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Criteria Identification For Returning To Sport After Achilles Tendon Injury

[1]Maude Traulle, PT; M.Sc.
[2]Jean Mazeas, PT
[3]Nicolas Bechaud, PT, DO
[4]Patrice Marine, PT, ATC
[5]Rémy Touzard, MD
[6]Jérôme Sadaka, MD
[7]Matthieu Trousselier, MD
[*8]Florian Forelli, PT, ATC, M.Sc.

ABSTRACT

Background: The Achilles tendon rupture is a pathology of growing incidence due to the increase in the intensity of amateur sports practices and the continuation of this practice with the rise in age. The rupture follows a degradation of the tendon's structure, known as degenerative tendinopathy, which is symptomatic only in rare cases. In the absence of prior pain, iterative rupture is the complication to be feared and prevented. Unfortunately, after orthopedic or surgical treatment, there is no consensus concerning criteria for returning to sports. Such criteria would aim to prevent the risk of recurrence and the appearance of other sports injuries.

Methods: A current literature review using the PubMed database in June 2021.

Results: The literature doesn't show any validated criteria for returning to sport.

Conclusion: Consequently, this work seeks to propose objective criteria for validating the return to sport in connection with the physical and psychological qualities of the subject, abrogating temporal criteria, too formal and remote from the clinical view. Thus, the physiotherapist is advised to take an interest in the ankle's range of motion and the stiffness of the tendon, strength and endurance of the calf muscle, the quality of the proprioceptive and postural functions on a more functional plan, based on the quality of the jumps and then on the subject's running pattern. Finally, a psychological assessment completes the battery of tests that will validate the return to sport.

Keywords: Achilles tendon rupture, return to sport, criteria, assessment, recurrence prevention.

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[1]OrthoSport Rehab Center, 16 rue de Paris, 95330 Domont, France. OrthoLab, Ramsay Santé, Clinic of Domont, 85 route de Domont, 95330 Domont, France. Email : maudetraulle@gmail.com
[2]OrthoSport Rehab Center, 16 rue de Paris, 95330 Domont, France. OrthoLab, Ramsay Santé, Clinic of Domont, 85 route de Domont, 95330 Domont, France. Email: jeanmazeas@gmail.com
[3]OrthoSport Rehab Center, 16 rue de Paris, 95330 Domont, France. Email : bechaud.nicolas@gmail.com
[4]OrthoSport Rehab Center, 16 rue de Paris, 95330 Domont, France. Medical and Research Center for High Sport Performance, CDFAS, 64 rue des Bouquinvilles, 95600 Eaubonne, France. Email : pmarine.mk@gmail.com
[5]Clinic of Domont, 85 route de Domont, 95330 Domont, France. Email :rtouzard@capio.fr
[6]Clinic of Domont, 85 route de Domont, 95330 Domont, France. Email : jsadaka@capio.fr
[7]Clinic of Domont, 85 route de Domont, 95330 Domont, France. Email :mtrousselier@capio.fr

CORRESPONDING AUTHOR

[*8]Florian Forelli, PT, ATC, M.Sc.

OrthoSport Rehab Center, 16 rue de Paris, 95330 Domont, France. OrthoLab, Ramsay Santé, Clinic of Domont, 85 route de Domont, 95330 Domont, France. Medical and Research Center for High Sport Performance, CDFAS, 64 rue des Bouquinvilles, 95600 Eaubonne, France. Email : fforelli@capio.fr

BACKGROUND

The incidence of Achilles tendon ruptures (ATR) ranges from 7 to 47 / 100,000 per year in Europe and mainly concerns men (6: 1) aged 30-50, according to Mattila et al. in 2015 [1] and Huttunen et al. in 2001 (2). Previous symptoms of pain or disfunction are only identified in 10% of cases.

These ruptures are linked to an endogenous mechanism associating a maximal contraction of the Triceps Surae and an asynchronous stretching of the suro-achilleo-calcaneo-plantar system. According to Flik in 2005 [3], it is most often performed near the calcaneal insertion, 3 to 6 cm above the entheses, on the narrowest area of the tendon, and the most poorly vascularized.

