C14 Head Impact by Golf Ball: Digital Data Acquisition and Analysis Compared to Alternative Methodologies

Laura L. Liptai, PhD, BioMedical Forensics, 1660 School Street, Moraga, CA 94556*

After attending this presentation, attendees will understand how to quantify head accelerations and head injury criterion from being struck in the head with a golf ball and compare these results to alternative methodologies.

This presentation will impact the forensic community and/or humanity by demonstrating the utility of three independent methods to quantify head accelerations from impact from a golf ball.

This paper presents the analysis used to quantify the head accelerations and head injury criterion from being struck in the head by a golf ball via three methods: digital data acquisition on a Hybrid III, scalp tensile strength calculations and pressure sensitive film.

A 39-year-old female (height: 5' 9", weight: 145 lbs) was hosting a league of 35 to 40 people on a Thursday evening at a golf course. After greeting some of the new players, she proceeded to the putting green where she was standing and looking down at a scorecard. She soon noticed a painful sensation and became dizzy. There was no loss of consciousness. A gentleman from the ninth hole had driven his ball into the trees and did not know where it went. A witness near the clubhouse saw the ball bounce one time and then strike the golf instructor on the top of her head. The instructor was escorted to the hospital by ambulance, where they noted a small hematoma just right from the center-top of the head. X-ray of the cervical spine was negative and brain CT revealed no soft tissue swelling or discoloration.

Using distances measured from the golf course, angle of the golf club face, golf ball lift and drag coefficients, and the equations of motion it was determined that the maximum speed at which the golf ball would have contacted the instructor was 27.5 mph. Using this impact speed, an experiment was designed to drop a golf ball from an equivalent drop height onto a Hybrid III dummy head to measure the resulting head accelerations and the head injury criterion (HIC) value. In addition, contact area was measured on the head form using pressure sensitive film.

Methodologically, instrumentation and equipment used included a tri-axial accelerometer mounted at the head center of gravity of a Hybrid-III female anthropomorphic test dummy, compression 80 golf balls, data filtering at 1650 Hz, and a data collection rate of 10,000 samples per second per channel.

The HIC became a US government standard in Federal Motor Vehicle Safety Standard (FMVSS) 208 in 1972 and it is characterized by the magnitude of linear head acceleration, duration, and indirectly, impulse. Head injury in the form of concussion is predicted by a HIC value greater than 1000. Six drop test trials were conducted with HIC results of 1.3, 1.8, 1.4, 1.3, 2.0, and 1.7. It was found that the HIC was below the threshold for concussion. HIC was utilized as a means to quantify the accelerations and impulse to the head in this case; however, HIC cannot be used as an injury threshold for all types of brain trauma since one mechanical criterion could not adequately assess risk for all types of head trauma diagnoses. Therefore, the use of HIC was limited to the retroactive quantification of head trauma as in forensics and/or comparative designs of head protection countermeasures.

Contact trauma analysis was to resolve if there should have been tearing of the parietal scalp from the golf ball impact. Using the 27.5 mph impact speed, golf ball contact time, contact area, and mass, the applied tensile load was calculated for the impact: 353.6 pounds/in2. The ultimate tensile strength of the parietal scalp is 569.7 pounds/in2, which would explain why there were no tears or lacerations in the parietal scalp.

The HIC results of 1.3 to 2.0 over 0.5 milliseconds, in conjunction with the lack of physical evidence of brain trauma, support the findings that concussion would not be likely. This was supported by no definitive loss of consciousness at the scene, no tearing of the parietal scalp and no soft tissue swelling/discoloration.

HIC, Head Impact, Brain Trauma

 ** Presenting Author*