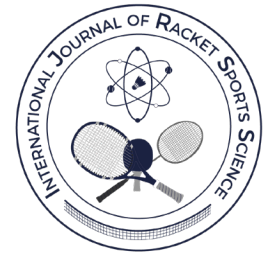


A narrative review of Achilles tendon ruptures in racket sports

Revisión narrativa de las roturas de tendón de Aquiles en deportes de raqueta



Elin Larsson ^{1 *}, Annelie Brorsson ^{1, 5}, Michael R. Carmont ^{1, 2}, Martin Fahlström ³, Eva Zeisig ⁴ and Katarina Nilsson-Helander ¹ 

¹ The Department of Orthopaedics, Sahlgrenska University Hospital Mölndal, Institute of Clinical Sciences at Sahlgrenska Academy, Gothenburg University, Sweden

² The Department of Trauma & Orthopaedic Surgery, Princess Royal Hospital, Shrewsbury & Telford Hospital NHS Trust, Shropshire, United Kingdom

³ Department of Clinical Sciences, Professional Development, Umeå University, Sweden

⁴ Department of Surgical and Perioperative Sciences, Orthopaedics, Umeå University, Sweden

⁵ IFK Kliniken Rehab, Gothenburg, Sweden

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Abstract

This review aims to report the existing research about Achilles tendon ruptures (ATR) in racket sports. Further, this narrative review will also include the acute management, rehabilitation, treatment and prognosis of an ATR. ATR is a common injury among individuals playing racket sports, however, the literature is limited and not up to date. Previous research claims that up to 70 percent of all ATR is related to sports activities where racket sports dominate. A large number of patients sustaining an ATR return to sport within a year from injury.

Keywords: *Achilles tendon ruptures, ATR, Racket Sports, Badminton, Tennis, Padel, Sports injuries.*

Resumen

Esta revisión pretende cubrir la investigación existente sobre las roturas del tendón de Aquiles (RTA) en los deportes de raqueta. Adicionalmente, esta revisión narrativa también incluirá el manejo agudo, la rehabilitación, el tratamiento y el pronóstico de una RTA. La RTA es una lesión común entre individuos que practican deportes de raqueta, sin embargo, la literatura es limitada y no está actualizada. Investigaciones previas afirman que hasta el 70% de todas las RTA están relacionadas con actividades deportivas donde predominan los deportes de raqueta. Un gran número de pacientes que sufren RTA regresan al deporte en el plazo de un año desde la lesión.

Palabras clave: *Rotura del tendón de Aquiles, deportes de raqueta, bádminton, tenis, pádel, lesiones deportivas.*

Corresponding author: Elin Larsson, elin.ma.larsson@vgregion.se

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INTRODUCTION

A middle-aged man is playing tennis at the tennis court. He just took a step back, awaiting a long ball, when he realizes that the ball is a drop shot, closer to the net. In an effort to reach the ball, he pushes off quickly and experiences a pop with immediate pain in the back of the calf, as though he was struck from behind, the Achilles tendon ruptured.

Achilles tendon rupture (ATR) is a common injury in both elite and recreational sports, that may lead to reduced function and activity level in the long-term (Tarantino et al., 2020). The incidence of ATR is increasing, where males are overrepresented with a ratio of 4:1 compared to females (Huttunen et al., 2014). The reason for this skewed distribution between the sexes is unknown. Racket sports are common activities for those rupturing their Achilles tendon (Houshian et al., 1998) however, research concerning specific racket sports in relation to acute ATR is limited.

The diagnosis of an acute ATR is clinical, meaning that the diagnosis can be determined by a patient interview and physical examination. The treatment for an acute ATR could be either surgical or non-surgical, followed by rehabilitation. There is an ongoing debate whether the advantages of each treatment outweigh the disadvantages. The difficulties with non-surgery compared with surgery are that re-ruptures occur more frequently, and also the tendon may undergo excessive elongation. Conversely, surgical intervention is associated with problems such as surgical site infection, adhesions, sural nerve injuries and other wound problems.