According to Cook et al. in 2016 [4], the tendon pathology corresponds to a continuum, meaning the injury evolves from a degenerative pathology. A rupture only appears on a previously injured tendon that has not healed correctly. In other words, if the tendon ruptures, it is because, on the kinetic chain formed by bone, muscle, and tendon, it represents the weakest link, unable to resist the traction that causes it to tear.

The sport practiced by the subject in question is a factor to consider: the type of terrain (soft to hard) and the type of effort required (acceleration or sprint speed) is involved. Indeed, according to Lai et al. in 2016 [5], during the sprint and especially in the acceleration phase on a hard surface, the triceps (as a whole) seems to contract almost isometrically, offering the Achilles tendon the role of the main contributor of propulsion due to its elastic qualities, explaining the prevalence of rupture in basketball.

In professional sport, most Achilles tendon ruptures occur early in the season in veteran players, and nearly half of them either do not return to the game or start less than ten games in the rest of their careers. The most common mechanism of injury is the uplift from a stopped position, just before the foot is involved, with a dorsiflexed foot, according to Lemme et al. in 2019 [6].

At the edge of the field, the therapist can objectify the ATR thanks to the calf squeeze test or Thompson test, which presents, according to the work of Schwietermann et al. in [7], a sensitivity of 96% and a specificity of 93%.

TREATMENT AND REHABILITATION

Two treatments are possible after objectified ATR: surgery or available treatment. These two treatments offer immobilization, the duration of which tends to be reduced as much as possible, allowing the patient to regain optimal mobility quickly, according to Park et al. in 2020 [8]. The Holm et al. team in 2015 explained that surgical treatment of acute Achilles tendon ruptures did not significantly reduce the risk of iterative rupture compared to non-surgical treatment. However, iterative rupture rates are low. The differences between patients with and without surgery are minor, with a risk difference of 1.6%, according to the study by Ochen et al. in 2019 [9].

Heikkinen et al. in 2017 presented two studies [10,11] whose conclusions explain that the increase in Achilles tendon length is associated with a decrease in the volume of the Triceps Surae and the persistence of plantar flexion strength deficits after surgical repair of an ATR. However, the lengthening of the tendon tends to be correlated with a poorer functional result, without distinction between surgical and non-surgical treatments, according to the systematic review by Holm et al. in 2015 [12].

Deficits in strength and muscle volume are partially offset by Flexor hallucis longus hypertrophy. Still, deficits of 11-13% of soleus and gastrocnemius muscle volumes and 12-18% of plantar flexion strength persist even after long-term follow-up, values found by Heikkinen et al. [10]. Furthermore, the authors suggest that these deficits seem to be increased when non-surgical treatment is chosen, even with intense and early physiotherapy follow-up [11]. Because of the persistence of the deficits, it becomes legitimate to ask the question of the return to sports practice and under what conditions?

BACK TO SPORT?

Krause et al. [13] demonstrated that 67% of high-level athletes after ATR operated or not, were able to resume their previous activity during a 5-year follow-up in their cohort of patients. The average time to return to play varies between athletes but can range from 6 to 10 months, according to Zellers et al. in 2016 [14]. In the American Football League, Yang et al. found in 2019 (15) that 61.3% of injured players could make a total return to competition after an average of 11.90 months after a primary tear. According to the same study, returning players showed a significant decrease in the number of games played in the return season compared to the previous injury season.

A decrease in strength of 10% or a little more may seem insignificant and perhaps even imperceptible to some patients. Still, it may prove to be a source of performance decline in some elite athletes, according to the work of Heikkinen and al; in 2017 [10]. Additionally, there is an increased risk of re-rupture in young athletes, which may be secondary to the abnormally high forces exerted on the tendon by such patients.

Trofa et al. [16] examined return to sport (RTS) and performance in professional athletes after surgical repair of the Achilles tendon after complete rupture and compared the pre and postoperative functional results of professional athletes from different major leagues in the USA. They said that the 30.6% of professional athletes included in the study with isolated ATR surgically treated were unable to return to the field. They also pointed out that the athletes who returned to play participated in fewer games had less playing time and had a lower level of performance than before the injury. However, these functional deficits were only observed for up to a year after the operation compared to a matched control group. The authors extrapolate these results by explaining that players who resume playing can expect to have performance similar to healthy controls two years after the operation.

