A104 Reliability of Biomechanical Descriptors to Assess Blunt Force Injuries in the Cranium

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After attending this presentation, attendees will better understand the reliability of features used to describe and interpret blunt force injuries in the cranium.

This presentation will impact the forensic science community by contributing to knowledge on the reliability of descriptions to evaluate bone fractures associated with blunt force injuries.

The predictable response of human bone to destructive forces has been demonstrated in experimental and observational research.[1-4] Bone fracture variability associated with blunt trauma is a combination of intrinsic and extrinsic factors. Biomechanical descriptions are fundamental to evaluating fracture variation and for interpreting the mechanism of traumatic injuries, but the reliability of biomechanical applications to bone trauma interpretation has rarely been tested on real-life forensic cases.

The purpose of this study is to address the reliability of anthropologists to interpret multiple blunt force injuries to the cranium using nine biomechanical descriptions consistently reported in case reports and published in the literature. Among these are included: minimum number of impacts; internal surface radiating fractures; internal surface angled-bevel (failure in compression); external scratch on the bone's surface; chipping of bone; depression or distortion of outer bone contour (failure in external tension); and radiating fractures. Six crania with previously categorized blunt force injuries were randomly selected from the evidentiary archives of cold cases in the Department of Anatomy at the University of Pretoria, South Africa. Six observers, who ranged in bone trauma experience from none to greater than 20 years, were provided with both written definitions and photographs, documenting the above-mentioned variables. Only the two observers had prior knowledge of the cases. All variables were scored following a dichotomous system (present or absent). The scores were summed into a "total trauma score" for each skull and each observer.

Percent agreement was used to evaluate the reliability of each feature among all six observers. A Total Trauma Score (TTS) was also created for each observer. The TTS acted as a component score for all traits for each cranium. An Intra-Class Correlation Coefficient (ICC) was used as an index of inter-rater reliability.

Depression or distortion of bone (plastic deformation) and external scratch on the bone's surface were the most reliable with percent agreements at 98.9%, followed with chipping of bone at 88.9%. The remaining traits ranged between 70% and 78%. The ICC for TTS was 78% (p-value=0.001) and had a 95% confidence interval of 36%-96%. When separated by experience, the observers with the most years of experience showed the most disparity among TTS (ICC=58%) and the observers with the least years of experience had less disparity among TTS (ICC=71%).

Knowledge of basic biomechanics and fracture pattern recognition is key to accurate interpretation of trauma in the human skeleton. Additionally, bone trauma interpretation is a complex, multifactorial process not easily amenable to statistical analysis. Yet, when biomechanical descriptions are evaluated within a dichotomous system, a comparison of bone trauma trait analysis among anthropologists of varying experiences is possible. Overall, the biomechanical descriptions are repeatable among observers of various experiences. Experience (in years) did not seem to positively affect the ICC, but bias may exist as some of the experienced observers had previous experience with the material.

The findings offer support for the use of the biomechanical approach to describe, analyze, and interpret traumatic injuries in bone. Within a biomechanical framework, observations related to blunt trauma interpretation are more likely to be reliable than simply classification methods. Future studies will include descriptions of ballistic injuries and will address the definition/refinement of blunt traits with lower reliability.

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Accurate interpretation of fracture characteristics is necessary for communication among scientists, in education, and in reports submitted to a court of law.

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Bone Trauma, Reliability, Biomechanics

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