F7 Three-Dimensional Analysis and Comparison of Human Anterior Teeth and Experimentally Created Bite Mark Depressions

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The objectives of this presentation are to: (1) describe a method of digitizing three dimensional contours of human anterior teeth from dental casts (models) and the depressions in leather experimentally created by those teeth, (2) describe the development and use of specialized software to accomplish metric and pattern analysis when comparing the two sets of data, and (3) discuss the statistical analysis of the comparisons generated by the software.

This presentation will impact the forensic community by creating a method of comparing bite mark depressions to dental casts in three- dimensions instead of the more common two-dimensional methods.

Hypothesis: The MicroScribe 3D Digitizer facilitates the recording of accurate three-dimensional data information from both teeth and the marks made with those teeth biting into an analogue of human skin. The data recorded from dental casts and the depressions created in the skin analogue can be analyzed and processed to create three-dimensional dental profiles for the anterior teeth of that person and for the depressions in the skin analogue. The two sets of data can be critically compared by special software that facilitates metric and pattern analysis.

Background: Johnson et al at Marquette University have proposed a system to scan dental models to record two-dimensional and three- dimensional features seen in the anterior teeth. This information can theoretically be used to create a database of dental profiles.

Tooth depressions in human skin occur at bite infliction and remain for varying periods of time when the person bitten is living. In the living the marks may fade, disappear altogether, or become raised in an inflammatory response. In deceased individuals the tooth indentations in skin may remain until decomposition.

In the cases where the depressions made by teeth remain, a model of the bite mark impression can be very useful for analysis. The resulting model shows the curvature of the surface bitten, that may not be apparent in two-dimensional photographs. Dorion (2005) stated that the process of creating a 2D image from a 3D object leads to loss of information.

Materials and Methods: Dental casts mounted on Hanau articulators were randomly selected from a New Mexico population of individuals between the ages of 20 and 50 years. Cowhide leather with a single layer thickness of approximately 0.5cm was doubled to simulate the folding of skin caught between upper and lower teeth in some bite marks scenarios. The leather was wetted by soaking in water and pressure was applied using the Reynolds Controlled Bite Force Generator (RCBFG), a device. The Reid Bite Reader (RBR) was used to measure the bite forces generated and to calibrate the RCBFG setting required to consistently apply forces that created the teeth impressions into the leather.

Using the Immersion MicroScribe 3D Model G2X Digitizer, information from both the bite mark depressions and the dental casts was transferred to a computer using auto scan properties. The auto scan was set to capture points at 0.5mm intervals. A systematic method for digitizing from the first pre-molar to the opposite first pre-molar was developed.

A sample of 50 bite mark impressions and 50 sets of dental casts were digitized. The patterned injury tooth depression datasets were entered as the unknowns and the dental cast datasets as the knowns by the use of unique numbers into the database.

The developed software performed a 3D comparison using metric and pattern analysis. Selected XYZ axis points recorded for each individual tooth and each tooth depression in the bitten substrate were analyzed. The analysis images were rotated into various orientations for viewing and to facilitate analysis. The software compared any individual point with another individual point and varying combination of points. A threshold setting was applied in the software to allow the display of all of the points, the most prominent points, and various intermediate settings.

The software generated a report quantifying the statistical similarity of the selected points. Indices of similarity were developed to indicate the likelihood that tooth depression data and dental cast data are the result of a cause-effect event. The dental data from the various models was also compared to generate an index of similarity between different data sets of teeth. This last feature may be used to augment, support, or critically examine research into the uniqueness of the anterior human dentition.

Results: The features of the incisal and occlusal surfaces from the dental casts were transferred to the wet leather. The MicroScribe 3D Digitizer is capable of recording accurate three-dimensional information from both depressions created by teeth and the teeth that may have created those depressions.

Blind testing with the bite mark and dental cast databases eliminates some forms of expectation bias which is very important in evidence based studies. The specificity and sensitivity was determined by statistical

analysis and were expressed in a ROC curve.

The new software facilitated precise metric and pattern analyses that were valid for comparing two sets of data. To evaluate the reliability of the software developed for this pilot study, larger sample tests and clinical trials must be performed.

Forensic Odontology, Bite Mark, Three-Dimensional Analysis