A96 The Importance of Taphonomic History When Conducting Histological and Isotopic Analyses on Bone

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Learning Overview: After attending this presentation, attendees will have a better understanding of how taphonomic histories influence microscopic and isotopic composition of bone.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by highlighting how differences in taphonomic history can be observed histologically as well as impact the isotopic composition of bone.

The 1943 Battle of Tarawa resulted in more than 5,000 casualties on Betio Island. The requisite need to bury the casualties immediately after the battle and the post-war repatriation efforts in the late 1940s led to commingling and disassociation of remains. Through a variety of anthropological methods, the Defense POW/MIA Accounting Agency has re-associated recent field recoveries from Betio Island with individuals that were buried at the National Memorial Cemetery of the Pacific (NMCP) in 1949 as "Unknowns." The Unknowns were disinterred from the NMCP between 2016 and 2017.[1,2] The Unknowns were treated with formaldehyde, while the skeletal elements that remained on Betio Island were not. The re-association of recent field recoveries with disinterred Unknowns allowed for a direct comparison of the same individual skeletal elements with vastly different taphonomic histories. The purpose of this study was two-fold: first, to determine if taphonomic history could be indicated through histology and, second, to determine if taphonomic history degrades isotopic analyses.[3]

A total of 18 skeletal elements, representing nine antimeres or fragment refits from five individuals, were compared histologically using normal and circular polarized light microscopy. Thin sections were prepared following standard histological protocols. The extent of diagenetic alteration of the bone microstructure was scored following the Oxford Histological Index (OHI); intensity of birefringence, extent of cracking, presence of discoloration, and the type of microbial alteration were also recorded.[4] Ten skeletal samples—two per individual, representing antimeres and fragment refits from field and NMCP contexts—were prepared for isotope testing as collagen and bioapatite at California State University, Chico. Collagen was submitted to the Stable Isotope Facility at the University of California, Davis for measurement of carbon and nitrogen isotope values (δ^{13}C and δ^{15}N, respectively). Bioapatite was submitted to IsoForensics, Inc. for measurement of δ^{13}C and oxygen (δ^{18}O) values.

The taphonomic history of the skeletal elements was reflected in characteristic alterations of the bone microstructure. Remains from Betio Island showed a greater extent of diagenetic alteration (bioerosion) in comparison to those treated with formaldehyde. Despite this, the amount (yield) of collagen extracted for isotope testing was consistently higher for elements from Betio Island as opposed to treated bone. Three of the five NMCP samples had collagen yields lower than the accepted 5% threshold, while one of five samples from the NMCP had a bioapatite yield lower than the accepted 25% threshold.[5] Considering all samples, regardless of material yield, mean pairwise differences in collagen δ^{13}C, collagen δ^{15}N, or bioapatite δ^{13}C values were not significant when compared to a theoretical mean of 0. There was a significant difference for bioapatite δ^{18}O values (one-sample *t*-test; p=0.0002), with higher δ^{18}O values measured for samples from Betio Island.

This research has implications for biomolecular forensic analyses of chemically altered remains (e.g., embalmed, prepared anatomical materials, etc.). Disinterred samples previously treated with formaldehyde demonstrated well-preserved bone microstructure due to the biocidal effects of the preservative, but overall lower collagen yields. Based on yield data, isotope testing results of 60% of prepared collagen samples could be considered potentially suspect. Conversely, samples from recent Betio Island recoveries demonstrated poor preservation of bone microstructure yet yielded reasonable amounts of both collagen and bioapatite (with one exception) for isotope testing. Disregarding material yields, collagen from disinterred bone was not isotopically distinct from collagen from recent Betio Island-recovered bone when considering either carbon or nitrogen isotopes values, while only δ^{18}O values (and not δ^{13}C values) of bioapatite differed between paired samples. The taphonomic history of a bone, like embalming or burial environment, influences the analytical results derived from that bone and thus should be considered during forensic analyses.

Reference(s):

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4. Hollund H.I., Jans M.M.E., Collins M.J., Kars H., Joosten I., Kars S.M. What Happened Here? Bone Histology as a Tool in Decoding the Postmortem Histories of Archaeological Bone from Castricum, the Netherlands. *Int. J. Osteoarchaeol.* 2012:22(5):537-548.
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Taphonomy, Histology, Isotopes

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