H68 Femoral Midshaft Histomorphometric Patterning: Improving Microscopic Age- at-Death Estimates From Adult Human Skeletal Remains

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After attending this presentation, attendees will understand how the use of microscopic techniques to estimate adult age at death is well established within physical anthropology's subfields of bioarchaeology and forensic anthropology, but diligent work is needed to overcome the long-standing problems of the Osteon Population Density (OPD) asymptote and relatively high Standard Error of the Estimate (SEE).

This presentation will impact the forensic science community by suggesting how the posterior Region Of Interest (ROI) can be utilized for production of the most accurate microscopic age-at-death estimates from adult human skeletal remains, and thus, for better understanding of the adaptive success of past populations by bioarchaeologists, and for more positive identifications by forensic anthropologists.

Review of the microscopic age-at-death estimation literature reveals that arbitrarily changing skeletal elements, histological variables, sample demographics, and sampling locations have not allowed for accurate age estimation of individuals over approximately 50 years or reduced the standard error of age estimates. This investigation, therefore, began with substantiated theory. All healthy, mobile femurs have in common: genetic programming to establish initial size and shape; the developmental processes of endochondral ossification, appositional growth, and modeling; biomechanical adaptation; periosteal adaptation; cortical thinning and shape change during aging; mechanosensation and mechanotransduction; and bone remodeling.

Building from this theoretical knowledge base, it was first hypothesized that topographical variation in remodeling exists around human femoral midshaft periosteal cortices that reflects the constraints of normal anatomical development, customary biomechanical usage, and standard mechanobiological functioning. Second, it was hypothesized ROIs associated with the I_{min} second moment of area biomechanical axis would exhibit the lowest remodeling as a result of minimal biomechanical loading. Third, it was hypothesized remodeling at biomechanical ROIs would be histomorphometrically more consistent than at anatomical ROIs due to unchanging functionality. These hypotheses were tested by counting remodeling events at eight standardized periosteal ROIs (four anatomical—A (anterior), P (posterior), M (medial), L (lateral) and four biomechanical—I_{maxAnt}, $I_{maxPost}$, I_{minMed}, and I_{minLat}) of 200 adult femoral midshaft cross-sections originally harvested by M.F. Ericksen from George Washington University dissecting room cadavers. The sample was specifically composed of 98 males and 102 females, largely of European descent, ranging in age from 30 to 97 years.

While no evidence was found for reduced remodeling at I_{min} ROIs or for more consistent remodeling at biomechanical ROIs, 14 statistically significant differences were found between ROI OPD medians indicating topographical variation in remodeling exists around the femoral midshaft. Specifically, the lowest OPD values were found to occur at the Anterior ROI, followed by the Posterior, I_{minMed}, $I_{maxPost}$, I_{maxAnt}, I_{minLat}, Medial, and Lateral ROIs. Additionally, although the anterior femoral cortex has traditionally been sampled for microscopic age at death estimation, here, the Anterior ROI was found to reach the OPD asymptote first and was associated with the highest SEE (± 11.542 years). Alternatively, the Posterior ROI was found to be associated with the lowest SEE (± 3.260 years) and second lowest median OPD value, but showed no signs of having reached the OPD asymptote. It therefore bears further investigation to see if this pattern can be replicated across multiple samples. If so, it is suggested the Posterior ROI be utilized for production of the most accurate microscopic age-at-death estimates from adult human skeletal remains, and thus, for better understanding of the adaptive success of past populations by bioarchaeologists, and for more identifications by forensic anthropologists.

Histomorphometrics, Age-at-Death, Regions of Interest

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