Assessing the reliability of kerf floor shapes in predicting saw types for use in forensic dismemberment cases

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Introduction

Kerf variables are used by forensic anthropologists in cases of human dismemberment to ascertain characteristics about the saw used. Saws have several variabilities including tooth shape, teeth-per-inch, set, power, blade width, and length. These characteristics impact the shape of the cut (kerf floor) that is produced when the saw is used on bone.

Previous literature has proposed that kerf floor shape reflects saw class characteristics. This preliminary research expands upon our current understanding of the relationship between the shape of the kerf floor and the saw used.

Kerf shape is thought to reflect characteristics specific to the class of saw utilized to make the cuts. In this study, a set of 12 kerf shape categories based on previous studies and observations were used to score bony kerfs. These categories were then used to test interobserver agreement of kerf floor assignments and in the evaluation of the kerf shape/saw characteristic relationship. Finally, the categories were collapsed based on observer difficulty in assigning the 12 categories. Then, the new collapsed scoring system was tested.

Methods

This research utilized a 90-specimen subsample of incomplete saw cuts on fully macerated human long bones made available by Mercyhurst University; these were originally collected in a National Institute of Justice grant project (2005-IJ-CX-K016)1. . The 19 saws used to make these cuts were semi-randomly selected to ensure approximately equal representation of each saw. Stereomicroscopic photos of the kerf profiles from these 90 specimens were scored by three observers (1 experienced, 2 inexperienced).

Preparation of Specimens

- A controlled sawing method was used to produce cuts on fully macerated long bones.
- Subsample of 90 specimens created using 19 different saws.

Creation of Kerf Shape Categories

- 12 Kerf shape categories were developed based on previous studies and observations.
- Shape outlines were generated and dispersed to observers.

Scoring and Analysis

- 1 experienced observer and 2 inexperienced observers scored stereomicroscopic photos of the subsample.
- The utility of kerf floor shape in classifying saw characteristics was assessed through the percentage of inter-observer agreement.

Results

Agreement between the two inexperienced observers and the experienced observer was 60.0% and 75.6% for the 12-shape scoring system. Collapsing the kerfs with flat or slightly rounded floors increased agreement to 90.0% and 88.8%. Other than being made by rip saws, no patterns were discerned between the flat/rounded kerf floors and saw characteristics.

Kerfs with a “W” or truncated-“W” shape had 100% agreement across all observers. All but one of the W-shaped kerfs were created by hand saws with alternating crosscut teeth. This preliminary research highlights the utility of kerf floor shape analysis and illustrates the need for further kerf floor shape assessment.

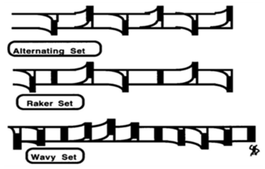

Figure I: Common saw tooth sets[1]

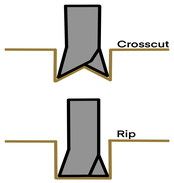

Figure II: Common saw tooth shapes

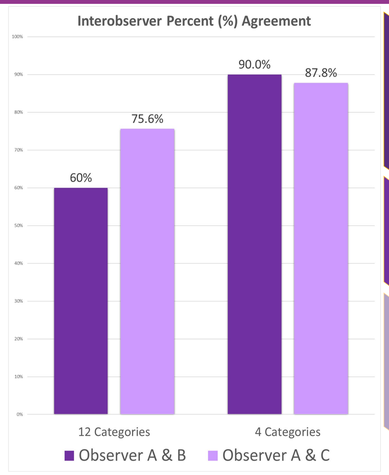

Figure III: Percentage of agreement where Observer A is the experienced observer and Observers B & C were inexperienced

12 Category Method

- When using the 12-category method, the percentage of agreement between the experienced observer A (and the inexperienced observers (B & C) was 60% and 75.6% respectively (Figure IV).

Kerf Scoring

- No disagreements were seen in scores 7 and 8
- No kerfs were scored as a 9
- No kerfs were unanimously scored as a 5

Collapsing Categories 1-6

- Disagreement between observers occurred most often in categories 1-6, which represent the kerfs with flat or slightly rounded floors.
  - 33 of 36 disagreements between Observers A and B
  - 18 of 22 disagreements between Observers A and C
- Collapsing categories 1-6 into the colored groupings seen in Table 1 increased the percentages of agreement to 90% and 87.8%, respectively.

Kerf Shape Scoring Categories

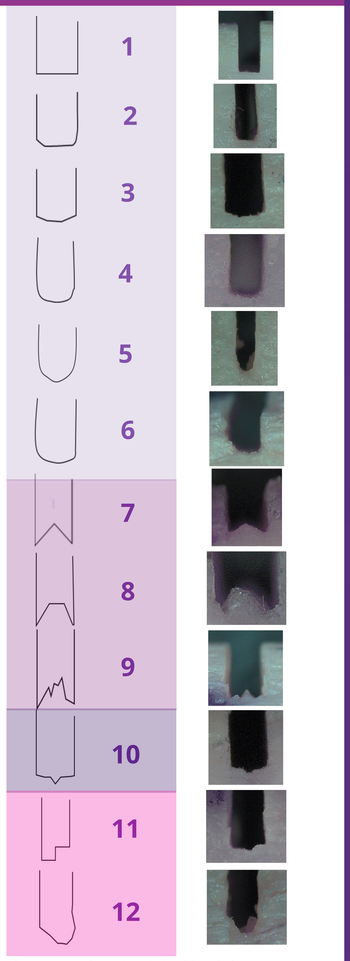

Figure IV: The 12 original kerf shapes are presented with their outlines used for scoring as well as examples of each in bone. The shading represents how the scores were collapsed into four groups to increase reliability.

Discussion

All sharp, W-shaped kerfs were created by handsaws with alternating crosscut teeth (Score 7), consistent with previous research. There were only two hand alternating crosscut saws (dovetail and general carpenter saw) that produced four kerfs that were not W-shaped. Also, two W-shaped kerfs with shallow peaks (Score 8) were created by a mechanical circular rip saw. This difference in shape was distinguished by all observers .

Beyond being created by rip saws, no patterns were found on the flat to rounded kerf floors. There was no distinguishing factor between power, set or TPI.

Score 10 is a new category that was developed, with the defining features being the relatively flat kerf floor with the midline divot. This new shape is attributed mechanical reciprocating rip saws with a raker set. All kerfs used in this study with this shape were identified by the observers. However, not all mechanical reciprocating rip saws produced this feature.

Conclusion

Future studies should focus on kerf shape patterns from a wider variety of saws to better the interpretations in forensic casework. An increased number of observers of varying experience should also be considered in future studies.

Acknowledgements

Firstly, we would like to express our sincere gratitude to all those that donate their body to science, facilitating such research. We would also like to thank Alexis VanBaarle and Lauren Butaric for their roles in cut and data collection. The Forensic Science Foundation funded part of this project via a Lucas Grant and we are thankful for that support. Finally, we would like to thank DMU for their support of the MSRP program.

References

1. National Institute of Justice, Office of Justice Programs, U.S. Department of Justice . (2010). Knife and saw toolmark analysis in bone: a manual designed for the examination of criminal mutilation and dismemberment. (Report # NCJ 232227). https://www.ojp.gov/pdffiles1/nij/grants/232227.pdf.