

In Vivo Segmental Foot Mobility during Walking and Step Descent in Patients with Midfoot Arthritis

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INTRODUCTION

- Tarsometatarsal (midfoot) arthritis is a challenging problem due to its high potential for chronic foot pain and functional disability.
- In addition, in recent years, the incidence of post-traumatic midfoot arthritis has increased at an alarming rate, secondary to motor vehicle trauma.
- Individuals with midfoot arthritis experience foot pain which limits their participation in walking and weight bearing activities.
- **Patients report stair descent as being particularly problematic.** While stair descent is acknowledged to be a more challenging functional activity compared to walking, the specific motions that differ between the two activities remain unknown.

The purpose of this study is to compare in vivo segmental foot mobility during walking and stair descent tasks in patients with midfoot arthritis.

METHODS

Subjects: 50 subjects participated in this study, 30 with midfoot arthritis and 20 control subjects, matched in age, gender and BMI. All patients with arthritis were diagnosed by an orthopaedic foot and ankle surgeon (Mean age: 62.4 years, Mean BMI: 29.6 ± 5.4) In accordance with IRB and HIPAA guidelines, Informed Consent was sought prior to initiating study procedures.



Figure 1. Sensor set up and subsequent kinematic model

In Vivo Data Acquisition: In vivo segmental foot motion was examined using a 5 segment model with previously established validity. Local co-ordinate systems were established by digitizing anatomical landmarks of interest. For walking trials, patients walked at self-selected monitored speed. To simulate stair descent, they stepped off a standard step height (15 cm) to the floor.

Data Analysis: Kinematic data were low-pass filtered using a fourth-order Butterworth filter with a cutoff frequency of 6 Hz and analyzed using MotionMonitor™ software. Euler angles, representing three sequential rotations (Z-Y-X) were used to describe joint motion. Peak values for all dependent variables were referenced to subtalar neutral: calcaneus eversion, forefoot abduction, 1st metatarsal plantarflexion and 1st metatarso-phalangeal (MTP) dorsiflexion.

Statistical Analysis: A 2 way ANOVA was to examine the effect of Group (Between-subjects effect) and Activity (Within-subjects effect) on all dependent variables.

