



## Physical Anthropology Section - 2013

### H78 Molar Size and Shape in the Estimation of Biological Affinity: A Comparison of Relative Cusp Location Using Geometric Morphometrics and Interlandmark Distances

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After attending this presentation, attendees will have gained knowledge on the variation present in the size and shape of molars between ancestral groups. Furthermore, attendees will learn which cusp measurements can be used to accurately estimate ancestry.

This presentation will impact the forensic science community by contributing to the understanding of modern human variation in molar shape and size, which can, in turn, be used to aid in the estimation of ancestry in unidentified individuals encountered in forensic casework.

Dental morphology has long been utilized in anthropology as a means to examine biological affinity.<sup>1-3</sup> Dental variation has traditionally been recorded in accordance with the Arizona State University Dental Anthropology System (ASUDAS) scoring procedures in which morphological traits were scored either by presence or absence or by degree of expression on an ordinal scale.<sup>4</sup> Morris' work on occlusal polygons represented the first use of geometric techniques to analyze cusp location on molars for the estimation of biological affinity in modern human populations.<sup>5</sup> Occlusal polygons utilize the length, angles between cusp tips, and area of the molar crowns by using each cusp tip as a vertex. Occlusal polygons have continued to be utilized by Bailey and Bailey et al. as a means to investigate biological affinity, but occlusal polygons have also been analyzed using updated geometric morphometric approaches.<sup>6-11</sup> The purpose of this research was to analyze the variation present in the relative cusp location in two modern population groups and to assess whether this variation can be used to accurately discern ancestry.

Coordinate data were collected from the cusp tips of 216 adult upper and lower first and second molars. The sample consisted of 107 (F=52, M=55) American Blacks from the Hamann-Todd Osteological Collection at the Cleveland Museum of Natural History and of 109 dental casts from American Whites (F=60, M=49) housed at the University of Alaska Fairbanks, Department of Anthropology. Using a coordinate digitizer, the tip of the stylus was placed on the apex of each cusp tip. In the event of slight wearing, the stylus was placed at the center of the exposed dentine. Only the x and y coordinates were retained for the analyses because the differential degree of wear between specimens would introduce noise to the data along the z-axis. The coordinate data for each molar were analyzed individually through MorphoJ to perform a Generalized Procrustes Analysis (GPA) and calculate centroid size.<sup>12</sup> The GPA translated, scaled, and rotated each specimen to a common coordinate system so that each landmark's coordinates could be directly compared independent of size. The Procrustes coordinates were exported and analyzed using FORDISC 3.0 custom database feature to perform discriminant function analysis (DFA).<sup>13</sup> Lastly, interlandmark distances were calculated from the coordinate data and also analyzed through DFA. All DFA utilized leave-one-out cross-validation and forward stepwise selection of variables.

The results of the two-way DFA between Blacks and Whites using the Procrustes coordinates ranged from 70% – 85% total correct classification. Correct classification using Procrustes coordinates for Blacks ranged from 65% – 82% while correct classifications for Whites ranged from 74% – 87%. In each analysis, Whites classified correctly more frequently than Blacks. The analysis that yielded the highest classification accuracies was a combination of the first lower molar and the second upper molar (B=82%, W=87%; total correct=85%). The results of the DFA on the interlandmark distances ranged from 62% – 80% correct classification. The analysis that resulted in the highest correct classification of interlandmark distances utilized the upper first molar and both lower molars. Most of the interlandmark distances selected for discrimination between White and Black groups included the distal aspect of the tooth, frequently involving the hypocone, for the upper molars, and the hypoconulid for the lower molars.

The molars, especially when used in combination with one another, can accurately differentiate ancestral affiliation between American Whites and Blacks and can be used to estimate ancestry in unknown forensic cases with up to 80% correct classification. While the shape variables derived through the GPA yielded slightly higher correct classifications, interlandmark distances also showed promise as a means to determine biological affinity and can be more easily measured by using standard calipers.

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### **Molar Morphology, DFA, Ancestry Estimation**