

ABNORMAL FRONTAL AND TRANSVERSE PLANE MOMENTS OF THE HINDFOOT IN PES CAVUS AND PES PLANUS FOOT PATHOLOGIES MEASURED WITH A MULTI-SEGMENT KINETIC FOOT MODEL

Emma Smart¹, Olivia Roussel¹, Thomas Jenkyn^{1,2*}

¹Biomedical Engineering, University of Western Ontario, London, ON, Canada

²Mechanical and Materials Engineering, University of Western Ontario, London, ON, Canada

*tjenkyn@uwo.ca

ABSTRACT

Introduction: Two common foot pathologies are pes cavus (high arch) and pes planus (flat foot). These are treated conservatively with in-shoe orthotics. While foot segment kinematics have been well-studied, the moments loading the foot segments have not been measured to date. To measure hindfoot kinetics a multi-segment kinetic foot model (MSKFM) is used with optical motion capture and floor-mounted force plates. This MSKFM is a novel modification of the Dupont foot model, which subdivides the foot into independently tracked hindfoot, midfoot, forefoot and hallux segments. Floor-mounted force plate kinetic data and motion capture kinematic data enable the moments and powers between foot segments to be calculated.

Methods: Testing occurred in a 12-camera motion capture laboratory (Motion Analysis Corp) with two force plates (AMTI). 15 auto-reflective markers in a modified Helen Hayes configuration tracked the body. On the right foot the MSKFM used an additional 10 auto-reflective markers. Each test subject walked over the two force plates, striking them with the right foot. Kinematic data was collected at 50 Hz and kinetic data at 1500 Hz. Intersegment moments and powers were calculated in the sagittal, frontal and transverse planes. Only frontal plane and transverse plane moments at the hindfoot (with respect to the lower leg) are reported here.

Results & Discussion: 10 test subjects comprised the normal cohort. There were 3 pes cavus and 5 pes planus test subjects. Normal hindfoot moments are adducting and inverting of the hindfoot in the frontal plane and slightly externally rotating in the transverse plane while the foot is on the ground. In the cavus foot, the hindfoot adducts and inverts similarly to the normal foot in the frontal plane. But in the transverse plane, the external rotation moment is larger with a peak near toe off. In the planus hindfoot, the frontal plane moments differ from the normal and cavus feet in the latter part of stance phase, being more adducting and inverting from heel raise to toe off. Interestingly, in the transverse plane, the planus hindfoot has more external rotation moment than both the cavus foot and normal foot, with two distinct peaks near midstance and at heel raise. This study shows that conservative orthotic support and correction of pes cavus and pes planus must take into account the abnormal moments in both the frontal and transverse planes of the hindfoot.