INVESTIGATING SKELETAL PERI- AND POST-MORTEM TRAUMA

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Introduction

The forensic anthropological analysis of trauma can provide evidence for foul play and contributes to the determination of cause and manner of death [1]. Bone mechanical and biological properties impact the way bone fractures due to the cross-sectional geometry and thickness of its cortical bone [2]. In the post-mortem (PM) interval bones will gradually lose some of their fresh characteristics and their mechanical and biological properties change which impacts their fracture pattern. The timing of skeletal trauma and the PM interval significantly impacts the reconstruction of the events leading up to death and the cause of death. However, there are no absolute time frames in which the characteristics of wet bone (perimortem) fractures transfer to dry (post-mortem) fractures.

This study aims to identify any time-dependent trends that may highlight the time of transition within the early PM interval in which the characteristics of bone change from wet to dry bone properties. Furthermore, to support the hypothesis that the characteristics of bone fractures change significantly in the first ten weeks after death by investigating the mechanical, macroscopic, microscopic, and chemical changes in the first ten weeks post-mortem.

Methods

64 ribs of 4 rib cages of mature fallow and roe deer were used. 32 ribs were buried in 10 boxes with 10 litres of soil (pH 5.5-6.0) while the other 32 ribs were placed on trays with ~1cm of soil underneath them. The ribs were experimentally fractured through a three-point bending DARTEC Series HC25 hydraulic materials testing machine with a 25kN load cell at increasing weekly intervals. The fractures and bones were analysed using macroscopic analysis, SEM analysis, thermal analysis, biomechanical analysis, and ATR-FTIR analysis. These results were then considered to establish whether any time-dependent trends were present and if they were a reliable tool to identify when the fresh characteristics of bone were lost. Statistical analyses of variances (ANOVA) were also performed on the mechanical and chemical results.

Results & Discussion

In the exposed ribs of all the statistical analyses performed in this study only the normalised load values and the carbonate-to-phosphate ratios gave significant results. All remaining observations, including those that were not statistically assessed, proved inconclusive.

In the buried ribs, no significant difference was found in the macroscopic, microscopic, composition and biomechanical analysis (Figure 1), but only in the carbonate-to-phosphate ratio.

The comparison of buried bones and exposed bones showed a significant difference in all the analytical techniques.

The inconclusiveness of the results as far as PM interval determination is concerned was to be expected for the small PM period of 10wks. The alterations in these particular characteristics in the first 10wks PM may be too small or variable to detect.

Conclusions

The present study confirmed the flexible and environment-dependent nature of the peri-mortem interval. However, this study did not prove the hypothesis that characteristics of bone fractures change significantly between week 0 and week 10. Therefore, Forensic Anthropologists cannot identify and differentiate fractures with certainty within the first ten weeks of the PM interval from biomechanical characteristics alone.

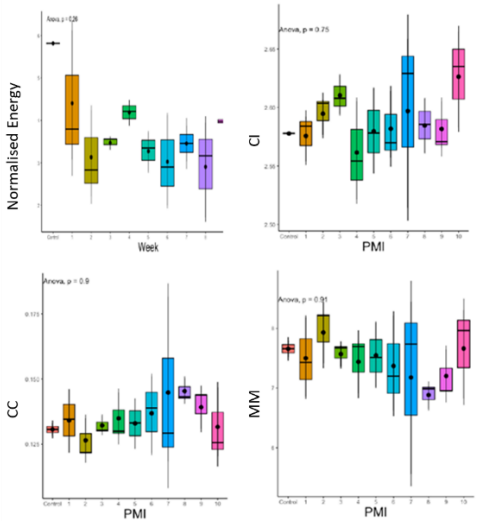

Figure 1: ANOVA test results for the normalized energy to fracture, Collagen content, Crystallinity Index and Mineral to matrix ratio in the 10wks PM interval.

References

1. Cunha E. and Cattaneo C. (2006) in *Forensic Anthropology and Medicine*. Humana Press. https://doi.org/10.1007/978-1-59745-099-7_3.
2. Daegling, D. J., et al. (2008) *Journal of forensic sciences*, 53(6), pp. 1301-1307. https://doi.org/10.1111/j.1556-4029.2008.00876.x