Biomechanical Response of the Pediatric Ankle

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ABSTRACT

The goal of this study is to evaluate the anthropometric characteristics and dynamic response of the pediatric ankle by non-invasively measuring leg and ankle anthropometry, ankle range of motion, and ankle stiffness. While much of the attention has been focused on the pediatric head and thorax, upwards of 28% of injuries in frontal crashes are to the lower limb. Now that more children are surviving MVA's, we are seeing an increase in extremity trauma. As the foot-ankle-lower leg complex makes contact with the front row seatback, injuries to the tibial physes, tibial palfond, and talus are fairly common and very serious. The pediatric ATD's have no instrumentation below the knee making it impossible to evaluate the amount of force on impact or the amount of force traveling up the kinetic chain during frontal collisions. The recent testing of child interactions with knee bolster airbags also raised questions regarding the biofidelity of the lower extremities of the pediatric ATD's. The airbag tests revealed that the ankle joint should be of interest to researchers, as the foot is the first body part to interact in a frontal collision. Without a biofidelic ankle in the child ATD there is no way to directly measure these forces or accurately predict injury in the entire lower extremity. Children between the ages of 4-12 years were placed into 2 groups (n=20) to correspond with the 6 and 10 year old ATD's. Anthropometric measurements were taken bilaterally on the foot, ankle, and leg. Range of motion (ROM) measurements were taken in plantar and dorsiflexion, inversion and eversion in a neutral position, and inversion and eversion of the rear foot. Both active and passive ROM were measured with a handheld goniometer. Ankle stiffness measurements were measured using an Isokinetic Dynamometer (Biodex System III, Biodex Medical Systems, Inc. Shirley, New York). Stiffness measurements were taken in all 6 motions. Each subject completed 3 sets of 5 repetitions in the 6 directions at speeds of 5, 30, 60 degrees per second in each position. The degrees and torque values were recorded throughout the entire ROM. Subjects were instructed to push against the dynamometer as it moves through the ROM. Data analysis will include defining the average range of motion for both groups. The average dynamic stiffness for the 6 motions will be calculated for each group and compared to the adult findings by Crandall et al. (1996). Testing is currently underway and is expected to be completed in March. Pilot testing data supports our methods and is producing repeatable data. The information gained from this study will benefit the automotive industry by providing critical information necessary to produce a more biofidelic ankle on the 6 and 10 year old ATD's, with the goal of increasing vehicle and car seat safety for children. The biomechanical data will also provide beneficial information to the rehabilitation community working with children with gait abnormalities and spasticity disorders, such as cerebral palsy.