

# Comparison between open surgery and minimally invasive methods in Achilles tendon rupture

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## Abstract

**Introduction:** Surgical repair can be carried out using either open surgery or minimally invasive techniques. The percutaneous technique combines the advantages of the open surgical treatment with those of the orthopedic approach. The aim of this study is to compare the Dresden's minimally invasive technique described by Amlang with conventional open surgery.

**Materials and Methods:** Between March 2010 and September 2013, 45 patients were operated on—15 using the conventional open technique and 15 by the Dresden's percutaneous technique. We divided the patients into two groups according to the group they had been allocated to and, afterwards, we analyzed comparatively the results. The election criteria for the method were random, provided that surgery was carried out within the seven days following the injury.

**Results:** We address comparative results of surgery duration, muscle trophism, scar length, and comparative differences in calf perimeter. The AOFAS score at month 5 was 90 in Group A and 95 in Group B. Average time of work retaking: Group A, 7 months; Group B, 3.53 months. Average time of sports retaking: Group A, 12.22 months; Group B, 6.53 months.

**Conclusions:** Dresden's percutaneous repair is a good option for Achilles tendon rupture; medical-functional results are good, and risks of re-rupture and sural nerve injury decrease.

**Key words:** Achilles tendon rupture; open repair; percutaneous repair; comparison

**Level of evidence:** III

## COMPARACIÓN ENTRE LA CIRUGÍA ABIERTA Y EL MÉTODO MÍNIMAMENTE INVASIVO PARA ROTURAS AGUDAS DEL TENDÓN DE AQUILES

### Resumen

**Introducción:** La reparación quirúrgica puede realizarse mediante cirugía abierta o por técnicas mínimamente invasivas. La técnica percutánea combina las ventajas del tratamiento quirúrgico abierto con el tratamiento ortopédico. El objetivo de este trabajo es comparar la técnica mínimamente invasiva de Dresden descrita por Amlang con la cirugía abierta convencional.

**Materiales y Métodos:** Entre marzo de 2010 y septiembre de 2013, 45 pacientes fueron operados, 15 casos con técnica abierta convencional y 15 casos con la técnica percutánea de Dresden. Se dividió a los pacientes en dos grupos según el método quirúrgico utilizado y, luego, se analizaron comparativamente los resultados. El criterio de elección del método quirúrgico fue al azar, siempre que se realizara dentro de los siete días de la rotura.

Conflict of interests: The authors have reported none.

**Resultados:** Se mencionan los resultados comparativos del tiempo quirúrgico, el trofismo, la longitud de la cicatriz, la diferencia comparativa en el perímetro del gemelo. El puntaje de la AOFAS a los 5 meses fue 90 para el grupo A y 95 para el grupo B. Tiempo promedio de retorno a la actividad laboral: grupo A, 7 meses; grupo B, 3.53 meses. Media del retorno a la actividad deportiva: grupo A, 12.22 meses; grupo B, 6.53 meses.

**Conclusiones:** La reparación percutánea de Dresden es una buena opción para las roturas del tendón de Aquiles; la evolución clínico-funcional es buena y se minimizan los riesgos de otra rotura y lesiones del nervio sural.

**Palabras clave:** Rotura del tendón de Aquiles; reparación abierta; reparación percutánea; comparación.

**Nivel de Evidencia:** III

## Introduction

The rupture of the Achilles tendon is a frequent condition.<sup>1-4</sup> It prevails among the male in the third and fourth decades of life and, generally speaking, it takes place while practicing sports.<sup>2,5</sup> Risk factors for primary rupture are male sex, age >40 years old, corticosteroids and fluoroquinolone use, and previous rupture of the contralateral Achilles tendon.<sup>6,7</sup> Diagnosis is basically done by physical examination. By palpation, it is possible to identify a gap on the area of the tendon injury, whereas the Thompson test is positive. When in diagnostic doubt, ultrasound or MRI are an option.<sup>6,8-10</sup>

