A92 The Issues and Complexities of Establishing Methodologies to Differentiate Between Vertical and Horizontal Impact Mechanisms in the Analysis of Skeletal Trauma

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Learning Overview: After attending this presentation, attendees will understand the difficulties of interpreting the mechanism of Blunt Force Trauma (BFT) skeletal trauma resulting from catastrophic loading events when minimal contextual information is available. There is a significant amount of literature documenting the complex relationships between impact (force, mechanism, etc.) and trauma; however, existing techniques/methods are limited when applied to medicolegal cases.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating that new approaches are required to determine the relationships between impact and skeletal trauma outcomes in order to meet standards of evidentiary value in medicolegal cases.

Background: Understanding wound characteristics is fundamental in the investigation, interpretation, and assessment of BFT. Forensic practitioners frequently recover and analyze traumatic injuries in individuals presenting BFT without contextual information. The absence of contextual information can hinder interpretation and, for the forensic pathologist, can create uncertainty in ascertaining the most probable manner of death. Forensic anthropological interpretations are additionally complicated by variables such as the length of time since death, loss of soft tissue, and the changes that may mask or mimic trauma resulting from, for example, the removal of remains from the death scene and other postmortem taphonomic changes. Identifying the impact mechanism (high-impact falls, pedestrian Motor Vehicle Accidents [MVAs], accidental/intentional impacts, etc.) is important to accurately determine the manner in which the death occurred and can be a critical component of evidence given in courts.[1]

The mechanism of BFT is difficult to interpret on the basis of skeletal fractures alone.[2] Considerable variation exists within each type of injury dependent on the impact force, direction, and individual biological characteristics. The extent of injuries from both lateral and vertical deceleration events are influenced by several of the same factors mentioned above.[3] In medicolegal settings where there may be limited contextual information, forensic pathologists determine the most probable scenario based on the condition of the physical remains of the individual, where BFT impacts are distinguishable by soft tissue injury and underlying skeletal damage.[4] In forensic medicine, there are limited studies and replicable methodologies that facilitate objective assessment of traumatic injuries, either in terms of impact force or impact mechanism.[5] This fact raises concern regarding the evidentiary value of the current state of trauma interpretation. It also leads to significant doubt regarding whether quantification of skeletal trauma from impact mechanism is at all possible considering the complex non-linear behavior skeletal trauma can exhibit. Because of the difficulties in relating impact mechanism to injury (especially when attempting to determine accidental or intentional injury causation) when bone is severely traumatized, it leaves a void in medicolegal reasoning.[6]

Goal: Given the complex processes governing the nature of BFT skeletal injuries, determining whether differences between impact mechanisms and other factors (i.e., impact forces) can be quantified requires investigation.

Aim: This study aims to determine the feasibility of quantifying differences between impact mechanisms by using a formula created from transformed variables recorded from specific trauma cases involving BFT trauma to the femur.

Methodology: Displacement, comminution, and femoral midshaft area data were recorded from full body postmortem computed tomography scans of 103 individuals (males, mean age 42.5, and females, mean age 48.9) where cause of death was the result of rapid deceleration impact events, both horizontal (pedestrian MVAs, n=59) and vertical (> 3-meter falls, n=46). These measurements were standardized and transformed into a continuous variable. Independent t-tests, binary logistic regression, and K Nearest-Neighbors (KNN) were used to analyze the data.

Results: Mean group differences between falls (9.62) and pedestrian MVAs (9.53), were not statistically significant, while KNN models showed a 59.5% to 70.9% probability of predicting impact mechanism.

Conclusions: The results indicate that similarities in variance between types of trauma outcomes and impact mechanisms demonstrate low equivalency (samples have limited differences). Further, relying on using single elements to explain complex skeletal trauma outcomes is limited. The research undertaken in this project has shown the inherent complexities of analyzing skeletal trauma post-hoc, and that even with quantitative methods, statistically differentiating between impact classes remains elusive.

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