n=68). The choice between the two treatment protocols was subjectively case-to-case done by the surgeon.

Open tenorrhaphies were conducted using the typical Kessler suture method [21]. Patients were placed prone with a thigh tourniquet. A 6-8 cm long incision on the medial edge of the Achilles tendon was performed. The subcutaneous tissue and fat were dissected; the peritenon was longitudinally cut to expose the lesion. Then, the ankle was plantar flexed to expose and hold the tendon stumps. After the #2 absorbable braided suture, the repair was completed by tubulization with #3-0 or #4-0 absorbable braided sutures. Subsequently, accurate closure of the peritenon was performed to reduce and prevent scar tissue adhesions. The skin was then closed with #3-0 nylon monofilament suture.

In the Achillon® group, injury was localized pre-operatively by echography and confirmed by clinical landmarks at time of surgery. Thus, the patients were positioned prone. A longitudinal medial skin incision was performed along the lesion and extended from 1.5 to 3 cm (Fig. 1A). The subcutaneous tissue was dissected, the peritenon was centrally cut, loaded with sutures and opened on the two sides to enable the inspection of the lesion and subsequent actions. The device was then inserted and pushed proximally, with the two inner arms below the peritenon, surrounding the tendon stump (Fig. 1B). When the device proximally reached a safe tendon area,

three sutures were inserted in succession, through the skin, peritenon and tendon, using the holes of the device (Fig. 1C). The device was then extracted from the skin access, pulling the sutures into the tendon inside the peritenon and then exiting from the skin access at the site of the injury (Fig. 1D). The procedure was repeated on the distal side, then the tendon was sutured to the correct length under visual control (Fig. 1E). Finally, accurate peritenon closure and suturing of the skin incision were performed.

Postoperative treatment

In patients treated with open tenorrhaphy, a more prudent rehabilitation protocol was employed in order to minimize the risk of a perturbed healing process, as suggested by classical studies [22,23]. Otherwise, in the Achillon® group it was possible to employ a more intensive rehabilitation program, because of the reduced invasiveness to the soft tissues.

In the open tenorrhaphy postoperative protocol, a non-weight-bearing short-leg cast was used in gravity equinus for 4 weeks after surgery. Then, serial casting with an articulated brace was started to gradually adjust the ankle to 90° by 8 weeks post-surgery. Then, weight-bearing was permitted with a functional position locked by brace or cast for another 4 weeks. Finally, free and full weight-bearing was allowed with a 2.5 cm heel until 6 months post-surgery.

In the minimally invasive Achillon® group, a non-weight-bearing short-leg cast was used in gravity equinus for 20 days after surgery. Then, active mobilization without weight-bearing was permitted, with gradual recovery of the functional position by the sixth week. Afterwards, loading with the plaster or brace locked at 90° was allowed until 60 days after surgery. Subsequently, gradual full weight-bearing was regained, with a 2.5 cm heel until 6 months post-surgery.

Statistical analysis

In order to calculate the incidence of major and minor complications, the number of patients who returned to sport and the final sport activity level reached was analyzed using the χ^2 test with the Yates correction. The surgical time, months to return to sport and days to return to work were analyzed using the two-tailed t-test. All analyses were carried out with GraphPad Prism version 6.0e (GraphPad Software, San Diego, CA, USA) with $p < 0.05$ as the significant cut-off.

Results

Patients

Men made up 85% (119/140) of the cohort, whose average age was 42.8 years (range 21-75). According to the surgical technique applied, patients were classified in two groups, which were characterized by a homogeneous distribution in terms of demographic parameters. In fact, no differences were detected between the two groups considering gender, age, concomitant diseases, body mass index (BMI) and number of people practicing sports (Table 1).

Tenorrhaphy

The time between the Achilles tendon rupture and the surgery was similar in the two groups. On average, it was 7.8 ± 8.7 days for patients undergoing open tenorrhaphy, compared to 7.0 ± 3.0 days of those treated with the Achillon® device. The high standard deviation in the open technique group was due to "delayed" surgery (>20 days) in 6 patients.

