## H10 Craniometric Concordance: 3D Surface Scanner and Digitizer Measurements

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After attending this presentation, attendees will better understand the level of agreement between human cranial measurements derived from 3D digitizer and 3D surface scanner techniques as well as the implications of using these differently derived measurements for sex and ancestry estimation.

This presentation will impact the forensic science community by providing information on which cranial measurements demonstrate the greatest variability between the two techniques, focusing specifically on measurements used for sex and ancestry estimation in FORDISC® 3.1. Additionally, the practical effects of measurement differences on discriminant function analyses will be examined in regard to the validity of sex and ancestry estimations in forensic cases.

Forensic anthropologists have historically relied upon caliper measurements and, more recently, 3D digitizer measurements taken from the cranium to estimate the sex and ancestry of unknown skeletal remains. Recent advances in technology have provided practitioners with new resources for collecting data from human crania. For example, 3D surface scanners have become an important tool because of their ability to create virtual models of human crania that can be archived. From these three-dimensional models, morphological features can easily be extracted and analyzed using engineering and morphometric software. Interlandmark distances can also be easily obtained and are assumed to be comparable to traditional osteometric measurements. Although previous studies have been conducted to assess the accuracy of 3D surface scans and the ability of researchers to locate traditional osteometric landmarks, sample sizes have been limited and none have attempted to analyze the differences between digitized and virtual measurements from a multivariate perspective for classification purposes.

This study analyzed 15 cranial measurements on a pooled sample of human crania (n=70), representing approximately equal numbers of 19$^{th}$- and 20$^{th}$ -century U.S. Black and White males and females from the Robert J. Terry Anatomical Skeletal Collection. Osteometric landmark coordinates were collected from each cranium using a MicroScribe® 3D digitizer. A NextEngine® desktop 3D laser scanner was used to collect 3D surface scans from the same crania. Cranial measurements were then calculated from the surface scans using Geomagic Studio 12. Notably, the initial digitization occurred many years before scanning and virtual measurement, and all three activities were conducted by three different individuals. The digitized and scan measurements from the 70 crania were then treated as paired data sets and univariately and multivariately compared to assess the level of agreement between the measurements derived from each method.

Paired *t*-tests detected significant differences ($p<0.05$) between the means of the 3D scanner and 3D digitizer measurements for ten of the fifteen cranial measurements. The mean differences ranged from 0.01 to 1.26mm and the standard deviation of the differences ranged between 0.85 and 3.05mm. The coefficient of variation for differences in each measurement ranged from 0.71 to 6.47. Bias was not consistently positive or negative throughout the fifteen measurements; measurements taken from the 3D surface scans resulted in positive bias for seven measurements and negative bias for the remaining eight. The samples were also subjected to discriminant function analysis in FORDISC® 3.1 to classify using measurement technique.[1] Using forward mean stepwise selection, the highest total correct classification rate obtained was 67.4%. When the two samples were analyzed against a third group of 70 crania (20$^{th}$-century Black males in the Forensic Data Bank), the Mahalanobis distances for all group comparisons were significant ($p<0.01$), except when comparing the 3D digitizer and 3D scanner groups ($p=0.031$). This indicates an inability to truly separate the samples based on measurement differences, suggesting that the two methods are comparable.

This research suggests that while caution should always be exercised when attempting to combine data obtained from these two techniques, measurement differences may be less significant than previously thought and the use of both methods may be applicable in forensic contexts.

**Reference:**

1. Jantz RL, Ousley SD. FORDISC® 3.1: Computerized forensic discriminant functions (computer program). Version 3.1. Knoxville, TN: University of Tennessee, 2010.

**Cranial Measurements, Digitizer, Surface Scanner**

 ** Presenting Author*