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Percutaneous repair of the Achilles tendon rupture in athletic population

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ABSTRACT

Aims: This review was designed in order to study the percutaneous repair of Achilles tendon rupture in athletic population. We present a comprehensive description of clinical, functional outcomes, complications, with emphasis on patients' level, and time of return to sports.

Methods: We proceeded to a systematic search of Medline (PubMed), Cochrane, and Scopus databases using keywords "Achilles Tendon", "Percutaneous Repair", "Percutaneous suturing", "Subcutaneous repair", "Subcutaneous suturing", "Athletes", and "Athletic" to identify articles or abstracts written in English.

Results: Thirteen studies, including 670 patients, could be identified. A variety of percutaneous repair techniques were performed. Re-rupture rate was very low. The most frequent complication was sural nerve damage. Average functional outcomes were satisfying. Up to 91.4% continued practicing sports after surgery. Furthermore, 78–84% returned to the same or higher sports level. Average time of return was 18 weeks in 9 studies.

Conclusion: Percutaneous repair of Achilles tendon rupture is an excellent perspective for athletic population. Low re-rupture rate and impressing level of return to sports allow athletes to continue their recreational activities or careers.

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1. Introduction

Achilles tendon (AT) is one of the strongest tendons of the human body¹ and takes its name from Achilles, the famous warrior of the ancient Greek literature.

Rupture of this tendon occurs mainly during sports activities, more frequently in middle-aged men, especially

recreational sportsmen who play sports occasionally.² The incidence of the tendon's rupture has increased over the last decades, a fact that is attributed to the increased sports participation among the population.^{3–5}

Management of AT rupture is a controversial issue. Surgical and conservative treatments are the current alternatives. Conservative treatment involves early equinus cast application for 6–8 weeks in order to approximate the edges of the

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ruptured tendon together to promote healing. Operative treatment involves open or percutaneous surgical technique in order to repair the ruptured tendon. Although there is an argument whether surgical or non-surgical treatment is the best option, operation appears to be more suitable for athletes due to the faster return to previous activities and the lower re-rupture rate.^{6–8}

Percutaneous suturing of the AT was first introduced by Ma and Griffith in 1977⁹ as an alternative for open repair, in order to avoid the procedure's complications. Since then, much progress has been made. Technological development brought modifications that improved the original technique,^{10–14} such as ultrasonography or endoscopy-assisted and mini-open technique, leading to better and more satisfying results.

Although there is no consensus over the ideal surgical procedure for athletes, several studies suggest that percutaneous repair offers better cosmetic results, reduced costs and yet comparable functional outcome and complication rate when compared to open repair.^{15–17}

The purpose of this study is to present a review of the existing literature concerning the results of percutaneous repair of the AT rupture in athletic population with emphasis on the time and the level of return to sports activities.

2. Materials and methods

2.1. Literature search and studies' selection

Relevant studies were searched in Medline (PubMed), Cochrane, and Scopus databases using keywords “Achilles Tendon”, “Percutaneous Repair”, “Percutaneous suturing”, “Subcutaneous repair”, “Subcutaneous suturing”, “Athletes”, and “Athletic”. Articles or abstracts published in English that reported clinical and functional results plus level and time of return to sports after percutaneous repair of the AT were included.

Reviews, cadaveric, non-human, biomechanical, in vitro, and studies that did not refer details concerning the level or time of return to sports were excluded.

After the initial assessment of 84 abstracts, we concluded to 13 articles. To obtain the information that we searched for, we analyzed 11 full articles and 2 abstracts.

2.2. Data extraction

We extracted the data from each study included. We isolated information about Sports level (pre–postoperative), time of return to sports, re-rupture rate, other complications (DVT, infection and delayed healing, adhesions, sural nerve damage), and functional outcomes (AOFAS, ATRS, Hannover scale, VISA-A scale, gastrocnemius muscle atrophy, ROM).

3. Results

Thirteen studies from 1990 to 2014 were assessed. The number of patients included in each study ranged from 12¹⁸ to 144,¹⁹ for a total of 670 repairs. Three studies^{11,12,19} were endoscopy-assisted, one study²⁰ was ultrasonography-assisted, and in one study,²¹ combined mini-open and percutaneous technique was performed.

Follow-up period was 1 year or above in 11 out of 12 studies. One study²² reported 6 months minimum follow-up. Eighty-one patients were reported as professional level athletes at their pre-injury state. The sex ratio was clearly in favor of males (M/F: 558/100). The ratio was not clarified for 12 patients.¹⁸ Mean age was between 30 and 40 years in 10 out of 13, above 40 in two^{22,23} and below 30 in one²¹ (Table 1).

3.1. Functional outcomes

The results of postoperative American Orthopedics Foot and Ankle Society (AOFAS) hindfoot clinical outcome score, which was used in 5 studies,^{12,20,24–26} were impressive (96.1 Average, 44–100 range).

