

Bite-Marks: Understanding the role of general practitioners in forensic identification

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Abstract:

Bite marks are patterns produced by human or animal dentitions and associated structures in any substance capable of being marked by those means. A bite mark is a pattern made by teeth in a substrate. Bite marks can range from a minor superficial abrasion to a sub-surface haemorrhage or even bruising of the skin. One of the primary aims of forensic dental identification is to identify people based on teeth morphology and their subtle variation. Generally, dental evidence may be used in the identification of individuals (both dead and alive), by comparing their dental status with ante and post-mortem records and also in identifying criminals using bite marks as an adjuvant to DNA analysis. The American Board of Forensic Odontology has set standard guidelines for collection and interpretation of bite marks. These guidelines help in increasing the scientific validity of evidence in a somewhat controversial field. The review examines the underpinning approach and scientific method for bite mark identification. It is targeted towards increasing the understanding and the ability of local practitioners to support forensic dental investigators in their work. Courts have always placed emphasis on a scientific approach when presenting expert evidence. The scientific approach is a “system” and its development must be carefully observed, recorded and analysed such that predictions may be made systematically based on the observations. Similarly, in forensic dental identification, especially when analysing bite marks, forensic odontologists must apply scientific methods to the analysis of a bite mark in a systematic manner to provide courts with testable evidence.

Keywords: Bite marks, Forensic identification, Odontology

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Introduction:

One of the most common aims of forensic dentistry is the identification of people. Much of this relies on the subtle differences in tooth anatomy and the variation of tooth features, including the historical dental care provided (1). In the recent years, it is far more widely used in forensic identification. The key lies in the utilization of dental radiographs, photographs and a detailed history of previous dental treatment for the purpose (4). For example a technique developed by Chen and Jain employs image registration methods on extracted teeth to register their contours and compare it with the radiograph to ascertain if there is a match between the two (5,6). The primary aim of this review is to briefly examine the basic concepts associated with bite marks and their analysis. It also deals with the American Board of Forensic Odontology guidelines and Daubert guidelines both of which give a basis of validity in the courts of law. The purpose of this review is to give the general clinician, awareness of the process of bite mark identification so they can provide support to the forensic dental investigator.

History

Forensic odontology came out the fore in the early 1960's in the United States. It was not until the 1970's with the establishment of odontology section of the American Academy of Forensic Sciences when a more concerted effort to apply rigour was founded. The main aim of the society was to unite forensic odontologists as a group and help create an avenue for exchange of ideas. However there were (prior to the 1970's) cases in court where forensic odontology played a role in judgements

Scientific base

Broadly speaking, bite marks can range from a minor superficial abrasion to a sub-surface haemorrhage or even bruising of the skin (1). The pattern of a bite mark on skin is mainly affected by the force applied and the length of time of the bite. In addition to these, other factors like mechanical and physiological factors also play a role in how a bite mark appears. Bite marks in humans are most commonly made up of a superficial abrasion with or without a haemorrhage and appears like an arch. In vast majority of cases, canines are the key tooth in producing bite marks. Incisors contribute to lesser extent to bite mark formation and in rare occasions premolars may also contribute (13). Any extra marks may be seen in bite marks caused by people wearing

dentures, crowns and bridges and may be used as added information when analysing a bite mark. In few cases, bite marks have been obtained from chocolates, chewing gum, fruits and vegetables.

The results of a study conducted by Pretty and Sweet in 2000 (13) involving 148 human bite marks showed that 33% of the marks were found on the breast, 19% on the arm, 8% on the genitalia, 7% on the back, 6% on both the face and the thigh, 5% on legs and hands, 4% of them on the neck, 3% of them on the shoulders, and 2% of them on both the abdomen and the buttocks (1). The positioning of the remaining 13% was not stated.

Bite mark evidence is widely accepted in the legal system, but the underpinning scientific validity is at times challenged. The area of bite mark identification remains one of the most controversial aspects of forensic identification. Bite marks and their analysis is founded on two basic presumptions, the first being that every individual has a unique dentition when compared to others, and the second being the uniqueness is invariably registered on either animate surfaces like skin or surfaces (like fruits or chocolates) (3). These assumptions have led to bite marks being accepted in courts of law around the world as expert evidence; however, a lack of science behind the assumptions has resulted in the methodology being unyielding (7-10). In order to overcome this controversy, to increase the quality of the investigation and also the standards of the conclusion the American Board of Forensic Odontology (ABFO) defined specific guidelines that are almost universally used in the analysis of bite marks. It also developed terminologies that expressed different aspects of bite marks and could also be used to express the findings (11). ABFO has been the first to standardise guidelines for those who collect and interpret bite marks and these guidelines help achieve standardised results (12). The guidelines break up bite marks analysis into a series of steps; description of bite marks, collection of bite marks both from the victim and also from the suspect and the final analysis of the obtained evidence (13). The analysis also relies on demographic variation in tooth morphology so recording basic details such as the age, sex, and ethnicity are important baseline information. The recording of the basic bite mark features such as location of the bite mark, size, shape and the colour are vital initial steps in the process. The subtle details of the bite mark such as distinguishing