The ideal treatment for the acute rupture of the Achilles tendon is still controversial.<sup>1,6,11-18</sup> In current literature, however, there are more reports on surgical treatment,<sup>19-25</sup> which can be administered by open surgery or minimally invasive techniques.<sup>2,6,12</sup> Percutaneous reparation combines the advantages of the open surgical treatment with the orthopedic treatment. The physiological bases of this procedure consist of keeping the hematoma within the paratendon with all its inflammatory mediators and growth factors.<sup>13</sup> However, percutaneous treatment is criticized due to sural nerve injury and new rupture rates which, according to the bibliography, oscillates between 6 and 34%.<sup>2,12,13,18,26,27</sup>

The aim of this study is to compare the Dresden's minimally invasive technique described by Amlang et. al.<sup>28</sup> to conventional open surgery. To show that, with minimally invasive techniques, healing rates are higher, the risk of post-operative complications is low whereas surgical duration, functional recovery and patients' retaking of daily activities are faster.

## Materials and methods

This is a comparative prospective cohort study comparing two surgical methods that have been described for acute rupture of the Achilles tendon. From March 2010 to September 2013, we operated on 45 patients with acute rupture of the Achilles tendon—30 patients received follow-up; therefore, they were included in this study. All of them had suffered a low-impact mechanism of injury and were subject to surgical treatment. Fifteen patients were excluded because they did not receive follow-up.

Patients were divided into two groups on the grounds of the surgical method received, and then results were comparatively analyzed. The election criteria for the surgical method were random, provided it was given within the seven days following the injury.

- Group A: 15 patients were subject to conventional open surgery using the ankle posterior-medial approach. The stitching technique was the one described by Kesler. The post-operative protocol included: short-cast with foot drop (4 weeks), neutral short-cast (three weeks) and walker boot (three weeks); afterwards, the patient was allowed to start physiotherapy and mobility exercises with 90° plantar and dorsal flexion. The weight bearing allowed was 50% at week 9 and 100% at week 10, always with walker boot protection.
- Group B: 15 patients were treated with the Dresden's minimally invasive surgery, described by Amlang et al.<sup>28</sup> The post-operative protocol included: short-cast with foot drop (3 weeks), neutral short-cast (2 weeks) and walker boot (2 weeks); afterwards, the patient was allowed to start physiotherapy and mobility exercises with 90° plantar and dorsal flexion. The weight bearing allowed was 50% at week 6 and 100% at week 7, always with walker boot protection.

Los criterios de inclusión fueron: 1) roturas agudas del tendón de Aquiles, 2) roturas cerradas y completas del tendón, 3) roturas ubicadas entre 2 y 8 cm distales del tendón de Aquiles, 4) pacientes >18 años y <55 años, 5) seguimiento mínimo de 18 meses, 6) tratamiento quirúrgico de las roturas mediante cirugía abierta convencional o mínimamente invasiva de Dresden.

Inclusion criteria were: 2) acute rupture of the Achilles tendon, 2) closed and complete rupture of the Achilles tendon, 3) rupture between the Achilles tendon distal 2 and 8 cm, 4) patients >18 and < 55 years old, 5) minimal follow-up of 18 months, 6) surgical treatment of rupture by conventional open surgery or Dresden's minimally invasive surgery.

Exclusion criteria were: 1) ruptures treated 10 days after the injury, 2) Achilles tendon rupture with tendon exposition, 3) mio-tendinous rupture, 4) rupture in Achilles tendon calcaneal insertion, 5) lack of follow-up, 6) local or systemic therapy which may have weakened the

tendon (e.g.: local infiltration with anesthetic substances or corticosteroids in the Achilles tendon area, immunosuppressive treatment in transplanted patients or patients with autoimmune conditions), 7) new rupture or previous surgery of the Achilles tendon.

