

## Original Article

# Achilles tendon repair by a minimally invasive technique using Tenolig®

Vinicius Cambaúva Menescal de Oliveira<sup>1</sup> , Sérgio Damião Santos Prata<sup>1</sup> 

1. Hospital Santa Marcelina, São Paulo, SP, Brazil.

## Abstract

**Objective:** To assess the degree of postoperative satisfaction of patients with acute Achilles tendon rupture who underwent surgical reconstruction by a minimally invasive technique using Tenolig®.

**Methods:** A retrospective observational study was conducted with 18 patients with acute Achilles tendon rupture diagnosed by a positive Thompson test who underwent surgery. Outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score and the Foot Function Index (FFI). Furthermore, quantitative variables were descriptively treated, and patients' age was correlated with FII and AOFAS score using Spearman's correlation coefficient at a significance level of 5%.

**Results:** Patients underwent surgery from one to six days after injury and were discharged one day later. Only one patient had a superficial postoperative infection. Patients' AOFAS scores ranged from 75 to 100 points, and FFI ranged from 0 to 20%. The patient with superficial postoperative infection had an AOFAS score and a FFI of 75 points and 20%, respectively.

**Conclusion:** Percutaneous repair of complete Achilles tendon rupture with Tenolig® resulted in high functional scores and a low rate of complications.

**Level of Evidence IV; Therapeutic Studies; Case Series.**

**Descriptors:** Achilles tendon; Rupture; Orthopedic procedures; Patient satisfaction.

## Introduction

Achilles tendon rupture is the third most frequent tendon injury in the human body and the most frequent in the lower limb<sup>(1)</sup>.

The Achilles tendon, the longest (15cm) and strongest tendon in the body, originates in the gastrocnemius and soleus muscles and is inserted in the posterior portion of the calcaneus; it also has the highest rates of rupture.

In 1990, G. T. Kuwada published a classification system of Achilles tendon rupture to guide treatment options. Type 1 injuries are partial ruptures that should be treated by immobilization with cast. Type 2 injuries consist of those with complete rupture and a tendinous gap smaller than 3cm between the stumps with the ankle at 90 degrees, and their recommended treatment is end-to-end tenodesis. Type 3 injuries, which have a tendinous gap from 3 to 6cm, may be treated with V-Y advancement, tend transfer, Bosworth turndown, or a combination of the three. Injuries measuring more than 6cm

require gastrocnemius elongation, free tendon graft, synthetic graft, or a combination of these methods<sup>(2)</sup>.

The treatment of this problem is controversial among the professionals, since some of them advocate for conservative methods and others prefer surgery. Conservative treatment requires prolonged immobilization, does not pose risks for complications or skin infection, but has high rates of rerupture, tendon elongation, and muscle mass loss. Conversely, open surgery restores tendon continuity, but poses risk for adhesions and skin complications (profound infection and tendon adherence), in addition to neurologic injury. Several percutaneous techniques have been described since 1977, such as the Tenolig® (FH Orthopaedics, Heimsbrunn, France), a device developed to maintain the tendon in contact with each other. The Tenolig® kit consists of two wires with anchors at one end and needles at the other end; two washers and two polyethylene disks for securing the distal end of the wire<sup>(3,4)</sup>.

Study performed at the Hospital Santa Marcelina, São Paulo, SP, Brazil.

**Correspondence:** Vinicius Cambaúva Menescal de Oliveira. 9 do Vale Av., Renascença, São Luís, Maranhão, Brazil, Zip Code: 65075-660. **Conflicts of interest:** none. **Source of funding:** none. **Date received:** August 27, 2020. **Date accepted:** November 30, 2020. **Online:** December 21, 2020

**How to cite this article:** Oliveira VCM, Prata SDS. Achilles tendon repair by a minimally invasive technique using Tenolig®. *J Foot Ankle.* 2020;14(3):269-73.



This type of injury is often treated by the foot and ankle team of the referral service in Orthopedics and Trauma at a hospital located in the east region of the city of São Paulo, Brazil. Surgical tendon repair may be performed by the following techniques: open and minimally invasive with percutaneous approach, a simple and rapid procedure, with early return to daily activities<sup>(1,5)</sup>.

