A76 The Interpretation of Human Pediatric Cranial Fracture Patterns Using Experimentally Generated Porcine Ground-Truth Data

Jennifer M. Vollner, MS, 354 Baker Hall, East Lansing, MI 48824; Caitlin C.M. Vogelsberg, MS, Michigan State University, Dept of Anthropology, 354 Baker Hall, East Lansing, MI 48824; Patrick E. Vaughan, BS, Michigan State University, Orthopaedic Biomechanics Laboratories, E Fee Hall, Rm 407, East Lansing, MI 48824; Todd W. Fenton, PhD, Michigan State University, Dept of Anthropology, 354 Baker Hall, East Lansing, MI 48824; Steven C. Clark, PhD, Occupational Research and Assessment, 124 Elm Street, Big Rapids, MI 49307; and Roger C. Haut, PhD, Michigan State University, Orthopaedic Biomechanics, A407 E Fee Hall, East Lansing, MI 48824*

After attending this presentation, attendees will be aware of: (1) the existence of the Pediatric Cranial Fracture Pattern Registry (PCFPR); (2) the applicability of experimental porcine cranial fracture-pattern data to human pediatric forensic cases; and, (3) the medicolegal implications of these data for cranial fracture-pattern interpretation.

The presentation will impact the forensic science community by demonstrating the value of ground-truth porcine experimental data in the interpretation of pediatric deaths involving blunt force cranial trauma when the injury history is unknown or of questionable reliability.

Pediatric deaths involving cranial fractures are challenging cases and increasingly call for a multi-disciplinary investigation to interpret injury mechanism and aid forensic pathologists in the determination of the manner of death. In response to these challenges, the PCFPR was recently established at Michigan State University and contains 206 de-identified pediatric death cases involving blunt force cranial trauma submitted by 15 partnering medical examiner offices. This resource was established to provide investigators with an assessment tool that links fracture patterns with provided injury scenarios.

Because limited human experimental ground-truth data exists linking cranial fractures with known scenarios, this study's laboratories have developed a porcine model and performed a series of studies to investigate the effects of surface shape and energy level on cranial fracture initiation and patterns.[1,2] With this foundational work in place, it is now necessary to begin relating the experimental findings to human forensic cases. This study applied the findings from previous research to interpret cases in the PCFPR. It was hypothesized that it would be possible to distinguish cranial fracture patterns produced by focal blunt impacts from fracture patterns generated by impacts onto a flat surface based on this previous research.

A total of 86 homicide cases with fracture pattern diagrams and forensic pathology observations were examined to determine whether the injuries were consistent with flat or shaped impact surfaces. Methods employed in this study were developed from the results of the aforementioned research projects in which infant porcine specimens were subjected to impacts at the center of the right parietal from various shaped implements including: flat surfaces, a 90° edged surface, a 2-inch diameter sphere, a five-eighths-inch diameter sphere, and a one-quarter-inch diameter flat-ended cylinder. These studies demonstrated that fracture patterns are dependent on impact surface shape. Specifically, flat surfaces result in peripherally initiated fractures whereas more focal contact surface shapes resulted in more fractures initiating at the point of impact, curvilinear fractures, and/or areas of depression. These same fracture patterns were investigated in the PCFPR homicides.

The results of this study include the classification of these 86 cases into the following categories: impacts to flat surfaces, non-flat/shaped surfaces, and those that could not be presently classified. Twenty-seven cases (31%) had peripheral fractures, which were most consistent with flat surface impacts, while 24 cases (28%) expressed injuries characteristic of shaped impact surfaces, either in isolation or in conjunction with one another. This is a conservative estimate as several cases exhibited confounding cranial fractures, making them difficult to classify. This left 35 cases (41%) unclassified. Of the cases classified as non-flat, 13 (15%) had fracture patterns consistent with point-of-impact fracture initiation, 8 (9%) presented curvilinear fracture patterns, and 14 (16%) expressed areas of depression. It is noteworthy that several of the non-flat impact cases had injury histories that conflicted with the fracture patterns (e.g., a claimed fall from a couch with non-flat fracture characteristics).

The understanding of fracture characteristics and the mechanisms that cause them have significant implications for forensic investigators. The presence of areas of depression, curvilinear, and/or point-of-impact fracture initiation indicated a high likelihood of focal implement impacts, not a flat surface. This information can be pivotal when attempting to determine the mechanism of pediatric cranial blunt force injuries, especially in cases of suspected neglect or abuse.

This project was supported by a grant from 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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Cranial Fractures, Blunt Force Trauma, Fracture Biomechanics