The Achilles tendon requires between six to twelve months to heal and remodel after an acute ATR. The recovery phase (6-12 months) after the injury includes supervised physiotherapy which is of importance for both the rehabilitation and to improve physical activity, functional outcome and return to sport (Holm et al., 2014; Zhang, et al., 2021).

INCIDENCE, CLINICAL FINDINGS AND DIAGNOSIS

Over the last few decades, epidemiological studies have reported increasing incidence of ATR (Huttunen et al., 2014; Ganestam et al., 2016). Between 1994 and 2013, the incidence of ATR increased from 27.0 to 31.2 ruptures/100,000 inhabitants/year in Denmark (Ganestam et al., 2016). In Sweden - between 2001 and 2012 - it has been reported an increase from 47.0 to 55.2 per 100,000 person-year in the incidence of men. The corresponding increase for women were 12.0 to 14.7 per 100,000 person-year (Huttunen et al., 2014). Thus, increasing numbers of males sustain ATR compared with females. Additionally, the median age at the time of injury is also increasing (Huttunen et al., 2014). A proposed explanation for the increasing incidence and median age is the growing interest in participating in recreational sport in the older age group (Huttunen et al., 2014; Ganestam et al., 2016).

The reported mechanisms of the injury are usually a characteristic for an acute ATR. Often, the injury occurs without any warning symptoms. A sudden dorsiflexion of the ankle or a "acceleration-deceleration mechanism" is a common description of the movement that caused the injury (Tarantino et al., 2020).

Clinical examination, including sensitive clinical tests, may be considered to be the golden standard to diagnose acute rupture and is more sensitive than ultrasonography (Maffulli, 1998). Simmonds' or Thompson's test (Fig 1) (Thompson, 1962), also called "calf squeeze test", is performed with the patient in prone position with their feet hanging over the edge of the examination couch. The examiner squeezes the calf muscle, which mimics a muscle contraction, and during normal circumstances this causes passive ankle plantarflexion. If the tendon is ruptured, no plantarflexion of the ankle will occur when squeezing the calf muscle, termed a positive test. There are cases when the tendon from the plantaris muscle is intact which could give a false negative sign and therefore, it is of importance to also perform Matles' test (Fig 2) (Matles, 1975). When performing Matles' test (Matles, 1975), the patient is also in prone position but the knees are bent to 90°. The uninjured ankle will be in a slight plantarflexed position while, with a ruptured tendon, the injured ankle will fall into an increased dorsiflexion.

Magnetic Resonance Imaging (MRI) or ultrasound (US) is not recommended for diagnosing an acute ATR in order to undermine the risk of missing patients with an acute ATR. However, US is recently introduced for treatment choice since the gap between the distal and proximal part of the tendon influence the outcome of respectively treatment (Westin et al., 2016). It is of importance to know that US is highly operator-dependent and that the subsequent evaluation of both still and video images can be challenging and a limiting factor.

ACHILLES TENDON RUPTURES IN RACKET SPORTS

A definite correlation between an injury and a particular sport is rare to find, however, there are several articles that show an association between racket sports and acute ATR. Houshian et al. (1998) showed that between 1986-1996, 70% of the ATR in Denmark were associated with sport activities. The most common sport activities were badminton, soccer and handball (Houshian et al., 1998). In another Danish study, performed on 39 badminton players sustaining an Achilles tendon rupture, 87% of the ruptures occurred towards the end of the game or in the middle. Furthermore, the authors concluded that tiredness or fatigue during racket sport was a predictor for an ATR (Kaalund et al., 1989). Other studies have shown that ATR forms 6.9-9% of acute tennis injuries (Raikin et al., 2013; Lemme et al., 2018) and 3-8.7% of acute badminton injuries (Fahlström, 2010). The incidence of ATR in padel, squash and lacrosse are not known.

