H26 Towards a Standardization of Burnt Bone Analysis: The Use of Micro-Computed Tomography and 3-Dimensional Imaging to Assess Morphological Change

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After attending this presentation attendees will learn of the issues surrounding analysis of burnt bone from a forensic anthropological basis, and methods which may be applied using advanced 3D imaging techniques in order to standardize and obviate some of these issues.

This presentation will impact the forensic science community by presenting a novel standardization method for the quantitative analysis of burnt bone, and raise significant issues with the methodology expounded by the current and historical literature.

An understanding of the heat induced alterations to bone is a necessary prerequisite for the subsequent identification of burned human remains. Fire, or any form of combustion, has the capability to alter, damage, or destroy evidence that is vital to the identification process. However, since bone undergoes extensive alterations when exposed to heat, the accuracy of standard identification methods will therefore be detrimentally affected. In spite of this, there is still a great deal not fully understood regarding the transformative processes that heat causes to bone and the most appropriate method for study. This is in part due to the large variation in experimental models used by investigators. Different temperature intervals, recorded measurements, and statistical analysis have lead to confusion in the literature regarding the typical mechanism and expression of heat alteration. Although there is a growing corpus now available to facilitate more accurate interpretation and analyses of burned bone, these studies are largely based on qualitative features and are, at best, misleading. Without quantitative measurements, there is no way to account accurately for the heat induced alterations that bone experiences, or modify current anthropological techniques. Recording quantitative measurements can therefore help to standardise burnt bone analysis, improve current analytical methods and, in the process, meet the imperative need to develop more accurate identification techniques for burned human remains.

The primary goal of this research was to quantify morphological and morphometrical differences between pre-burn and post-burn skeletal specimens (before and after burning comparison) using advanced micro-imaging and three-dimensional volumetric techniques. The experimental investigation was conducted on a data set of porcine skeletal elements burned between 300°C and 1200°C. Differences between the use of embalmed and unembalmed specimens were also investigated. The material was scanned before and after burning using Micro-Computed Tomography and 3D surface laser scanning. The resulting pre- and post-burn CT and surface scans were analyzed using volumetric reconstruction software in order that a comprehensive qualitative and metrical assessment could be carried out between the pre and post-burn homologues. Numerical data, which could be statistically analysed for the quantification of heat-induced alterations, was obtained by generating volumes of interest (VOI). Interpolation and resampling was applied to the resulting VOI. This allowed us to investigate and quantify the percentage change in standard histomorphological skeletal characteristics between the pre- and post-burn states. The cortical thickness of each specimen was also measured in order to calculate average volume change. Changes in surface shape, morphology, and distortions were quantified using Geomagic best-fit contour alignments.

The study found recognizable quantifiable morphological change between the pre- and post-burn homologues, some of which run counter to established expectations of thermal alteration from published sources. In particular, although an increase in trabecular thickness and subsequent decrease in trabecular separation was expected (due to the well- documented loss of carbonates during inversion and fusion) this trend was not achieved during this investigation. The results show a decrease in trabecular thickness at 600°C and 900°C, and although recorded to initiate at 500°C, both features showed a marked change at temperature as low as 300°C. These deviations from the normal trend can all be explained by the high presence of bone marrow in the rib sections; this reflects the process of “normal” anatomical burning whereby tissues contain their full complement of inorganic and organic components (including marrow and fat), highlighting the need to establish element specific models for each anatomical region.

Burnt Bone, Computed Tomography, Forensic Anthropology