H33 Objective Interpretation of the Striation Pattern Observed in Experimentally Cut Costal Cartilage

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The goal of this presentation is to introduce a quantitative method developed for the analysis of tool mark impression evidence in cut costal cartilage. The method is designed in consideration of the federal guidelines for admissibility of forensic evidence.

This presentation will impact the forensic community by presenting a method that transitions a traditionally subjective analytical test to an objective test, an approach that can be translated to other areas of visual analysis, i.e., ballistic and fiber analysis.

Published literature on tool mark impression examination demonstrates the generally accepted theory that class and individual characteristics of a weapon's cutting edge are recorded in the cut surfaces of cartilage and bone and can be identified using microscopic analysis. Several studies have correlated variation in striation pattern observed in the cut surface to the cutting edge design and wear defects of a tool, while others have gone so far as to conclude the striation pattern is unique to the tool. Despite the general acceptance, limitations of the current methodology are lack of quantitative analysis, failure to measure error rate, and minimal independent testing.

Federal guidelines regarding admissibility of forensic evidence have become more rigorous in recent years and as a result tool mark impression evidence has been found inadmissible on multiple occasions. A recent conviction was overturned by the Supreme Court of Florida because of what was determined to be the invalid admission of expert testimony regarding tool mark impression analysis. The expert witness identified a particular knife as a murder weapon based on a technique of microscopic analysis of the markings left by the knife in a piece of cut cartilage. The expert for the defense testified that the methodology used was not generally accepted as reliable and did not therefore satisfy the federal guidelines. The Florida Supreme Court ruled that while the knife itself was admissible, the interpretation of the cut marks provided by the witness was inadmissible. The Court found that no scientific precedent existed to support the opinion that a specific knife can be identified from marks made on cartilage (Ramirez I, 542 So.2d at 354-55).[1]

The inadmissibility of cut mark impression evidence is a threat to the successful adjudication of countless violent crimes. In 2008, Harris County Medical Examiner's Office Forensic Anthropology Division received forty cut mark cases for tool mark impression evidence analysis and six suspect weapons for direct comparison. Given the limitations of the current methodology and need for admissible analysis, a quantitative method to analyze cut mark impression evidence in costal cartilage is developed. The goal of the project is to quantitatively discern between striation patterns made with knives of different cutting edge design.

Experimental incised wounds were made in pig (*Sus scrofa)* costal cartilage using a serrated, non-serrated, and micro-serrated kitchen knife. Thirty incised wounds were made with each knife. Each cut surface was cast with [Mikrosil Casting Material.] Each cast was photographed using a digital camera attached to a stereomicroscope. The images were imported into [Adobe Photoshop CS Extended software.] Using the Ruler function of the Photoshop program, the distances between the striations were measured. Presence of striations, regularity of the striation pattern and presence of primary and secondary striation patterns were documented. Presence and absence of striation and distances between striations were statistically evaluated using [SPSS 16.0 Basic software.]

A pilot study was conducted using ten cut marks. Four analysts (three practicing forensic anthropologists and one doctorate level anthropology intern) independently analyzed the ten cut marks (twenty cut surfaces). The results of the pilot study showed 100% agreement among the analysts for striation recognition and 85% agreement in regularity of the pattern (std. error 0.124). No correlation between the presence of serrations in the knife's cutting edge and regularity of striation patterns was found (r = -0.05). In light of the very small sample, sampling error cannot be excluded as a possible cause.

The pilot study shows striation patterns are easily recognized within cut costal cartilage surfaces. Evaluation of the correlation between the cutting edge design and striation pattern, observer error, and repeatability will be possible following the examination of the complete sample of cut marks.

Reference:

[1] *Ramirez v. State of Florida* 2001 WL 1628609, 27 Fla. L. Weekly S 18 Supreme Court of Florida, Dec. 20

Forensic Anthropology, Tool Marks, Impression Evidence Analysis

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