H42 Assessing the Efficacy of Basicranial Angle to Determine Ancestry

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After attending this presentation, attendees will understand the potential application of using cranial base angle to determine ancestry of unknown human skeletal remains.

This presentation will impact the forensic science community by providing a new method to aid in the identification of fragmentary skeletal remains.

A primary task of the forensic anthropologist is to construct a biological profile of unknown human skeletal remains. The skull is recognized as providing the highest accuracy for determining ancestry. However, portions of the skull that are most diagnostic, such as the face, may be damaged or missing, particularly when a skeleton is discovered in an outdoor context. In such situations, data used to construct the biological profile may be limited. The cranial base is centrally located in the head and protected by soft tissue which may prevent bony destruction. While the basicranium is a popular region for evolutionary studies, it has not been used as frequently as an identifying feature in forensic contexts. Holland achieved 70% – 90% correct classification of White and Black males and females utilizing multiple linear regression models.[1,2]

Wescott and Moore-Jansen later found the measurements used in that study have high interobserver error rates.[3] McKeown and Wescott attained 85% correct classification using geometric morphometric methods for determining ancestry utilizing cranial base landmarks.[4] The current study examines basicranial flexion in modern human populations to determine if it is a useful indicator of ancestral group affiliation.

A total of 196 males and females of European American and African American ancestry from the Hamann-Todd Human Osteological Collection and the Robert J. Terry Anatomical Skeletal Collection were utilized in this study to test the null hypothesis that there is no difference in mean basicranial angle between ancestral groups. Nasion-sella length, basion-sella height, and basion-nasion length were measured and then used to calculate the cranial base angle at sella using the Law of Cosines. Interobserver and intraobserver error tests were conducted to determine if the measurements are repeatable. Intraobserver error is equal to or less than 1.20mm for each measurement and interobserver error averaged less than 1.83mm for each measurement.

There is a statistically significant difference in mean basicranial angle between European Americans and African Americans (t=2.49, *p-value* <0.05). Analysis of covariance indicates that ancestry is the sole factor influencing basicranial angle while collection, sex, and age at death have no significant effect. Logistic regression analysis was employed to calculate the odds that an individual belongs to an ancestral group, producing the model *log(odds)=6.1233 + -0.0451*cranial base angle*. The probability that the angle is African American is given by the formula *P=1/(1 + e^log(odds))*. Individuals with a cranial base angle greater than 140.2° are more likely African American, whereas individuals with a cranial base angle less than 131.3° are more likely European American. Individuals with a cranial base angle between 131.4° and 140.1° cannot be classified with certainty greater than 0.55. A receiver operating characteristic curve analysis was performed to assess the sensitivity and specificity of the test at multiple levels. The probability that the ancestry classification for a randomly chosen positive case (African American) will exceed the result for a randomly chosen negative case (European American) is 0.617. Eighty-eight individuals could not be classified using the established cut-off rule. Of the remaining 108 individuals, 66% were correctly assigned to their ancestral category.

This study demonstrates that cranial base angle can be used to estimate ancestry of unknown skeletal remains. The current method only requires one to identify three cranial landmarks and record three measurements to calculate cranial base angle using sliding and spreading calipers. The calculated angle can be used to provide a probability that the specimen belongs to a particular ancestral group. The only difficulty in applying this method is accessing sella to measure anterior and posterior cranial base lengths. The vault must be absent if using sliding calipers or else a medical imaging modality must be used. Overall, this method is particularly useful for fragmentary remains to aid in the construction of the biological profile and should be used in conjunction with other metric and non-metric methods. It must be tested on an independent sample to further judge its classificatory power.

References:

1. Holland TD. Race determination of fragmentary crania by analysis of the cranial base. J Forensic Sci 1986a:31(2):719-25.
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3. Wescott DJ, Moore-Jansen PH. Metric variation in the occipital bone. J Forensic Sci 2001:46(5):1159-63.
4. McKeown AH, Wescott DJ. Sex and ancestry estimation from landmarks of the cranial base. *Proceedings of the American Academy of Forensic Sciences*; Seattle, WA., 2010;16:375.

Cranial Base, Ancestry, Identification

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