Joint-Specific Kinematic Deviations in Asymptomatic Flatfoot: Insights into Early Biomechanical Adaptations

Andrew C. Peterson[1], Kassidy Knutson[1], Karen M. Kruger[2,3], Amy L. Lenz[1,4]
[1]Department of Orthopaedics, University of Utah, Salt Lake City, UT, USA.
[2]Joint Department of Biomedical Engineering, Marquette University, Milwaukee, WI, USA.
[3]Motion Analysis Center, Shriners Children's, Chicago, IL, USA.
[4]Department of Biomedical Engineering, University of Utah, Salt Lake City, UT, USA.
Email: andrew.c.peterson@utah.edu

Summary

This study examines joint kinematics during walking in individuals with asymptomatic flatfoot (AFF) and healthy controls. AFF showed increased eversion, inversion, and external rotation in specific joints highlighting early compensatory adaptations and the need for early detection and biomechanical assessment.

Introduction

Flatfoot deformities span a continuum [1], with asymptomatic flatfoot (AFF) representing a potential pre-symptomatic stage that may have early compensatory mechanisms [2]. The contributions of individual joint motion within the foot to flatfoot deformity are not well understood. This study investigates the walking kinematics of the tibiotalar (TT), tibiofibular (TiF), talofibular (TaF), subtalar (ST), and talonavicular (TN) joints in individuals with AFF compared to healthy controls, aiming to identify compensatory deviations and symptomatic flatfoot progression.

Methods

We analyzed TT, TiF, TaF, ST, and TN joints in AFF and healthy controls using biplane fluoroscopy and weightbearing CT for precision bone-level tracking [3]. 1D-SPM identified significant gait deviation across all three planes. Statistical analysis included alpha values of 0.05 and 0.32 to capture 2 and 1 standard deviations of differences, respectively.

Results and Discussion

Significant kinematic differences were observed between individuals with AFF and healthy controls. At alpha = 0.05, the TT joint exhibited an increased inversion in the AFF group during early stance. At alpha = 0.32, the AFF group exhibited trends of increased TT inversion, TaF external rotation, ST eversion/external rotation, and TN external rotation at various point throughout stance (Figure 1). These findings highlight joint specific kinematics deviations in AFF, suggesting early adaptation to medial arch collapse and hindfoot instability.

Conclusions

This study reveals kinematic differences in AFF compared to healthy controls, emphasizing the role of the TT, TaF, ST, and TN joints in early compensatory mechanisms. These altered mechanics, even without symptoms, may signal progression of symptomatic flatfoot. Identifying these kinematic patterns offers insights into flatfoot deformity and underscores the importance of early detection. Future work may include using this population to determine factors that contribute to development of a symptomatic flatfoot.

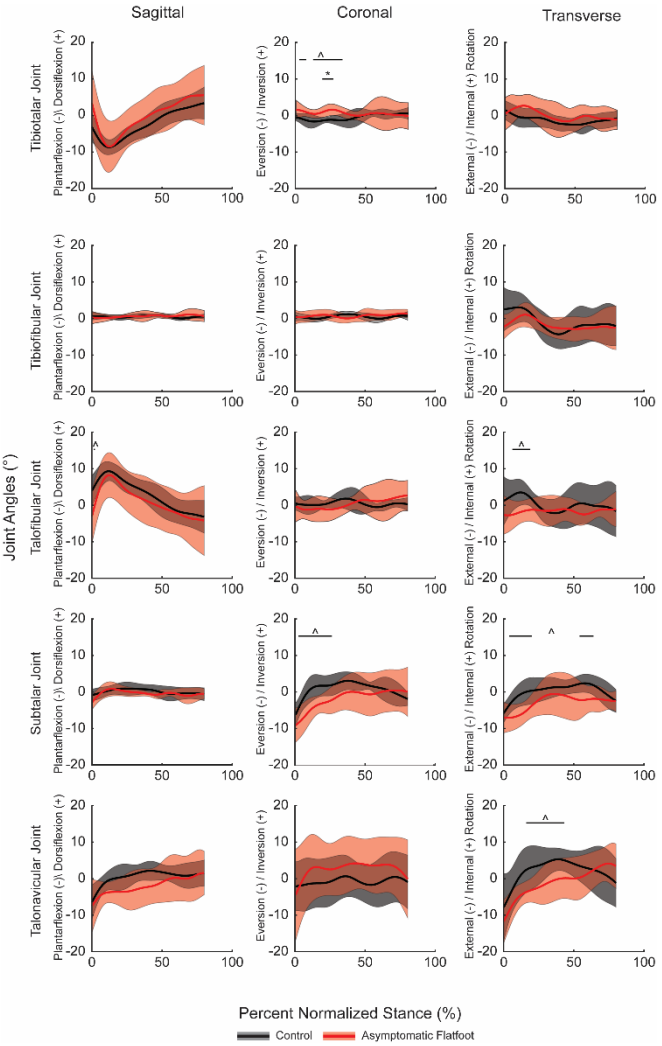

Figure 1: Kinematic plots of joint angles versus percent normalized stance. An asterisk (*) and a carrot (^) represent significant differences with alpha equal to 0.05 and 0.32, respectively.

Acknowledgments

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References

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