Novel Evaluation of Segmental Foot and Ankle Kinematics of Children with Charcot-Marie-Tooth Disease

"Charcot-Marie-Tooth disease (CMT) is a genetically heterogeneous disorder characterized by degeneration of the longest motor and sensory nerve fibers and commonly impacts the foot. Previous work identified foot drop, hindfoot inversion, and reduced ankle flexion moments however, to date, there have been no three-dimensional analyses using a segmental foot model. The goal of this work was to identify segmental foot deviations during gait among patients with CMT. A better understanding of segmental foot dysfunction during gait in children and youth with CMT will assist in prescribing appropriate treatment and understanding gait prognosis.

This retrospective study used the Milwaukee Foot Model (MFM) to characterize the segmental kinematics of the foot and ankle as part of assessment for orthopaedic surgery planning. Weightbearing radiographs were taken from anterior/posterior, lateral, and modified coronal plane views and processed using custom software which aligns the marker-based reference system with the radiographic bone-based (skeletal) system. A population of children with CMT was compared to a population of typically developing children.

In the CMT group, the tibia was more anteriorly tilted than the Control group. Hindfoot deviations showed the CMT group to be more inverted and internally rotated. The forefoot was more plantarflexed and internally rotated. At the hallux, increased dorsiflexion, supination (stance only), and valgus were observed. Decreased range of motion was observed in the sagittal planes of the tibia and hallux and transverse plane of the forefoot. There was increased range of motion in all other segments and planes with the exception of the coronal plane of the tibia, which showed no difference.

This study demonstrates the application of a skeletal-based approach to segmental foot analysis for individuals with Charcot-Marie-Tooth disease. The MFM was able to distinguish kinematic deviations in all three planes of motion. Increased plantarflexion of the forefoot and inversion of the hindfoot agree with previous work showing foot drop and hindfoot inversion. The variability observed in the CMT Group justifies the use of subgroups in this population. This work offers insight into the underlying bony orientation and resulting kinematic deviations in a population of children with CMT. Insight provided by this data may help increase our quantitative understanding of the ambulatory kinematics of the condition as an aid to surgical planning and post-treatment follow up."

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