Fluoroscopic Assessment of Hindfoot Kinematics During Gait: Comparison of Barefoot and Shod Motion

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Introduction

Current gait analysis techniques rely on external markers to quantify kinematic results. The external markers, however only approximate the underlying bony anatomy, and analysis of shod feet is severely restricted. Fluoroscopic analysis by comparison, eliminates the need for external markers by utilizing bony landmarks to create a coordinate system. This allows for the analysis of shod feet providing more relevant clinical data to assist in the assessment of orthotics and footwear.

Objectives

Compare shod (SH) vs. barefoot (BF) kinematics among normal individuals using fluoroscopic gait analysis.

Methods

Five subjects were selected for assessment in this IRB approved study. Subjects were assessed to assure no foot injuries. All subjects were male 18-30 years of age. Subjects walked through the fluoroscopic capture volume both barefoot and with tennis shoes. Each subject completed five trials for each shod condition, and each trial consisted of approximately 100 frames of data. External markers and a 15-camera Vicon motion analysis system (Oxford, UK) was used to define segments outside the field of view of the fluoroscopic system, and an AMTI force plate (Waterford, MA) was used to synchronize the fluoroscopic system to the Vicon system. A local coordinate system was created for the tibia, talus and calcaneus (Figure 1). Angle changes during progression in stance phase about the talocrural and subtalar joints were assessed using a modified version of the Milwaukee Foot Model (MFM).

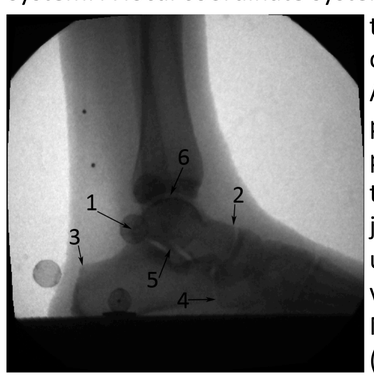
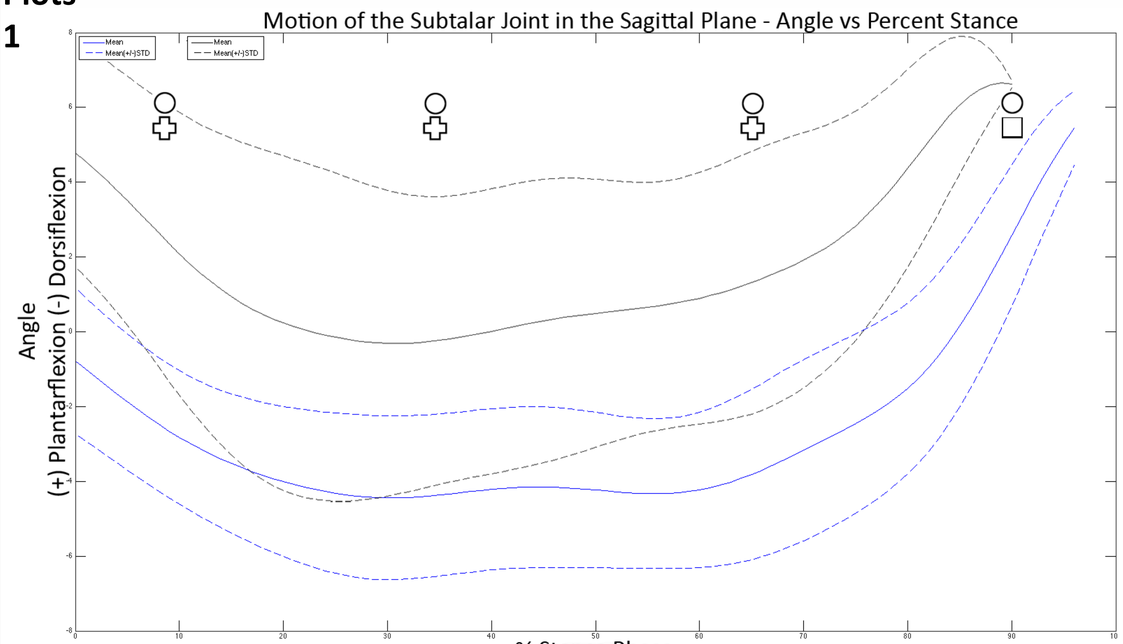