Three studies^{20,23,27} used the Achilles tendon Total Rupture Score (ATRS); one of them used AOFAS score too.²⁰ Postoperative ATRS ranged from 84.3 to 91.4 with an average of 89. Postoperative Hannover and VISA-A scales were used in one study with scores of 94.5 and 93.1, respectively²¹ (Table 2).

Table 1 – Studies available in literature.

Study	Date of publication	Sample size	Professional athletes	Sex ratio (M\F)	Mean age (years)	Follow-up (months)
Gaiani et al. ²⁴	2012	80	10	52/28	34	12 (minimum)
Doral et al. ¹²	2009	62	7	58/4	32	46
Halasi et al. ¹⁹	2003	144	Not reported	123/21	38.3	12 (minimum)
Jallageas et al. ²⁵	2013	16	2	13/3	37	15
Vadala et al. ²¹	2014	36	36	33/3	29.7	28
Cretnik et al. ²⁶	2004	132	5	124/8	37	24 (minimum)
Lacoste et al. ²⁰	2014	75	4	60/15	39.9	20.7
Maffulli et al. ²⁷	2011	17	17	13/4	34.2	72
Bradley et al. ¹⁸	1990	12	Not reported	Not reported	36	21.6
Delponte ²²	2003	24	Not reported	19/5	51	6 (minimum)
Guillo et al. ²³	2013	23	Not reported	21/2	42.2	25.7
Chiu et al. ¹¹	2013	19	Not reported	18/1	38.7	24
Martinelli ²⁸	2000	30	Not reported	24/6	30.5	60

Table 2 – Validated clinical and functional scores after treatment and number of studies that used them.

	Number of studies used	Average	Range
AOFAS	5	96.1	(44–100)
ATRS	3	89	(84.3–91.4)
Hannover scale	1	94.5	Data not extracted
VISA-A	1	93.1	Data not extracted

Loss of the operated limb's strength was a common finding during the measurements; however, only two patients were reported to be unable to perform single-leg tiptoe rising.²⁶ Endurance trials showed lower rates of the operated limb too.^{18,21}

Range of motion (ROM) results after percutaneous repair was satisfying. The average active dorsiflexion was slightly limited in 3 studies^{11,12,23} and increased in one study.²⁵ Average plantar flexion decrease was reported too.^{11,18} Furthermore, studies that did not report the average ROM mentioned 14 patients with increased and 14 with decreased active dorsiflexion.^{19,26} They also reported 15 patients with active plantar flexion limitation.²⁶

Gastrocnemius muscle atrophy was evaluated by measuring the calf circumference (side to side comparison). Mean calf circumference reduction was constantly reported. We considered a >2 cm decrease in calf perimeter as significant. Average reduction was significant in 2^{12,27} and non-significant in 4 studies.^{18,23,25,28} Additionally, 28 and 14 patients had a significant and non-significant decrease, respectively.^{19,21}

3.2. Return to sports – level and time of return

Occasionally, operated patients did not return to sports activities after injury. Except for three studies,^{11,18,24} the others referred to the number of patients that abandoned athleticism. However, the results of three studies^{19,22,23} were inexplicit as they reported specifically the number of athletes that returned and omitted the whole sample. Twenty-six out of 299 patients (8.6%) and 23 athletes out of 167 patients stopped practicing sports (Table 3).

However, these last data (23 athletes) are inexplicit and inconclusive regarding the percentage of patients that stopped sports activities, because it does not refer to the entire sample.

All but two studies^{12,24} took the level of return to sports into consideration. One hundred and fifteen (145/173 = 84% out of those who returned, or 145/193 = 75% out of total) patients were reported to have returned to the same level after percutaneous repair, as long as 28 (28/173 = 16% out of those who returned or 28/193 = 14% out of total) did not manage to reach their pre-injury level. Furthermore, three studies,^{19,22,23} which mentioned athletes' results exclusively, reported 115 (115/150 = 78%) athletes that returned to the same level and 33 (33/150 = 22%) to lower level (Table 4).

One study²⁶ revealed outcomes related to professional athletes (5/5 = 100% returned to their pre-injury level). Another one¹⁸ recorded an 86% return to the same level (14% lower level).

The average time of return to sports for 9 out of 13 studies was 18.1 weeks (8–48 weeks). Two studies^{18,23} did not focus on the time of return (Table 5).

Pre-injury level time of return was 20–40 weeks (30 average) in one study.²¹ Professional athletes' average time of return to sports was 18 weeks in one study (12–24).²⁶

3.3. Complications

Re-rupture occurred in 14 (6 total, 8 partial) out of 670 patients (2.1%). Infection of the operated area and delayed healing rates were 2.1% (14/670 both). Sural nerve damage was reported in 22 patients (3.3%). Deep venous thrombosis (DVT) was mentioned as a complication in only 2/12 studies.^{19,26} As a matter of fact, these were the studies with the largest sample size (144/132). DVT rate was very low (4/670 or 0.6%). Adhesions' rate was extremely low too (4/670 or 0.6%) (Table 6).

