



Minimally Invasive versus Open Surgery in Patients with Complete Acute Achilles Tendon Rupture

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Authors' contributions

This work was carried out in collaboration between all authors. Authors RGBH, MASD, AJMJ and MSRF designed the study. Authors AJMJ, LCBO, SGF and IAO performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CAMR, HASM, MSRF and DLP managed the analyses of the study. Authors MRBL, DLP, AJMJ and MSRF managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: The incidence of Achilles tendon ruptures is 18 per 100,000 habitants, its etiology is mechanical or degenerative, and surgical treatment is required in both cases. Evolution depends on several factors.

Objective: To compare the functional results of minimally invasive and open surgery in Achilles tendon ruptures using the Leppilahti Scale.

Methods: A cross-sectional study of patients with Achilles tendon rupture managed by open and minimally invasive surgery from January 2014 to August 2015. The following variables were studied: surgical time, complications, underlying diseases and functional grade according to the Leppilahti scale.

Results: There were 41 patients, 38 (92.7%) of them men and 3 (7.3%) women. The right side was affected in 22 (53.7%) and the left in 19 (46.3%) cases. 19 (46.3%) patients underwent minimal invasive surgery and 22 (53.7%) open surgery. With the Leppilahti Scale, patients with minimal invasive surgery had excellent functionality in 6 (31.57%) and good functionality in 13 (68.42%) cases while conventional surgery had excellent functionality in 2 (9.1%), good functionality in 12 (54.5%), regular functionality in 6 (27.3%), and bad functionality in 2 (9.1%) patients. Minimally invasive management showed improvement in pain, muscle stiffness, muscle weakness of the triceps sural, range of motion differences between ankles, isokinetic muscle strength, overall outcome, and surgical time compared to open surgery ($p \leq 0.05$).

Conclusions: Minimally invasive surgery offers better surgical results than open surgery for repair of the Achilles tendon.

Keywords: Leppilahti scale; achilles tendon; minimal invasive surgery.

1. INTRODUCTION

The Achilles tendon is one of the largest and strongest in the human body. It originates in the second third of the calcaneus and fuses proximally with the gastrocnemius muscle, a fusiform muscle formed by two heads - medial and lateral - both merging in a singular muscle belly [1]. Beneath the gastrocnemius is the soleus, a long and flattened muscle that when joined forms the triceps surae, with the Achilles tendon in the bottom allowing for plantar flexion of the foot [2]. This tendon has the ability to elongate up to 4% before microscopic rupture, but when 8% elongation is exceeded a macroscopic rupture occurs [3].

The causes of these injuries may be mechanical, related with practicing sports (soccer), or degenerative (chronic tendonitis, peritendinitis, and retrocalcaneal bursitis). In addition, the tendon's low vascularity, previous injuries, the type of footwear, and the use of corticosteroids and fluoroquinolones predispose to rupture through muscular dysfunction [4,5].

The diagnosis is clinically made using the O'Brien test, which consists of inserting a needle in the midline of the posterior face of the calf and results positive if performing the flexion and plantar extension maneuver leads to no needle

movement. The Matles maneuver is performed by placing the patient in a prone position and requesting a 90° knee flexion; it results positive if dorsiflexion of the foot is observed. The Thompson maneuver, which consists of pressuring the gastrocnemius, is positive in the absence of dorsiflexion in the ankle [6]. As a diagnostic complement, radiography (visualization of the Kager triangle), ultrasound and/or nuclear magnetic resonance is requested [7].

The treatment was considered conservative, but the Kahn et al study reported open surgery significantly reduces the risk of re-rupture compared to conservative care. Nevertheless, multiple complications such as surgical wound dehiscence, infections, hypertrophic scarring, prolonged immobilization, secondary joint stiffness, triceps surae atrophy, pulmonary thromboembolism, and deep venous thrombosis [8].

Minimal invasive surgery is performed with the *Achillon system* created by Assal in 2002. It performs a medial paratendinous incision up to 2 centimeters in length proximally from the soft spot. The tendon sheath is incised and stay sutures are placed on both edges. The Achillon is introduced in the closed position under the paratenon proximally, holding the proximal

portion under the device with a clamp. It also has a pair of internal clamps connected to another pair of external clamps for their respective repair. A splint must be placed at 30° of plantar flexion; prophylactic anticoagulation along with low molecular weight heparin must also be used for three weeks as an antithrombotic measure [9].