The standard percutaneous technique consists of: (1) union of the ruptured ends without using a large surgical approach, thus also avoiding the drainage of the local hematoma and rushing the repair; (2) avoiding damaging of the tendon's vascular supply. This technique leads to a rapid transformation of the collagen fibers into elastic fibers, which are mechanically effective. Complications include: sural nerve injury, infection, rerupture, deep vein thrombosis, and hypertrophic scars. Thus, the procedure may not be appropriate for patients with diabetes mellitus or peripheral vascular disease<sup>(4,6)</sup>.

The importance of the present study relies on analyzing the outcome of the minimally invasive technique for the percutaneous repair of the tendon injury using Tenolig® and assess the degree of patients' postoperative satisfaction, based on pain level, functionality, and ankle and hindfoot mobility. Therefore, our study will contribute for the planning of future procedures and for the management of individuals with this type of injury and have a surgical indication.

The aim of this study is to assess the degree of postoperative satisfaction of patients who underwent a minimally invasive technique for repair of acute Achilles tendon rupture.

## Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brasil database under CAAE (Ethics Evaluation Submission Certificate) number: 98291018.3.0000.0066.

A retrospective observational study was conducted with 18 patients who underwent Achilles tendon repair with a percutaneous suture from September 2017 to October 2019 and were followed up by the Orthopedics and Trauma service of a hospital located in the east region of the city of São Paulo, Brazil.

Exclusion criteria were patients who underwent other surgical techniques or who received conservative treatment, patients with other associated diseases, and those refused to answer the questionnaires and/or did not sign the Informed Consent Form (ICF).

Initially, the researchers assessed the electronic medical records of the 18 patients who underwent the minimally invasive technique during the study period, who were contacted by phone and invited to participate in the research. Next, those who agree to participate were evaluated using the following instruments: the American Orthopaedic Foot and Ankle Society (AOFAS) scale<sup>(7)</sup>, which analyzes pain, functionality, maximum walking distance in blocks, walking surfaces, gain abnormality, sagittal mobility (flexion and extension), hindfoot mobility (inversion and eversion), ankle-hindfoot stability, and alignment; and the Foot Function Index (FFI) questionnaire<sup>(8)</sup>, initially developed in English and subsequently trans-

lated into Portuguese and revised, in order to assess foot functionality in patients with musculoskeletal injuries.

That said, the diagnosis of Achilles tendon was clinical in all patients, consisting of a positive Thompson test for the injury and of the presence of a gap in the topographic region of the injury. The test was applied with the patient placed in the horizontal prone position with the knee flexed at 90 degrees, and the examiner then squeezes the calf muscle. In normal conditions, this procedure should result in plantar flexion of the ankle, but it is not observed in the presence of a complete Achilles tendon injury. An important sign of injury is the presence of a gap detected by physical examination.

Moreover, the collected data were referred to statistical analysis, in which all variables were initially subjected to descriptive analysis. Then the analysis proceeded with the identification of minimum and maximum values and the calculation of means, standard deviations, and medians, for quantitative variables, and with the calculation of absolute and relative frequencies for qualitative variables. Correlation between scores and age was assessed using the Spearman correlation coefficient<sup>(9)</sup>. The SPSS 17.0 for Windows software was used for calculations. The level of significance for the tests was set at 5%.

## Surgical description

The patient is placed in the prone position under spinal anesthesia; asepsis and antisepsis of the affected lower limb are performed; sterile fields are placed; a sterile cushion is positioned in the anterior region of the ankle to maintain it initially at 90 degrees; a surgical pen was used to draw the proximal and distal stumps of the ruptured tendon through simple palpation; proximal entry points were demarcated 5cm above the injured region on the posteromedial and posterolateral surfaces of the tendon; distal exit points were demarcated 5cm below the injured region on the posteromedial and posterolateral surfaces of the tendon; a small incision was made on the entry site; the first Tenolig® is inserted using strong tweezers, the needle penetrates the tendon perpendicularly, and the surgeon feels the knee crossing the gap site under his/her finger; then the needle penetrates the distal stump and exits at the previously established point; the needle is pulled outwards until the anchor is positioned at the level of the proximal entry point; the second Tenolig® is inserted in the same manner, on opposite sides; for the tightening, the pad is removed to position the ankle in a maximum equinus position, the two straps are pulled tight simultaneously, thus making sure that the anchors are properly anchored; the plastic disks are threaded on, with convex surface against the skin; washers were inserted fixed using pliers; the implant is tested after having relaxed the tension of the straps; the distal ends of the straps are cut 3cm from the washers; proximal sutures are made; a shaped compress is slipped under the discs; a sterile dressing is made; a resin boot holding the foot in the equinus position is made.

