F18 Description of the Human Dentition Using Three-Dimensional Landmarks: An Investigation of Similarity and Match Rates

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The goal of this presentation is to describe the principle shape variables of the human anterior dentition in three-dimensions (3D).

This presentation will impact the forensic science community by illustrating the similarities and match rate for the human dentition from three-dimensional laser scanned models.

The basis of bite mark analysis incorporates two core premises: (1) The human dentition is unique; and (2) The uniqueness transfers to the skin. Recent research, with regards to skin distortion, has suggested that the first premise should be re-stated.

When taking the affect of the skin into play, the more pertinent question to ask may be, *what is the probability of finding a dentition in the general population similar enough that the two cannot be distinguished once impressed in the skin?*

In order to adequately and correctly address this issue, the description of uniqueness must reflect loss of resolution that occurs once the dentition is impressed in the skin. This loss of resolution, with transference of teeth to skin, results in an increased probability of more than one possible dental match. This is due to the inherent qualities of the tissue resulting in a range of distortional effects. The visco-elastic, anisotropic, non-linear nature of skin contributes to the distortion seen in a bite mark. Therefore, the more logical question centers on the limits of discrimination between similar dentitions; in other words, how similar the human dentition is, given constraints of the impression medium. Consideration of similarity of dentitions, coupled with loss of resolution due to skin distortion, may lead to establishment of boundaries of confidence levels expressed in bite mark analysis.

One well established means used to describe and delineate between biological forms is geometric morphometric analysis. Geometric morphometric methods allow for a quantitative analysis of shape by capturing the geometry of morphological structures of interest and preserving this information through statistical analysis. One of the important contributions of this technique is the clear definition of size and shape.

Advances in digital imaging have facilitated the use of landmark placement as coordinates. These coordinates can then be analyzed to describe size and shape of the object in question. The software allows placement of landmark points that are used to delineate dental features including intercanine widths, mesial-distal lengths, rotations, and in 3D, curves, and surfaces.

Landmark placement essentially delineates “dentition space”, or possible configurations of human bite pattern. Given this framework, it can be determined: (1) How big is the bite-space; (2) How much of it is actually occupied by human individuals. As humans are a single species, it is rational to assume that dental dimensions would fit in a finite boundary as determined by the species; (3) Configurations of the human dentition; and (4) Probability of match-rate. Thus a pilot study was conducted on 3D digital dental models to investigate these hypotheses.

All necessary Human Subject Institutional Review Board (HSIRB) protocols were completed for this project and exemption has been granted. Permission has been obtained from a dental company, which manufactures orthodontic appliances and occlusal guards, to copy and utilize 3D laser scanned digital dental model images (resolution of 10 *um*) of patient dentitions. All patient identifying information was stripped from the file. The 3D datasets were collected for use in CAD/CAM fabrication of occlusal guards (night guards, etc.), thus the data represents a wide population of age, gender, race and socio- economic status. The scans were NOT part of orthodontic therapy. The mal-alignment patterns ranged from relatively straight to severely mal- aligned. 500 upper and 500 lower models were obtained.

The datasets were analyzed in 3D, using geometric morphometric software. With the landmark placement software, the dentition can be rotated freely in 3D space and enlarged as needed for accurate placement of landmarks. Inter and intra operator error was determined after an appropriate wash out period.

Curves were placed which delineated the incisal edges of the six anterior teeth in both uppers and lowers. Each curve contains 10 landmark data points on each incisal edge. A total of 60 data points were obtained for each arch.

Following landmark data point extraction, statistical analysis was completed to describe the configuration of the human dentition and to determine match rates in the population studied.

The data presented will allow the forensic community to understand the similarity of a dentition to the general population. **Forensic Odontology, Bite Mark Research, Dentition Similarity**

 ** Presenting Author*