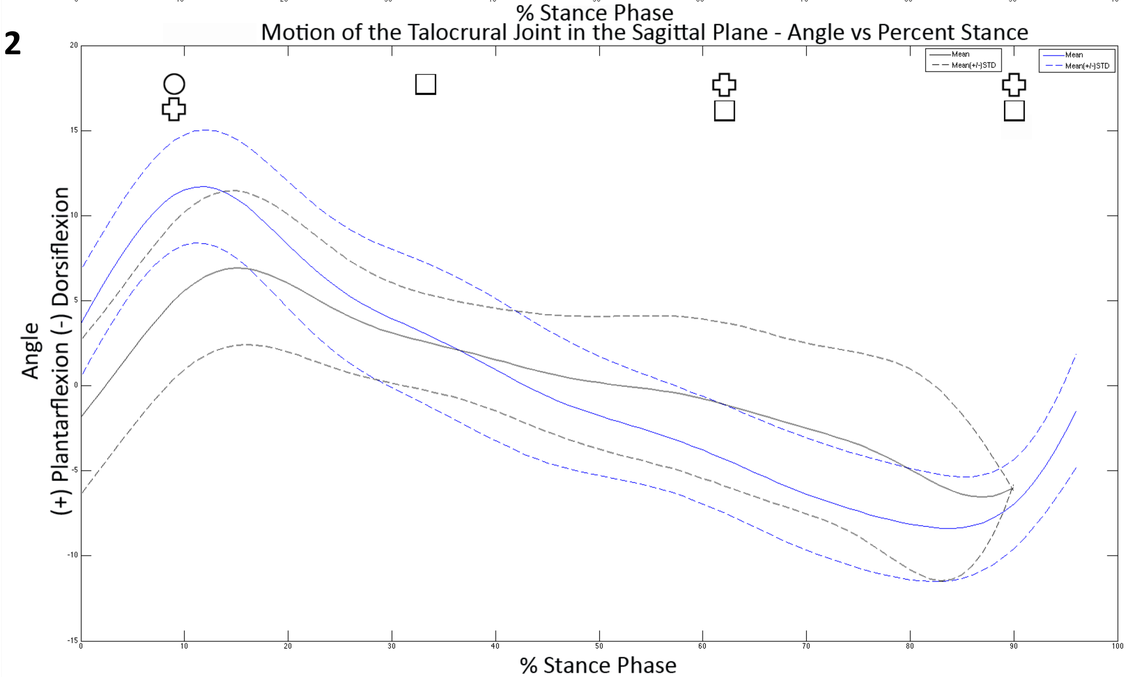
Figure 1

Plots

1



2



Explanation of Plots 1 and 2:

Black lines denote shod motion blue lines denote barefoot motion. Dashed lines denote +/- one STD. Assessment was performed for four phases of gate Loading Response (LR) 0-19%, Mid Stance (MSt) 19-50%, Terminal Stance (TSt) 50-81%, and Pre-Swing (PSw) 81-100%. Circles denote significantly different minimums in a single phase. Pluses denote significantly different maximums in a single phase. Squares denote significantly different range of motion in a single phase.

Results

Barefoot subtalar joint minimum angles during each gait phase exceeded those when shod. Maximum subtalar angles were also greater except during pre-swing. Ranges of motion were not statistically different except for limitations during pre-swing. Barefoot talocrural joint minimum angles were reduced during loading response but similar in the other 3 phases to the shod condition. Maximum angles were higher in all 4 phases.

Conclusions

The fluoroscopic system provided kinematic analysis during shod gait in a series of adult control subjects. Ranges of motion about the subtalar joint were largely unaffected when comparing the shod and barefoot conditions. Increased dorsiflexion was noted when shod. Talocrural range of motion was increased through most of stance with increased plantarflexion.

References

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