The surgical time was significantly reduced due to the employment of Achillon® device. In fact, the open surgery lasted 46.7 ± 9.4 minutes, which were limited to 39.3 ± 5.8 minutes in the mini-open technique with the use of Achillon® device ($p<0.001$).

Postoperative morbidity

In the postoperative period, 4 patients (5.6%) belonging to the open surgery group had occurrence of major complications, whereas those treated with the Achillon® suture system developed them in 2 cases (2.9%, p=0.729). The different major complications with their frequency in the two patient populations were described in table 2. In particular, the occurrence of tendon re-rupture was sporadic in both groups. Furthermore, one of the two re-ruptures that occurred in the minimally invasive treatment group was consequent to an accidental trauma, a few days after surgery, at a moment in which the patient was without the protection of the brace despite medical indications.

On the contrary, the open tenorrhaphy group recorded the occurrences of minor complications in 18 patients (25%), which are opposed to the 2 cases detected following the use of Achillon® suture system (2.9%, p<0.001). This difference is due to a significant reduction (p<0.05) of delayed wound healing and scar adhesion incidences in the mini-open tenorrhaphy group. No differences were otherwise observed in terms of sural nerve disorders (table 3).

Functional outcomes

The working days lost after the Achilles tendon rupture were significantly higher for patients undergoing open tenorrhaphy (85.2 ± 55.8 days) with respect to those treated with the Achillon® device (66.5 ± 50.9 days, p<0.05).

No difference was detected between groups regarding the percentage of patients who return to sports (53/68 after open tenorrhaphy and 56/64 following mini-open surgery; p=0.223) as well as who completely recovered the pre-injury sports skill (42/53 and 50/56, respectively; p=0.238). However, patients undergoing Achillon® minimally invasive surgery return to sports significantly earlier (6.1 ± 2.5 months) than those treated with the traditional open tenorrhaphy (8.0 ± 3.2 months; p<0.05).

Discussion

Up to now, relatively few studies comparing minimally invasive tenorrhaphy and other techniques are available in literature [13,14,16,17,18]. Furthermore, with the exception of a review (summarizing 8 different studies) [19], the cohorts were generally limited at few tens of patients. Here, in our knowledge, we analyzed the outcomes of the so far largest cohort treated for Achilles tendon rupture by either classic open or minimally invasive tenorrhaphy with the employment of Achillon® suture system, two techniques characterized by the absence of absolute contraindications.

The employment of Achillon® suture device reduced the surgical time by more than 15%, if compared with the classic open technique. On average, such reduction led the time requested for surgery under the 40 minutes and, together with the less invasiveness of the procedure, it could be at the basis of the low infection risk typically associated with this type of surgery [19].

Consequently and similarly to those already reported [20], the overall incidence of complication was lower in patients treated with the Achillon® device with respect to those undergoing open tenorrhaphy, despite the latter had a more conservative rehabilitation protocol. In particular, in the former group, we did not detect any delay in wound healing and the occurrences of scar adhesion were limited at two cases of 68 patients. Furthermore, no sural nerve disorders were reported in the Achillon® group at the follow-up, clue that the device is able to avoid one the common side effects of other minimally invasive procedure like the percutaneous technique [10,11,12]. Moreover, occurrences of deep infections and deep venous thrombosis have been detected only in patients treated with open tenorrhaphy, confirming the increased invasiveness of this type of surgery.

Nevertheless, the most important post-operative complication in Achilles tenorrhaphy is the re-rupture of tendon, which is proportionally more common with the reduction of surgical invasiveness [6,9,10]. Here, we achieved a quite identical re-rupture rate between the two considered surgical approaches. In fact, we observed a single case (1.4%) after open tenorrhaphy and two cases (2.9%) after the employment of the Achillon® device, one of which attributable to a second accidental trauma rather than result of the surgical choice. These data confirm the reliability of the Achillon® suture system which already proved a low rate of re-rupture [19] and demonstrated a suture strength comparable to that of the Kessler-type end-to-end suture used in the classical technique [24].