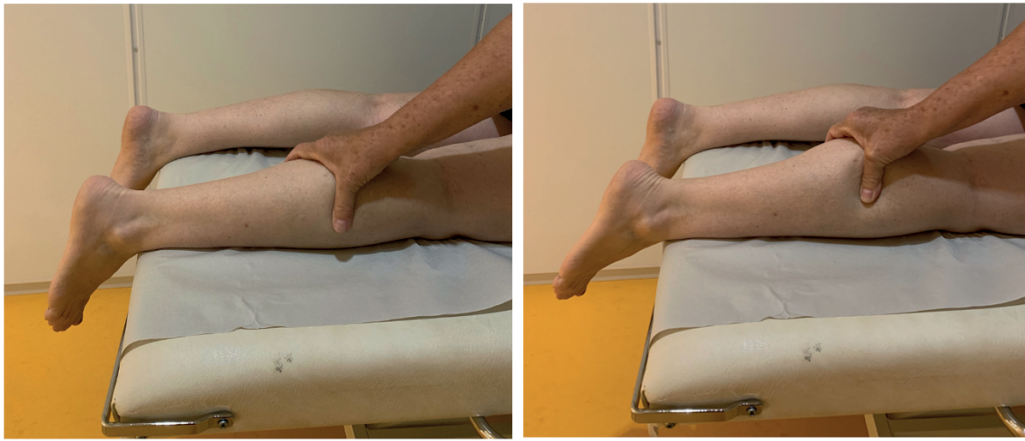


Figure 1. Thompson's test with a negative result (no rupture in the Achilles tendon). If no plantarflexion occur during the squeeze the result is positive.



Figure 2. Matles' test. In the left picture the ankle has an anatomic angle compared to the right where the dorsiflexion of the ankle is increased which is an indirect sign of an Achilles tendon rupture.

TREATMENT OF AN ACHILLES TENDON RUPTURE

When it is suspected that a player has suffered an ATR on the racket sport court, the best treatment for the tendon is to immobilise the injured ankle in a plantarflexed position and help the player to an appropriate medical facility for assessment, diagnosis and management planning. The player should not be weight bearing on the injured limb and if available and familiar with crutches these may be used.

Patients that suffer from an acute ATR can receive either surgical or non-surgical treatment and there is no consensus that one method is superior to the other. Several randomized controlled studies (RCTs) and meta-analyses have been published but the outcomes of these differ. In summary, re-ruptures are more frequent in non-surgically treated patients while surgical wound problems and sural nerve injury are complications relating only to surgically treated patients ([Deng et al., 2017](#); [Khan et al., 2005](#);

[Soroceanu et al., 2012](#); [Nilsson-Helander et al., 2010](#)). The re-rupture rate in non-surgical treated patients has been considered to be reduced if functional rehabilitation, including early weight-bearing, is incorporated ([Beyer et al., 2015](#); [Wu et al., 2016](#); [Zhang et al., 2015](#)). The differing findings from RCTs have led to a general paradigm shifts for the standard treatment tending to move towards non-operative treatment. Even though there are many guidelines to the selection of a treatment regimen, the final decision should be based on a patient's individual factors and preferences.

Non-surgical treatment may involve a cast or a walker brace, keeping the ankle in approximately 30° plantar flexion. After 2 weeks, if a cast has been used, it will be replaced by a walker brace with 3-4 wedges ([Fig 3](#)) that keeps that ankle in a slight plantar flexion. Also, 2 weeks after the injury, supervised physiotherapy should be introduced. The wedges will be gradually removed one by one during 6 weeks, and after 8 weeks allowing a neutral position of the ankle.



Figure 3. A walker brace with wedges.

Several surgical techniques are described and are in general sub-divided into open, mini-invasive and percutaneous. Repairs may be performed with endoscopically assisted surgery or with ultrasonographic guidance. Techniques using smaller incision known as minimally-invasive have been developed to minimize wound related problems however, these together with percutaneous techniques have been associated with a higher frequency of sural nerve injuries compared to open surgery (Čretnik et al., 2005). After surgery, same algorithm as non-surgical treatment is used, including a cast for 2 weeks followed by a walker brace with wedges (or walker brace instead of a cast) and supervised physiotherapy 2 weeks after the surgery.

REHABILITATION PHASES

The rehabilitation is often divided in four different phases depending both on the time from the injury/surgery but also on the functional status of the patient (Silbernagel et al., 2014). The four phases are Controlled mobilization phase (0-8 weeks), Early mobilization phase (6-11 weeks), Late mobilization phase (10-15 weeks) and Return to sport phase (3-12 months) (Silbernagel et al., 2014).

