D7 Biomechanical Evaluation of Pediatric-Inflicted Head Trauma

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After attending this presentation, attendees will have an appreciation for biomechanical evaluations that can be applied in order to objectively determine the mechanical causation of inflicted vs. accidental head trauma in a pediatric population.

This presentation will impact the forensic science community by informing attendees that in cases of head trauma in infants and young children, it is often alleged that the parent or care provider struck the child victim with their hand or with or against a hard surface, causing serious and sometimes fatal bodily injury. By performing a systematic biomechanical evaluation, this presentation will quantify the risk of head and brain injury associated with such mechanisms of injury.

Methods: Two adult male investigators served as participants; neither had any physical disabilities that might affect their performance. An instrumented Child Restraint and Airbag Interaction (CRABI) -12 biofidelic mannequin, of height 0.75m and mass 10.0kg, was utilized as the infant surrogate. A 500G piezo-electric tri-axial accelerometer was installed at the Center of Mass (CoM) of the CRABI headform along with a tri-axial digital gyroscope, in accordance with the **Society of Automotive Engineers** (SAE) J211.

Eight conditions were investigated, including striking the head with both an open hand and baseball bat as well as impacting the mannequin head against interior wall structures, both on and between supporting studs. Such walls were manufactured for the purpose of this study using 2"x4" white wood with both 16" Outside Corner (OC) and 24" OC separation between vertical studs, over which $^{3}/_{8}$" and ½" gypsum drywall was fastened in accordance with state building codes. Participants were instructed to impart gentle, moderate, and vigorous impacts on the infant surrogate, repeated five times for each of the eight conditions, resulting in a total 240 trials.

Results: Data from both the analog linear accelerometer and digital gyroscope was acquired at 10,000Hz, per channel, using LabVIEW™ and filtered in MATLAB® using a phase-less 4th-order Butterworth filter with a 1650Hz cutoff frequency, per SAE J211. Head linear acceleration and angular velocities were recorded, angular acceleration was derived, peak magnitude values were calculated, and Head Injury Criterion (HIC15) computed. Descriptive statistics are reported across repeated trials and participants.

Conclusions: Forces associated with linear acceleration are typically responsible for focal injuries, including subgaleal hematomas, lacerations, skull fractures, and brain contusions, whereas forces associated with rotational inertia account for diffuse injuries, including concussive brain insult, axonal injury, and bridging vein rupture, leading to space-occupying subdural hematomas. Findings from this biomechanical evaluation can be applied to objectively determine the mechanical causation of inflicted trauma from claimed accidental reasons.

Biomechanics, Head and Brain Injury, Pediatrics