H135 An Analysis of Process Signatures to Burn Progression of Human Bodies During Commercial Cremation

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After attending this presentation, attendees will have a better understanding of the expected process signatures of burn destruction of bone in a commercial crematory environment.

This presentation will impact the forensic science community by demonstrating that burning is predictable and a predictable progression of thermal destruction to bone is visible and quantifiable.

Distinguishing between thermal damage and non-thermal peri-mortem bone trauma is critical to the forensic analysis of burned human remains. However, standards for such determination developed through the study of actual human remains are limited. Symes *et al.* provides the most detailed analysis of thermal patterns of destruction to the body based on forensic casework.[1] Through this analysis, several process signatures were identified, such as the shielding of soft tissue due to body position, and pugilistic posture of the limbs. Previous bone research frequently relied on pig carcasses (*Sus scrofa*) as proxy cadavers. However, their bones present a distinctly different anatomical structure disallowing a clear comparison to the effects of fire on human anatomy. Performing actualistic studies using human bodies is necessary to fully understand these processes. Past studies into burned human remains have most often focused on one area of the body such as the cranial bones.[2] Few studies have been conducted using fully articulated bodies. Although Bohnert *et al.* (2008) studied cremated bodies (15 total) this study utilized wooden caskets and a multi-chambered retort.[3]

The purpose of this research was to identify a predictable progression of thermal destruction characteristics to human bodies cremated in a commercial environment, thereby establishing a baseline for analysis of forensic significance in unexplained deaths. Further, statistical analyses were undertaken to determine if burn progression is correlated with cadaver weight, sex, or the position of the body in the fire.

Between September 2010 and March 2011, nine cremations were analyzed at a commercial crematorium in Pennsylvania as part of NIJ award No. 2008-DN-BX-K131. Through videography, still photography, and visual observation, data were collected and compiled. Utilizing these data, eight thermal modifications occurring with the highest frequency were identified for analysis. These events included pugilistic posture of the hands, disarticulation of the hands, disarticulation of the thumb, pugilistic posture of the lower limbs, femur fractures, rib end fraying, exposure and destruction of cranial bone, and disarticulation of the lower limbs. Body position and supine/prone positioning were examined. Ranked data were then evaluated using Spearman's Rank Correlation between each case to look for a quantifiable pattern in burn progression.

Despite a small sample size, initial analyses indicated that expected thermal characteristics were predictable due to soft tissue shielding and body position. Each was readily identifiable and predictable in progression. Interestingly, there did not appear to be a high correlation between individuals of the same sex, nor did body weight or age have a strong influence on the progression of the burn. However, there was a correlation between cases with similar body positions, indicating that the positioning of the body plays a role in burn progression. Generally, pugilistic posture of the limbs occurred early in the cremation process with restrictions of the limbs occurring in those bodies positioned face down. Also, fraying of rib ends depended on body position. The sternal-end frayed in the supine position, while the vertebral-end frayed in the prone position.

Predictable burn progression was supported by statistical analysis when events were ranked by order of occurrence, resulting in similar burn patterns across multiple cases in similar settings. Body position appears to play a role when variability in expected burn patterns is exhibited. Despite predictable patterns based on body position and tissue protection features, further research in non-commercial, natural settings would contribute to anthropological predictability of bone destruction in fires. Understanding the expected patterns of thermal destruction is important to accurately distinguish between thermal damage and non-thermal peri-mortem bone trauma in forensic cases.

References:

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Cremation, Thermal Destruction, Burn Progression

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