The lower incidence of complications achieved in our patient cohort treated with the Achillon® device, together with the associated shorter rehabilitation protocol, could be responsible of the rapid return to work (about 2 months) and sports (about 6 months) typical of this procedure [25,26]. In our cohort, the employment of Achillon® suture system significantly reduced (by more than 20%) the working days lost during the healing (66.5 days against 85.2 days after open surgery). Similarly, patients treated with the Achillon® device who decided to return to sports required about 24% less time (6.1 months) with respect to those undergoing classic open treatment (8.0 months). Anyhow, the percentage of patients in the two groups who practice sports again was similar, and often they recovered completely the pre-injury skill.

Conclusion.

Achillon® suture system is a reliable tool able to reduce the incidence in soft tissue complications if compared to the classic open tenorrhaphy, while maintaining the strengths and leading to superimposed functional outcomes. The shorter time of surgery and rehabilitation, as well as the

lower amount of work days lost, are further advantageous factors in terms of both patient's life quality and social cost.

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Table 1. Demographic parameters

	Open tenorraphy	Achillon®
Age, y		
Mean	42.5 ± 11.1	43.1 ± 9.9
Range	21-75	26-73
Gender		
Male	60/72 (83.3%)	59/68 (86.8%)
Female	12/72 (16.7%)	9/68 (13.2%)
BMI	24.8 ± 3.6	25.4 ± 3.2
Metabolic disorders†	6/72 (8.3%)	10/68 (14.7%)
People practicing sports	68/72 (94.4%)	64/68 (94.1%)

† Metabolic disorders included diabetes, hypercholesterolemia, hyperuricemia, and metabolic pathologic obesity. * = $P < 0.05$

Table 2. Major complications

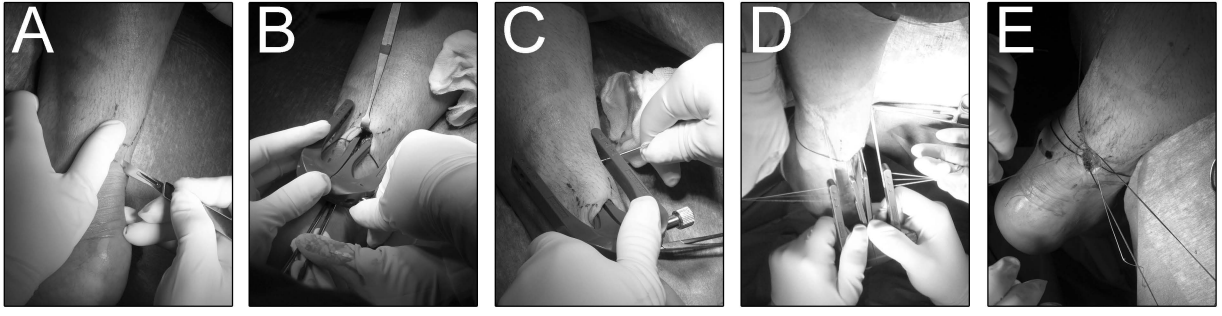
	Open tenorraphy	Achillon®
Rerupture	1/72 (1.4%)	2/68 (2.9%)
Deep infections	2/72 (2.8%)	0/68 (0.0%)
Cutaneous necrosis	0/72 (0.0%)	0/68 (0.0%)
Deep venous thrombosis	1/72 (1.4%)	0/68 (0.0%)
Pulmunary embolism	0/72 (0.0%)	0/68 (0.0%)
Death	0/72 (0.0%)	0/68 (0.0%)

* = $P < 0.05$

Table 3. Minor complications

	Open tenorraphy	Achillon®	
Delayed wound healing	6/72 (8.3%)	0/68 (0.0%)	*
Scar adhesion	11/72 (15.3%)	2/68 (2.9%)	*
Sural nerve disorders	1/72 (1.4%)	0/68 (0.0%)	

* = $P < 0.05$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