A133 Differentiating Peri-Mortem From Postmortem Blunt Force Trauma by Evaluating Fracture Tension Surface Topography Using Geographic Information Systems

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The goal of this presentation is to present the results of a novel method that uses Geographic Information Systems (GIS) to quantifiably distinguish between peri-mortem and postmortem blunt force trauma fractures. Attendees will learn that microscopic topographic differences are observable on the fracture tension surface between bones fractured near the time of death and those fractured later in the Postmortem Interval (PMI), and that these differences can be detected and quantified from high-resolution digital images of the fracture surface using GIS software.

This presentation will impact the forensic science community by introducing a new quantifiable method for analyzing the fracture tension surface morphology by using GIS software to differentiate peri-mortem from postmortem blunt force trauma in forensic anthropological investigations.

Forensic anthropologists must be able to accurately distinguish between wet and dry bone fractures in cases involving blunt force trauma. While previous research has established that fracture surface morphology can provide clues to differentiate between peri-mortem (wet) and postmortem (dry) fractures, no studies have made attempts to calibrate or measure these changes.[1-4] The present study explores the use of GIS to assess and quantify changes in the fracture tension surface topography of bones broken throughout the PMI. Because of its ability to evaluate spatial data, GIS software is well-suited to analyzing spatial patterns in the irregular landscape of a fracture surface.[5] The goal of this study is to establish if fracture surface topography can be consistently used to differentiate between peri-mortem and postmortem bone fractures. The tension surface of the fracture was chosen for analysis because previous research has found that osteons, when placed under tension, will "pull-out" of the fracture surface and create pits and projections on the fracture surface.[6] These pits and projects are read by GIS software as hills and valleys on the fracture surface.

A total of 144 fracture surfaces from pig long bones broken near the time of death and at weekly periods throughout the postmortem interval were imaged using a NextEngine® 3D scanner. The scans were trimmed and imported into ArcMap™ 10.1 in vector format as coordinate points. The Hotspot Analysis tool was used to identify statistically significant areas of high elevation (hot spots) and low elevation (cold spots) and assessed whether those clusters were statistically significant within the context of neighboring feature values. For each fracture surface, the percentage of the total tension surface area considered a cold spot (valley), hot spot (hill), and intermediate value (flat area) were calculated.

Analysis of variance results indicate there is a significant difference in topographic features (hot, cold, and intermediate spots) and temporal intervals corresponding to early, middle, and late decomposition ($p=0.011$, 0.026, and 0.025, respectively). Regression analysis shows low correlation between months in the PMI and the topographic features. The overall trend in the data suggests that bones broken closer to the time of death have a higher percentage of hot and cold spots compared to bones broken later in the PMI. This implies that the bones broken near the time of death exhibit a rougher fracture tension surface with more pits and projections than bones broken later in the PMI. The microscopic roughened appearance of wet bone fracture surfaces is likely the result of torn collagen bundles and osteonal pullouts; however, as the bone dries, the osteons and collagen become less elastic and more brittle, so osteons and collagen bundles will not stretch under tension. Thus, drying results in a smoother fracture surface. The low correlation between PMI and fracture features suggest that time is not a major causal factor, but rather the change in topography is likely the result of the loss of organic material as the bone dries. The findings of this research demonstrate promise for using GIS in forensic anthropological fracture research and cases and that this method warrants further investigation.

References:

1. Johnson E. Current developments in bone technology. In: Schiffer MB, editor. Advances in archaeological method and theory. Vol. 8. Orlando: Academic Press, 1985;157-235.
2. Villa P, Mahieu E. Breakage patterns of human long bones. *J Hum Evol* 1991;21:27-48.
3. Wieberg DA, Wescott DJ. Estimating the timing of long bone fractures: correlation between the postmortem interval, bone moisture content, and blunt force trauma fracture characteristics. *J Forensic Sci*, 2008;53(5):1028-1034.
4. Shattuck RE. Perimortem fracture patterns in south-central Texas: a preliminary investigation into the perimortem interval. MA thesis, Texas State University, Department of Anthropology, 2010.
5. Longley PA, Goodchild MF, Maguire DJ, Rhind DW. Geographical information systems and science. 2nd ed. West Sussex, England: John Wiley & Sons Ltd., 2005.
6. Hiller LP, Stover SM, Gibson VA, Gibeling JC, Prater CS, Hazelwood SJ, Yeh OC, Martin RB. Osteon pullout in the equine third metacarpal bone: effects of ex vivo fatigue. *J Orthopaed Res*, 2003;481-488.

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