



F17 Similarities of the Human Dentition in an Open Population Using Two-Dimensional Geometric Morphometric Analysis

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The goal of this presentation is to analyze a large dataset of human dentitions using 2-D geometric morphometric analysis.

This presentation will impact the forensic science community by demonstrating the similarity of the human dentition with respect to bite mark analysis.

In February 2009, The National Academy of Sciences released the report *Strengthening Forensic Sciences in the United States: A Path Forward*. This report provided critical comments on the collection, analysis, and application of forensic data in all the forensic disciplines. With respect to the field of forensic odontology, the NAS outlined several inherent problems with bite mark analysis, one of which includes the notion of uniqueness of the human dentition, an integral component of the field.

The premise for bite mark analysis is based on the belief that in an open population every person's tooth arrangement, arch shape and size is unique. The subsequent premise is that based on metric analysis of the bite mark, a dentition can be matched to the injury. Very few scientific studies have attempted to address the issue of individuality of the dentition. Those that did either used a flawed statistical approach or had very small datasets. In this limited literature, authors have tended to arrive at conclusions that support their hypotheses rather than examine their own data, which contrary to their claims, actually supports dental similarity rather than uniqueness.

In this study a more appropriate question is asked by addressing similarities between dentitions of individuals in an open population.

In a joint effort between the SUNYAB School of Dental Medicine's Laboratory of Forensic Odontology Research and the Suffolk County Medical Examiners Forensic Odontology Department, an examination of the similarities between tooth arrangement and intercanine arch size was conducted. The study was based on data from a 2D geometric morphometric analysis utilizing landmark placement of coordinates on digitized images of dental exemplars. Dental models were collected from the SUNY dental clinic and from the practices of participating odontologists from Suffolk County. Models were scanned on a flatbed scanner and digital images were acquired at 300dpi resolution. Landmarks were placed using the tpsDIG set of freeware, and data analysis was performed using the IMP statistical freeware package. Landmarks in this study were placed on the mesial/distal endpoints of the six anterior teeth for both upper and lower dentitions. In addition, landmarks were placed on the central point of each canine, delineating intercanine width. A pilot study was conducted to determine if there was any measurable sexual dimorphism. It was concluded that the correlation was only slightly better than chance, and that therefore, males and females could be combined in the dataset.

Internal controls were added to the dataset that consisted of additional images of the same patient's dentition. These controls illustrated the ability of the statistical analysis to successfully determine a match.

Repeated measurement error was calculated and expressed as a Procrustes distance value, essentially representing the resolution of measurement. This value was then used as a baseline for match rate calculation. A Poisson distribution was noted in Procrustes distance when the datasets were analyzed. This indicated that as measurement resolution was reduced, match rate of dentition dramatically increased. The practical implication of this is that as the dentition is impressed in the skin and distortion occurs thus reducing resolution of measurement, large percentages of dental configurations in an open population may appear to have caused the same bite mark.

Superposition of the extracted landmarks showed that the human dentition occupies a well-defined shape-space. One of the prominent conclusions arising from this study was that as the database size increased, the shape-space became more densely populated, rather than spreading out. This again illustrates the similarity of the human dentition

After this presentation attendees will see the possibility of more than one dentition having a similar dental profile. The results of the study will impact the forensic community by providing a statistical quantification of the similarities of the human dentition and therefore aid in the resolution of some of the "problems" mentioned in the NAS Report findings.

Bite Marks, Dentition, 2-D Analysis