A62 Using Basicranial Landmarks to Estimate Ancestry in an American Sample

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After attending this presentation, attendees will appreciate the utility of cranial base landmarks in identifying human skeletal remains.

This presentation will impact the forensic science community by providing an alternate metric method for estimating ancestry from fragmentary crania.

The cranium is one of the most informative and widely used areas of the human skeleton in establishing the sex and ancestry of human remains. Standard methods of cranial morphometrics in forensic anthropology include the use of landmarks and features on the ectocranial surface of the vault and the face.[1] These methods largely require intact crania. In a forensic setting, the cranium is often damaged and the traditionally used landmarks are obscured or destroyed.[2] When fragmentary or unable to be reconstructed, the cranium is often not used for identification purposes in these cases.[3-5] As a result, potentially valuable information contained within the remaining unexamined portions of the cranium is discarded. For example, in the case of fatal fires, the cranium is often deemed unusable because the typically evaluated areas for anthropological analysis (vault, face, and mandible) are damaged or missing; however, the cranial base is protected by the neck musculature, and oftentimes presents with fragmentary remains. The cranial base is a relatively underused region of the cranium in forensic anthropological analysis and is only recently being rigorously evaluated for its utility in the prediction of ancestry and sex.[6-9] This project tests the hypothesis that there are differences in cranial base shape between American White and Black individuals by comparing cranial base landmark data with standard ectocranial landmark data.

A total of 73 landmarks of the endocranial and ectocranial surfaces were registered using a MicroScribe® G2X portable coordinate measuring machine from 245 adult crania in the Hamann-Todd Human Osteological Collection and the William M. Bass Donated Collection. Landmarks were divided into four subsets: endobasicranial (18 landmarks), ectobasicranial (18 landmarks), all basicranial (36 landmarks), and ectocranial (43 landmarks). The first three subsets include uncommon landmarks, while the ectocranial set includes landmarks commonly used in a FORDISC® analysis.[10] First, landmarks were subjected to a generalized Procrustes analysis to bring them to a common coordinate system. Second, a discriminant function analysis with cross-validation was performed to assess the efficacy of landmark subsets in accurately classifying the crania. Finally, sensitivity, specificity, negative predictive value, and positive predictive value were calculated to further assess individual model performance. All analyses were performed in MorphoJ v1.06d with α=0.05.[11]

All discriminant models exhibited statistically significant differences in mean landmark configuration between ancestral groups ($p < 0.001$). The ectocranial subset had the highest classification rate of 88.6%, followed by ectobasicranium (82.0%), basicranium (78.8%), and endobasicranium (77.9%). Overall, the models have higher specificity (range 83.9%-91.6%) than sensitivity (range 67.3%-83.3%) and are able to more accurately classify White individuals than Black individuals. Positive predictive values have a range of 71.6%-85.2% and negative predictive values have a range of 79.6%-90.4% with the ectocranial set performing best.

Overall, landmark configurations exhibit a longer and narrower base in the Black sample compared to the White sample. The most anterior cranial base landmark, the foramen cecum, is displaced posteriorly in White crania, and the internal occipital protuberance is displaced anteriorly, resulting in a shorter cranium in White compared to Black crania. The paired landmarks, including the stylomastoid foramen, endasterion, and jugular foramen, as well as the sigmoid sulcus point, which is the intersection between the posterior lip of the sigmoid sulcus and the occipitomastoid suture, all are more laterally displaced in White crania relative to Black.

These findings suggest that both midline and paired landmarks in the cranial base are useful in estimating ancestry, as corroborating evidence, or especially in cases in which the more commonly used areas of the cranium are not available for analysis. Although traditional ectocranial landmarks provide the highest classificatory rate, basicranial landmarks from the ectocranial and/or endocranial surfaces can be used to estimate ancestry and contribute to the construction of the biological profile. Forensic anthropologists should consider recording basicranial landmark coordinates when analyzing fragmentary cranial remains.

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