Assessment of Ear- and Tooth-Mounted Accelerometers as Representative of Human Head Response

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ABSTRACT

Monitoring head accelerations as an indicator of possible brain injury may lead to faster identification of injury and treatments. This study investigates the coupling of a tri-axial accelerometer mounted to a back molar and compares it with that of a tri-axial accelerometer inserted in the boney ear canal. Both of these tri-axial accelerometers were mounted to three post mortem human surrogate (PMHS) skulls, and compared with a rigidly mounted laboratory sensor reference cube. Each specimen was subjected to a high loading from a vertical drop tower and a low frequency cyclic loading from a shaker device. The specimens were subjected to an approximate 150g input acceleration on the drop tower, and up to 35g at a frequency of 9Hz on the shaker device. Each specimen was tested on all three of the anatomical axes on both the drop tower and the cyclic shaker. Both the tooth-mounted accelerometer and the ear-mounted accelerometer were is close agreement with each other, and compared favorably with the rigid reference accelerometers. The coupling of the tooth with the skull did produce an amplification of the resultant acceleration, but maintains the basic biofidelity required to develop a simple transfer function for the sensor data. Planned future work includes testing three PMHS skulls in a similar fashion with the focus of the study being on how the skull deforms under high-g loading. There is evidence that the skull deforms under the loading conditions previously tested, but the magnitude and locations of these deformations remain unknown. A 3D optical system called ARAMIS will be utilized to track real-time skull deformation and analyzed to determine the rate at which the skull deforms and rotates so that these measurements can be compared to established metrics for rotation rates that contribute to concussion and mild traumatic brain injury (mTBI). By having a better understanding of the possible local mechanisms that may contribute to mTBI, better safety systems can be designed to ensure the best possible protection for people ranging from athletes to soldiers.