A18 Re-Evaluating Skeletal Ancestry Traits Using Three-Dimensional Technology

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Learning Overview: After attending this presentation, attendees will better understand the use of Three-Dimensional (3D) technology to quantify morphological ancestry traits on the human skull.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating possible advancements in the field of forensic anthropology, more specifically the development of a new, more precise, and standardized method of ancestry assessment using modern-day technology. With regard to competence and performance, this method can contribute to making ancestry assessments less dependent on an anthropologist's experience with human variation and more accessible to younger forensic anthropologists.

According to the Royal Canadian Mounted Police (RCMP), women of Canadian Indigenous descent, previously referred to as Aboriginal, are at a higher risk of being victims of violence than other women in Canada.[1] As of 2015, 204 cases of missing and murdered Indigenous women remained unsolved, making it a major concern for Canadian Indigenous communities, who are still pressing for the identification of these women.[2] Forensic anthropology can contribute to the identification of victims by establishing a biological profile of the skeleton, including the evaluation of sex, ancestry, and age from human remains.[3] Ancestry assessment describes population affinity based on two criteria: morphological analyses, which examine size and shape of bone features, and metric analyses, which use skeletal measurements.[4] Morphological analyses are difficult to reproduce and standardize, as they strongly depend on subjective judgments by anthropologists, based on their experience with human variation.[5]

The purpose of this research was to improve the rigor of morphological analyses of ancestry by using 3D technology to quantify relevant features on the human skull. More specifically, circumference/perimeter, surface area, and proportion ratios were used to characterize the 3D outline of the orbits, the nasal cavity, and the palate. The sample was comprised of 24 Canadian Inuit, 50 European-American, and 13 African-American adult female crania, for a total sample size of 87 individuals. The samples were imaged using photogrammetry, the 3D models were constructed in 3DF Zephyr, and the shape analysis was performed in 3DS Max. The data were statistically analyzed using a non-Parametric Multivariate Analysis Of Variance (PERMANOVA), a Linear Discriminant Analysis (LDA), and a Principal Component Analysis (PCA). Results showed that individually, the 3D measurements were not very informative, since there was significant overlap between groups for the different traits evaluated. However, major differences between groups were clearest when 3D measurements were combined using multivariate statistics. Overall, European-Americans were statistically different from the other two groups, while Canadian Inuit and African American individuals were harder to distinguish statistically. The current method presented a classification rate of 87.36% (jackknifed: 80.46%) and an average repeatability of 97% when all measurements were combined. Nevertheless, this project had limitations and further research should evaluate the current method with a larger sample size, more populations, other ancestry-related cranial traits, such as the oval window, and other 3D measurements, such as volume.[6] Despite its limitations, this new and simple method of 3D shape analysis has potential and shows promise for the future of ancestry assessment via 3D imaging.

Reference(s):

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4. Cris E. Hughes, Chelsey A. Juarez, Taylor L. Hughes, Alison Galloway, Gillian Fowler, and Shirley Chacon. A Simulation for Exploring the Effects of the "Trait List" Method's Subjectivity on Consistency and Accuracy of Ancestry Estimations, *Journal of Forensic Science* 56, no. 5 (September 2011): 1094-1106.
5. Joseph H. Hefner. Cranial Nonmetric Variation and Estimating Ancestry. *Journal of Forensic Science* 54, no. 5 (September 2009): 985-995.
6. Tim D. White, Michael T. Black, and Pieter A. Folkens. *Human osteology, 3rd ed.* (Amsterdam: Elsevier Inc., Academic Press, 2012).

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