To check the reparation of the tendon, four months after the surgery, we did IMR. Medical-functional evaluation was carried out using the AOFAS (American Orthopedic Foot & Ankle Score) and the ARPS (Achilles rupture performance score) scores. The AOFAS scale allocates 50 marks to function, 40 marks to pain and 10 points to alignment. A perfect score of 100 marks suggests that the patient is painless, shows complete range of motion in ankle and hindfoot, no instability, good alignment, possibility of walking more than 6 blocks (600 meters) on any surface, no limping, no limitations to daily life or recreational activities, and no need of technical walking aid.

The ARPS scale allocates marks on the grounds of pain, rigidity, calf weakness, foot-wearing restrictions, comparative range of motion between ankles, subjective results, and isokinetic muscle strength. The maximal score is 100; up to 90 it shows excellent results; between 75 and 89, good results; between 60 and 74, fair results, and <60, poor results.

We evaluated the following parameters in both groups:

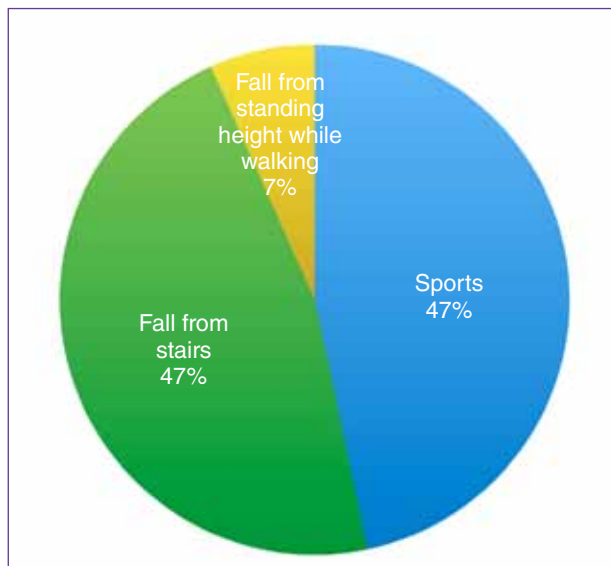
1. Days passed between the injury and the surgery
2. Surgery duration
3. Ankle range of motion
4. Visual analogue scale
5. Muscle trophism
6. AOFAS and ARPS scales
7. Scar length
8. Time since surgery to reassume work and sports
9. Scar looks according to the patient's assessment: excellent, good, fair, or poor
10. Complications

## Results

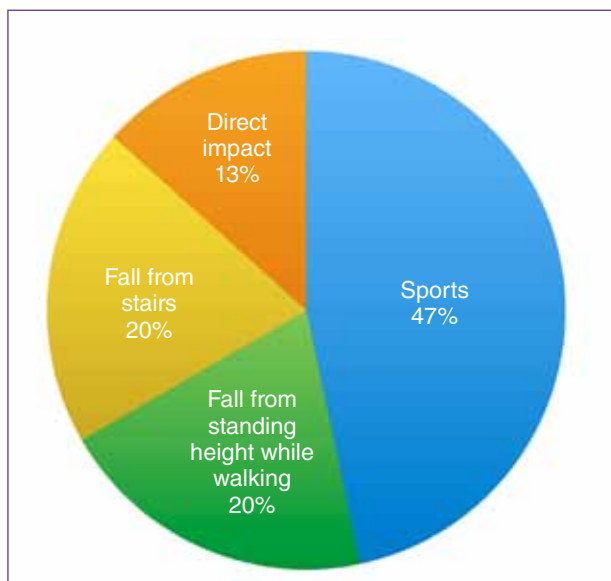
### Description of the groups

- Group A: 15 males aged 42.66 years old on average (ranging from 36 to 53). Thirteen patients had their right Achilles tendon affected, whereas 2 had their left one injured. The mechanism of injury was sports practice (7 cases), stairs climbing and descending (7 cases), and fall from standing height (one case) (Figure 1). All of the patients were treated with conventional open surgery using the distal posterior-medial approach of the Achilles tendon. We used Ethibond 2-0 suture for the modified Kessler technique and Vicryl 2-0 for the fine independent stitches. We associated the Lynn's technique in four patients with plantaris muscle rupture. Only one patient showed wound dehiscence.

