A2 Radiographic Image Analysis and the Estimation of Age at Death in Adult Males

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After attending this presentation, attendees will understand how the analysis of digital radiographs of the pubic bone can be used to estimate age at death for male decedents.

This presentation will impact the forensic science community by providing data indicating that digital radiographic images of the male os pubis can be reliably used to place individuals within intervals of age at death comparable to those of more commonly employed methods based on morphological changes of the pubic bone.[1,2] The techniques developed in this research can be used to estimate age at death from pubic bones where details of the symphyseal face have been damaged or otherwise obscured and, with refinement, may eventually enable age-at-death estimation without excision and maceration of the pubic bone.

This research was conducted using the Hartnett-Fulginiti collection curated at the Forensic Science Center in Maricopa County, AZ. This collection is comprised of more than 600 specimens of pubic symphyses from decedents of known sex, age at death, and ancestry. A training sample, composed of 100 pubic bones from male decedents ranging in age from 18 to 91 years, was selected to provide roughly equal representation from each of the seven morphological phases of the Hartnett-Fulginiti method for the estimation of age at death.[2] Although preference was given to the left os pubis, the right was used when the left was damaged or otherwise unsuitable for analysis.

Digital radiographs of each specimen were taken from a fixed distance and with constant settings. The resulting images were subjected to analysis in which characteristics of the distribution of gray values (mean, standard deviation, minimum, maximum, median, mode, skew, and kurtosis) were recorded. In an attempt to control for individual variation in size and shape, image analysis was constrained to the triangular area defined by the upper and lower bounds of the symphyseal face and the most medial point on the margin of the obturator foramen. Recorded characteristics were evaluated for their correlation to age at death, and a subset of six variables (comprised of standard deviation, maximum value, skew, kurtosis, and the constructed metrics of range and signed difference between mean and median) was selected for a k-means clustering analysis. Although Hartigan's Rule suggested that 13 clusters was the optimal clustering solution for this data, this resulted in several clusters that were based around a small number of individuals, and a clustering solution of nine was adopted instead. Each of the nine clusters was defined by the location of its centroid and described by the mean, standard deviation, and range of the within-cluster age-at-death distribution.

To test whether radiographic image analysis could produce viable age-at-death estimates, the six variables listed above were recorded for a secondary sample of 57 randomly selected males ranging in age from 22 to 84 years. The six-dimensional Euclidean distance between each new individual and the centroids of the nine previously defined clusters was calculated, and individuals were assigned to the cluster whose centroid they were nearest to. The frequency with which the ages of the individuals in the secondary sample fell within intervals constructed around the mean age of each cluster was then recorded. Results indicate that overall, an individual's true age at death was within 17 years of the mean age of the cluster to which they were assigned in 75.4% of the trials. Although a 34-year age interval is large, it is nearly equivalent to those employed by widely used morphological techniques for the estimation of age at death.[1,2] Moreover, the majority of the individuals whose ages were not in the predicted interval were either very young or very old. For individuals whose age at death was between 25 and 75 years, true age at death was within 17 years of the assigned cluster's mean in 87.8% of cases and, for 81.5% of individuals between the ages of 40 and 60 years, true age at death was within ten years of the assigned cluster's mean.

Although preliminary, these results suggest that image analysis of radiographs of the male os pubis can be employed for the estimation of age at death. With further refinement, the utility of this technique for both younger and older individuals may be increased. Moreover, further exploration of the uses of radiographic image analysis may eventually obviate excision and maceration of the pubic bone for the development of a biological profile.

Reference(s):

1. Brooks S., Suchey J.M. Skeletal age determination based on the os pubis: A comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods. *Hum Evo.l* 1990:5(3):227-238.
2. Hartnett K.M. Analysis of age-at-death estimation using data from a new, modern autopsy sample – Part I: Pubic bone. *J Forensic Sci.* 2010:55(5):1145-1151.

Age-At-Death Estimation, Pubic Bones, Radiographs

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