

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 inhabitants, 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 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.

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

31 **Introduction**

32
33 The Achilles tendon is one of the largest and strongest in the human body. It originates in the second third
34 of the calcaneus and fuses proximally with the gastrocnemius muscle, a fusiform muscle formed by two
35 heads - medial and lateral - both merging in a singular muscle belly.¹ Beneath the gastrocnemius is the
36 soleus, a long and flattened muscle that when joined forms the triceps surae, with the Achilles tendon in
37 the bottom allowing for plantar flexion of the foot.² This tendon has the ability to elongate up to 4% before
38 microscopic rupture, but when 8% elongation is exceeded a macroscopic rupture occurs.³

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

43 The diagnosis is clinically made using the O'Brien test, which consists of inserting a needle in the midline
44 of the posterior face of the calf and results positive if performing the flexion and plantar extension ma-
45 neuver leads to no needle movement. The Matles maneuver is performed by placing the patient in a prone
46 position and requesting a 90° knee flexion; it results positive if dorsiflexion of the foot is observed. The
47 Thompson maneuver, which consists of pressuring the gastrocnemius, is positive in the absence of dorsif-
48 lexion in the ankle.⁶ As a diagnostic complement, radiography (visualization of the Kager triangle), ultra-
49 sound and/or nuclear magnetic resonance is requested.⁷

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

54 Minimal invasive surgery is performed with the *Achillon system* created by Assal in 2002. It performs a
55 medial paratendinous incision up to 2 centimeters in length proximally from the soft spot. The tendon
56 sheath is incised and stay sutures are placed on both edges. The Achillon is introduced in the closed posi-
57 tion under the paratenon proximally, holding the proximal portion under the device with a clamp. It also
58 has a pair of internal clamps connected to another pair of external clamps for their respective repair. A
59 splint must be placed at 30° of plantar flexion; prophylactic anticoagulation along with low molecular
60 weight heparin must also be used for three weeks as an antithrombotic measure.⁹

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

63 The treatment depends on the degree of functional impairment. That is why the Leppilahti scale created in
64 1998 was used as reference. It assigns scores to pain intensity, stiffness, muscle weakness, shoe wear

65 restrictions; active range of motion, subjective outcome, isokinetic muscle strength, and overall out-
66 come.¹¹The objective of this study is to compare the functional results of minimally invasive vs. open
67 surgery in Achilles tendon rupture.

68 **Methods**

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

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

82 **Results**

84 **Forty one** patients with acute Achilles tendon rupture were studied, 38 (92.7%) of them men and 3 (7.3%)
85 women. The mean patient age was 43.14 (22 -76) \pm 12.79 years. 22 (53.7%) patients were affected on the
86 right side and 19 (46.3%) on the left side. The concomitant pathologies present in patients were diabetes
87 mellitus type II and systemic arterial hypertension in 2 (4.9%) patients, respectively, and hypothyroidism
88 in 1 (2.4%) patient. Minimally invasive surgery was performed in 19 (46.3%) patients and open surgery
89 was performed in 22 (53.7%) patients. The average surgical time was 54.34 (30 – 90) minutes.

90 The mean surgical time was 41.52 and 65 minutes in minimally invasive surgery and open surgery re-
91 spectively, with p=0.000 significant differences. The results in the Leppilahti scale in both procedures are
92 shown in Table I.

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

94 The details are shown in Table II.

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

98 The comparison between both procedures using the Leppilahti scale showed statistically significant dif-
99 ferent between both procedures for pain, muscle stiffness, triceps muscle weakness, active range of mo-
100 tion between both ankles, isokinetic muscle strength, overall outcome, and surgical time. They are shown
101 in Table III.

102 **Discussion**

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

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

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

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

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

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

123 When analyzing the two types of surgery, it was identified that minimally invasive surgery lead to less
124 pain ($p = 0.028$), lower muscle rigidity (0.042), lower muscle weakness of the triceps
125 ($p=0.003$), difference in the active range of motion($p=0.016$), lowered the isokinetic resistance of the
126 muscle ($p=0.021$) and had a better overall result($p=0.002$).

127 Conclusion: Minimally invasive surgery offers better surgical results than open surgery for acute Achilles
128 tendon rupture.

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179 **Tables**
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Table I. Results using the Leppilahti scale in minimal invasive and Open surgery

Procedure		n	%	Score
Pain	Minimallyinvasivesurgery	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	Minimallyinvasivesurgery	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	Minimallyinvasivesurgery	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	Minimallyinvasivesurgery	0	0	0
		0	0	5
		19	100	10
		0	0	0
	Open surgery	4	18.1	5
		18	81.8	10
		0	0	0
		0	0	5
Subjetiveresults	Minimallyinvasivesurgery	4	21	10
		15	78.9	15
		0	0	0
		2	9.1	5
	Open surgery	8	36.4	10
		12	54.5	15
		0	0	0
		0	0	5
Lower muscle rigidity	Minimallyinvasivesurgery	14	73.6	10
		5	26.3	15
		0	0	0
		0	0	5
	Open surgery	21	95.4	10
		1	4.5	15
		7	36.8	85
		3	15.7	90
Global results	Minimallyinvasivesurgery	3	15.7	95
		0	0	100
		4	18.2	85
		2	9.1	90
	Open surgery	0	0	95
		0	0	100

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

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Procedure	n	%	Functionality
MinimallyinvasiveSurgery	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

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Variable	Procedure	Media		p
Pain	MinimallyinvasiveSurgery	11.58		0.028

	Open surgery	9.47		
Muscle stiffness	MinimallyinvasiveSurgery	11.58		0.042
	Open surgery	9.47		
Lower muscle weakness in the triceps	MinimallyinvasiveSurgery	13.95		0.003
	Open surgery	11.58		
Restrictions for de use of shoes	MinimallyinvasiveSurgery	10.00		0.331
	Open surgery	9.47		
Difference between active range of motion in both ankles	MinimallyinvasiveSurgery	13.16		0.016
	Open surgery	11.05		
Subjetive Results	MinimallyinvasiveSurgery	13.95		0.205
	Open surgery	12.63		
Lowered the isokinetic resistance of the muscle	MinimallyinvasiveSurgery	11.32		0.021
	Open surgery	10.00		
Global Results	MinimallyinvasiveSurgery	85.26		0.002
	Open surgery	73.68		
Surgicaltiming	MinimallyinvasiveSurgery	42.00		0.000
	Open surgery	63.42		
Abreviaturas: p= probability				