RESULTS

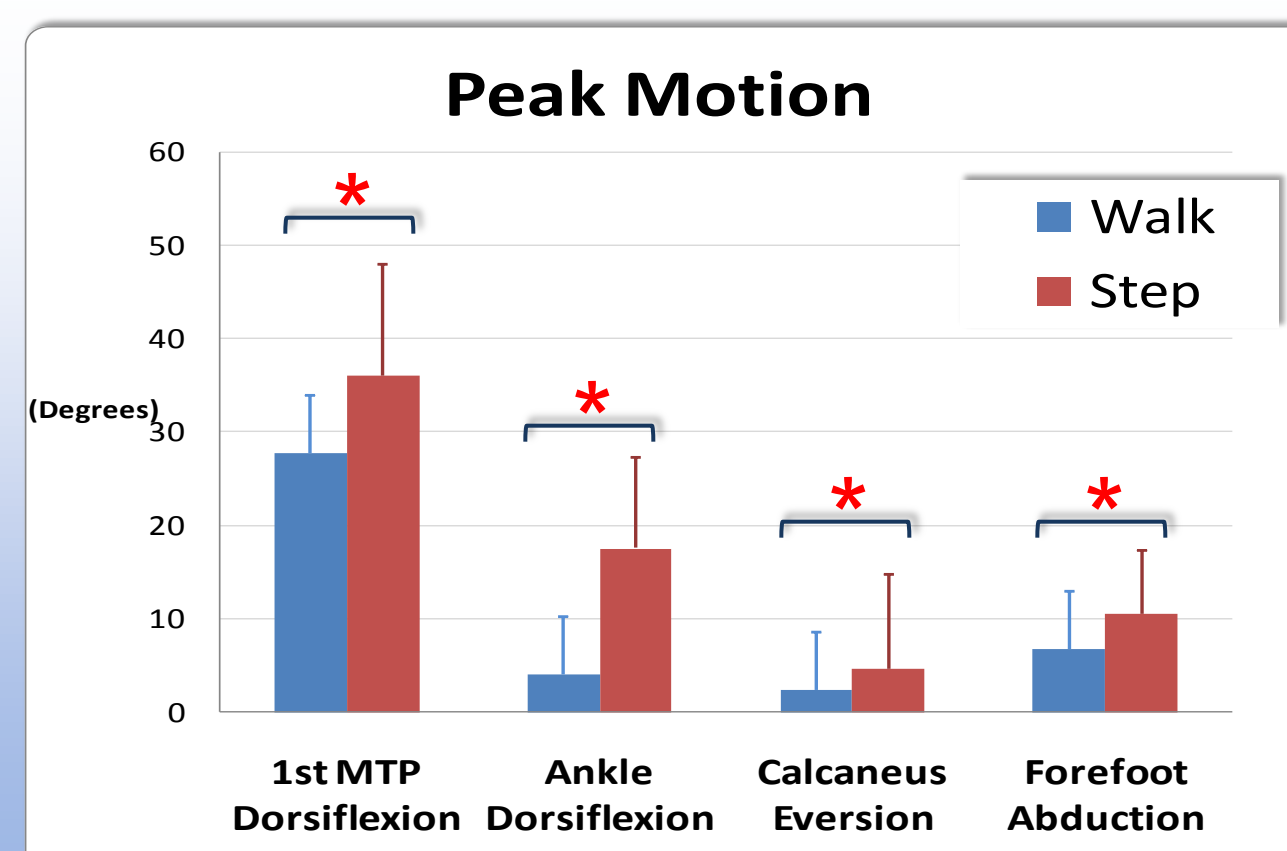


Figure 2. All subjects demonstrated significantly more peak 1st MTP dorsiflexion ($p < 0.01$), ankle dorsiflexion ($p < 0.01$), calcaneal eversion ($p = 0.03$) and forefoot abduction ($p = 0.01$) during step descent compared to walking.

