The influence of an intensive 10 km treadmill run on second metatarsal bone stress in distance runners

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Summary

Repetitive loading which occurs in distance running can result in bone stress injury, with the second metatarsal being a common site for injury. Fatigue may increase the risk of bone stress injury. This study found no difference in peak dorsal bone stress in the second metatarsal before and after an intensive 10 km treadmill run. An acute fatiguing run may not increase risk of metatarsal bone stress injury.

Introduction

Repetitive loading which occurs in distance running causes microdamage to bone which can result in bone stress injury if adequate rest is not taken to allow bone to repair. The metatarsals in the foot are a common location for bone stress injuries in track and field athletes, with the second metatarsal having a particularly high incidence [1].

The role of fatigue in the development of bone stress injuries is unclear. *In vivo* strain gauge measurements have shown an increase in second metatarsal compression strain during a treadmill walking fatigue protocol [2]. It is unknown how running-induced fatigue influences metatarsal bone stress. The aim of this study was to investigate how a 10 km intensive treadmill run influences second metatarsal bone stress.

Methods

Participants were 28 healthy, rearfoot runners (14 F/14 M) aged 18-40 years who ran ≥15 km per week and ≥3x week.

Motion capture cameras recorded kinematics (Qualisys, Sweden, 185 Hz) while participants ran barefoot over an EVA runway containing a pressure plate (HR Mat, TekScan, USA, 185 Hz) placed over an in-ground force plate (AMTI, USA, 1850 Hz). A multi-segment foot model was adapted to obtain sagittal plane second metatarsal pitch angle.

Five to seven overground running trials were collected before and after a 10 km treadmill run. Overground trials were at preferred speed (±5%) and the treadmill speed was 105% (5% slower) of estimated 10 km race time. Participants wore their own running shoes on the treadmill.

Second metatarsal and second toe forces were calculated by scaling the vertical and horizontal ground reaction forces based on the percentage of total foot force under those regions from the pressure data. Second metatarsal pitch angle was calculated using the positions of the proximal and distal second metatarsal markers.

Dorsal bone stress was estimated using a 2D second metatarsal beam theory model and bone geometries from a similar population [3]. A paired t test determined the effect of the 10 km run on second metatarsal bone stress.

Results and Discussion

No significant difference was found between peak dorsal stress before (mean ± SD: 164.84 ± 33.34 MPa) and after (162.85 ± 31.04 MPa) the treadmill run ($p = 0.096$, $d = 0.06$) (Figure 1). Pitch angle decreased from pre- (29.5 ± 0.7°) to post- (28.7 ± 0.7°) 10 km run ($p = 0.046$, $d = 0.21$).

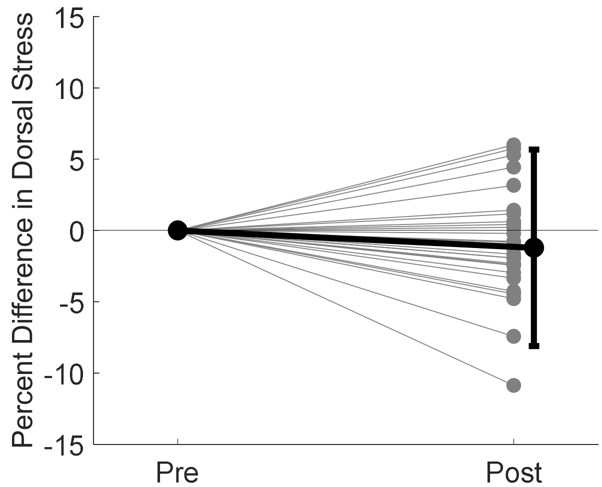

Figure 1: Percent difference in peak dorsal stress between pre- and post- 10 km run trials. Black circles show means, vertical lines show standard deviations, and grey circles represent participants.

Participants reached a mean of 16.6 ± 1.9 out of 20 on the Borg scale, comparable to Willwacher et al. [4] who found kinematic changes at the end of an intensive 10 km run. In the present study, the 10 km run affected foot kinematics but not peak dorsal stress on average, although individual differences were observed in peak dorsal stress. A limitation was that the 10 km was run shod on the treadmill while data were collected during overground barefoot running.

Conclusions

A 10 km intensive treadmill run did not cause an acute change in peak second metatarsal bone stress. A single fatiguing run may not influence risk of bone stress injury. Chronic fatigue should be considered.

References

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