This data was later confirmed by Siu et al. [17], who stated that professional basketball players examined with unilateral ATR reached their peak post-injury performance level in the second return-to-play season. That post-injury

peak performance was significantly worse than the pre-injury level but was similar to that of matched uninjured players.

A 2021 epidemiological study conducted by Grassi et al. (18) on the Italian professional football league A showed between 2008 and 2019, an incidence rate of 0.007 per 1000 hours of play (training and match combined). If the incidence rate is relatively low, all players return to the game, but 40% of them have lowered their level, reducing their participation time or being demoted to the second division after an ATR.

If such data is observed in terms of resumption of sport and level of return to play, it is fair to ask whether objective conditions have been set to resume sport in a safe and optimized manner.

RETURN TO SPORTS CRITERIA

The literature currently does not find a consensus on the criteria for returning to sport after a complete rupture of the Achilles tendon, whether operated or not. Consequently, we propose a reflection based on the criteria of return to sport validated after the anterior cruciate ligament reconstruction [19,20] or the hamstrings injury [21,22] by adapting them to the operated ATR or not.

Analysis of the load applied to the myotendinous junction by the teams of Lai et al., Starbuck et al., as well as Yeh et al. [5,23,24] (figure 1), show growth between the upright position, walking, jumping, and running for maximum applied load at the start of the sprint, which correlates with the main injury mechanism of ATR. Therefore, RTS criteria should be based on this progression.

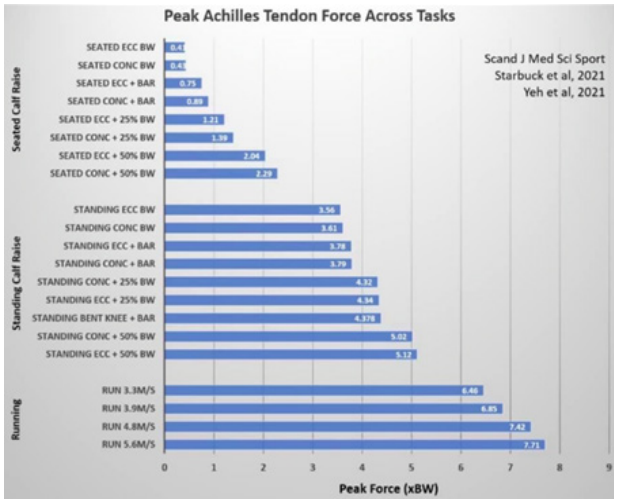

Figure 1: Histogram of the load applied to the Achilles tendon as a function of the movement performed (Copyright the Sports MAP Network ©)

Pain and functional impact

In 2016, Hansen et al (25) showed that the presence of tendon pain and its functional impact at 3 months is a predictive factor for the ability to return to sport one year after the rupture. The team therefore proposes to use the "Achilles tendon total rupture score" (ATRS), which is a scale (Figure 2) evaluating the functional impact of Achilles rupture, as a validation criterion for the RTS. Thus, even if the threshold value of the scale has not yet been defined, a mediocre score could be synonymous with no RTS (26).

APPENDIX
ATRS
(Achilles Tendon Total Rupture Score)

All questions refer to your limitations/difficulties related to your injured Achilles tendon.

Mark with an X in the box which matches your level of limitation!

1. Are you limited due to decreased strength in the calf/Achilles tendon/foot?

0 1 2 3 4 5 6 7 8 9 10

2. Are you limited due to fatigue in the calf/Achilles tendon/foot?

0 1 2 3 4 5 6 7 8 9 10

3. Are you limited due to stiffness in the calf/Achilles tendon/foot?

0 1 2 3 4 5 6 7 8 9 10

4. Are you limited due to pain in the calf/Achilles tendon/foot?

0 1 2 3 4 5 6 7 8 9 10

5. Are you limited during activities of daily living?

0 1 2 3 4 5 6 7 8 9 10

All questions refer to your limitations/difficulties related to your injured Achilles tendon

Mark with an X in the box which matches your level of limitation!

