

DIFFERENCES IN MIDFOOT ROTATIONS BETWEEN FOOT TYPES

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INTRODUCTION

Typical full-body models used in gait analysis view the foot as a single rigid segment and essentially ignore the complex motions of the foot. Using newer motion capture technology and smaller markers, detailed foot models can now be incorporated into the full-body model. Several groups have reported more detailed models to determine the kinematics of various foot segments[1-3]. One of the main purposes of a foot model is to distinguish deviations from a “normal” foot. This project looks at the midfoot rotations for four different foot types to see if a novel foot model can be used to distinguish between foot types.

STATEMENT OF CLINICAL SIGNIFICANCE

Detailed foot models can provide an important tool for studying outcomes of foot surgeries and for pre-operative planning. An improved kinematic model will enhance our understanding of foot biomechanics and subsequently help to improve surgical outcomes.

METHODOLOGY

The left feet of 23 adult subjects walking at self-selected speeds were analyzed with an eight-camera Vicon 612 system recording at 120 Hz. The subjects were examined by an orthopedic surgeon and classified into 4 categories; 13 neutrally aligned feet (N), 6 flat feet (F), 2 high arched feet (H), and 3 slight equinus feet (E). All of the non-normal feet were asymptomatic and of mild pathology. Twenty reflective markers (9.4 mm in diameter) were placed on bony landmarks of the foot and lower leg. The following segments were studied: shank (tibia and fibula), hindfoot (calcaneus), midfoot (navicular, cuboid and cuneiforms), forefoot (metatarsals) and hallux (proximal and distal). Axial rotations were determined through a custom Vicon BodyBuilder model. Local coordinate systems were created to approximate the actual joint centers using distances and directions taken from a static trial of the subject.

RESULTS

The Figure 1A shows that all four foot types have the same general shape, although all four curves differ in range and magnitude. The Figure 1B illustrates the normal and flat foot groups are very similar in magnitude and pattern, while the other two are similar in pattern. The Figure 1C shows all four foot types to be somewhat similar in range and shape. The Figure 1D again shows all of the foot types to have similar shapes, but not ranges of values. In the Figure 1A the flat foot group is shown to be more dorsiflexed than the high arch group. The Figure 1B rotations show that the flat foot and the normal foot are nearly identical while the high arch is more inverted and the slight equinus is more everted. Only the

means are reported because the n in each group were too small to get statistically significant results.

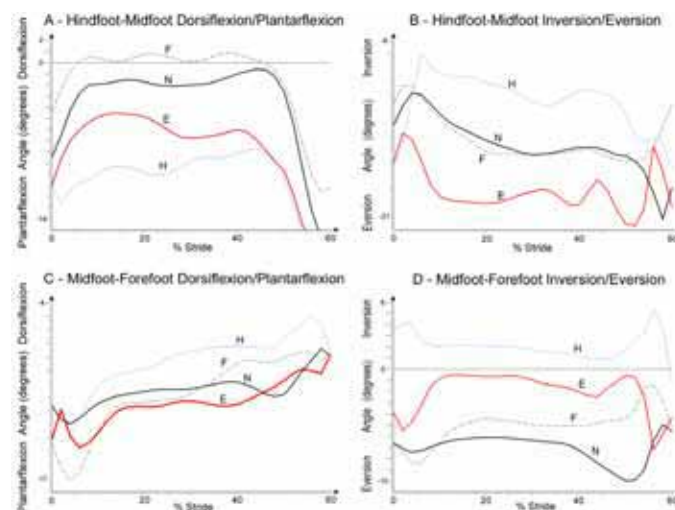


Figure 1A-1D. Mean joint rotations for the hindfoot-midfoot and the midfoot-forefoot. The four foot types shown are neutral aligned (N), flat foot (F), high arch (H), and slight equinus (E)

DISCUSSION

The fact that the rotations in the midfoot-forefoot plantarflexion/dorsiflexion graph are all similar in curvature and range, while the hindfoot-midfoot plantarflexion/dorsiflexion and the midfoot-forefoot inversion/eversion are similar in curvature but not in ranges implies that the model seems to be sensitive enough to see differences and similarities between foot types. If the model was not able to distinguish between the foot types, one would expect to see the same general relationships in the rotations of all four of the graphs. These outcomes indicate that a large population study is feasible and needed in order to statistically analyze the findings and make any clinical predictions of foot type and function. These results look similar to the results in the aforementioned papers. The shortcomings of this study were the lack of clearly defined pathologies and the relatively small numbers of pathologic feet.

REFERENCES

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