H38 Histological Aging of Neurocranial Bone

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After attending this presentation, attendees will be introduced to the microstructure of several neurocranial bones and the utility of numerous features in formulating regression equations to estimate age-at-death.

This presentation will impact the forensic science community by expanding knowledge of bone histology to include neurocranial specimens as a solitary means of age estimation in biological profiles.

Successful skeletal age-at-death estimation employs a variety of traditional methods. One disadvantage is the necessity of near complete and proper preservation of target elements to reliably estimate age. Instances lacking traditional gross odonto-skeletal features force anthropologists to rely on bone or dental microscopy. Relevant histological research has focused on numerous bones, including the ribs, clavicles and mandible, but primarily the long bones. One limitation in some previous research is the insufficient attention to how biomechanical and metabolic factors affect the osteonal remodeling process in long bones and the accuracy of aging techniques. The influence of variation resulting from localized trauma, as well as the generalized effect of diet, disease, or excessive or minimal physical activity, is also important. [1-2]

Past histological research has focused on bones believed to be less vulnerable to environmental stressors.[3-4] This research examines the neurocranium, specifically the frontal, parietal, and temporal. Hypothetically, this region is less affected by biomechanical remodeling factors, given fewer muscle attachments, and has rarely been utilized in age-related histological research, with only Clarke and Cool performing histomorphometrics.[1,3] Their results indicate a low correlation of variables to age resulting from the irregular organization of features. However, these results may be due to a small sample size and a skewed older age distribution. Curtis focused on histomorphometrics of the frontal bone.[4] It was concluded that age-predictive equations should be controlled for sex when new variables were included. While promising, her large sample size is primarily reliable when estimating age on individuals over sixty years. Notwithstanding these issues, it is necessary to continue neurocranial histomorphometrics by expanding the younger to middle ages.

This research was performed at the University of Tennessee, Department of Anthropology's Mineralized Tissue Histology Laboratory, the Forensic Anthropology Laboratory at the University of Tennessee Medical Center, and the Pima County Office of the Medical Examiner in Tucson, Arizona. Sixty white male and female decedents of known age (20 through 82 years old), 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. Complete medical histories were available; so retrospectively, if outliers demonstrate differential bone remodeling or atrophy, they could be excluded from analyses.

A research light microscope and computer imaging software were used to examine slides at 40, 100, and 200 magnifications; a photographic series of the entirety of each thin section was captured using a mounted digital camera attachment. The following histological features were examined: external table thickness, the 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, and osteon population density.

Pearson's correlation coefficients identified which of the above-mentioned variables (measurements from the frontal, parietal, and temporal bones) proved significant to estimate age. Also, stepwise selection determined which independent measurements were predictors. The significance level required for entry into the model was $\alpha=0.15$; predictors with coefficients greater than a significance of $\alpha=0.05$ were dropped and the model rerun. Statistical results demonstrate that the ratio of secondary osteon maximum to minimum diameter is a significant predictor. Also, the frontal bone has a stronger correlation to age than does the parietal or temporal bones. The results indicate the utility of neurocranial histomorphology in formulating age-at-death estimation regression equations.

References:

1. Clarke DF. Histological and radiographic variation in the parietal bone in a cadaveric population. Master's thesis, University of Queensland, Australia, 1987.
2. Stout SD Histomorphometric analysis of human skeletal remains. In Kennedy KK, Iscan MY, editors) Reconstruction of life from the skeleton. New York: Alan R. Liss, 1989.
3. Cool SM, Hendrikz JK, Wood WB. Microscopic age changes in the human occipital bone. J Forensic Sci *1995;40:789-796.*
4. Curtis JM. Estimation of age at death from the microscopic appearance of the frontal bone. Master's Thesis: Graduate School of the University of Indianapolis, 2003.

Histomorphology, Neurocranium, Age Estimation

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