- Group B: 15 patients: 13 males and two females aged 40.66 years old on average (ranging from 31 to 49). Ten patients had their right Achilles tendon affected, whereas five had their left one injured. The mechanism of injury was exercise (7 cases), fall from standing height while walking (3 cases), fall from stairs (3 cases) and direct impact (2 cases) (Figure 2). All of the patients were treated with percutaneous reparation of the Achilles tendon with the Dresden's technique described by Amlang et al.<sup>28</sup> We used Ethibond 2-0 suture.



▲ **Figure 1.** Mechanism of injury of the Achilles tendon in patients treated with the conventional open method.



▲ **Figure 2.** Mechanism of injury of the Achilles tendon in patients treated with the Dresden's percutaneous method.

### Comparison between both groups (Table 1)

1. Time passed between the injury and the surgery: 4 days (ranging from 1 to 9) in Group A, and 2.86 days (ranging from 1 to 7) in Group B ( $p=0.769$ )
2. Surgery duration: 32 minutes (ranging from 20 to 42) in Group A, and 17.13 minutes (ranging from 13 to 20) in Group B ( $p=0.711$ )
3. Post-operative pain: 46.66% of the patients subject to conventional surgery and 13.33% of the patients treated with the Dresden's technique suffered post-operative pain.
4. Muscle trophism: Group A, 15 eutrophic patients; Group B, 14 eutrophic patients and one hypotrophic patient. Differences in calf perimeter comparatively with the healthy one, assessed 15 cm below the patient's knee: Group A, 1.62 cm (ranging from 0 to 6); Group B, 1.07 cm (ranging from 0 to 2.5).
5. Skin sensitivity: Group A, 13 normal and 2 with hypoesthesia in the area of the wound; Group B, 11 normal and four with hypoesthesia in the area of the wound.
6. Size and length of the scar: Group A, 7.87 cm on average (ranging from 6 to 11.4); Group B, 2.04 cm (ranging from 1 to 3) ( $p<0.05$ ).
7. Scar tenderness: No patient suffered pain in the scar.
8. Visual analogue scale: Group A, 0.86 (ranging from 0 to 3); Group B, 0.8 (ranging from 0 to 2) ( $p<0.05$ ).

9. AOFAS scale at month 5: Group A, 90 (ranging from 85 to 95); Group B, 95.33 (ranging from 90 to 100) ( $p<0.05$ )
10. ARPS scale at month 5: Group A, 92.66 (ranging from 80 to 100); Group B, 98 (ranging from 90 to 100)
11. Range of motion
  - Plantar flexion comparatively with healthy, non-operated on lower limb: Group A—active plantar flexion: right=31.44°, left=30.89°; passive plantar flexion: right=33.44°, left=32.78°; Group B—active plantar flexion: right=27°, left=27.3°; passive plantar flexion: right=29.6°, left=30.3 (Table 2).
  - Dorsal flexion comparatively with healthy, non-operated on lower limb: Group A—active dorsal flexion: right=17.89°, left=18°; passive dorsal flexion: right=19°, left=18.89°; Group B—active dorsal flexion: right=17°, left=17.3°; passive dorsal flexion: right=19°, left=21.3 (Table 2).
12. Retaking of working activities: Group A, 7 months on average (ranging from 4 to 24); Group B, 3.53 months on average (ranging from 3 to 5) ( $p=0.54$ ).
13. Retaking of working activities: Group A, 7 months on average (ranging from 4 to 24); Group B, 3.53 months on average (ranging from 3 to 5) ( $p=0.54$ ).
14. Complications: Group A, one patient with wound dehiscence. There were no complications in Group B.

