H53 A Forensic Pathology Tool to Predict Pediatric Skull Fractures — Part 4: Interface Effects on Head Drops

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The goal of this presentation is to inform attendees about research on the influence of impact interface on fracture patterns in controlled head-drop experiments onto the parietal bone with a subadult porcine (*Sus scrofa*) model.

This presentation will impact the forensic science community by comparing controlled head drops onto rigid and compliant interfaces.

In forensic investigations, distinguishing accidental from inflicted injury based on skull fracture alone is challenging as both cases may produce similar patterns. From this, the research team identified the need for a deeper understanding of the fracture mechanics of the skull through controlled simulation of traumatic head injuries.

Recent studies have demonstrated the utility of an infant porcine model in simulating impacts to the developing human skull. It has been shown that increasing the impact energy applied to entrapped heads increases the number and length of cranial fractures.[1,2] The current study examines the effect of interface compliance on skull fractures from head drops in the porcine model.

The hypotheses of this study were twofold: first, head drops onto a rigid interface would produce more fracturing than drops onto a compliant interface; and second, fracture patterns produced in high-energy head drops onto a compliant interface would be similar to those produced by lower-energy drops onto a rigid interface. To generate a single impact onto the center of the right parietal bone, a custom drop tower was developed with an adjustable height. Specimen heads of a given age could be dropped with a consistent orientation onto various surfaces at the same impact energy. Pigs that had died of natural causes between 3 and 19 days of age (n=87) were collected and frozen within 12 hours of death for this study.

The study was performed with controlled head drops onto a rigid surface and two carpeted interfaces. The rigid surface was a half-inch thick aluminum disk (n=32). “Carpet 1” interface covered the rigid surface with a thin, commercial-grade carpet (n=23) and “carpet 2” interface covered the surface with a thick polyester carpet with an underlayment (n=32). After impact, the crania were inspected for diastatic fractures, the soft tissue was removed, and the dry cranial bones were reassembled. Fractures were recorded on a standard diagram and the location and length of each was recorded to the nearest millimeter.

Total fracture length from head drops onto the rigid surface was significantly higher than both carpet 1 ($p=0.002$) and carpet 2 ($p<0.001$). Carpet 1 also produced a significantly higher total fracture length than carpet 2 ($p=0.009$).

Carpet 2 data was compared to previously published low-energy drops onto a rigid interface (1). Total fracture length ($p=.259$) and total number of fractures ($p=.204$) showed no significant difference. However, low-energy rigid drops produced significantly more diastatic fractures ($p<.001$) and fractures that crossed through a suture ($p=.049$). The low-energy rigid drop tests also tended to produce more fractures in bones other than the impacted bone ($p=.057$).

In summary, this study showed that a head dropped onto a rigid interface would produce significantly more total fracturing than one dropped onto a compliant interface. Energy absorbed through deformation of the compliant interface reduces the impact energy imparted to the skull to lessen cranial fracturing. Furthermore, while the degree of fracturing was similar for high-energy drops onto a compliant interface as low-energy drops onto a rigid interface, the fracture patterns were different, so that these impact scenarios would be distinguishable post-trauma. These results demonstrate that impact interface may be a significant factor in the interpretation of injury causation that involves cranial fractures in the pediatric trauma victim.

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References:

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Cranial Fractures, Biomechanics, Child Abuse