1-1-2012

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Katherine A. Konop
*Marquette University*

Jason T. Long
*Marquette University*

Joseph Krzak
*Shriners Hospitals for Children*

Adam Graf
*Shriners Hospitals for Children*

Gerald F. Harris
*Marquette University*, gerald.harris@marquette.edu

Published version. *Proceedings of the Gait & Clinical Movement Analysis Society 2012 Analysis Society* , pp 179-180 (2012), Publisher Link. 

# SEGMENTAL KINEMATIC ASSESSMENT OF PEDIATRIC PES PLANOVALGUS WITH RADIOGRAPHIC SKELETAL INDEXING

Katherine A. Konop[1], Jason T. Long[1], Joseph Krzak[2], Adam Graf[2] and Gerald F. Harris[1,2]

[1]Marquette University, Milwaukee, WI, [2]Shriners Hospitals for Children, Chicago, IL
E-mail: katherine.reichardt@marquette.edu

## INTRODUCTION

Pes planovalgus (flatfoot) is a condition characterized by flattening of the medial longitudinal arch, along with hindfoot valgus. In flexible flatfoot, one of the most common orthopaedic conditions in children, the arch is flat during stance, but is present during nonweightbearing [1]. While children will not outgrow the condition, most cases of flexible flatfoot are asymptomatic and do not require surgical intervention [2]. However, untreated flatfoot in a child can cause pain, cramping, or fatigue of the foot, ankle, or leg, and has the potential to cause painful arthritic problems later in life [3].

Treatment for symptomatic flatfoot begins conservatively with supportive footwear and arch support [3]. In non-responsive cases, surgery may be indicated. A number of surgical methods have been reported for the treatment of flatfoot [3]. Surgical intervention is generally more predictable and successful in young children than in older patients [4].

Gait observation and analysis is often done to assess the shape of the footprint, foot progression angle, calcaneal eversion, heel-to-toe contact, position of the knee, and the presence of a limp [1]. Few studies have performed detailed segmental motion analysis of the planovalgus foot during gait in the pediatric population [5]. No studies currently report motion analysis referenced to the underlying skeletal anatomy. This study characterizes the motion of four segments of the foot and lower extremity (LE) (tibia, hindfoot, forefoot, hallux) during gait in 5 children with flatfoot. The analysis includes skeletal indexing of the foot and ankle using a series of radiographs (Milwaukee Foot Model, MFM).

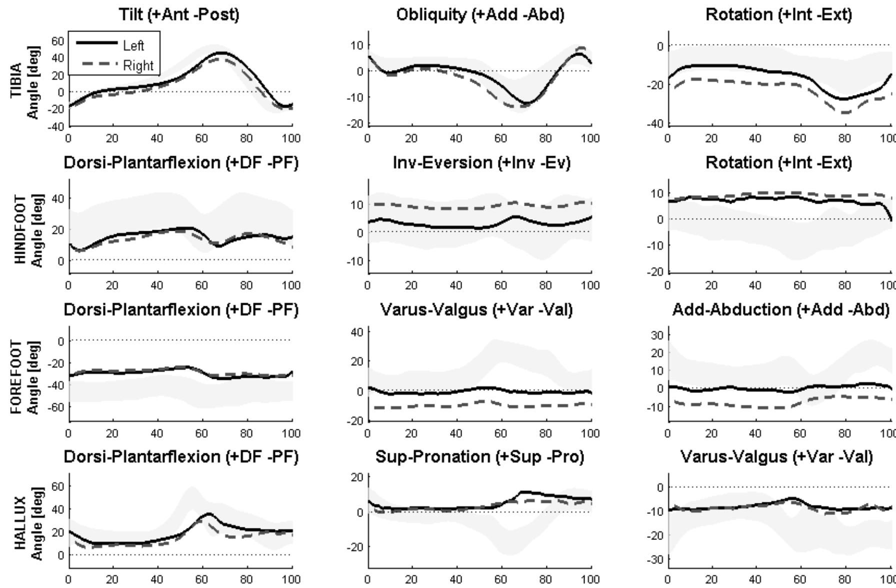
## CLINICAL SIGNIFICANCE

In this study, segmental foot motion is indexed to the underlying skeletal anatomy of each child based on a series of weightbearing radiographs. It is hoped that this unique process will provide new insight into the underlying skeletal motion resulting from pes planovalgus. Improvements in quantitative characterization, treatment planning, and post-treatment follow-up are the primary objectives of this work.

## METHODS

Five children (ten feet) with pes planovalgus were selected for study (mean 11.3 years, 144 cm, 36.6 kg). Each child was instrumented bilaterally with twelve 16-mm markers on the LEs (medial superior tibia, medial and lateral malleoli, calcaneal tuberosity, medial and lateral aspect of calcaneus, tuberosity of fifth metatarsal, head of first and fifth metatarsals, XYZ triad on hallux). Gait analysis was performed with a Vicon 15-camera system at 120 fps. Subjects performed a minimum of three acceptable walking trials. Weightbearing radiographs were acquired from anterior/posterior, lateral, and modified coronal plane views, using a foot position template with an alignment index to the laboratory coordinate system.

Data were filtered with a Woltring filter and processed with a modified version of the MFM, which aligns the marker-based reference system with the radiographic bone-based (skeletal) system.




## RESULTS

Triplanar segmental motion for the ten planovalgus feet over the gait cycle (%) are illustrated in the figure. The background shadow plots depict normal segmental motion [6].

In the sagittal plane, hindfoot dorsiflexion and forefoot plantarflexion are significantly reduced. Other notable differences include decreased ranges of motion in the coronal and transverse planes at the hindfoot, forefoot and hallux. Changes in motion morphology are consistently seen in all three planes at the hindfoot, forefoot, and hallux.

## DISCUSSION

This study demonstrates application of a radiographically indexed, skeletal-based approach to segmental foot analysis in pediatric pes planovalgus. Results are consistent with known characteristics of the deformity. Flattening of the longitudinal arch is seen throughout the gait cycle when compared to controls. Relative hindfoot plantarflexion and forefoot dorsiflexion occur during both stance and swing phases, with a slight restoration of the longitudinal arch during swing. Forefoot valgus is also noted throughout the gait cycle. Overall, reductions in ranges of motion consistent with clinical observations are noted at the hindfoot, forefoot, and hallux. Continued work is being directed toward increasing the population sample sizes and investigating methods for dynamic skeletal assessment throughout the gait cycle.

## REFERENCES

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## DISCLOSURE STATEMENT

The contents of this abstract were developed under a grant from the Department of Education, NIDRR, Grant number H133E100007. However, those contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government.