## Results

Eighteen patients aged from 29 to 62 years were assessed (mean 45.39 years, standard deviation 9.22 years, and me-

dian 42.50 years). Overall, 16 (88.9%) patients were male; 16 (88.9%) injured themselves while playing soccer, one (5.6%) fell from his own height, and one (5.6%) fall of a ladder.

Of the total sample, 16 (88.9%) patients participated in recreational sports activities, two (11.1%) were sedentary, and none was a professional athlete; furthermore, 11 (61.1%) of injuries were located on the right side, and seven (38.9%) on the left side.

The patients underwent surgery from one to six days after injury (mean 1.61 day, standard deviation 1.24 day, and median 1 day) with a postoperative discharge of one day. One patient (5.6%) had postoperative superficial infection. Three patients (16.7%) were smokers.

AOFAS scores ranged from 75 to 100 (mean 93.50 points, standard deviation 6.40 points, and median 93.50 points). The patient with infection had an AOFAS score of 75 points, whereas the other patients scored above 90 points.

FFI ranged from 0 to 20% (mean 5.94%, standard deviation 5.58%, and median 5%). The patient with infection had a FFI of 20%, whereas the other patients scored from 0% to 15%.

Table 1 shows the frequency distribution of patients according to their jobs.

**AOFAS score:** Table 2 shows the absolute and relative (%) frequencies of the following variables: sex, smoking, affected side, physical activity, and complication, according to the AOFAS score. No significant difference was found in AOFAS scores with regard to sex, smoking, affected side, physical activity, and presence of complication. Spearman's correlation coefficient did not show any significant correlation between age and AOFAS score ( $r=0.312$ ,  $p=0.208$ ).

**FFI:** Table 3 shows absolute and relative (%) frequencies of the variables: sex, smoking, affected side, physical activity, and complication according to the FFI. No significant difference was found in the FFI with regard to sex, smoking, affected side, physical activity, and presence of complication. Spearman's correlation coefficient did not show any significant correlation between age and FFI ( $r=-0.409$ ,  $p=0.092$ ).

**Table 1.** Frequency distribution of the eighteen patients according to their jobs

Job	n	%
Trader	3	16.7
Housekeeper	2	11.1
Driver	2	11.1
Production	2	11.1
Seller	2	11.1
Retired	1	5.6
Joiner	1	5.6
Physician	1	5.6
Doorman	1	5.6
Teacher	1	5.6
Security guard	1	5.6
General services	1	5.6

**Table 2.** Absolute and relative (%) frequencies for the variables: sex, smoking, affected side, physical activity, and complication according to the AOFAS score

	AOFAS				p*
	<90 (n=1)	90-94 (n=8)	95-99 (n=5)	100 (n=4)	
Sex					0.739
Female	0 (0.0)	1 (12.5)	0 (0.0)	1 (25.0)	
Male	1 (100.0)	7 (87.5)	5 (100.0)	3 (75.0)	
Smoking	0 (0.0)	1 (12.5)	0 (0.0)	2 (50.0)	0.328
Affected side					0.600
Right	0 (0.0)	5 (62.5)	4 (80.0)	2 (50.0)	
Left	1 (100.0)	3 (37.5)	1 (20.0)	2 (50.0)	
Physical activity					0.739
Recreational	1 (100.0)	7 (87.5)	5 (100.0)	3 (75.0)	
Sedentary	0 (0.0)	1 (12.5)	0 (0.0)	1 (25.0)	
Complication	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.056

\* Descriptive level of probability in the Fisher's exact test.

**Table 3.** Absolute and relative (%) frequencies for the variables: sex, smoking, affected side, physical activity, and complication according to the FFI

	FFI				p*
	0% (n=4)	1-9% (n=9)	10-19% (n=4)	>=20% (n=1)	
Sex					1
Female	0 (0.0)	1 (11.1)	1 (25.0)	0 (0.0)	
Male	1 (100.0)	8 (88.9)	3 (75.0)	1 (100.0)	
Smoking	1 (25.0)	2 (22.2)	0 (0.0)	0 (0.0)	1
Affected side					0.715
Right	3 (75.0)	5 (55.6)	3 (75.0)	0 (0.0)	
Left	1 (25.0)	4 (44.4)	1 (25.0)	1 (100.0)	
Physical activity					1
Recreational	4 (100.0)	8 (88.9)	3 (75.0)	1 (100.0)	
Sedentary	0 (0.0)	1 (11.1)	1 (25.0)	0 (0.0)	
Complication	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0.056

\* Descriptive level of probability in the Fisher's exact test.