Another treatment that has shown benefits is platelet-rich plasma, which favors tendinous scarring and decreases functional recovery time [10].

The treatment depends on the degree of functional impairment. That is why the Leppilahti scale created in 1998 was used as reference. It assigns scores to pain intensity, stiffness, muscle weakness, shoe wear restrictions; active range of motion, subjective outcome, isokinetic muscle strength, and overall outcome [11]. The objective of this study is to compare the functional results of minimally invasive vs. open surgery in Achilles tendon rupture.

2. METHODS

Cross-sectional study carried out in the Puebla High Specialty Hospital Unit on Trauma and Orthopedic Surgery in the Mexican Social Security Institute. Patients with acute Achilles tendon rupture, without previous treatment, were recruited from January 2014 to August 2015 after accepting to participate in the study and signing informed consent. Patients with exposed Achilles tendon rupture were excluded. Patient information was obtained through physical examination and clinical files to analyze age, gender, type of surgical procedure, complications, concomitant diseases, and the application of the Leppilahti Scale evaluation.

The Leppilahti Scale is widely validated and published. It evaluates pain intensity, stiffness, muscle weakness, shoe wear restrictions, active range of motion, subjective outcome, isokinetic muscle strength, and overall outcome. The statistic used was descriptive with measures of central tendency, dispersion, and Student t test in IBM's SPSS version 22 program. The protocol was duly authorized by the research and ethics committee of the participating medical unit.

3. RESULTS

Forty one patients with acute Achilles tendon rupture were studied, 38 (92.7%) of them men

and 3 (7.3%) women. The mean patient age was 43.14 (22-76) ± 12.79 years. 22 (53.7%) patients were affected on the right side and 19 (46.3%) on the left side. The concomitant pathologies present in patients were diabetes mellitus type II and systemic arterial hypertension in 2 (4.9%) patients, respectively, and hypothyroidism in 1 (2.4%) patient. Minimally invasive surgery was performed in 19 (46.3%) patients and open surgery was performed in 22 (53.7%) patients. The average surgical time was 54.34 (30–90) minutes.

The mean surgical time was 41.52 and 65 minutes in minimally invasive surgery and open surgery respectively, with p=0.000 significant differences. The results in the Leppilahti scale in both procedures are shown in Table 1.

The functional result of both procedures was classified as bad, regular, good, and excellent. The details are shown in Table 2.

The complications in open surgery patients were cutaneous necrosis in 3 (7.3%) patients, surgical wound infection in 2 (4.9%) patients, surgical wound dehiscence in 1 (2.4%) patient and re-rupture in 1 (2.4%) patient; there were no complications in patients operated with minimally invasive surgery.

The comparison between both procedures using the Leppilahti scale showed statistically significant different between both procedures for pain, muscle stiffness, triceps muscle weakness, active range of motion between both ankles, isokinetic muscle strength, overall outcome, and surgical time. They are shown in Table 3.

4. DISCUSSION

Achilles tendon ruptures are injuries that mainly affect the masculine gender, as Justin MW et al reported in a study in which men were more susceptible to tendinous injuries caused by sports activities such as soccer and tennis. Those results were similar to those obtained in this study.

The association of chronic degenerative diseases with Achilles tendon rupture is in constant increase, as reported by Justin MW et al when identifying obesity, hypertension, and diabetes mellitus with this injury, which is why underlying diseases should be identified as was done in this study identifying the same diseases [12].

