Morphological and mechanical properties of the Achilles tendon during running between novice and experienced runners

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Summary

We compared the morphological and mechanical of the Achilles tendon (AT) between 15 novice and 15 experienced runners. MRI determined the cross-sectional area of AT. The real-time AT displacement changes during maximal voluntary isometric contraction (MVIC) and the plantar flexion moment of the ankle were obtained simultaneously by connecting the ultrasound device and isokinetic dynamometer [1, 2]. Results showed no significant differences in AT cross-sectional area, length, elongation, tendon force, stiffness, stress, and strain between the two groups. Although novice and experienced runners differed in their running experience, no significant adaptive changes were observed in the AT in the short term. The AT required a prolonged training period (e.g., several months or more) to exhibit noticeable changes in its morphology and mechanical properties.

Introduction

AT was reported to have the highest incidence proportion of all running-related injuries [3]. Studies have shown that experienced runners exhibit more efficient biomechanical performance than novice runners. However, it is not yet clear whether differences in running experience can alter the morphological and mechanical properties of the AT during running. Therefore, the purpose of this study was to investigate the differences in the morphological and mechanical properties of the AT between novice and experienced runners.

Methods

Thirty healthy men were recruited, including novice runners (n = 15), and experienced runners (n = 15). Before the experiment, the resting length and cross-sectional area of the AT were measured using an ultrasound imaging device (uSmart 3300, US) and a clinical 3T MRI scanner (Prisma 3.0T MRI, Germany), respectively [2]. Then, participants were instructed to lie prone on the isokinetic dynamometer (CON-TREX MJ, Germany) with their hip and knee joints fully extended, and ankle joints in a neutral position. They were asked to gradually increase their ankle joint dorsiflexion MVIC from relaxation to the maximum within 5 seconds to obtain the plantar flexion moment of the ankle joint. A linear probe was placed on the medial head of the gastrocnemius muscle and the tendon insertion point to acquire displacement changes simultaneously. Independent samples *t*-tests were used to compare the differences in AT morphological and mechanical properties between novice and experienced runners.

Results and Discussion

The study compared the morphological and mechanical properties of the AT between novice and experienced runners, finding no significant differences in stress, strain, tendon force, stiffness, elongation, length, or cross-sectional area. This suggested that short-term running experience did not significantly alter AT properties. Future research should explore long-term adaptations and refine measurement techniques to detect changes in tendon biomechanics better.

Conclusions

This study found no significant differences in AT biomechanics between novice and experienced runners, suggesting that the tendon did not undergo immediate adaptive changes despite varying levels of running experience. The results indicated that noticeable changes in tendon morphology and mechanical properties required a prolonged training period.

Acknowledgments

Young Scientists Found of the National Natural Science Foundation of China (grant/award number: 12302416); Zhejiang Provincial Natural Science Foundation of China (grant/award number: LMS25A020008); Natural Science Foundation of Ningbo Municipality (grant/award number: 2023J129).

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Table 1: Morphological and mechanical properties of Achilles Tendon between novice and experienced runners.

Variables	Novice runners	Experienced runners	*P*-value	*F* (Levene's Test)	*t*-value
CSA (mm^2)	78.5833 ± 17.21114	77.9847 ± 9.21673	0.906	7.187	0.119
Tendon length (cm)	19.2933 ± 2.75900	18.7400 ± 1.69234	0.513	2.71	0.662
Elongation (mm)	1.6564 ± 0.65913	1.7283 ± 0.40414	0.721	2.819	-0.36
Achilles Tendon Force (BW)	1.5513 ± 0.60806	1.8683 ±0.59503	0.160	0.002	-1.443
Stiffness (N/mm)	186.4960 ± 76.66448	197.4413 ± 89.30582	0.721	1.26	-0.36
Stress (MPa)	19.9750 ± 6.68709	24.9275 ± 10.88493	0.144	2.439	-1.501
Strain (%)	8.8920 ± 3.94308	9.2707 ± 2.25599	0.749	2.882	-0.323