A118 Thinking Outside the Box: Theory and Innovation in Sharp Trauma Analysis

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After attending this presentation, attendees will have an appreciation for how sharp trauma to bone can be analyzed using a novel approach.

This presentation will impact the forensic science community by demonstrating that pattern analysis on bone can be accomplished using Geographic Information Systems (GIS), a tool not normally associated with forensic applications.

In 1910, Locard was the first to recognize the principle of the transfer of evidence. Since then, pattern analysis has become one of the fundamental tenets of criminalistics and, by inclusion, forensic science. In the forensic sciences, tool mark pattern analysis is an inter-discipline crossover. For the criminalist, the emphasis is on the transfer of tool-specific characteristics to inanimate objects. In forensic anthropology, the transfer is to bone.

Sharp trauma involving toothed instruments or tools is a case in point. Teeth create transfer evidence in the form of patterned marks on bone. The fundamental theory behind the analysis of these marks is a simple one. Each class of toothed instrument creates a cut-mark pattern unique, or nearly so, to that class of tool or instrument. Symes took this theoretical base and created the first comprehensive documentation of these transfer patterns. His work formed the foundation of this and other studies of toothed instrument cut marks.

Once tool-specific patterns have been recognized, interpretation and identification of an unknown pattern is a matter of comparison to known patterns. In most situations, the analysis of class-specific cut-mark patterns relies on morphometric characteristics, like kerf thickness and kerf profile. As Symes has demonstrated, this is a highly effective method. Yet there are times when morphometric analysis is hindered, if not rendered useless, by the absence of observable class-specific characteristics. There is one feature of tooth-instrument transfer that is nearly universally present — striations on the cut surface or kerf wall. As a saw or other toothed instrument cuts through bone, the teeth leave behind striations on the cut surface. Despite their visibility, these striations have limited diagnostic power in pattern analysis using traditional morphometric methods.

GIS is a computer-based process designed to visualize patterns. GIS has been described as a means of analyzing and interpreting relationships, patterns, and trends. Anyone who has used consumer mapping "aps" has used GIS. While the intent of GIS is to recognize patterns on large geographic regions, size should not be a limiting factor. Looking for patterns on an area the size of a state and on the kerf wall of a cut bone is simply a matter of scale.

The inspiration to use GIS to examine striation patterns on bone came from two recent studies. Both were novel approaches to the use of GIS and demonstrated the value of using tools that were not designed for their original purpose. In the first, Powell and colleagues utilized GIS to map out fracture patterns on infant porcine skulls.[1] In the second study, Rose and colleagues moved to the microscopic level in GIS patterns of bone microstructure.[2] Their success in the use of GIS in their respective studies demonstrated the effectiveness of GIS in the recognition and interpretation of patterns other than geographic ones. Based on these prior studies, Williams and Davis successfully explored the use of GIS in recognizing and differentiating striation patterns on the cut surface of bone.[3] In this study, striation patterns were viewed as the equivalent of variations in geographic topology. Two different saw classes were compared, each with uniquely different striation patterns. GIS consistently recognized these as distinctly different patterns of transfer evidence. Using traditional morphometric methods, such a distinction would not be possible.

The theory of transfer evidence on cut bone has followed the traditional route of morphometric analysis. Recent studies have demonstrated that "working outside the box" by using technologies that were not originally designed for bone-specific patterns has yielded encouraging positive results. These studies have shown that GIS has promise to become a tool in trauma analysis and not merely an interesting academic exercise.

References:

1. Powell BJ, Passalacqua NV, Baumer TG, Fenton TW, Haut RC. Fracture Patterns on the Infant Porcine Skull Following Severe Blunt Impact. *J Forensic Sci* 2012; 57(2):312-317.
2. Rose DC, Agnew AM, Gocha TP, Stout SD, Field JS. Technical note: The Use of Geographical Information Systems Software for the Spatial Analysis of Bone Microstructure. *Am J Phy Anthropol* 2013; 148 (4): 648-654.
3. Williams JA, Davis R. The Utility of GIS in the Spatial Analysis of Saw Cut Marks on Bone. *Proceedings of the American Academy of Forensic Sciences*. 66th Annual Scientific Meeting. Seattle, WA. 2014; 20: 429-430.

Theory, Cut Marks, GIS