6. Are you limited when walking on uneven surfaces?

0 1 2 3 4 5 6 7 8 9 10

7. Are you limited when walking quickly up the stairs or up a hill?

0 1 2 3 4 5 6 7 8 9 10

8. Are you limited during activities that include running?

0 1 2 3 4 5 6 7 8 9 10

9. Are you limited during activities that include jumping?

0 1 2 3 4 5 6 7 8 9 10

10. Are you limited in performing hard physical labor?

0 1 2 3 4 5 6 7 8 9 10

Total Score:

Figure 2: The Achilles tendon total rupture score from Nilsson-Helander et al. in 2007

This statement is supplemented by the work of Bostick et al. of 2010 [27], which explains that patients with pain at three months have a slower recovery of the muscular endurance of the triceps sural according to examinations at six months and one year from the rupture but can ultimately recover in a comparable way to the healthy side.

The impact of pain on the apprehension of movement can be assessed with the Visual Analogic Scale and the Tampa Kinesiophobia Scale from the work of Olsson et al. of 2012 [28]. Therefore, the use of ATRS, which combines the assessment of pain, kinesiophobia and their respective impacts on muscle and Achilles tendon function, is recommended.

Range of motion

One of the proposed RTS criteria is the dorsiflexion measurement to assess the length of the tendon and the passive stability of the ankle. One of the significant

risk factors for lateral ankle sprain trauma is the defect of mobility in dorsiflexion of the ankle, according to the 2019 consensus conference of the International Ankle Consortium Rehabilitation-Oriented Assessment (ROAST) [29].

In addition, a significant difference in joint mobility, measured with the knee straight and/or the knee flexed but above all compared to the healthy side, could originate in a tendon elongation, which would be particularly damaging for the transmission of muscle force to the segment of the foot and would generate a propulsion deficit imputing the performance according to the work of Butler et al. in 2003 [30].

The measurement of Achilles length is projected by the use of the "Achilles Tendon Resting Angle (ATRA)," which is strongly correlated with ultrasonic measurement techniques such as the Copenhagen Achilles Length Measure (CALM), as concluded by Hansen et al. in 2020 [31]. In addition, ATRA shows excellent inter-rater reliability with a low measurement error, according to the same authors in 2017 [32]. The measurement is easy to use in clinical practice and provides an indirect measure of the length of the Achilles tendon after rupture, whether operated on or not.

Muscular Strength

According to the latest review on the subject, the work of Bäcker et al. [33] analyzes the means of assessing strength after Achilles rupture. Concentric isokinetic analyses at 60 ° and 120 ° / s are recommended because these values present the best reproducibility indices, according to Morrison and Kaminski in 2007 [34]. Still, the authors specify that there is no consensus on evaluation speeds. According to the work of Walker et al. in 2020 [35], the subject's position, with the knee flexed or stretched, does not significantly influence the results of force tests at 30 ° or 60 ° / s.

Suppose the limb symmetry index (LSI) calculation is recommended for the lower limb. In that case, the literature offers some references of rationalized normative value to the subject's size, allowing us to validate a functional muscle recovery. Indeed, the work of Kruger et al. [36] evaluated the couple of plantar flexion and dorsiflexion of the ankle of the dominant leg in 306 men (mean age: 26 years) at 30◦ / s, using a flexed knee position. They reported values of 30 Nm (0.34 Nm / kg) and 70 Nm (1.02 Nm / kg) for dorsiflexion and plantar flexion, respectively, and a dorsiflexion / plantarflexion ratio of 43%.

Fugl-Meyer [37], using the extended knee position and a test speed of 30◦ / s, reported on 15 athletes and 15 sedentary controls, all male, and found dorsiflexion values of 35 Nm (0.47 Nm / kg) and 33 Nm (0.44 Nm / kg), respectively for these two groups. Their plantar flexion values ranged between 184 Nm (2.45 Nm / kg) for athletes and 126 Nm (1.8 Nm / kg) for sedentary participants, while the respective dorsiflexion / extension ratios, were 19% (athletes) and 26% (sedentary controls).

