A comparison of lower limb joint work during walking: traditional running shoes versus advanced footwear technology

John Kerr[1,2], Key Nahan[1,2], Steffen Willwacher[3], Kirsty McDonald[1,2]
[1]University of New South Wales, Sydney, NSW, Australia
[2]Neuroscience Research Australia, Sydney, NSW, Australia
[3]Offenburg University of Applied Sciences, Offenburg, Germany
Email: john.kerr@unsw.edu.au

Summary

Advanced footwear technology (AFT) offers performance benefits in running. The shoes incorporate rounded carbon fibre plates, advanced midsole foam, and a rocker bottom geometry that reduces ankle work during running. However, little is known about how these shoes impact walking biomechanics. This is an important question because it is unlikely AFT is used exclusively for running. The aim of this analysis was to compare ankle, knee, and hip work in a traditional running shoe and AFT. We found no significant difference in work for all joints.

Introduction

Shoe technology can alter walking biomechanics. Adding longitudinal bending stiffness to the foot shifts the centre of pressure (COP) anteriorly and may affect peak plantar flexor force production [1]. Rocker bottom geometry moves the COP similarly, reducing peak propulsive plantar flexor moments [2]. AFT incorporates these features and has been reported to result in several mechanical changes during running, relative to traditional running shoes including lower negative and positive work at the ankle during running [3]. While the primary purpose of AFT is to optimise running performance, bouts of walking have become increasingly common as AFT popularity increases among recreational cohorts. Yet, it is unclear how AFT affects joint kinetics during walking. The aim of this analysis is to compare hip, knee and ankle work during walking in a traditional running shoe and AFT. We hypothesise that AFT will decrease ankle but not alter knee or hip work.

Methods

Nine healthy participants provided written consent to participate in this study, approved by University of New South Wales Human Research Ethics Committee. Participants performed 30 s walking trials at 1.2 m/s while wearing a traditional running shoe (Brooks Hyperion Tempo™) and an AFT (ASICS Metaspeed Sky+™) in a randomised order. Walking was done on a split-belt, instrumented treadmill (Motekforce Link) while ground reaction forces (1000 Hz) and motion capture data (200 Hz; Vicon) were collected. Dominant limb ankle (shank-calcaneus), knee and hip joint total power was non-dimensionalised by $Mg\sqrt{gL}$ where M is body mass, g is acceleration due to gravity and L is leg length. Joint work was computed from raw power data and non-dimensionalised by MgL. It was then divided by non-dimensionalised stride length $(stride\ length/\ L)$ to present the work done per unit distance travelled. Linear mixed effects models in R were used for all statistical analyses.

Results and Discussion

Despite differences in shoe architecture and previously demonstrated differences at the ankle joint during running, there were no significant differences between footwear condition for positive ankle (p=0.814), positive knee (p=0.220), positive hip (p=0.655), negative ankle (p=0.759), negative knee (p=0.308) or negative hip (p=0.794) joint work. Ankle, knee, and hip power were also similar in both conditions (Figure 1). While AFT does not appear to impact mechanical work of the lower limb joints during walking, it is possible that the AFT simultaneously decreased and increased joint work demands via different mechanisms (e.g., rounded carbon fibre plate, advanced midsole foam, rocker bottom geometry), which we continue to investigate.

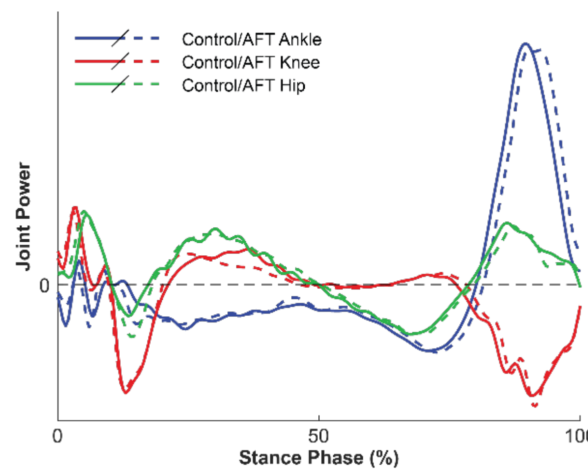

Figure 1: Non-dimensionalised ankle (blue), knee (red), and hip (green) joint power in traditional footwear (solid) and AFT (dashed).

Conclusions

In conclusion, we reject our hypothesis that ankle joint work would be modified by the use of AFT relative to traditional running footwear in walking. Future work could explore potential differences due to changes in walking speed, or during gait transitions (e.g., walking to running, running to walking).

References

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