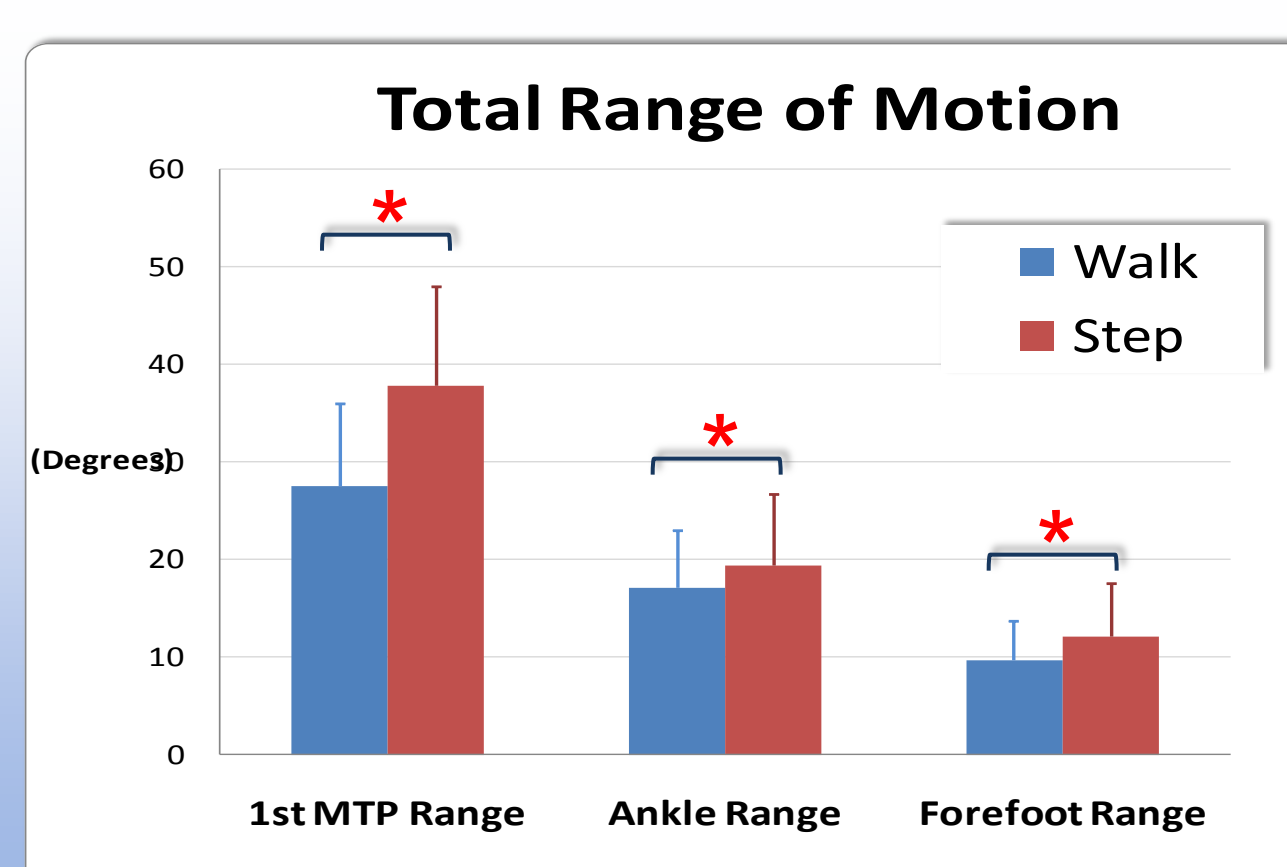


Figure 3. All subjects demonstrated significantly greater total range of 1st MTP dorsiflexion ($p < 0.01$), ankle dorsiflexion ($p < 0.01$) and forefoot abduction ($p = 0.02$) during step descent compared to walking.

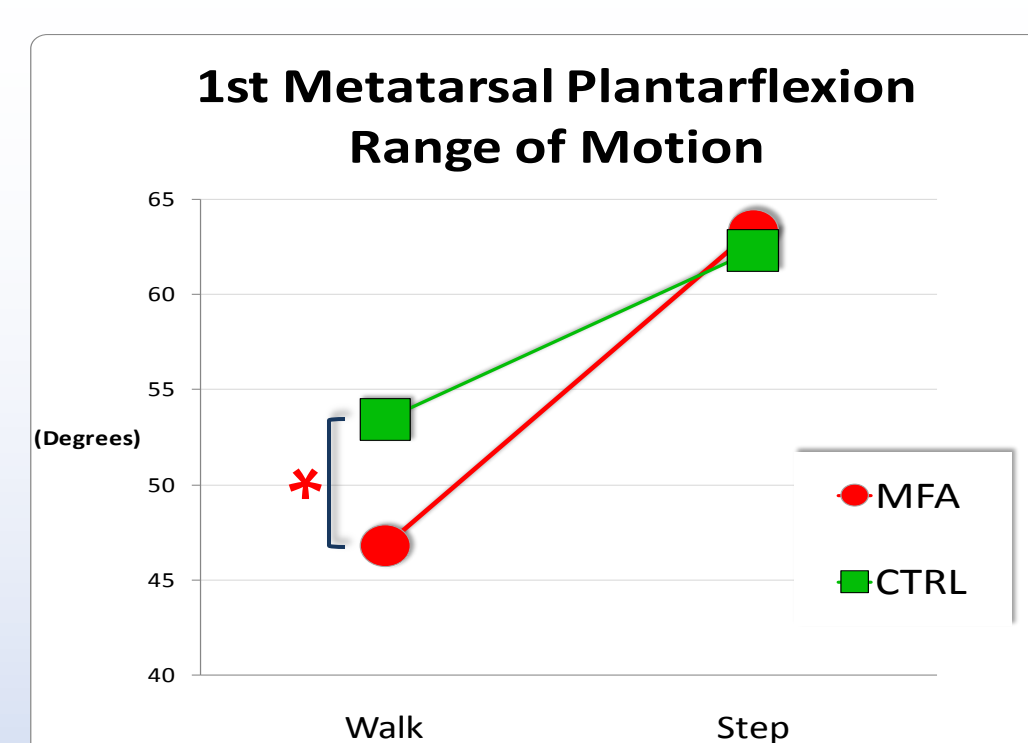


Figure 4a. Group x Activity Interaction ($p = 0.02$) During walking, patients with midfoot arthritis showed significantly less 1st Metatarsal plantarflexion range of motion compared to control subjects. However, in the step task, both groups showed similar 1st Metatarsal plantarflexion range of motion.