## Discussion

Achilles tendon injuries are relatively common in middle-aged athletes. The most frequent mechanisms of rupture are: impulse with the anterior portion of the foot that is bearing the weight during knee extension, sudden unexpected dorsiflexion of the ankle, and violent dorsiflexion of a plantarflexed foot, as it happens when a person falls from a high place<sup>(1)</sup>.

The diagnosis of acute Achilles tendon rupture is mainly based on patient's history, physical examination, and imaging

tests. Patients present with sudden inability to walk and acute pain when running or jumping. Some patients describe that they heard a popping sound in the back of the leg in dorsiflexion of the ankle or had the feeling of being kicked in the back of the ankle<sup>(10)</sup>.

The treatment may be conservative or surgical. These are some of the surgical techniques: open repair, with or without reinforcement (tendon transfer, opening of fibrous membrane, allografts) and percutaneous minimally invasive repair. The open approach is associated with greater complications compared to percutaneous or minimally invasive approaches<sup>(5,10)</sup>.

Percutaneous techniques have the following advantages: low rate of complications, reduced surgical time, expedited rehabilitation, reduced cost, and better aesthetic outcomes, but they may lead to a higher rate of recurrence compared to techniques of open surgical repair<sup>(11)</sup>.

The involvement of the sural nerve was a major difficulty in percutaneous minimally invasive techniques, causing damages and inflexibility. Suture needles may easily damage when sural nerves are blindly sutured<sup>(12)</sup>.

It was also observed a lack of consensus among professionals with regard to the best treatment option, because studies did not show significant differences in the outcome after conservative or surgical treatment: some meta-analyses reveal that conservative treatment increases the risk of rerupture, while other studies found that surgery may cause wound-related complications<sup>(13)</sup>.

Jallageas et al. performed a cross-sectional study assessing 31 patients with a mean age of 38 years who presented with a ruptured Achilles tendon that occurred during sports participation. Percutaneous surgery was performed in 16 patients, and open surgery in 15 patients. No patient experienced a rerupture. The return to sports occurred at 130 days after percutaneous surgery and 178 days after open surgery. Percutaneous surgery resulted in less muscle atrophy than open surgery. The average AOFAS score was 94, comparable to published studies. The majority of patients (77%) had returned to their preinjury level of sports activity<sup>(14)</sup>.

Antunes et al. conducted a retrospective study with 30 patients with Achilles tendon rupture during sports (80% soccer and 20% running) who underwent surgery with percutaneous Tenolig® to evaluate the functional outcome and post-rupture and rerupture rate. In relation to activity level, 16.6% of

patients of patients had occasional activity, 46.6% had mild activity, and 36.6% had intense activity. During follow-up, 86.6% of patients had an average AOFAS score of good (80 to 100 points). There was a rerupture rate of 10%, on average 4 months after surgery, all of which were surgically intervened by open approach<sup>(5)</sup>.

Lacoste, Féron and Cherrier conducted a prospective study with 75 patients with a mean age of 39.09 years who suffered Achilles tendon rupture. Most injuries (82.8%) were sports-related. All patients underwent Tenolig® repair under followed by early rehabilitation therapy started after 3 weeks. Mean follow-up was 20.7 months. Mean time to sports resumption was 8.6 months, with two thirds of satisfied patients returning to their returning to their previous level of sporting activities. The mean AOFAS functional score was 95<sup>(3)</sup>.


A study by Tagliavero et al. concluded that percutaneous treatment represents the gold standard for acute Achilles ruptures because it is minimally invasive and respectful to the biology of tendon cicatrization and devoid of serious complications. Percutaneous suture guarantees a strong stabilization of the stumps of the ruptured tendon. The patients treated with Tenolig® showed shorter surgical time, hospital permanence and immobilization, and it functionally stimulates the tendon healing in a short time<sup>(15)</sup>.

The percutaneous approach have many advantages, such as: (1) avoiding tendon devascularization and maintaining hematoma after rupture, preserving anatomic and biological factors to stimulate tissue regeneration; (2) reducing immobilization time, which helps align collagen fibers by transforming them into functional elastic fibers; (3) it is a rapid procedure, thus allowing to approximate the stumps of the tendon, causing few skin complications<sup>(5)</sup>.

