Effect of Frontal Plane Ankle Positions on Achilles Tendon Non-Uniformity and Muscle Force Sharing Strategies

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Summary

The Achilles Tendon (AT) has a wide insertion onto the calcaneus. Along with its twisted nature, different foot positions have been shown to affect its mechanics during active plantarflexion. Hence, we aimed to investigate the effect of foot eversion and inversion on AT non-uniformity and triceps surae (TS) activation strategies. Ultrasound of free AT and TS EMG of 23 healthy adults were investigated in five different foot positions: inversion 5º and 10º (IN5 and IN10), eversion 5º and 10º (EV5 and EV10), and neutral (N). Submaximal isometric contractions were performed with knee straight (180º) in all ankle positions. There were no differences in AT non-uniformity between different foot positions. However, relative MG contribution during EV5 was greater in comparison to IN5 and IN10. Additionally, the overall EMG of TS was higher during EV10 and IN10 when compared to N.

Introduction

The AT plays an important role in human locomotion on top of it being the largest tendon in the body. As it inserts onto the calcaneus, foot positions have an impact on its function, mechanics, and overall internal displacement. Currently, foot abduction and adduction have been shown to affect AT non-uniformity, with potential implications on AT pathology and rehabilitation [1]. With ankle being a near omnidirectional joint, the foot can also experience different frontal plane motions during activities such as walking or running. Thus, we aimed to investigate the effect of different frontal plane foot positions on AT non-uniformity.

Methods

Healthy participants (N=23) with no previous AT injuries were seated in a chair with their knees straight at 180º. Isometric contractions at 30% isometric maximal voluntary contraction (MVC) were performed in five different ankle positions in randomized order: neutral (N), inversion 5º and 10º (IN5 and IN10), eversion 5º and 10º (EV5 and EV10). US probe (AixplorerUltimate, SuperSonic Image, France) was strapped around the ankle to ensure contact at the free AT region, with EMG (Pico EMG, Cometa, Italy) attached to the TS muscles. A validated [2] US speckle tracking script was used to analyze AT non-uniformity. EMG and force data was processed in a custom-made MATALB script (MATLAB R2020a, MathWorks Inc, Natick, MA). The total TS EMG was calculated from the sum of all MVC normalized TS EMG.

Results and Discussion

AT non-uniformity did not differ between different ankle positions. However, EV5 exhibited greater MG contribution in comparison with IN5 [$F(2.46, 18) = 6.16$, $p < 0.05$, $d = -0.446$] and IN10 [$F(2.46, 18) = 6.16$, $p < 0.05$, $d = -0.542$]. In addition, both EV10 [$F(2.66, 18) = 11.22$, $p < 0.05$, $d = 0.903$] and IN10 [$F(2.66, 18) = 11.22$, $p < 0.05$, $d = 0.804$] had higher overall TS EMG activity in comparison with N position (Figure 1). The absence of differences in AT non-uniformity (Figure 1) may be the result of insufficient IN and EV angle, inadequate contraction intensity, or upper chain compensations.

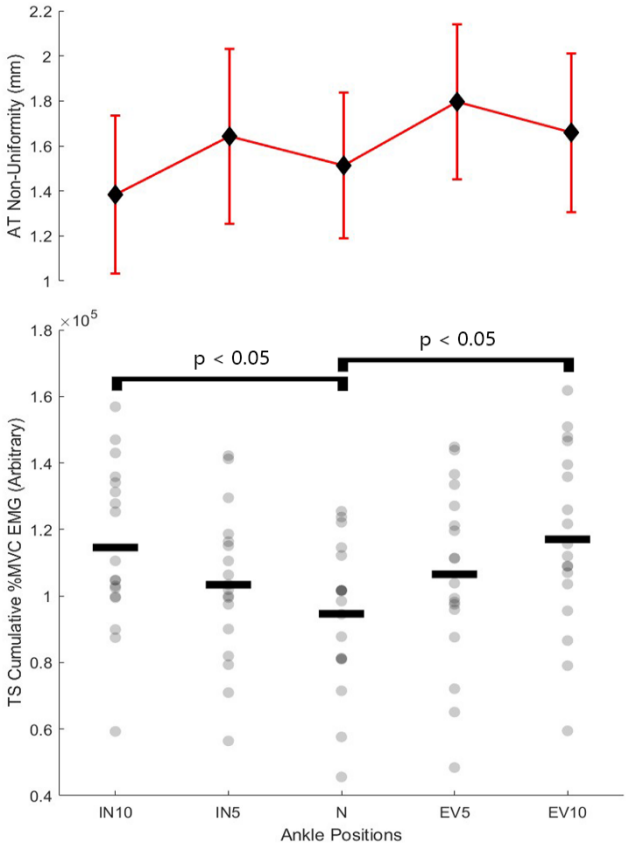

Figure 1: Non-uniformity and cumulative %MVC of different foot positions.

Conclusions

Consistency of non-uniform displacement was accompanied by increase in relative MG contribution in EV and overall TS EMG in both EV and IN. This could infer to the muscle's influence on AT mechanics in different frontal plane positions, and possible development of injuries when foot is in repetitive contact with uneven surfaces during activities such as running.

References

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[2] Slane & Thelen (2014). *J Biomechanics*, 47(12): 2831.