Original Research Article

Title: Minimally invasive versus open surgery in patients with complete acute Achilles tendon rupture.

Minimally invasive versus open surgery in acute Achilles tendon rupture

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.

Method: 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 tricep 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.

Key words: Leppilahti Scale; Achilles tendon; Minimal invasive surgery;

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 90º 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 30º 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.

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.

Results

41 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) $\pm$ 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 I.

The functional result of both procedures was classified as bad, regular, good, and excellent.

The details are shown in Table II.

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 III.

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]

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)*.

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

Bibliography

1. Thevendran G, Sarraf KM, Patel NK, Sadri A, Rosenfeld P. The ruptured Achilles tendon: a current overview from biology of rupture to treatment. Musculoskelet Surg. 2013;97(1):9-20.
2. Del Buono A, Chan O, Maffulli N. Achilles tendon: functional anatomy and novel emerging models of imaging classification. Int Orthop. 2013;37(4):715–721.
3. Feldbrin Z, Hendel D, Lipkin A, Zin D, Schorr L. Achilles tendon rupture and our experience with the Achillon device. Isr Med Assoc J. 2010;12(10):609-612.
4. Pavan-Kumar A, Shashikiran R, Raghuram C. A novel modification of Bosworth's technique to repair zone I Achilles tendon ruptures. J Orthop Traumatol. 2013;14(1):59-65.
5. Patel A, Ogawa B, Charlton T, Thordarson D. Incidence of Deep Vein Thrombosis and Pulmonary Embolism after Achilles Tendon Rupture. Int Orthop Relat Res. 2012; 470(1):270-274.
6. Assal M. Mini-Open Repair of Acute Ruptures. En Nunley JA. Ed. The Achilles Tendon: Treatment and Rehabilitation. New York: Springer; 2010. Pp. 67-81.
7. Calder JDF, Saxby TS. Early, active rehabilitation following mini-open repair of Achilles tendon rupture: a prospective stud. Br J Sports Med. 2005; 39(11):857–859.
8. Kahn RJ, Fick D, Keogh A, Crawford J, Brammar T, Parker M. Treatment of acute Achilles tendon ruptures. A meta-analysis of randomized, controlled trials. J Bone Joint Surg Am. 2005;87(10):2202-10
9. Takeda S, Imai T, Chaki Y, Kasano E. Four consecutive cases of Achilles tendon disorders associated with levofloxacin treatment in hemodialysis patients. Clin Exp Nephrol 2012;16(6):977-978.
10. Michael RC, Rossi R, Schffler S, Mei-Dan O, Beaufils P. Percutaneous & Mini Invasive Achilles tendon repair. Sports Med Arthrosc Rehabil Ther Technol. 2011; 3: 28. Doi:10.1186/1758-2555-3-28
11. Bardas C, Benea H, Martin A, Tomoaia G. The traumatic rupture of the Achilles' tendon - an analysis of the modern methods of evaluation and treatment. Clujul Med. 2013; 86(2):128-132.

12. Nilsson-Helander K, Silbernagel KG, Thomeé R, Faxén E, Olsson N, Eriksson BI, et. al. Acute Achilles Tendon Rupture. A Randomized, Controlled Study Comparing Surgical and Nonsurgical Treatments Using Validated Outcome Measures. Am J Sports Med. 2010; 38(11):2186-93.
13. Kahn RJ, Fick D, Koegh A, Crawford J, Brammar T, Parker M. Treatment of acute achilles tendon ruptures. A meta-analysis of randomized, controlled trials. J Bone Joint Surg Am. 2005;87(10):2202-10
14. Kearney RS, Achten J, Lamb SE, Parsons N, Costa ML. The Achilles tendon total rupture score: a study of responsiveness, internal consistency and convergent validity on patients with acute Achilles tendon ruptures. Health Qual Life Outcomes. 2012; 10:24 doi: 10.1186/1477-7525-10-24
15. Calder JDF, Saxby TS. Early, active rehabilitation following mini-open repair of Achilles tendon rupture: a prospective study. Br J Sports Med. 2005;39:857–859.
16. Bhattacharyya M, Gerber B. Mini-invasive surgical repair of the Achilles tendón - Does it reduce post-operative morbidity? Int Orthop. 2009; 33(1):151–156.
17. Leppilahti J, Forsman K, Puranne J, Orava S. Outcome and prognostic factors of Achilles rupture repair using a new scoring method. Clin Orthop. 1998;346:152-161.

Tables

Table I. Results using the Leppilahti scale in minimall invasive and Open surgery

	Procedure	n	%	Score
Pain	Minimall 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	Minimal 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	Minimal invasive surgery	0	0	0
		0	0	5
		7	36.8	10
		12	63.1	15

		0	0	0
	Open surgery	1	4.5	5
		15	68.2	10
		6	27.3	15
		0	0	0
	Minimal invasive surgery	0	0	5
Restriction for the use of referred shoes		19	100	10
		0	0	0
	Open surgery	4	18.1	5
		18	81.8	10
		0	0	0
	Minimal invasive surgery	0	0	5
		4	21	10
		15	78.9	15
Subjetive Results		0	0	0
	Open surgery	2	9.1	5
		8	36.4	10
		12	54.5	15
		0	0	0
	Minimal invasive surgery	0	0	5
		14	73.6	10
		5	26.3	15
Lower muscle rigidity		0	0	0
	Open surgery	0	0	5
		21	95.4	10
		1	4.5	15
		7	36.8	85
	Minimal invasive surgery	3	15.7	90
		3	15.7	95
		0	0	100
Global Results		4	18.2	85
	Open surgery	2	9.1	90
		0	0	95
		0	0	100

Abbreviations: n= sample, %=percent

Table II. Functional results in patients with minimall invasive and Open surgery

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

Abbreviations: n= sample, %=percent

Table III. Difference between results obtained with minimall invasive and Open surgery

Variable	Procedure	Media	*p*
Pain	Minimall invasive Surgery	11.58	***0.028***
	Open surgery	9.47	
Muscle stiffness	Minimall invasive Surgery	11.58	***0.042***
	Open surgery	9.47	

Lower muscle weakness in the triceps	Minimall invasive Surgery	13.95	***0.003***
	Open surgery	11.58	
Restrictions for de use of shoes	Minimall invasive Surgery	10.00	*0.331*
	Open surgery	9.47	
Difference between active range of motion in both ankles	Minimall invasive Surgery	13.16	***0.016***
	Open surgery	11.05	
Subjetive Results	Minimall invasive Surgery	13.95	*0.205*
	Open surgery	12.63	
Lowered the isokinetic resistance of the muscle	Minimall invasive Surgery	11.32	***0.021***
	Open surgery	10.00	
Global Results	Minimall invasive Surgery	85.26	***0.002***
	Open surgery	73.68	
Surgical timing	Minimall invasive Surgery	42.00	***0.000***
	Open surgery	63.42	
Abreviaturas: p= probability			

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