A124 Fracture Surface Characteristics for the Interpretation of Peri-Mortem Blunt Force Fractures in Bone

Christopher W. Rainwater, MS, OCME, New York, NY 10016; Derek Congram, PhD, International Committee of the Red Cross, Bogota, D.C., COLOMBIA; Steven A. Symes, PhD, MS Medical Examiner's Office, MCL, Pearl, MS 39208; Nicholas V. Passalacqua, PhD, Western Carolina University, Cullowhee, NC 28723*

Learning Overview: The goal of this presentation is to define and explain two peri-mortem blunt fracture characteristics in bone and to demonstrate their utility in assessing direction of failure using biomechanical principles, particularly highlighted in remains that have been significantly altered by taphonomic processes.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing explanations of blunt fracture characteristics that assist in the interpretation of force and fracture directionality, which can aid in the determination of cause and manner of death. The cases presented will also help clarify distinctions between peri-mortem trauma and postmortem damage.

The interpretation of peri-mortem traumatic injuries to the skeleton may be one of the most difficult and important aspects of forensic anthropological analyses. In cases in which the remains have been skeletonized, the hard tissues are the only record from which cause and/or manner of death can be elucidated. In order to properly analyze skeletal trauma, one must understand not only bone biomechanics, but also take into consideration the shape and size of the impacting implement, as well as the impacting force. Further, in order to fully characterize the bony defects, a thorough taphonomic analysis in which peri-mortem fractures are distinguished from postmortem (taphonomic) damage must also be completed.

Once skeletal elements have passed from the peri-mortem interval and lost their viscoelastic properties, postmortem fractures differ from their peri-mortem counterparts, even under similar loading conditions. Instead of straining to slow the applied loading forces, "dry" bone is relatively brittle and unable to resist the load. As the bone failure progresses through tension, shear, and compression in less time than fresh bone, the resulting postmortem fracture features tend to be rough, jagged, and lack the large peak and valley notches characteristic of fresh bone failure.

The goal of this presentation is to define, explain, and test the application of two peri-mortem blunt fracture characteristics in bone to contribute to the determination of peri- or postmortem timing of the fracture: *bone tear*, and *bone spurs and notches*. To interpret these characteristics, an understanding of bone biomechanics, primarily the forces of tension and compression is required. In general, forensic anthropology terms, tension forces can be understood as pulling bone apart, while compression forces push bone together. Initial failure in dense cortical bone is usually indicative of tension and the traditional interpretation of blunt force butterfly fractures exemplifies using the utility of tension and compression forces to assess directionality. Here, it is argued that fracture surface morphology adds additional information that can be used to examine peri-mortem blunt fracture circumstancs, even in incomplete or poorly preserved remains. Further, it should be noted that other fracture configurations, such as spiral fractures and axial loading, may similarly be interpreted using these characteristics; however, in these cases, the fracture surface morphologies may be more complex.

Two peri-mortem fracture characteristics, *bone tear*, and *bone spurs and notches*, were introduced in Symes et al.[1] However, here we are defining and explaining these features in order to make them standardized and thus increase their diagnostic power in future analyses. *Bone tear* is found on the fracture surface, representing tension forces. This fracture surface will appear smooth, mottled, and wavy, representing the bone being torn apart. *Spurs/notches* are found on the fracture surface representing compression. This fracture surface will rise and fall into sharp peaks and valleys, as this area represents the bone being pushed together until it fails.

These fracture surface characteristics were applied to two cases with depositional periods of approximately 70 years. Results found that in both cases, these characteristics were present and observable, allowing for additional interpretation of the skeletal trauma present on the remains, despite the co-occurrence of significant postmortem damage and weathering. However, additional research is needed, as demonstrated in Christensen et al., and the approach to the analysis of skeletal trauma using fracture surface morphologies is promising.[2]

Reference(s):

1. Symes S.A., L'Abbe E.N., Chapman E.N., Wolff I., Dirkmaat D.C. Interpreting Traumatic Injury to Bone in Medicolegal Investigations. In: Dirkmaat D.C., editor. *A Companion to Forensic Anthropology.* West Sussex, UK: Blackwell Publishing, 2012;340-389.
2. Christensen A., Hefner J.T., Smith M., Webb J., Bottrell M., Fenton T. Forensic Fractography of Bone: A New Approach to Skeletal Trauma Analysis. *Forensic Anthropology.* 2017; 1(1)32-51.

Blunt Force Trauma, Skeletal Trauma Analysis, Fracture Surface Morphology