Do carbon plate running shoes increase tibial impact or promote biomechanical running gait asymmetry?

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Summary

Carbon plate running shoes (CPRS) have revolutionised running gear since their introduction in 2017, but their orthopaedic effects remain controversial. While world records have been broken, the incidence of running-related injuries has risen, particularly to the Achilles tendon. As such overuse symptoms are often unilateral, altered symmetry in leg loading might be a contributing factor. To investigate the effect of CPRS on running gait symmetry, a cross-sectional study with 22 trained triathletes (13 men, 9 women) was conducted. Athletes completed five trials wearing four different CPRS models and their own pair of shoes, while loading asymmetry was assessed using triaxial peak tibial acceleration (PTA). Results showed no significant changes in loading asymmetry when wearing CPRS. However, for one CPRS model an increased mean PTA was found. These findings suggest that internal changes in tissue loading when wearing CPRS may not be sufficiently reflected by PTA, while some changes are detectable.

Introduction

Carbon plate running shoes (CPRS) have become one of the most impactful improvements to running gear technology since their first instruction in 2017. As CPRS gain popularity among runners of all levels, biomechanical and orthopaedic effects seem to be controversial: While new world records in marathon running have been set, also the prevalence of running-related overuse injuries, especially regarding the Achilles tendon, seem to have increased. It is notable that those injuries effect usually just one leg, despite the fact that running is generally considered a symmetrical sport.

Methods

To ascertain whether CPRS exert an influence on the symmetry of running gait, a two-day trial was conducted involving 22 trained amateur triathletes (13 men, 9 women). The ventilatory thresholds (VT1 and VT2) were determined via incremental treadmill testing until volitional exhaustion on the first day. On the second day of testing, the athletes completed five trials of three minutes at three different speeds (90% v_{VT1}, $0.5(v_{\mathrm{VT1}} + v_{\mathrm{VT2}})$ and, 100% v_{VT2}), wearing four different CPRS models (HOK: Hoka Rocket X2, MIZ: Mizuno Wave Rebellion Pro, PUM: Puma Fast-R Nitro Elite, SAU: Saucony Endorphin Pro 3) and their own preferred non-CPRS. During both tests, the athletes were equipped with inertial measurement units to measure axial and resultant triaxial peak tibial accelerations (PTA) throughout the entire step cycle on each leg (Figure 1).

Figure 1: Experimental setup: Inertial measurement units were attached to the tibiae (and the sacrum) to measure triaxial peak accelerations.

Results and Discussion

The results demonstrate that the asymmetry indexes for axial and resultant triaxial PTA were not affected by the different CPRS models across all three speeds ($p > 0.384$, Figure 2). However, one CPRS models was found to induce an increased resultant triaxial PTA ($p < 0.006$).

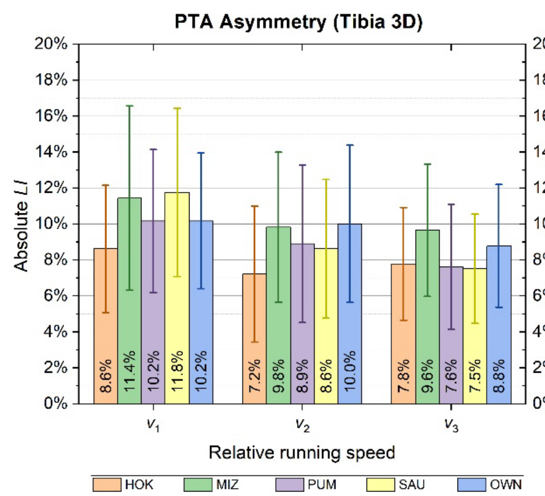

Figure 2: Resultant peak tibial acceleration asymmetry for the four CPRS models and the individual pair of shoes (OWN).

Conclusions

In essence, the results of this study indicate that the cause of the increased incidence of lower limb injuries when wearing CPRS may not be explained by altered asymmetries between left and right leg based on peak tibial accelerations. Hence, internal changes in tissue loading when wearing CPRS may not be sufficiently reflected by external PTA, although some changes are detectable. Future research should examine the changes in internal tissue loading when wearing CPRS.