A34 The Influence of Implement Shape on Fracture Pattern and Defect Size in Experimental Blunt Cranial Impacts

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After attending this presentation, attendees will better understand relationships between Point Of Impact (POI) -involved implement and fracture patterns from single, blunt cranial impacts to unconstrained human cadaver heads.

This presentation will impact the forensic science community by contributing to ground-truth data in support of assessing implement shape and POI in cases involving blunt cranial trauma.

Previous research has demonstrated that implement shape influences location and pattern of fractures in controlled impacts to fully constrained adult human heads and developing porcine specimens.[1-3] This current study further investigated the effects of implement shape on fracture patterns in experimental impacts to upright, unconstrained human heads. This study explored two major questions relevant to analyses of blunt cranial trauma: (1) Do different-shaped implements produce distinct fracture patterns?; and, (2) Can fracture patterns be used to estimate the POI? For 12 experimental cases in which implement and POI were known, these questions were explored through analyses of fracture patterns, defect size, and spatial relationship between fractures and the known POI.

Twelve adult male cadaver heads were impacted with a pneumatic impact system that allowed for controlled energy impacts to unconstrained specimens. Single impacts were administered to the mid-parietal, inferior to the parietal boss, with three implements that approximated a hammer (1"-diameter cylinder with a rounded surface; *n*=4), a baseball bat (2.5"-diameter cylinder with a curved surface; *n*=4), and a brick or broad, flat implement (3"-diameter flat disk; *n*=4).

Following single impacts, ectocranial fracture patterns were diagrammed and photographed. To observe endocranial outcomes, adjusted craniotomy cuts were conducted on the crania after maceration. Relevant data collected were: type of fractures present, spatial relationship between fractures and known POIs, and approximate size of any circular-type defects.

Energy to fracture and overall peak force were not statistically different between implements. For all three implements, the average fracture energy was 12.44J±6.04J, and the average overall peak force was 5221N±1936N.

The results of fracture patterns and their relationship with POI revealed trends by implement. In 3/4 impacts with the hammer implement, focal and circular depressed fractures circumscribed the POI. Endocranially, these impacts also generated corresponding internally beveled, delaminated “bone plugs” concentrated under the POI. Such endocranial defects were largely absent in the bat and brick impact experiments. In 3/4 impact experiments with the bat, curvilinear fractures occurred around the POI; however, they did not completely encompass the POI and exhibited an oval shape. The brick implement produced more variable fracture patterns. Half (2/4) of these impacts resulted only in linear fractures located remote from the POI in adjacent bones. In the other two brick impacts, large concentric fractures formed around the POI.

Circular-type defects were produced in 3/4 hammer, 3/4 bat, and 2/4 brick impact experiments. The hammer implement produced defects with the smallest average diameter (29mm±1.15mm.) These defects were of a consistent size, slightly larger than the implement diameter. The brick implement produced the largest defects (59mm±7.07mm); defects were typically smaller than the diameter of the implement. The bat produced defects of an intermediate size (34mm±15.72mm); however, defect sizes were inconsistent and overlapped in range with defects produced by the other two implements. These results indicate that defect size may assist in making a general distinction between small and large implements (i.e., hammer vs. brick), but it may not be possible to infer implement size based on defect size alone.

The results of this study reveal emerging trends in cranial fracture patterns associated with implement shape and suggest some baseline parameters for locating POI. In this experimental sample, an approximately circular defect, particularly in association with an endocranial bone plug, served as an effective indicator of POI. In contrast, when fracture patterns consisted only of linear fractures without the presence of round defects (1/4 hammer, 1/4 bat, 2/4 brick), impact location was obscured.

This project was supported by the National Institute of Justice, Office of Justice Programs, United States Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Department of Justice.

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Blunt Force Trauma, Cranial Fracture Patterns, Trauma Analysis

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