H52 Microscopic Analysis of Sharp Force Trauma From Knives: A Validation Study

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The goal of this presentation is to present error rates in determining blade class characteristics from tool mark impressions made by knives.

The presentation will impact the forensic science community by providing a baseline study with which known error rates for determining knife class characteristics from tool marks can be referenced.

Forensic anthropologists are often asked to examine defects on bone and cartilage created as a result of sharp force trauma. Previous research has established the precedent for analyzing cut mark morphology on bone and cartilage and has promoted the use of class characteristics (Andahl 1978; Symes 1992). While this research has been invaluable in advancing toolmark analysis in bone, it has largely focused on tool marks left by saws as they are more variable than knives and thus have the capability to leave more class characteristics. Although a general anthropological approach to tool mark analyses has been established and accepted, there is a lack of method validation and known error rates for correctly identifying these characteristics, particularly in reference to knives. This is necessary in light of the recommendations of the recent National Academy of Sciences Report (2009) and considering that analytical results are subject to *Daubert* standards of courtroom-acceptable scientific evidence (1993). Researchers have noted this deficiency, but previous efforts have suggested no correlation between serrations on a blade and the regularity of striation patterns in experimentally cut pig cartilage (Love *et al*. 2010).

This research attempts to establish a baseline study to assess the accuracy of associating a tool mark with a particular blade class under optimal conditions. Experimental defects will be evaluated for class characteristics that relate to only two blade characteristics: blade serration (serrated, partially serrated, and non-serrated) and direction of blade bevel (left, right, or both). A medium-to-soft casting wax is presented as an optimal material when it is necessary to transect material with an experimental cut. Wax blocks were impacted in two ways: (1) in a single impact transecting the wax block (to mimic a stab wound); and, (2) in a repetitive, reciprocating motion (to mimic dismemberment). Impacts were made for each of the fourteen knives in the study sample and coded to be unknown to the researchers (four partially serrated blades, five non-serrated blades, and five serrated blades with a variety of different bevels and serration patterns). The test cuts were then assessed by three researchers with varying degrees of experience analyzing sharp force trauma. Additionally, two microscopes were used to test the necessary level of technology for these analyses (a digital microscope offering an increased depth of field and the ability to reconstruct defects in three dimensions and a standard light microscope). Cuts were analyzed at the observer's preference between 10x and 50x magnification with the assistance of fiber optic lights to produce oblique lighting. In total, 168 cut marks were observed. Error rate was assessed as the number of misclassifications divided by the total number of observations.

Serrated blades were generally distinguishable from non-serrated blades due to their distinct, patterned striations whereas non-serrated blades leave fine, unpatterned striae. Distinct striations can generally be considered as equidistant, but the angle of the impact of the blade is the most influential aspect of the distance between striae left by blade teeth, so pattern recognition was favored over measurements. Two observers misclassified two of the four partially serrated blades as serrated blades while the third misclassified all four as serrated blades. Blade bevel was assessed by determining the corresponding direction change in the v- shaped kerf. The average raw error rates (misidentification of class) for all three observers was 19% for the assessment of blade serration using both the digital and light microscopes. Partially serrated blades were particularly problematic in this study as the impact may not have left both a serrated and a non-serrated signature. When the adjusted error rates are considered from only serrated and non-serrated blades, the average error rate for determining blade serration was 2% on both the digital and light microscopes. Average error rates were 18% for determining blade bevel on the digital microscope and 10% on the light microscope, but this corresponded to the experience level of the observer. These preliminary results show that, under optimal conditions and an appropriate level of experience, assessments of blade serration and blade bevel can be made with a high level of accuracy. This research will be supplemented by experimental cuts in bone and cartilage.

Tool Marks, Sharp Force Trauma, Validation Study

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