**Table 1.** Comparison between both groups

	Group A (open)	Group B (Dresden)	p
Time up to the surgery (days)	4	<b>2,86</b>	0.769
Surgery duration (min)	32	<b>17,13</b>	0.711
Post-operative pain	7 patients	2 patients	<0.05
Scar length (cm)	7.87	<b>2.04</b>	<0.05
AOFAS	90	95.33	<0.05
VAS	0.86	0.8	<0.05
Work retaking (months)	7	<b>3,53</b>	0.054
Sport retaking (months)	12,2	<b>6,53</b>	<0.05
Complications	1	0	0.30

EAV = visual analogue scale, AOFAS = American Orthopedic Foot & Ankle Score.

### Discussion

The rupture of the Achilles tendon is a frequent injury which, in general, is associated with sports.<sup>3,16,29</sup> The “weekend warrior” is defined as a middle-aged person who puts in occasional efforts into athletic or sport activities and who, as it has been shown, runs a greater risk of having his or her Achilles tendon injured.<sup>30</sup>

There is no universal agreement on and the bibliography is not clear about the ideal treatment for the acute rupture of the Achilles tendon.<sup>11,12,16,27,31</sup> Kan et al.<sup>32</sup> compared non-operative treatment to surgical treatment in the acute rupture of the Achilles tendon and concluded that the patients subject to surgical treatment had lower re-rupture rates. Surgical treatment, however, was associated with significantly higher rates of complications, such as wound dehiscence, infection and neurovascular injury.<sup>3,14</sup>

Percutaneous and minimally invasive techniques are more and more frequent.<sup>33</sup> The rates of re-rupture and sural nerve entrapment, published in the international bibliography, vary (Figure 3).<sup>2,12,34,35</sup> Some authors mention that the rates of re-rupture in the Achilles tendons operated on using percutaneous techniques are higher than in those subject to conventional open techniques.<sup>12, 35</sup>

**Table 2.** Ankle range of motion

	Open method				Percutaneous method			
	Active		Passive		Active		Passive	
	Right	Left	Right	Left	Right	Left	Right	Left
<b>Plantar flexion</b>	31.44°	30.89°	33.44°	32.78°	27°	27.3°	29.6°	30.3°
<b>Dorsal flexion</b>	17.89°	18°	19°	18.89°	17°	17.3°	19°	21.3°

In a series of 52 patients, Chanr kang et al.<sup>34</sup> found that 7.6% suffered sural nerve injury without re-rupture. Amlang et al.<sup>28</sup> informed that, in their series, there was neither sural nerve injury nor there was re-rupture of the Achilles tendon. Maes and Copin<sup>36</sup> reported 10% of re-ruptures with percutaneous techniques. In our series of 30 patients, in which we compared conventional open surgery with percutaneous surgery, we saw neither sural nerve injuries nor re-ruptures. In a corpse study published by Hockenbury et al.,<sup>27</sup> sural nerve compression was 2.5 cm proximal to the Achilles tendon tenorrhaphy. We should take into account that the sural nerve lies 10-20 cm proximal to the tip of the lateral malleolus—variation in

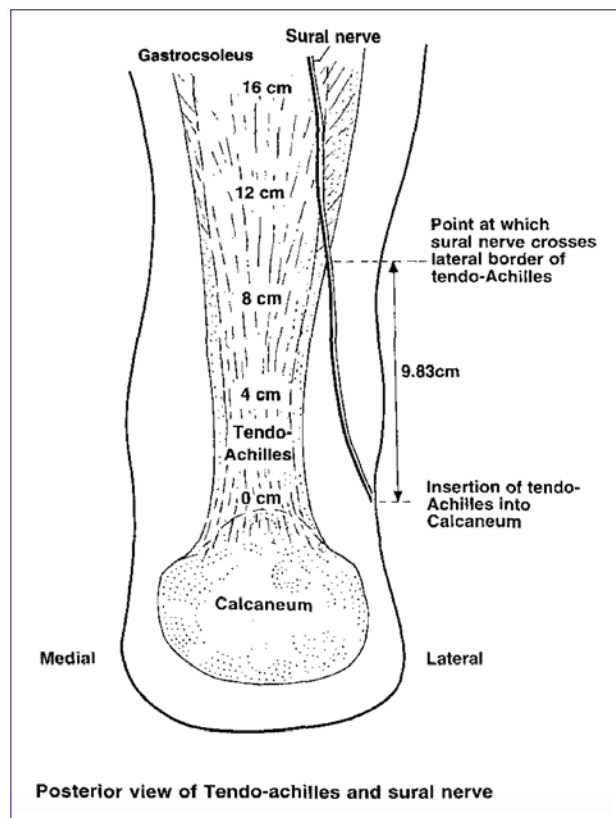
the nerve location increases the likelihood of damaging it while using percutaneous techniques.<sup>37</sup>