A follow-up study after percutaneous repair with Tenolig® concluded that this technique has been used for many years and led to more satisfactory outcomes for patients, minimizing complications that occur in open and even mini-open methods, such as healing problems and prolonged immobilization<sup>(16)</sup>.

## Conclusion

Percutaneous repair of complete Achilles tendon rupture with Tenolig® resulted in high functional scores and a low rate of complications.

**Contribuição dos autores:** Each author contributed individually and significantly to the development of this article: VCMO (<https://orcid.org/0000-0002-6886-6682>): conceived and planned the activities that led to the study, wrote the article, interpreted the results of the study, participated in the review process, approved the final manuscript version; SDSP (<https://orcid.org/0000-0001-5957-527X>): wrote the article, participated in the review process, approved the final manuscript version 

## References

1. Canale ST, Beaty JH. Campbell's operative orthopaedics. 12ed. Rio de Janeiro: Elsevier; 2016.
2. Kuwada GT. Classification of tendo Achillis rupture with consideration of surgical repair techniques. *J Foot Surg.* 1990;29(4):361-5.
3. Lacoste S, Féron JM, Cherrier B. Percutaneous Tenolig® repair under intra-operative ultrasonography guidance in acute Achilles tendon rupture. *Orthop Traumatol Surg Res.* 2014;100(8):925-30.
4. Alexa O, Veliceasa B, Puha C, Popia I. Percutaneous repair of Achilles tendon rupture: a technical note. *Rev Med Chir Soc Med Nat Iasi.* 2008;112(4):993-8.
5. Antunes A, Carvalho MS, Seara M, Oliveira P, Moura AM, Pinto R. Percutaneous suture of acute rupture of the Achilles tendon in athletes using Tenolig® Review of 30 cases. *Rev Port Ortop Traum.* 2013;21(2):209-14.
6. Kadakia AR, Dekker RG 2nd, Ho BS. Acute Achilles tendon ruptures: an update on treatment. *J Am Acad Orthop Surg.* 2017; 25(1):23-31.
7. Rodrigues RC, Masiero D, Mizusaki JM, Imoto AM, Peccin MS, Cohen M, et al. Translation, cultural adaptation and validation of the "American Orthopaedic Foot and Ankle Society's (AOFAS) Ankle-Hindfoot Scale". *Acta Ortop Bras.* 2008;16(2):107-11.
8. Yi LC, Staboli IM, Kamonseki DH, Budiman-Mak E, Arie EK. Translation and cross-cultural adaptation of FFI to Brazilian portuguese version: FFI - Brazil. *Rev Bras Reumatol.* 2015;55(5): 398-405.
9. Rosner B. Fundamentals of biostatistics. Boston: PWS Publishers; 1986.
10. Park SH, Lee HS, Young KW, Seo SG. Treatment of acute Achilles tendon rupture. *Clin Orthop Surg.* 2020;12(1):1-8.
11. Del Buono A, Volpin A, Maffulli N. Minimally invasive versus open surgery for acute Achilles tendon rupture: a systematic review. *Br Med Bull.* 2014;109:45-54.
12. Aibinder WR, Patel A, Arnouk J, El-Gendi H, Korshunov Y, Mitgang J, et al. The rate of sural nerve violation using the Achillon device: a cadaveric study. *Foot Ankle Int.* 2013;34(6):870-5.
13. Laver L, Feldman V, Palmanovich E, Yaacobi E, Marom N, Mei-Dan O. Treatment of Achilles tendon ruptures. *Harefuah.* 2016;155(7): 443-7.
14. Jallageas R, Bordes J, Daviet JC, Mabit C, Coste C. Evaluation of surgical treatment for ruptured Achilles tendon in 31 athletes. *Orthop Traumatol Surg Res.* 2013;99(5):577-84.
15. Tagliavero G, Biz C, Mastrangelo G, Aldegheri R. The repair of the Achilles tendon rupture: comparison of two percutaneous techniques. *Strategies Trauma Limb Reconstr.* 2011;6(3):147-54.
16. Mezzarobba S, Bortolato S, Giacomazzi A, Fancellu G, Marcovich R, Valentini R. Percutaneous repair of Achilles tendon ruptures with Tenolig: quantitative analysis of postural control and gait pattern. *Foot.* 2012;22(4):303-9.