4. Discussion

Epidemiological data of our study confirmed the prominence of male patients versus females with AT rupture.⁵ Mean age at the time of the injury was calculated as 36.9 years (Table 1).

Table 3 – Total athletes returned to sports.

Return to sports (stopped practicing sports)	Number of studies analyzed	Sample	Total	Percentage %
Patients (athletes/non-athletes)	9	26	299	8.6
Only athletes	3	23	Data not available	Data not available

Table 4 – The level of return to sports.

Level of return	Athletes/non-athletes (A-NA)/Only athletes (A)	Number of studies analyzed	Sample	Total (of those who returned)	Percentage %
Same (or higher)	A-NA	6	145	173	84
	A	3	115	150	78
Lower	A-NA	6	28	173	16
	A	3	33	150	22

Table 5 – Time of return to sports.

	Number of studies analyzed	Average (weeks)	Range (weeks)
Time of return to sports	9	18.1	8–48

Table 6 – Complication rate.

Ft	Patients (640)	Percentage (%)
Re-rupture	14	2.1
Infection of the operated area	14	2.1
Delayed healing	14	2.1
Sural nerve damage	22	3.3
DVT	4	0.6
Adhesions	4	0.6

The most frequent complication was sural nerve damage (3.3%). Infection of the operated area and delayed healing were less frequent (2.1%). DVT and adhesions were reported rarely (0.6%).

Re-rupture rate was extremely low (2.1%)(Table 2). Four studies reported re-ruptures: 6 (2 total, 4 partial) out of 144 patients,¹⁹ 5 (1 total, 4 partial) out of 132 patients,²⁶ 1 (total) out of 75 patients,²⁰ and 2 (total) out of 12 patients.¹⁸ The first three are on the top-4 studies concerning the sample size, and as a matter of fact, the number of the re-ruptures occurred is acceptable. The fourth study is the oldest included in our review and was conducted at a time that percutaneous technique was relatively new.^{9,18} According to the above, re-rupture rate outcomes were satisfying.

Functional outcomes were pleasing. High average AOFAS, ATRS, Hannover scale, and VISA-A scale scores were recorded (Table 3).

Strength decrease of the operated limb was reported repeatedly. On the other hand, this decrease, recorded during the measurements, rarely affected patients' single-leg tiptoe rising test.²⁶ Endurance reduction was reported too.^{18,21} Limited or increased ROM was often observed; however, high average clinical outcome scores (AOFAS, ATRS, Hannover, VISA-A scale) revealed that ROM alterations rarely affected the limb's function. Significant calf circumference reduction was reported in three studies.^{12,19,27} We are cautious over the outcomes regarding functional evaluation, because rehabilitation protocols were not taken into consideration in this review.

Ninety-one percent (91.4%, 273/299) of the people that participated in 9 studies resumed practicing sports (Table 4). On the other hand, 8.6% (26/299) of them, plus 23 athletes (out of 167 patients) reported in three studies, abandoned sports.^{19,22,23} Even though the rates of patients that stopped sports activities is low, it could have been lower, as long as the majority of patients that quit sports did so due to mental block and not functional incapability.

In addition to the great percentage of patients who returned to sports, level of return to sports results were satisfying too. Eighty-four percent (84%, 145/173) of a group that included athletes and non-athletes and 78% (115/150) of a group that exclusively consisted of athletes achieved a same or higher level of return (Table 5). Furthermore, one study, which was

actually the oldest one, reported 86% return to sports to the same or higher level.¹⁸ Although rehabilitation protocol was not taken into consideration, the results from above show that a great amount of patients not only resumed practicing sports but did it at their pre-injury level too.

Finally, the average time of return to sports after analyzing 9 studies was 18.1 weeks (8–48) (Table 6). As the range shows, there is a wide distribution regarding the time of return. Lack of rehabilitation protocol evaluation, inevitably, makes the interpretation of the results above inconclusive.

The present investigation has several limitations. Lack of direct contact with the authors of the articles, included in this study, inevitably affects scientific validity, which is biased by the quality of reporting. Also, linguistic capabilities of the research team were limited to English, possibly missing papers written in other languages. Level of evidence was mentioned only in three studies (Level 4). Consequently, the strength of the studies' results included in our review may be questioned.

5. Conclusion

Percutaneous repair is an excellent choice for people practicing sports after AT rupture. In our study, we did not evaluate rehabilitation. Nevertheless, the combination of low re-rupture rate (Table 2) and high percentage of return to the same or higher sports level (Table 5) allows us to establish that athletic population should prefer percutaneous repair after AT rupture.

Conflicts of interest

The authors have none to declare.

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