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In vivo talocrural and subtalar kinematics during nonweightbearing and weightbearing dorsiflexion-plantarflexion activities

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Introduction

Understanding of the effect of weightbearing on the kinematics of the subtalar and talocrural joints is critical for the diagnosis and treatment of foot and ankle disorders. However, precise kinematics of these joints during dynamic activities in vivo is not well studied. The purpose of this study was to compare in vivo kinematics of these joints during nonweightbearing and weightbearing activities in healthy subjects.

Methods

Seven healthy subjects with a mean age of 32 ± 7 years were enrolled. Nonweightbearing and weightbearing activities from dorsiflexion to plantarflexion were recorded with oblique lateral fluoroscopy at 7.5 frames/sec. Geometric bone models of the tibia/fibula, talus, and calcaneus were created from CT images of the subject. Anatomic coordinate systems were embedded in each bone model. Three dimensional kinematics of the subtalar, talocrural, and ankle joint complex were determined using 3D-2D model registration techniques (Figure 1) [1,2]. Bone models were projected onto the distortion-corrected fluoroscopic image, and three dimensional positions and orientations of the bones were determined by matching the silhouette of the bone models with the silhouette of the image.

Results

During the nonweightbearing activity from 20° of dorsiflexion to 15° of plantarflexion of the ankle, the subtalar joint everted by 4° and dorsiflexed by 2°. The talocrural joint inverted by 3°, plantarflexed by 32°, and adducted

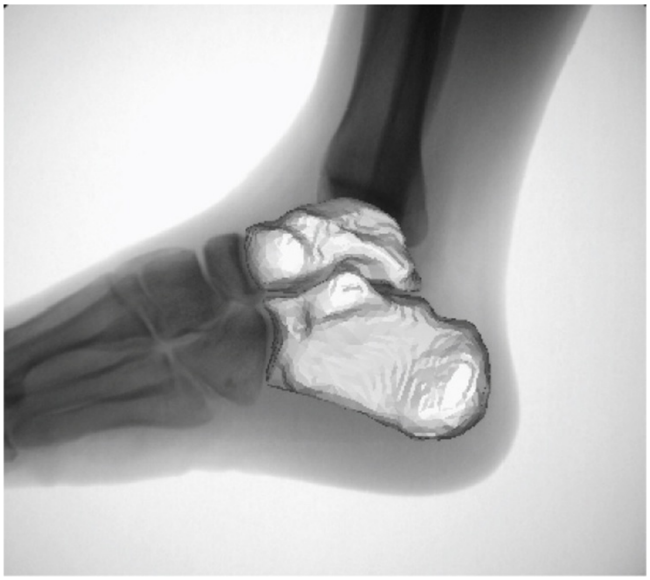

Figure 1
Shape matching of the talus and calcaneus.

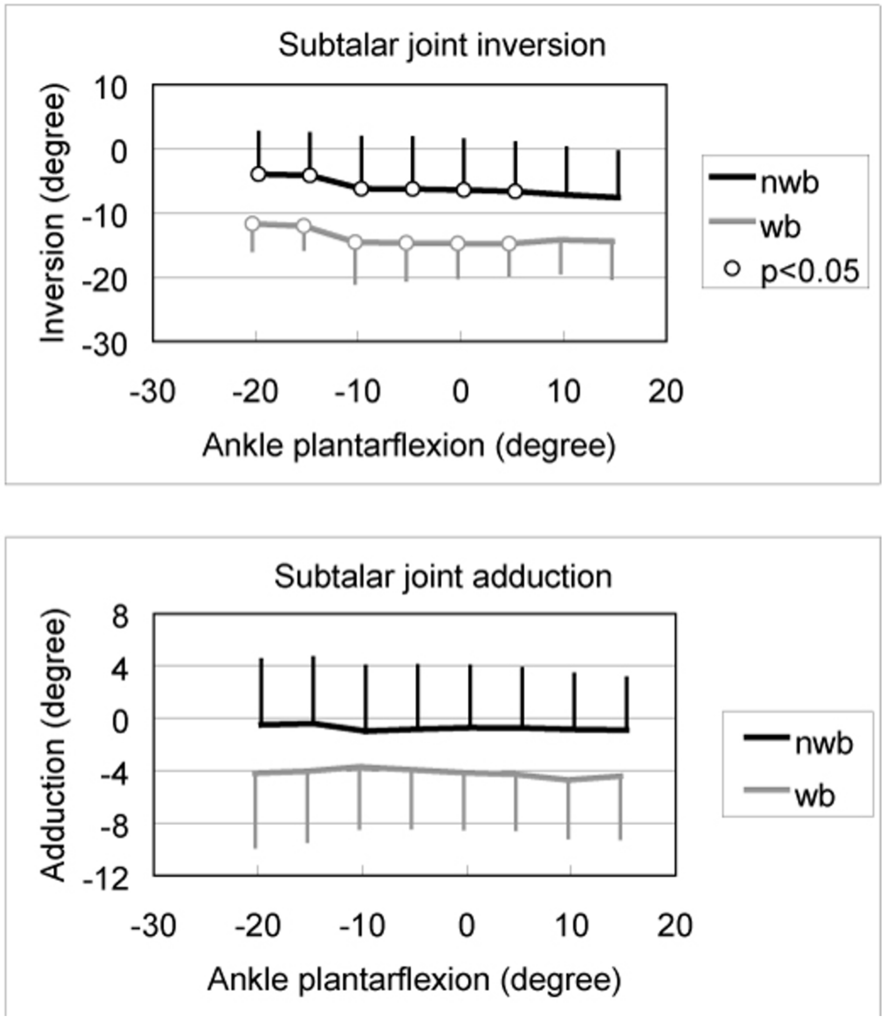

Figure 2

Subtalar joint inversion and adduction during nonweightbearing and weightbearing activities. *Significant differences in repeated measures ANOVA. °Significant differences in post-hoc pair-wise comparisons.

by 7°. Duing the weightbearing activity, the subtalar joint was significantly more everted, (7–8° of difference, Figure 2), dorsiflexed (3–5°), and abducted (3–4°, Figure 2) than during nonweightbearing activity. The talocrural joint was significantly more plantarflexed (7–8°) and adducted (2–5°) during weightbearing activity.

Conclusion

Coupled motion of the subtalar and talocrural joints during weightbearing activity serves to maximize joint contact area and stabilize the subtalar joint. 3D-2D model registration techniques appear to be useful tools for the quantitative analysis of the talocrural and subtalar kinematics during dynamic activities.

References

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