A4 Topographic Analyses and the Estimation of Age at Death From the Pubic Bone

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Learning Overview: After attending this presentation, attendees will understand the potential of topographic analyses for the development of new, objective, and fully quantitative methods for the estimation of age at death based upon age-related changes to the surface complexity of the pubic bone.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by illustrating the relationship between the surface complexity of multiple regions of the pubic bone and age at death. Results in this presentation indicate that topographic analyses may be used to develop age-estimation techniques that overcome the limitations of qualitative methods and improve upon the accuracy of current quantitative methods, especially for older decedents.

This research was conducted using the Hartnett-Fulginiti collection curated at the Forensic Science Center in Maricopa County, AZ. This collection comprises more than 600 specimens of pubic symphyses from decedents of known sex, age at death, and ancestry. A sample of pubic bones from 20 individuals (9 females, 11 males) with ages at death ranging between 18 and 84 was selected for analysis. Selection was based solely upon age at death and not upon the degree to which bones conformed to the morphological expectations associated with their known age.

All pubic bones in the sample were scanned using an Identica Blue 2015 laser scanner, and the resulting 3D meshes were partitioned into two regions of interest: the symphyseal face and a portion of the ventral surface. Remnant cartilage adhering to some bones resulted in poor scan quality and yielded final sample sizes of 16 left ventral surfaces (6 female, 10 male) and 18 right symphyseal faces (8 female, 10 male). Scans for each region were given the same orientation and all meshes were reduced to 15,000 faces for computational purposes. The surface complexity of each mesh was quantified using the metrics of Relief Index (RFI), Oriented Patch Count (OPC), and Dirichlet Normal Energy (DNE) as implemented in the molaR package developed for the R statistical environment. The values for each of these metrics were then evaluated for their association with known age at death.

While the combined-sex sample sizes used in this study are small, they are capable of recognizing correlations whose magnitudes exceed r=0.61 (for the symphyseal face) and r=0.64 (for the ventral surface) with a power of 0.8 and at a significance level of α=0.05. Even with these limitations, age at death is significantly correlated with RFI and OPC on the symphyseal face (RFI: r=-0.67, p-value=0.002; OPC: r=0.64, p-value=0.004) and significantly correlated to RFI and DNE on the ventral surface (RFI: r=0.66, p-value=0.005; DNE: r =0.69, p-value=0.003). The rate and trajectory of changes in surface complexity differ between the ventral surface and the symphyseal face. This suggests that a method for age estimation that takes into account multiple regions of the pubic bone may yield increased accuracy in comparison to current techniques. Modelling the relationships between these metrics and age at death as non-linear would likely improve upon these results, but the strength of these correlations (especially given the small sample size) suggest that RFI, OPC, and DNE can be profitably used in the development of a novel, fully quantitative method for the estimation of age at death. Moreover, these preliminary results suggest that quantification of the surface complexity of the ventral surface of the pubic bone may yield suitable estimates of age at death when the more commonly used symphyseal face has been damaged or is otherwise unavailable.

Age Estimation, 3D Laser Scans, Topographic Analyses