Each patient needs a tailored rehabilitation program with personal guidance aiming to return to their desired activity. Weaning off from the supportive walker brace can be a challenge for both the patient and the physical

therapist. The risk for re-rupture is the greatest during this time period (Möller et al., 2001; Pajala et al., 2002; Rettig, Liotta et al., 2005) but there is also a need to load the tendon to promote the tendon healing and remodeling process. Since the load on the Achilles tendon is 2.5-3 times the body weight in each step during walking (Komi et al., 1992), the numbers of steps per day often needs to be limited during this phase to permit the tendon to adapt to the relatively small loads. Swelling and pain around the ankle are clinical signs of overuse. A compression stocking during daytime may be useful for minimizing swelling in lower leg (Rabe et al., 2018).

The return to physical activity & sport phase is often initiating around three to four months after the injury. During this phase, the patient needs guidance when to commence start with running and jumping activities in line with his or her goals.

It has been suggested that the following criteria can be used to decide when a patient is able to start with running activities (Silbernagel et al., 2014).

1. To be at least 12 weeks after injury and be able to perform 5 single-leg standing heel-rises at 90% of the maximum heel-rise height on the injured side.
2. If unable to achieve the above criteria by week 14-15, the patient can start running progression if they are able to lift at least 70% of their body weight during one single-leg heel-rise.

It is also suggested that there should be 3 days between running/jumping activities to allow recovery between sessions.

If the patient is aiming to return to racket sports, the rehabilitation should gradually include exercises to replicate the particular sports activity. Six to seven months after the injury, the patient should be able to bit by bit return to racket sports.

It is desirable that the coach and physiotherapist discuss the challenges and high impact movements in the particular racket sport. For example, in tennis, there are different techniques for the serve with different loading of lower limb, also the loading differs depending on which side is affected; the dominant or non-dominant side (Elliott, 2006). A relevant clinical question is if it is possible to practice step by step not losing technique with good quality?

PROGNOSIS

Do the individuals that suffers from an acute ATR recover adequately to return to their racket sport? In the Danish study from 1989 including 39 patients that suffered from an ATR during badminton, 46% resumed sport within 6 months of the injury. After 12 months 82% of the patients resumed activity. These results are in line with a meta-analysis by Zellers et al. that concluded that four out of five patient that suffered from an acute ATR returned to sport within 6 months (Zellers et al., 2016).

EARLY REHABILITATION PHASE (6-11 WEEKS) Visit for physical therapy 2-3 times a week and home exercises daily	
Exercise programme:	- Leg presses
- Exercise bike	- Leg extensions
- Ankle range of motion	- Leg curls
- Ankle strengthening using a resistance band or cable machine	- Foot exercises
- Sitting heel-rise with external load (25-50% of body weight)	If the patient meets the criteria of five single leg heel-rises at 90% of height, then start:
- Standing heel-rise progressing from two legs to one leg	- Bilateral rebounding heel-rises
- Gait training	- Bilateral hops in place
- Balance exercises	- Gentle jogging in place

Figure 4. A general rehabilitation programme during the early rehabilitation phase ad modum Silbernagel et al (Silbernagel et al., 2014).

However, it has been proven that an important factor to minimize ankle- and knee biomechanical deficits during more demanding activities after an ATR, is to regain the heel-rise height in the injured ankle within the first year after the injury (Brorsson, Grävare Silbernagel et al., 2018). Moreover, seven years after an ATR, the patients still have deficits in heel-rise height, strength and endurance in the injured lower limb even if they have returned to middle-high physical activity (Brorsson, Willy et al., 2017). Heel-rise height has been shown to improve during the first two years after the injury but after two years no improvements in lower leg function has been found (Brorsson, Grävare Silbernagel et al., 2018).

CONCLUSIONS

ATR is a common injury among racket sport players. If the injury is being recognized early and the patient receives individualized treatment, in combination with monitored physiotherapy during rehabilitation, players are likely to return to the same level of sports activity whether surgical or non-surgical treatment is chosen.

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