



A52 The Use of the Palate for Ancestry and Sex Estimation

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After attending this presentation, attendees will better understand the use of the palate in the estimation of ancestry and sex for adult individuals.

This presentation will impact the forensic science community by providing insight into a method for ancestry and sex estimation in adult individuals using metrics of the palate. In addition, this presentation demonstrates the need for further research into the use of palate shape and depth for sex and ancestry estimation.

The estimation of ancestry remains the most difficult parameter of the biological profile and, due to the changing demographic structure within the United States, ancestry estimation is becoming increasingly difficult. Until recently, utilization of the palate for ancestry estimation focused on non-metric traits of palate shape and the dentition itself. In 2015, Maier and colleagues developed three landmarks to measure palate depth and found significant ancestry and sex differences.¹ The goal of the present research is to metrically examine size and shape differences between four groups using Maier et al.'s palate landmarks: (1) Black Males (BM); Black Females (BF); (2) White Males (WM); and, (4) White Females (WF).

A total of 519 dentulous adult individuals of known ancestry, sex, and age were sampled from the Hamann-Todd Osteological Collection housed at the Cleveland Museum of Natural History: 259 Blacks (130 females and 129 males) and 260 Whites (130 females and 130 males). Using a digitizer, one new coordinate was collected, the midpoint between the Central Incisors (CI), as well as three additional coordinates in accordance with Maier et al.: (1) the most posterior aspect of the Incisive Foramen (IF); (2) the Intersection of the median and transverse palatine Sutures (IS); and, (3) the most posterior aspect of the Palate/Posterior (PP) nasal spine.¹ Interlandmark Distances (ILDs) were calculated and subjected to jackknifed Linear Discriminant Function Analysis (LDFA) to explore size differences and classification accuracy between ancestry/sex groups. Next, Geometric Morphometric Analyses (GMA) were conducted to explore shape differences. Classification accuracy was again assessed using LDFA and the Procrustes Coordinates (PCoords) generated from the GMA, as well as the Principal Components (PCs) from the principal component analysis.

Using LDFA of the ILDs, correct classification among the four groups was 50.5%. With the exception of BF-WF ($p=0.0106$) and BF-WM ($p=0.1528$), the Mahalanobis Distance (D^2) between the groups was significant at the $p<0.01$ level. Correct classification between the two ancestral groups (pooled sexes) was 62.8% and between the sexes (pooled ancestry) was 72.3%. Blacks were significantly larger ($p<0.05$) than Whites for three ILDs except IF-PP and CI-IF, which were not significantly different between ancestry groups, and IS-PP, which was larger in Whites. Males were significantly larger ($p<0.05$) than females for all ILDs except CI-IF and IS-PP, which were not significantly different between the sexes. Classification between the four groups using LDFA of the PCoords was 52.79%, slightly higher than, but similar to, the size analysis. LDFA classification between the two ancestral groups was 72.5% (pooled sexes) and between the sexes was 82.3% (pooled ancestry). The first six PCs explained 99.9% of the variance. Using LDFA and these six PCs produced 52.0% classification accuracy between the four ancestry/sex groups. Sex classification was 69.0% and ancestry classification was 62.2% using PCs one to six.



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The results of this study show statistically significant differences among the palate of the four reference groups. Classification accuracy for the four groups was highest with the shape analyses; however, the results from the size analysis were comparable. Classification by sex and ancestry independently was highest using LDFA of the Procrustes coordinates. The results from this study are similar to the Maier et al. study examining palate depth in which significant differences existed between Whites and Blacks and between males and females. The combination of size and shape analyses from this preliminary study with the measurement of palate depth, as conducted by Maier et al., has the potential to produce even higher classification accuracies.

Reference(s):

1. Maier C.A., Zhang K., Manhein M.H., Li X. Palate shape and depth: a shape-matching and machine learning method for estimating ancestry from human skeletal remains. *J Forensic Sci.* 2015;60(5):1129-1134.
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