Lategan [38], in a 2011 study of 438 young men, using the flexed hip and knee position, established values normalized to the subject's weight. He found values for plantar flexion 1.85 Nm / kg and 0.52 Nm / kg for dorsiflexion at a speed of 30◦ / s, and gave a flexor / extensor ratio of 28.9%.

There is no strict consensus on normative values. Therefore, no objective conclusion can be drawn as to whether the force of the calf muscles is adequate or not, depending on the level of physical or sporting activity of the subject.

In addition to the isokinetic muscle test, the review by Bäcker et al. [33] mentions the Heel Rise Test. Triceps Surae endurance is assessed using the One Leg Heel Rise Test. This test is a reliable measure of endurance in patients with Achilles tendon rupture, according to Möller in 2005 [39]. The 2017 study by Hébert-Losier et al. gives us norms according to the age and sex of the subject [40]. In addition, the ability to pass a single heel-rise test three months after rupture or surgery appears, according to the work of Olsson et al. in 2012 [28], to be strongly correlated with kinesiophobia and reflects the general level of progression of the subject, which influences the potential for a return to physical activity.

Hop Tests

To perform a closer examination of the propulsive function of the ankle, the literature examined the hop tests. Dams et al. in 2019 recommend the single hop test [41] that only use 12 months postoperatively. According to Kotsifaki et al. in 2021 [42], performance at this jump represents the function of the ankle and hip in propulsion. Therefore, the score is representative, at least in part, of the performance of the Triceps Surae during propulsion and the Achilles tendon's ability to transfer this explosive force. Its use is therefore recommended.

The elasticity index of the muscle-tendon complex given by the performance differential in Squat Jump (SJ) with Counter Movement Jump (CMJ) gives indications on the quality of the tendon and its ability to transmit energy from the muscle to move the whole body.

By comparing it to the opposite side, this index gives a representation of the state of healing of the tendon in terms of stiffness. The literature shows that tendon stiffness is an essential asset in propulsion efficiency, according to Butler et al. in 2003 [30], which is essential for athletes. However, to our knowledge, there is currently no standardized reference for this index, so it is legitimate to refer to a deviation of 10% as a limit to physiology.

Running

The first sporting gesture present in most professional sports, running, is the most frequent functional movement. Therefore, it seems legitimate for us to offer it as a criterion for returning to the game.

Running analysis can take on a variety of aspects. For example, the study of the amount of bilateral propulsion and the kinematics of the pelvis adapt to the post-rupture follow-up of the Achilles tendon, operated or not. Hip abductor moment deficit is a risk factor for anterior cruciate ligament rupture and lateral ankle sprain. However, an increase in the pelvic obliquities in the support phase is indicative of a lack of stability of the pelvic girdle. Since the symmetry of the pelvic kinematics is, according to the

work of Brown et al. in 2014 [43], dependent neither on the dominance of one lower limb over the other nor on the state of fatigue of the limbs, this index can be used as an indicator of recovery and therefore must be validated to allow a return to sport. This same study, whose findings of the symmetry of limb kinematics when running a healthy subject, may extend to propulsion symmetry.

This study suggests that the side-to-side differences are probably not due to lower limb dominance and that the differences are not more apparent with fatigue. This, therefore, does not mean that if the symmetry of the lower limbs during the race is acquired, the subject is not at risk of being injured during the race. Still, the presence of asymmetry, moving away from the physiological model, can be considered as a risk factor.

Acceleration and pelvic kinematics can be measured using onboard sensors equipped with this technology and specific smartphone applications, using in the work of Ahamed et al. in 2019 [44]. According to the work of Fellin et al. in 2010 [45], running analysis can be done on a treadmill because the use of such a tool only very partially modifies the subject's running pattern. Moreover, these authors use the 90% symmetry index value as a reference for their analyses, a value that can be extrapolated to our proposals.

CONCLUSION

Achilles tendon rupture is a pathology of increasing incidence, representing the rise of intensive and high-level sports practice in aging populations. After treatment, the return to sport must meet objective criteria that may or may not offer approval. To limit the risk of iterative injury, this work makes proposals for criteria that will have to be validated in the future before systematic use.

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