Weapon-Wound Matching of Sharp Force Trauma to Bone using Micro-CT – A Methodology and Pilot Study

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INTRODUCTION

UK Home Office Statistics 2012 reported 636 homicides between April 2010 – March 2011: 37% of these involved the use of a sharp instrument such as a knife with 14% of investigations not resulting in prosecution1. Sharp force trauma in forensic anthropology concerns the analysis of the marks (kerfs) caused by ‘sharp’ weapons like knives, ice-picks etc2. Tool mark analysis and weapon-matching analysis is a developing area and requires the anthropologist to establish, either weapon class, or exact weapon used to commit the homicide. This is traditionally done macroscopically but is rarely sufficient to determine weapon class3 and hence current research trends is investigating the use of imaging techniques for post-mortem examination4. Newer techniques such as micro-CT, could allow much more detailed investigations into bone trauma indicating great potential for research into weapon-wound matching5. Our study aims to use micro-CT and 3D/3D programs to analyse sharp force trauma which, to our knowledge, will be the first attempt at investigating 3D weapon-wound matching. The applications of this study can potentially lead to new techniques in forensic anthropology for weapon-wound matching and hence aid in criminal investigations.

SUMMARY

Nearly 40% of murders in the UK result from sharp force trauma caused by knives (Home Office 2012). Weapon-wound matching in Forensic anthropology attempts to estimate weapon class from the wound characteristics but few studies have investigated quantitative methods for performing this analysis on the microscopic scale. In this study five cadaveric pig torsos, prepared to mimic human anatomy, will be stabbed in the upright position with 12 different knives by two volunteers. Knife dynamics will be recorded using a Casio high-speed camera (1000fps), with wound tracts being recorded using photogrammetry. Samples will be defleshed exposing the regions on the ribs where the knives have made contact, thus marking the bone, so micro-CT can be performed. All samples will undergo a post and pre-stab CT. The analysis will be performed using various quantitative and qualitative methods to establish the feasibility of weapon-wound matching. Results are pending, however it’s hypothesized that, on the macroscopic scale, and individual blades weapons have their own unique edge profiles which should leave unique striations on the bone for weapon-wound matching. If this is the case, and we can quantify this, then applications in forensic investigation for weapon-wound matching is a natural progression.

METHODOLOGY

To be undertaken on 14th November 2012

Sample Preparation

5 whole pig thoraxes prepared to mimic human anatomy will be sourced from a medical meat supplier and delivered to the surgical training facilities UHCW.

The pig thoraxes will be fixed in the upright position at the anatomical height of an average male for stabbing.

A selection of 12 knives, some new, some serrated and some from prisoners property will be used to stab the pig samples.

Pork ribs were purchased for a butcher and then stabbed using 3 different kitchen blades. 1 serrated blade and 2 non-serrated blades, one small and one large.

The ribs were then defleshed by placing them in an antiformalin solution for ~24 h (NaClO3, Ca (OCl)2, NaOH and H2O). The scans will then be reconstructed and calibrated ready for the analysis of knife marks.

PILOT STUDY

 student’s T-Test

Both a graph and Student’s T-test was used to display and analyse the significant data recorded for both kerf depth and width for each knife.

Both the student's T-Test and graph show that there exists a statistically significant difference in the basic dimensions of marks left on bone from different types of knives. It appears that both serrated knives and large kitchen knives leave a narrower and shallower mark than small non-serrated knives indicating that determining probable knife type is possible.

Further Work and Applications

The pilot study hints at the potential of micro-CT in providing detailed information on the dimensions of the cuts left behind on bone by various knives. Whether striations are visible on the kerf wall has yet to be considered but will follow. The impact of velocity on bone damage will also be investigated. Also the use of mesh and CAD software for weapon-wound matching will be explored along with possible 3D printing of marks left. Furthermore, having compared two ‘same knives’ it appears that their are microscopically differences between that may results in unique cut mark features that could be used to determine the individual knife used. Following the results of this experiment (commencing November 14th) further work potentially using human cadavers will be conducted to control for the differences between pig tissue and bone and human. If the research indicated that micro-CT is a powerful tool in aiding in weapon-wound matching for sharp force trauma then methods for application in forensic cases will be investigated.

REFERENCES


Websites

Saville, P.A., et al 2007. CT, could allow the scale of the marks being studied, the velocities of the stabs and the effectiveness of the antiformalin solution. Ribs will then be replaced with sheep’s skin to mimic the skin. Following stabbing, wounds tracts will be labelled and photographed (making use of photographic prints). Finally, the post-stab CT will be conducted.