A82 Examining the Accuracy of Age Estimates From New Histological Sampling Strategies at the Femoral Midshaft

Timothy P. Gocha, PhD, The Ohio State University, 1645 Neil Avenue, 279 Hamilton Hall, Columbus, OH 43210; Sam D. Stout, PhD, Ohio State University, Dept of Anthropology, 4034 Smith Laboratory, Columbus, OH 43210-1106; and Amanda M. Agnew, PhD, The Ohio State University, 279 Hamilton Hall, 1645 Neil Avenue, Columbus, OH 43210*

After attending this presentation, attendees will understand the spatial variation present in the distribution of intracortical remodeling events throughout the entirety of the femoral midshaft and the importance of selecting Regions Of Interest (ROI) for developing new histological aging methods.

This presentation will impact the forensic science community by introducing new sampling strategies for the quantification of histological remodeling that can be used to estimate age and further demonstrating these age estimates to be highly accurate throughout the adult life span.

As a complement to macroscopic aging methods, or when necessary macroscopic elements are damaged/absent, age can be estimated through histological examination of remodeling events in cortical bone. During the past half century, the femoral midshaft has been the most commonly employed site for histological studies; however, a consensus is still lacking on where to best quantify remodeling, as different methods employ various ROIs that differ in size, number, and location. To address this knowledge gap, this study employed Geographic Information Systems (GIS) software to digitally map all remodeling events (intact and fragmentary osteons and resorptive bays) across the entirety of the femoral midshaft. Patterns in the spatial distribution of remodeling were then examined to identify which region(s) of the femoral cortex produce the most accurate age estimates.

Thirty complete cross-sections from modern cadaveric femora were used, 15 of each sex, ranging from 21 year to 97 years of age (mean=58.9; Standard Deviation (SD)=22.1 years), with both sexes having similar age distributions. Each sample was photographed under polarized light and seamless cross-sectional images were imported into arcGIS® v10.1. Polygon features were created to overlay cortical areas and all remodeling events (n=230,870) were identified and digitally annotated with point features. A total of ten different sampling strategies were employed, each subdividing the entire cortex in a different manner. Osteon Population Density (OPD) was calculated by summing all remodeling events within an ROI and dividing by its area.

Statistical analyses were performed in the Statistical Package for the Social Sciences (SPSS) 21. OPD values were normally distributed for each ROI, and Multivariate Analysis of Covariance (MANCOVA) analyses revealed that OPD was not significantly different between sexes for any ROI, allowing the combination of male and female data for further analyses. Paired t-tests revealed OPD calculations were not statistically different between observers. Stepwise linear regression was used to determine which ROIs from each sampling strategy were most useful in estimating age. To further evaluate the performance of the resulting predictive models, jackknife age estimates were generated by removing an individual from the sample, recalculating the regression model, and then estimating the age of the individual not included in the model; this was done iteratively for all individuals. The accuracy of these estimates was analyzed through measures of bias and inaccuracy.

Results indicate the two most promising sampling strategies are dividing the femoral cortex into Anterior, Posterior, Medial, and Lateral (APML) quadrants separated into periosteal, middle, and endosteal thirds, and also APML octants separated into thirds. Stepwise regression selected four ROIs for each method, primarily in the lateral and anterolateral regions of the cortex, and spread between all depths of the cortex. The resulting model for the APML quadrants by thirds explains more than 90% of the variation in age (adj. R^2=0.907, p=0.000) with a standard error of 6.73 years, while the APML octants by thirds explained more than 93% of the variation in age (adj. R^2=0.931, p=0.000) with a standard error of 5.82 years. Jackknife age estimates from both models were very promising, with average differences between estimated and known age (bias) being less than one year and average absolute differences between estimated and known age (inaccuracy) being less than six years. Further, individuals in their 90s had bias and inaccuracy measures of less than seven and four years for the quadrants and octants methods, respectively. Such accuracy in age estimation, even into the tenth decade of life, demonstrates that this new method for histological aging considerably outperforms more traditional macroscopic methods of aging in older individuals. Considering increasing life expectancies, this research has great promise in providing forensic anthropologists with a tool to accurately age elderly individuals.

Age Estimation, Skeletal Histology, Forensic Anthropology

*Presenting Author