H77 A Validation Study of Computed Tomography Extracted Cranial Landmarks

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After attending this presentation, attendees will understand the utility of Computed Tomography (CT) cranial scans for 3D geometric morphometric analysis, positive identifications, and ancestry estimation.

This presentation will impact the forensic science community by presenting the utility of using extracted cranial landmarks from CT scans that could be used in the estimation of ancestry.

The main research objective of this study was to investigate the variation between cranial landmarks extracted from CT scans and those collected from digitization. The sample consisted of 29 individuals from the Morton collection housed at the University of Pennsylvania's Museum of Archaeology and Anthropology. The dry skulls were digitized with a 3D digitizer and scanned with CT. The CT scans were made available by Janet Monge as part of the Open Research Scan Archive (ORSA) at the University of Pennsylvania. Thirteen traditional cranial landmarks were obtainable from each CT scan using the coordinate option of a software program. These coordinates were then compared to the digitized coordinates. A geometric morphometrics software program was used for multivariate statistical analysis. Procrustes' superimposition was used to translate, scale, and rotate the landmark data until a consensus configuration was identified with a least-square fit. New shape coordinates were derived for the entire dataset and for each digitized and scanned individual.

The digitized landmarks and CT-extracted coordinates were first treated as two separate groups to examine for overall differences. Principal Components Analysis (PCA) was performed to reduce dimensionality by decreasing the number of variables to the few that represented the majority of variation. Most of the variation (86%) was in the first four principal components with 57% of the variation found in the anterior portion of the cranium along the first principal component. Canonical Variant Analysis (CVA) was used to identify the landmarks responsible for the variation between the CT coordinates and the digitized coordinates. CVA provided one significant canonical variant, which accounted for 99.8% of the variation and included landmarks along the midline (e.g., nasion and opisthion). A Discriminant Function Analysis (DFA) was also performed to discern the approximate level of separation between the two groups with a correct classification rate of 64% using cross-validation. This was expected and illustrated the similarities between the two groups of coordinates. In addition, a Multivariate Analysis Of Variance (MANOVA) was performed to measure the variance between the two groups. A significant difference was found between the CT and the direct coordinates (*p-value=0.022)*.

To directly assess the difference between digitized and CT coordinates of each individual cranium a Procrustes' superimposition, PCA, and Procrustes' ANOVA were performed using a geometric morphometrics software program. Average Procrustes' ANOVA results of the Procrustes' coordinates suggested that the CT and digitized coordinates of each individual were not significantly different in terms of shape (*p-value=0.578)*. Also, bilateral variables were insignificant (*p-value=0.340*). The greatest PCA-derived one principal component variation was found in bilateral landmarks (e.g., zygomaxillare), which illustrated some distortion occurring in the CT coordinates for bilateral landmarks. Overall, these results validated the utility of CT coordinates.

The results of this study showed significant differences between CT and digitized coordinates when used in large datasets. Most of the variation observed included landmarks along the midline between the two groups. In contrast, the individual analyses exhibited the largest variation among bilateral landmarks. The significant differences found for the entire dataset suggested that the combination of CT and digitized coordinates may not be appropriate for population variation studies. However, the individual results of this study supported the utility of CT coordinates for putative identifications.

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