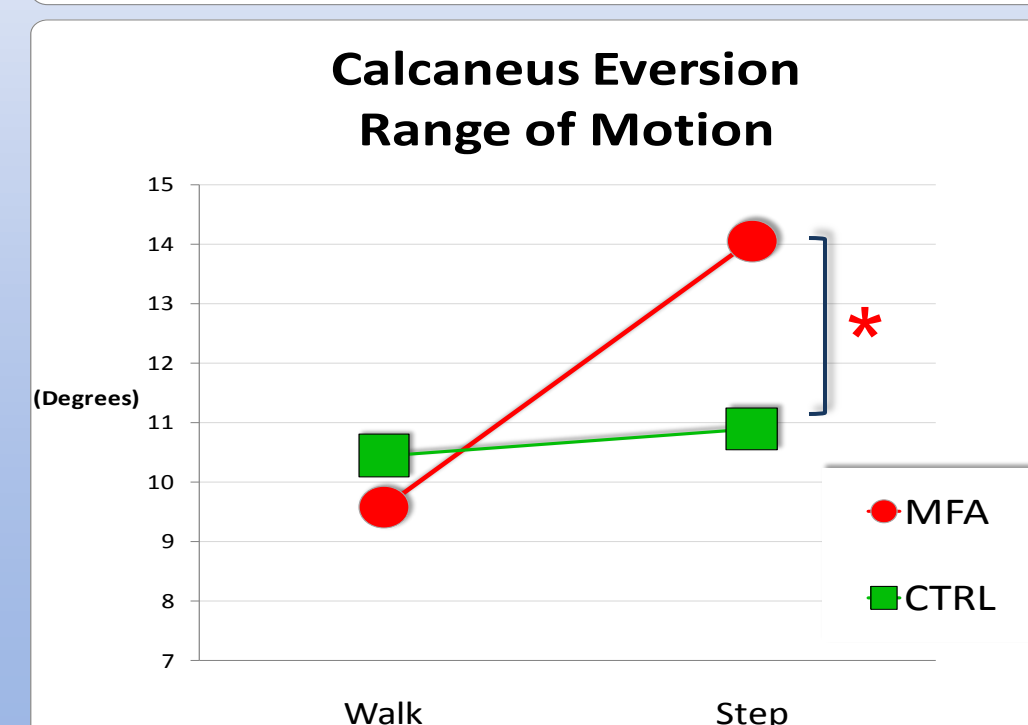


Figure 4b. Group x Activity Interaction ($p = 0.01$) During walking, patients with midfoot arthritis showed similar calcaneus eversion range of motion compared to control subjects. However, in the step task, patients with midfoot arthritis showed significantly more calcaneus eversion range of motion compared to control subjects.

CONCLUSIONS AND DISCUSSION

- Step descent requires more 1st MTP dorsiflexion, ankle dorsiflexion, calcaneus eversion and forefoot abduction than walking. In addition, step descent also necessitates greater excursion (total range) of 1st MTP dorsiflexion, ankle dorsiflexion and forefoot abduction.

Independently or in combination, these motions may contribute to articular stress and thus provoke symptoms.

- Patients with midfoot arthritis responded differently to the step task compared to control subjects in their use of 1st metatarsal and calcaneus eversion range of motion. Increased 1st Metatarsal plantarflexion and calcaneal eversion range of motion in the step activity was noted in patients with midfoot arthritis

The increased range of motion may be indicative of loss of midfoot stability in more challenging non-gait activities.

