G17 Validation of an Algorithm to Mathematically Describe Bitemarks

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After attending this presentation, attendees will better understand the basic principles of defining a dentition mathematically.

This presentation will impact the forensic science community by beginning the process of scientifically validating bitemark analysis.

Recently, bitemark analysis has been criticized for lacking a scientific basis. The individuality of a specific bitemark has at times been questioned. This has led to doubt regarding the accuracy of attributing a bitemark wound to a specific biter's teeth. Research has been undertaken to determine how unique a dental pattern is and whether this uniqueness can be measured.

An algorithm for mathematically describing bitemarks has been detailed in the forensic dental literature.[1] The method involves analyzing an image of a dentition to locate the centroids of the biting surfaces of the teeth of interest. Wikipedia defines a "centroid" as "the geometric center of a plane figure." It is the arithmetic mean, or average, position of all the points in the shape. Once the centroids have been established, the centroids are connected with lines (or vectors). A vector is a quantity having direction as well as magnitude, especially as in determining the position of one point in space relative to another. Finally, the angles between consecutive pairs of vectors are calculated and recorded. An angle in planar geometry is defined as the figure formed by two rays (vectors), called the sides of the angle, sharing a common endpoint, called the vertex of the angle. Angles formed by two vectors lie in a plane. When eight teeth are studied, eight centroids will be found. The centroids will be connected by seven vectors, which will describe six angles.

A computer program, Bite2020, was been written in C# (Microsoft C Sharp). The software is based on a centroids-vectors-angles algorithm. The program does the work of finding the centroids of the teeth of interest, then calculates the vectors and angles. The resulting mathematical description is saved in a Microsoft® Excel® file. It is envisioned that the program will be used by forensic odontologists as a routine part of their bitemark case workup. The program has been developed to be intuitive, self-instructive, and easy to use.

Once a dentition has been mathematically described and recorded, the results can be compared to a database of previously recorded dentitions. This will allow the forensic odontologist to assess how unique the dentition of interest is when compared to the realm of heretofore analyzed dentitions.

It is anticipated that a repository of bitemark metrics will be maintained by either the American Board of Forensic Odontology (ABFO), the American Society of Forensic Odontology (ASFO), or another forensic organization.

The purpose of this presentation is to begin the process of validating the ability of the algorithm to accurately identify, analyze, and record mathematical descriptions of bitemarks. The validation process for the purpose of this presentation has been divided into three parts. First, the ability of the algorithm to correctly find, calculate, and record the centroids of a number of standard geometric shapes will be compared to expected values. Second, the ability of one investigator to reproduce the same values when analyzing the same dentitions at different sessions will be evaluated. This measurement is known as repeatability or test-retest reliability. It is used to assess the consistency of a measure from one time to another. The third part will assess the ability of different investigators to reproduce similar values when analyzing the same dentitions. In statistics, this measurement is known as inter-rater reliability or inter-rater agreement, or concordance, and is the metric or degree of agreement among raters and is used to assess the degree to which different raters/observers provide consistent estimates of the same phenomenon.

This algorithm shows promise in formulating a scientific basis for the art of bitemark analysis.

Reference(s):

1. McGivney J. and Barsley R. A Method for Mathematically Documenting Bitemarks. *Journal of Forensic Sciences*. Vol. 44, No. 1, 1999, pp. 185-186.

Algorithm, Bitemark, Mathematics

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