H6 Bone Histomorphometrics and Sex Assessment

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After attending this presentation, attendees will gain an understanding of bone histomorphometrics as it relates to partial estimation of the biological profile to identify unknown human remains from forensic settings. They will be introduced to the utility of histomorphometrics in the estimation of sex.

This presentation will impact the forensic science community by expanding the knowledge and scope of bone histology to include methodologies in addition to age-at-death estimation techniques thereby strengthening the overall accuracy of the biological profile and, consequently, the likelihood of positive identification.

Histological analyses have proven valuable in discerning fundamental age information about individuals. In fact, bone histology has been utilized to determine age-at-death for over forty years.[1-5] Histological analyses have not particularly focused on assessing sex as part of the biological profile; however, some research has demonstrated the need for sex-specific analyses when developing age-at-death regression equations.[6,7] Studies have also noted that the mean values of specific histological variables are significantly different between the sexes, possibly indicating different rates of bone modeling and remodeling.[6-8] Though past literature has not attempted to assess sex based on histomorphometrics, the finding that differences in bone remodeling do exist and that sex-specific equations to estimate age are potentially more reliable than sex-pooled equations indicate the utility of such methodologies.

This research was performed at the Department of Anthropology's Mineralized Tissue Histology Laboratory and the Forensic Anthropology Laboratory at the University of Tennessee Medical Center. Forty-eight white male and female decedents of known age, sex, and ancestry from the University of Tennessee Medical Center were sampled during autopsy to remove three one-by-one centimeter specimens from the sectioned margin of the left frontal, parietal, and temporal bones. An additional 50 left frontal bone samples were procured from males and females with known demographics from the Tennessee Medical Center. Complete medical histories were available, so retrospectively, if outliers demonstrate differential bone remodeling or atrophy, they could be excluded from analyses.

Bone samples were given a unique numeric, cleaned and dried, and embedded. Three thin-sections were cut for each sample and then ground and polished for analysis. A research light microscope and computer imaging software were used to examine slides at various magnifications; photographic series of the entirety of each thin-section was captured using a mounted digital camera attachment. Prepared thin-section slides were first examined to recognize cellular structures, evidence of remodeling, and the distribution of remodeling prior to quantification of the following histological features: external table thickness, number of secondary osteons, secondary osteon area, secondary osteon perimeter, secondary osteon maximum and minimum diameters, secondary osteon diameter ratios, secondary osteon Haversian canal area, secondary osteon Haversian canal perimeter, secondary osteon Haversian canal maximum and minimum diameters, secondary osteon Haversian canal diameter ratios, number of secondary osteon fragments, osteon population density, and osteon circularity.

This research created a discriminant function analysis based on the collected histomorphometrics to assess sex. A jack-knifed discriminant function analysis was run separately for the frontal, parietal, and temporal bones and then again to include all three bones to determine how accurate the histological features are at "discriminating" between subgroups and predicting which subgroup (male or female) each individual belongs to. Using only the frontal bone to assess sex resulted in a 67% correct classification, the parietal a 52% correct classification, and the temporal a 64% correct classification. When the discriminant function analysis utilized a combination of sub-variables from the frontal, parietal, and temporal to assess sex, it did so with 80% correct classification for females and 90% correct classification for males with an overall 86% correct classification. These results lend credibility to the prospect of using bone microstructure to assess sex.

In conclusion, bone histomorphometrics has potential in not only estimating age-at-death of unidentified individuals, it also contributes to assessment of sex.

References:

1. Crowder CM. Histological age estimation. In: Blau S, Ubelaker DH, editors. Handbook of forensic anthropology and archaeology, world archaeological congress research handbooks in archaeology. Walnut Creek, CA: Left Coast Press, 2009: 222-235.
2. Crowder CM, Stout SD. Bone histology, an anthropological perspective. Boca Raton, FL: CRC Press, 2012.
3. Kerley ER. The microscopic determination of age in human bone. Am J Phys Anthropol 1965;23:149-64.
4. Kerley ER, Ubelaker DH. Revisions in the microscopic method of estimating age at death in human cortical bone. Am J Phys Anthropol 1978;49:545-6.
5. Stout SD. Methods of determining age at death using bone microstructure. In: Saunders SR, Katzenberg MA, editors. Skeletal biology of past peoples: research methods. New York, NY: Wiley- Liss, 1992: 21-5.
6. Curtis JM. Estimation of age at death from the microscopic appearance of the frontal bone [thesis]. Indianapolis, (IN): University of Indianapolis, 2003.
7. Ericksen MF. Histological estimation of age at death using the anterior cortex of the femur. Am J Phys Anthropol 1991;84:171-9.
8. Kimura K. Estimation of age at death from second metacarpals. Z Morphol Anthropol1992;79:169-81.

Histomorphometrics, Sex Assessment, Forensic Anthropology

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