

Achilles tendon strain and stress during running in runners with Achilles tendinopathy

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Summary

Achilles tendinopathy (AT) is a common running-related injury. Studies into biomechanical risk factors mainly focused on surrogate measures of tendon loading. The aim of this study is to compare Achilles tendon strain and stress between runners with AT and injury-free runners during running. Twenty-four long-distance runners (12 AT, 12 injury-free) were included and ran on an instrumented treadmill, while capturing 3D marker positions, ground reaction forces and the displacement of the Achilles tendon origin by using ultrasound. Runners with AT had significantly higher peak tendon strain during stance compared to IF runners, but no differences in tendon stress were found. This may reflect alterations in the mechanical properties of the Achilles tendon and could be a cause or consequence of AT, but larger prospective studies in at-risk runners should explore these mechanisms further. Potentially, tendon strain can be a target for injury prevention, treatment and recovery.

Introduction

Achilles tendinopathy is one of the most common running-related injuries [1]. Previous studies investigating biomechanical risk factors during running mainly focused on kinematic and kinetic factors [2]. These are, however, surrogate measures for Achilles tendon loading. To better understand the biomechanical mechanisms underlying this injury, a more direct tendon-related measure of load is needed, like Achilles tendon strain or stress. Achilles tendon strain has been examined during isometric plantar flexion in runners with AT [3] but not during running. Therefore, the aim of this study is to compare Achilles tendon strain and stress between runners with AT and injury-free runners during running.

Methods

Twenty-four long-distance runners (12 with AT, age: 41.8 ± 12.5 years, BMI: 23.5 ± 2.9 , 12 injury-free, age: 33.4 ± 21.8 years, BMI: 21.8 ± 2.3) were included in this study. 3D marker positions, ground reaction forces and displacement of the Achilles tendon origin were recorded during running at 3.33 m/s on an instrumented treadmill. The Achilles tendon origin was defined as the myotendinous junction with the gastrocnemius medialis, which was reliably tracked using an ultrasound transducer attached to the lower leg during running [4]. The insertion on the calcaneus was located by ultrasound and tracked with an in-shoe marker cluster [4]. Tendon length was represented by the distance between origin and insertion. Tendon strain was defined as the percentage change in tendon length during running relative to the tendon length during static standing. Tendon stress was calculated as tendon force

divided by cross sectional area, which was determined with ultrasound as well. Independent t-tests were conducted to compare time-normalized waveforms and peak and average values of tendon strain and stress between groups.

Results

Runners with AT had significantly higher peak tendon strain during stance compared to injury-free runners ($5.07 \pm 2.37\%$ vs. $2.87 \pm 2.11\%$; $p = .025$). Peak tendon stress was 17% lower and CSA 23% larger in runners with AT, but no significant group differences were found, nor were there for force and for strain and stress waveforms (Figure 1, Table 1).

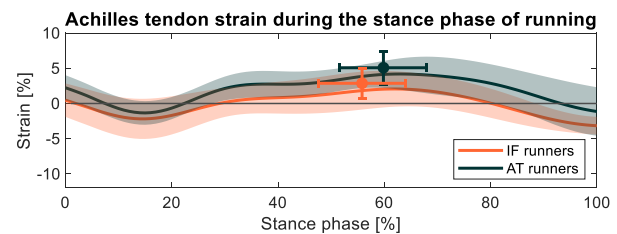


Figure 1: Time-normalized Achilles tendon strain during stance phase. The two dots represent peak strain values and its timing. Standard deviation is represented as vertical and horizontal lines.

Table 1: Achilles tendon mechanical properties during the stance phase of running in AT and injury-free (IF) runners

	IF group	AT group
Peak strain (%)*	2.87 ± 2.11	5.07 ± 2.37
Peak stress (N/mm ²)	75.19 ± 14.40	60.99 ± 18.30
Peak Achilles tendon force (N)	4596.11 ± 590.55	4403.21 ± 585.71
Normalized peak Achilles tendon force (N/kg)	63.10 ± 7.74	57.83 ± 11.22

Data presented as mean \pm SD. *Significant group difference ($p < .05$)

Conclusions

Peak Achilles tendon strain during running is increased in runners with AT. This may reflect alterations in the Achilles tendon mechanical properties and could be a cause or consequence of AT, but larger prospective studies in at-risk runners should explore these mechanisms further. Potentially, tendon strain can be a target for injury prevention and treatment and recovery.

References

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