Another issue we analyzed in our study was the scar length, which was remarkably shorter in the patients subject to percutaneous techniques (2.04 cm) than in those who received conventional techniques (7.87 cm). This a relevant difference because patients prefer shorter incisions, while this way risks of complications decrease. In a prospective study on 66 patients which compared open with percutaneous reparation techniques, Lim et al.<sup>18</sup> informed higher rates of wound complications in the group of open surgery, with which they underwent seven cases of wound infection (21%) and two cases of adherences (6%) as compared to only three cases of wound creasing or retraction (9%) in the group with percutaneous reparation. In our series, one patient treated with open techniques showed wound dehiscence and there were no such cases in the group treated with percutaneous techniques.

Risks factors for post-operative infection in Achilles tendon tenorrhaphy include age >60 years old, smoking, corticosteroids treatment, diabetes and treatment delay > 7 days.<sup>38</sup> Pajala et al.<sup>39</sup> showed that 56% of the patients that developed deep infections had three or more of these risk factors. In our study, two patients in the group subject to conventional open surgery suffered superficial infection and were treated with antibiotics *p.o.* Patient with percutaneous surgery suffered neither superficial nor deep infection.

With respect to the ankle range of motion, our study did not show significant differences between the two techniques, nor did Henríquez et al. do so<sup>2</sup> in their publication comparing percutaneous to open surgery in the Achilles tendon rupture.

Aktas and Kocaoglu<sup>40</sup> evaluated open and percutaneous techniques in the reparation of the Achilles tendon and verified similar results in the AOFAS scores. In our series, although average scores were not significantly different, both the AOFAS and the ARPS scores showed better results in the final evaluation of percutaneous techniques. Many studies showed the benefits offered by early mobility and weight bearing following Achilles tendon tenorrhaphy.<sup>41,42</sup> In our post-operative protocol, however, out of caution we delayed weight bearing and mobility in the patients subject to percutaneous techniques, contrarily to what Amlang et al.<sup>28</sup> published.



**Figure 3.** Dorsal view of the Achilles tendon and the sural nerve (Reproduced with authorization—Webb J, Moorjani N, Radford M. Anatomy of the sural nerve and its relation to the Achilles tendon. *Foot Ankle Int* 2000; 21(6):475-7.)

Ceccarelli et al.,<sup>16</sup> in their comparative series of 24 patients did not find significant differences regarding work retaking (at average week 12 in both groups). In our study, we saw that the patients subject to percutaneous techniques were back to work 3.47 months earlier than those who received conventional techniques, results that are similar to those published by Henríquez y cols.<sup>2</sup>

## Conclusions

### General conclusions

1. Surgical repair of the Achilles tendon rupture both conventionally open and percutaneously developed good medical-functional results.

2. In this study, the percutaneous repair group developed fewer complications than the group of conventional open repair.

3. There was evidence neither of re-rupture nor of sural nerve injury in both groups.

### Specific comparative conclusions

1. In percutaneous reparation, both the AOFAS and the ARPS scores are better.

2. Open surgical repair took longer and produced a longer scar.

3. Patients operated on percutaneously reassumed working and sport activities sooner than those subject to conventional open surgery.

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