A53 Femoral Midshaft Shape: An Indicator of Adult Age-at-Death?

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After attending this presentation, attendees will understand that the cross-sectional shape of the adult human femoral midshaft is highly variable and that discovery of a uniform shape transformation pattern among this variability may allow for production of age-at-death ranges from unidentified skeletal remains.

This presentation will impact the forensic science community by eliminating a method proposed to utilize femoral midshaft cross-sectional shape to produce age-at-death estimates from unidentified adult human skeletal remains.

Literature review indicates anterior-posterior elongated femoral cross-sections are associated with great workload and mobility. This finding has been utilized previously to reconstruct behavioral differences, such as sexual division of labor and subsistence strategy within and between past populations; however, recent transversal biomechanical data reveals the femoral midshaft changes in size and shape throughout adulthood: once the human femur is fully developed, biomechanically adapted, and periosteally adjusted by adjacent musculature a net loss of cortical area begins as the amount of bone deposited on the periosteal surface lessens in comparison to the amount of bone removed from the endosteal surface. Additionally, analysis of shape ratios and the angle formed between the I_{max} biomechanical axis and the medial-lateral anatomical axis indicates young adults often have anterior-posterior elongated cortices but mature adults increasingly display circular to medial-lateral elongated cortices.

Because members of modern industrialized society are not expected to display evidence of a sexual division of labor or differential subsistence strategies, this study hypothesized that femoral cross-sectional shape variability could partially reflect adult age-at-death, as reduced mobility is often associated with increasing age. This hypothesis was tested by extracting geometric morphometric data from 200 adult femoral midshaft cross-sections originally harvested by M.F. Ericksen from The George Washington University dissecting-room cadavers. The sample was composed of 97 males and 103 females largely of European descent, ranging in age from 30 to 97 years (mean=71 years, standard deviation=12 years). A quantitative evaluation software was utilized to extract the periosteal outlines from oriented bitmap images of the femoral cross-sections, quantify the contour shapes with elliptic Fourier descriptors, and perform principal component analysis to summarize the shape information.

Although the results illustrated observable differences among the sample of femoral cross-sections, shape variance was not found to be significantly correlated with age. Specifically, none of the seven first principal components, accounting for 95% of the variance, correlated with age after a Bonferroni adjustment. The first principal component (representing an anterior-posterior flattening of the section and accounting for 63% of the total variance) was found to be significantly correlated only with the biomechanical properties, such as I_x/I_y and I_{max}/I_{min}, that are themselves different indicators of shape. Only PC3 and PC4 (accounting for a total of 7% of the variance) were statistically linked with sex (males display a rounder shape). Overall, these findings reinforce how femoral midshaft shape primarily reflects mechanical environment regardless of age and suggest there is too much variation in mobility among this sample of modern humans for femoral shape to be a useful indicator of age-at-death.

Age-at-Death, Geometric Morphometrics, Elliptical Fourier Analysis