Histotaphonomic changes of experimentally burned bone and the application of confocal laser scanning microscopy

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INTRODUCTION

Burning of skeletal remains can alter the structural and chemical properties of bone, which can cause complications for forensic investigations and archaeological site interpretations. Researchers utilize various methods (i.e., the Oxford Histological Index (OHI), the General Histological Index (GHI), and the Birefringence Index (BI)) to quantify the histotaphonomy of bone to determine if the bone is preserved well enough for the application of histological methods, such as age-at-death estimation[1]. The purpose of this study is to compare the histotaphonomy of various skeletal elements pre- and post- burning and to test if confocal laser scanning can aid in the visualization of histological structures not visible in charred bone under transmitted light microscopy.

MATERIALS & METHODS

Six donors from the Forensic Anthropology Center at Texas State University were placed in various fire-death scenarios at the Forensic Anthropology Research Facility. Samples were taken both pre- and post- burning from the femur, fifth metatarsal, and sixth rib for comparison. Blocks of each bone were embedded in epoxy resin from which cross-sections were obtained, ground and polished to approximately 70 µm thick, and mounted to a slide using Eukitt. Samples were visualized using transmitted light microscopy and index scores were collected and compared. Images were also collected using an Olympus Fluoview 300 Confocal Microscope equipped with five diode lasers at the following nanometer (nm) levels: 405, 445, 488, 561, and 640.

RESULTS

There were no significant differences in OHI, GHI, or BI between the pre- and post-burn samples, however not all post-burn samples could be scored. Burned bone with microstructures that were no longer visible under transmitted light were visible with confocal laser scanning microscopy. Additionally, severity of burning affected the laser intensity required to visualize the bone microstructures, with charred bone requiring the 561 or 640 laser for visibility.

DISCUSSION & CONCLUSION

This research shows that burned skeletal elements found fragmented in situ may be viable for histological analysis. Additionally, the presence of soft tissue, followed by the length of burn time, appear to be the two most important factors in predicting the extent of taphonomic change to bone postburn. Results indicate the practical use of confocal laser scanning microscopy to analyze the microstructure of burned bone for the application of histological methods. The differences in required laser intensity may be due to the changes in the physical composition of the bone caused by burning, e.g., loss of collagen.

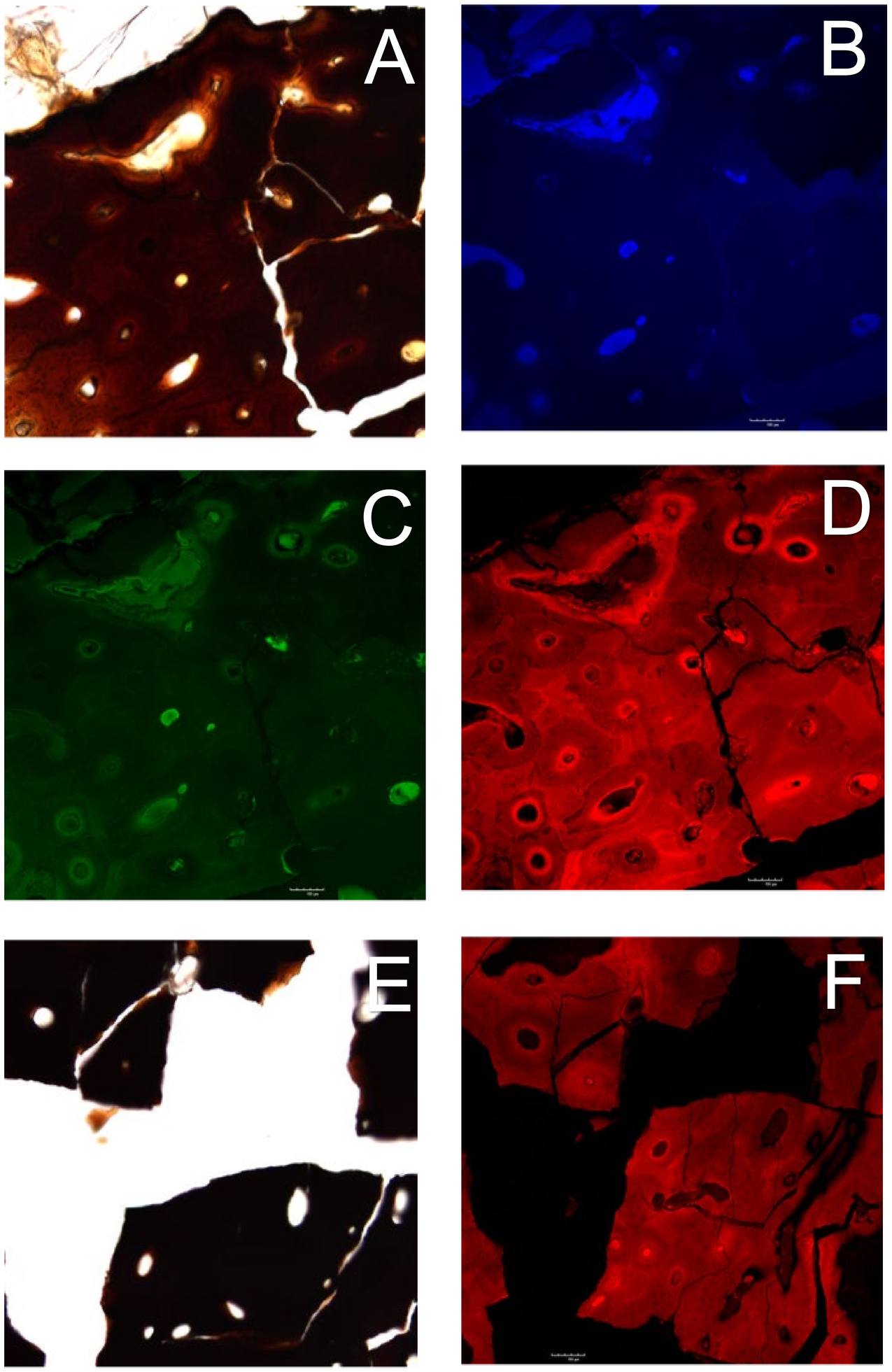

Figure 1. Burned left metatarsal from individual 1 imaged with transmitted light (A) and confocal laser scanning microscopy 405 laser (B), 488 laser (C), and 561 laser (D). Burned left metatarsal from individual 2 imaged with transmitted light (E) and confocal laser scanning microscopy 640 laser (F).

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1. Mavroudas, S. R., L. A. Meckel, T. P. Gocha, J. Z. Goldstein, and S. L.Garza. 2022. “The Effects of Experimental Whole-Body Burning onHistological Age-at-Death Estimation From Human Cortical Bone andDental Cementum.” Biology 11, no. 11: 1569. https://doi.org/10.3390/biology11111569.

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