A35 Estimating Points of Impact in Multiple Blunt Force Cranial Trauma: Lessons From Experimental Impacts

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After attending this presentation, attendees will gain awareness of: (1) the influence of implement shape on fracture patterning in multiple, blunt cranial impact experiments; and, (2) the implications of this study for fracture pattern interpretation in a medicolegal setting.

This presentation will impact the forensic science community by presenting ground-truth data for multiple cranial impacts with known implements and known number and location of impacts.

The forensic literature is conspicuously lacking in guidelines for locating points of impact and, thus, accurately estimating number of impacts in cases involving blunt cranial trauma. The current study investigates the related issues of estimating locations and number of impacts in a series of multiple blunt force impact experiments on human cadaver heads. Research questions included: (1) Can fracture patterns be used to accurately locate all points of impact?; and, (2) How might implement shape influence practitioners' ability to make this assessment?

Controlled impact experiments were performed on 12 unembalmed, unconstrained human cadaver heads using a pneumatic impact system. Three aluminum impactors were selected to investigate implement effects on fracture patterns: a hammer (1"-diameter flat implement; n=4 specimens), a baseball bat (2.5"-diameter cylinder; n=4), and a brick (3"-diameter flat implement; n=4). Three impacts were delivered to each head: first to the mid-parietal, second to the anterior parietal, and third to the posterior parietal. After each impact, fractures were photographed and diagrammed. Following this series of three impacts, each cranium was macerated and a modified craniotomy cut was made to enable ectocranial and endocranial assessment of fracture.

Input energy for the impact experiments was 105.33J±19.48J for the hammer implement, 112.06J±3.70J for the bat, and 91.81J±18.7J for the brick. Energy differences between implements were non-significant.

The results indicated that sole reliance on ectocranial fractures may lead to an incorrect assessment of location and even a possible overestimation of the number of impacts. In contrast, assessment of only endocranial fracture, in this case internally beveled "bone plugs," may underestimate impact number.

Combined ectocranial and endocranial data provided clear indication of impact location for most impacts with the hammer implement. Nine of 12 impact sites exhibited circular fractures circumscribing the Point Of Impact (POI) ectocranially, 8/12 impact sites exhibited endocranial bone plugs, and 6/12 impact sites exhibited both. One or both features were present in association with known POI at 11/12 impact sites.

The bat produced semicircular fractures partially circumscribing the POI in 5/12 impacts, bone plugs in 3/12 impacts, and both features in 2/12 impacts. One or both features were observed in association with the known POI in 6/12 impacts. In all four specimens, at least one impact site was obscured due to the absence of circular fractures around the POI, presence of linear fractures distant from the POI, and/or lack of bone plugs associated with the POI.

The brick produced semicircular fractures surrounding the POI in 5/12 impacts, bone plugs in 1/12 impacts, and both features in 1/12 impacts. One or both features were observed in association with known POI in 5/12 impacts. In all four specimens, at least one impact site was obscured because: (1) fractures were linear and initiated at sutures adjacent to the POI (2/4 specimens); (2) new fractures intersected with fractures generated in previous impacts (4/4 specimens); and/or, (3) few endocranial defects were observed (4/4 specimens).

The results of this study suggest that practitioners should consider both endocranial and ectocranial data when assessing cranial blunt force trauma. In this experimental set, ectocranial circular defects and endocranial "bone plugs" were consistently observed in association with known points of impact. These features were observed in most hammer impacts, but only about half of the bat and brick impacts. This indicates that implement shape can affect assessment of impact location and, potentially, the number of impacts to an adult human head.

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Blunt Force Trauma, Cranial Fracture Patterns, Trauma Analysis