Table 1. Results using the Leppilahti scale in minimal invasive and open surgery

	Procedure	n	%	Score
Pain	Minimally invasive surgery	0	0	0
		0	0	5
		13	68.42	10
		6	31.57	15
	Open Surgery	0	0	0
		5	22.7	5
		15	68.2	10
		2	9.1	15
Weackness	Minimally invasive surgery	0	0	0
		0	0	5
		13	68.42	10
		6	31.57	15
	Open Surgery	0	0	0
		5	22.7	5
		15	68.2	10
		2	9.1	15
Active range of Motion	Minimally invasive surgery	0	0	0
		0	0	5
		7	36.8	10
		12	63.1	15
	Open surgery	0	0	0
		1	4.5	5
		15	68.2	10
		6	27.3	15
Restriction for the use of referred shoes	Minimally invasive surgery	0	0	0
		0	0	5
		19	100	10
	Open surgery	0	0	0
		4	18.1	5
		18	81.8	10
Subjetive results	Minimally invasive surgery	0	0	0
		0	0	5
		4	21	10
		15	78.9	15
	Open surgery	0	0	0
		2	9.1	5
		8	36.4	10
		12	54.5	15
Lower muscle rigidity	Minimally invasive surgery	0	0	0
		0	0	5
		14	73.6	10
		5	26.3	15
	Open surgery	0	0	0
		0	0	5
		21	95.4	10
		1	4.5	15
Global results	Minimally invasive surgery	7	36.8	85
		3	15.7	90
		3	15.7	95
		0	0	100
	Open surgery	4	18.2	85
		2	9.1	90
		0	0	95
		0	0	100

Abbreviations: n=sample, %=percent, Global results: 90 a 100 excellent, 75 a 89 good, 60 a 79 regular, <59 bad

Table 2. Functional results in patients with minimally invasive and open surgery

Procedure	n	%	Functionality
Minimally invasive surgery	0	0	Bad
	0	0	Regular
	13	68.42	Good
	6	31.57	Excellent
Open surgery	2	9.1	Bad
	6	27.3	Regular
	12	54.5	Good
	2	9.1	Excellent

Abbreviations: n=sample, %=percent

Table 3. Difference between results obtained with minimal invasive and open surgery

Variable	Procedure	Media	p
Pain	Minimally invasive Surgery	11.58	0.028
	Open surgery	9.47	
Muscle stiffness	Minimally invasive Surgery	11.58	0.042
	Open surgery	9.47	
Lower muscle weakness in the triceps	Minimally invasive Surgery	13.95	0.003
	Open surgery	11.58	
Restrictions for de use of shoes	Minimally invasive Surgery	10.00	0.331
	Open surgery	9.47	
Difference between active range of motion in both ankles	Minimally invasive Surgery	13.16	0.016
	Open surgery	11.05	
Subjective results	Minimally invasive Surgery	13.95	0.205
	Open surgery	12.63	
Lowered the isokinetic resistance of the muscle	Minimally invasive Surgery	11.32	0.021
	Open surgery	10.00	
Global results	Minimally invasive Surgery	85.26	0.002
	Open surgery	73.68	
Surgical timing	Minimally invasive Surgery	42.00	0.000
	Open surgery	63.42	

Abbreviations: p= probability

Khan et al colleagues report that the ideal treatment for acute Achilles tendon rupture is open surgery, which also significantly reduces the risk of re-rupture but can lead to multiple complications - as occurred in this study – such as surgical wound dehiscence, infections, and secondary joint stiffness [13]. Kearney et al report that complications are more frequent in open surgeries due to increased risk of necrosis, severe pain, and dehiscence, results that are in agreement with those obtained in this study [14].

Calder et al determined that minimal invasive surgery had better functional and anatomical results, and should therefore be among the main therapies for patients with acute total Achilles tendon rupture [15].

From an economic standpoint, lower expenses were incurred in minimally invasive surgery due to substantial reductions in hospital stay length and rate of complications, which is why Mayukh et al suggest using this technique in well-selected patients [16].

Leppilahti et al determined minimally invasive surgery scored better than open surgery, which agrees with the results in this study [17].

When analyzing the two types of surgery, it was identified that minimally invasive surgery lead to less pain ($p = 0.028$), lower muscle rigidity (0.042), lower muscle weakness of the triceps ($p=0.003$), difference in the active range of motion ($p=0.016$),

lowered the isokinetic resistance of the muscle ($p=0.021$) and had a better overall result ($p=0.002$).

5. CONCLUSION

Minimally invasive surgery offers better surgical results than open surgery for acute Achilles tendon rupture.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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