



Mechanical Risk Factors for Stress Fracture in Elite Runners

Citation

Hunt, Kenneth, Nathan Wilcox-Fogel, Rishi Trikha, and Adam Tenforde. 2016. "Mechanical Risk Factors for Stress Fracture in Elite Runners." *Orthopaedic Journal of Sports Medicine* 4 (7 suppl4): 2325967116S00133. doi:10.1177/2325967116S00133. <http://dx.doi.org/10.1177/2325967116S00133>.

Published Version

doi:10.1177/2325967116S00133

Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:29002579>

Terms of Use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA>

Share Your Story

The Harvard community has made this article openly available.
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)

Mechanical Risk Factors for Stress Fracture in Elite Runners

Kenneth Hunt, MD¹, Nathan Wilcox-Fogel², Rishi Trikha², Adam Tenforde, MD³

¹University of Colorado Department of Orthopaedics, Aurora, CO, USA, ²Stanford University Department of Orthopaedics, Redwood City, CA, USA, ³Harvard Medical School, Boston, MA, USA.

Objectives: Bone stress injuries (BSI) are responsible for significant missed competition and training in distance runners. A recent review of our institution's injury database revealed that one-fifth of NCAA-level runners sustained one or more BSI over a three-year period. While much is known about certain risk factors for stress injury such as the Female Athlete Triad, little is known about biomechanical risk factors including dynamic loading of the foot during running differs between athletes with history of BSI and those without. The aims of this study were: 1) characterize the dynamic loading patterns of elite distance runners during athletic movement, 2) determine the difference in dynamic loading magnitude and location in runners who have history of a BSI compared to non-injured runners and 3) establish a database to be used for follow-up evaluation. We hypothesized that athletes with a history of BSI in the lower extremity apply greater dynamic loads during athletic movements compared to uninjured athletes.

Methods: We recruited 40 healthy varsity distance runners (16 females, 24 males) from our institution to participate in the study. Dynamic foot loading data was collected on all athletes using a validated wireless insole pressure measurement system during a series of athletic movements (e.g., walking, running and lateral cutting). Data was collected for contact area, maximum force, peak pressure, maximum mean pressure and force-time integral at each of eleven foot regions during each athletic movement. All force and pressure data were normalized to body weight. Injury history and other potential risk factors of interest were collected by self-report questionnaire and chart review. All BSI occurred as a result of participation of running, diagnosed by a physician and confirmed with advanced imaging. Mean values were calculated for each variable and foot region in each athlete and paired t-tests were performed for injury history comparisons.

Results: A total of 23 runners with a history of 1 or more lower extremity BSI (11 females, 12 males), and 17 athletes with no history of BSI (5 females, 12 males) participated. Runners with a history of BSI trended toward greater peak pressures during running activities ($p = .13$) compared to uninjured controls, and displayed significantly greater peak pressures in the forefoot during cutting movements ($p < .05$). Further, those with history of BSI in the foot and ankle displayed greater force-time integral in the forefoot during running ($p = .06$). In the medial forefoot, athletes with history of BSI displayed significantly greater maximum mean pressures during jump takeoff ($p < .05$), running ($p = .05$) and cutting ($p < .05$). We did not observe a difference in foot strike patterns or FAAM Sport scores between injured and uninjured runners. Menstrual irregularities were seen in a majority of female athletes and were not associated with BSI.

Conclusion: Our findings suggest that elite runners with a history of BSI exert greater pressures and force-time integral in the forefoot and medial midfoot during running and cutting compared to uninjured athletes. The greater loads in the forefoot and medial midfoot may play a role in the incidence and recurrence of BSI in running athletes. Further study of our athlete cohort will allow elucidation of specific high pressure points in the foot that may place athletes at risk for specific BSI, and allow us to investigate the utility of preventive measures.

The Orthopaedic Journal of Sports Medicine, 4(7)(suppl 4)

DOI: 10.1177/2325967116S00133

©The Author(s) 2016