C41 A Comparison of Tool Marks From Knives, Saws, Axes, and Loppers Used for Dismemberment and Some Comments on Forces

Sarah V. Hainsworth, PhD, University of Leicester, Department of Engineering, Leicester, LE1 7RH, UNITED KINGDOM; Gary Nolan, BSc, University of Leicester, University Road, Leicester, LE1 7RH, UNITED KINGDOM; and Guy N. Rutty, MD, Forensic Pathology Unit, University of Leicester, Robert Kilpatrick Building, Leicester, LE2 7LX, UNITED KINGDOM*

The goal of this presentation is to discuss the types of tool marks left on bone surfaces from knives, saws, axes, and loppers used in dismemberment and to show the characteristic features of the different types of tool marks. Some comments about the levels of force required to achieve dismemberment with the different types of weapons will be made so that a forensic pathologist might have a clear idea of the level of force required with particular implements.

This presentation will impact the forensic science community by showing how implements used in dismemberment leave tool marks. This is particularly important for forensic pathologists but also for forensic scientists and engineers who are asked to provide expert opinions on the force required for dismemberment with the various weapons.

Tool marks are the marks left in a softer material when a harder material is used to cut or strike them. Several types of tool mark are possible: imprints left by the indentation of the tool into the softer surface such as when a knife point embeds in bone; or striations that are left by the edge of the tool by either a sawing or cutting action. Tool marks that leave an imprint or indentation leave a "negative" imprint of the tool itself in the material and as such the imprints can be used to help determine the size and shape of the tool's tip. If the hardness of the bone is known, the size of the impression can be used to calculate the force required (Figure 1). Striations are parallel lines that are caused by a tool's blade either cutting or sawing the material. For sawing, the marks are parallel to the blade's length, for cutting the orientation of the marks depends on the direction of cutting.

Figure 2 shows the typical marks that are left on a bone surface from sawing for example. One goal of the work in this paper is to better understand how tool marks arise in bone or cartilage from the various tools that are typically used for dismembering bodies.

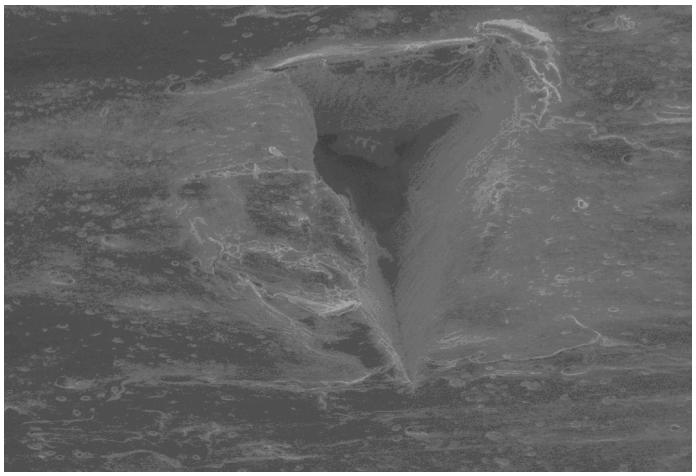
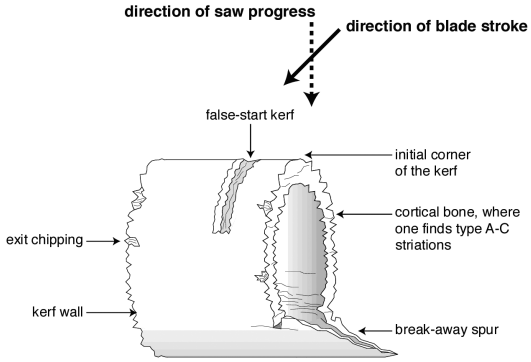


Figure 1: Imprint left in a deer bone from a knife, the size of the impression can be used to estimate the force required.



 ** Presenting Author*

Figure 2: Schematic showing tool marks left on bone from sawing that can be used to identify the tool that made them.

The goal of tool mark analysis in forensic medicine is to compare the marks left on bone or cartilage with the suspected tool or instrument under conditions as close as possible to the conditions under which the original tool marks were made.

Tool mark experts try to match the mark found on the bone or cartilage to weapons that are thought to have made the mark. This can be done by making new marks from the suspect weapon and comparing the dimensions and markings with the ones that were characterized from the bone or cartilage. Traditionally, the impressions or striations are compared with a 3D stereo comparison microscope which allows both samples to be examined at the same time and regions where the marks correspond can be determined from carefully matching the positions of the samples. If a good match is found, over a sufficient area then the marks are deemed to have been made by the same instrument. This technique is used for matching marks from saws, screwdrivers, chisels, knives, hammers etc.

For marks on wood, metal, and polymers, tool marks are often clear and well retained. Bone is also a relatively hard, stiff material and this will also retain good marks. Cartilage is relatively soft and low in stiffness and the marks retained can be less clear. Both cartilage and bone have to be defleshed and dried before tool mark analysis can be performed. Tool mark analysis on bone and cartilage is more challenging because of these factors.

Currently, for marks left with knives, for example, an expert can usually say with confidence in court that a knife *may* have produced the wound, *could* be the murder weapon, or that it is possible to eliminate a particular knife from the enquiry. It is often more difficult to say that a mark *was definitely* made by a particular knife.

The presentation will show a range of examples of the marks left by different tools and show how the forces involved can be determined in some instances and how "uniqueness" can sometimes be determined from the striations left on the surfaces.

Tool Marks, Dismemberment, Force