between a laceration, an abrasion, a contusion, an incision, an avulsion or an artefact based on the severity of the injury are important follow-up steps (13). During the collection of evidence from a victim, ABFO define the responsibility of the examiner to include if the suspected bite mark has been in any way affected, either due to contamination, decomposition, or simple things such as change of position or even washing the injury (13). Bite marks must always be documented in such a way that they may be used as reference when needed. Photographic methods have superseded other techniques (eg impressions) as a result of their improved accuracy. Photographic techniques have been outlined by ABFO and these may be used to record bite marks in detail (13). Saliva must be swabbed from the wound and tissue samples (eg DNA) can be obtained. Impressions based on standards set by ABFO must be made such that any three dimensional characteristics present are recorded accurately. It acts as an adjuvant to photographic techniques where details are recorded only in two dimensions. Materials and methods used for this purpose must be recorded accurately by the analyst (13).

In many cases (after appropriate court orders) the analyst may collect evidence from the suspect. Any form of dental history prior to the bite mark is an essential recorded detail. Photographs of the suspect, both the front and the profile should be obtained (13) along with an intra-oral and an extra-oral examination. Where possible, two sets of impressions for study casts, and a comprehensive dental chart of the suspect should be made (13).

The ideal recommended bite mark analysis technique is to compare any similarities (and differences) between the photograph of the bite mark and the suspect's dentition using a digitised model of the bite mark and the suspect's dentition, both at the same scale. A scoring guide developed by ABFO is recommended to evaluate the comparison and come to a conclusion. ABFO has also outlined terms used in bite mark analysis and these have been explained in Table 1.

Acceptance of expert evidence

Courts always place emphasis on a scientifically validated approach when presenting expert evidence or testimony. Courts require expert evidence in cases where the expert by definition knows far more than the court on a particular topic or subject. Daubert guidelines provided a standard

set of recommendations to follow in providing expert evidence (30). Daubert guidelines are a trilogy of Supreme Court cases as well as revisions of the Federal Rules of Evidence which represents efforts of American Law to filter expert evidence presented in court. Daubert rules clearly stated that the admissibility of scientific evidence mainly depends on its evidentiary reliability. Courts must consider whether scientific basis has been tested by trial and error, the methodological firmness of those tests, and the results of that testing (30).

Daubert Guidelines

A technique must be tried and tested before it is used as evidence in the court of law, the technique in question has to be peer reviewed, well researched and published. Error rates if any have to be calculated, and finally, the technique must be generally accepted as conclusive among experts in a similar field. Daubert reads that if a lawyer understands evidence and can determine a fact in an issue based on his scientific or technical knowledge, then they may testify in the form of an opinion. It may also be based on whether the testimony is based on facts or data, or if the testimony is a result of reliable methods and principles and/or whether the witness has applied all the principles and methods reliably to the case (30). Daubert requires judges to assess research findings, methods, evidence to support the principles used to extrapolate from research. The primary principle of Daubert is that it changed the focus from Frye's deference to the experts, to a more active judicial evaluation of a particular field's claims of expertise (30). Judges did not have to understand the research methodology involved because it was sufficient to ask for the conclusions of professionals in the respective fields. However, Daubert dictates that judges need to question which methods support the scientific opinions presented as testimony by experts, and this requires that they understand those methods and data. Daubert described that the primary responsibility of trial courts is to assess whether expert testimony is relevant and whether its basis is reliable (30).

Other important considerations

The examiner should be a qualified experienced forensic dental investigator and where possible certified by the ABFO. The process of bite mark identification must follow the ABFO guidelines, and be supported by relevant peer review studies. The examiner should also be clear on both

the matching and discrepancy features to provide a balanced reasoned analysis. It is only against this

backdrop of scientific rigour that bite mark evidence should be admitted (13).

Table 1. Forensically Important terms relating to Bite Marks

Terms	Description
Class characteristic	A feature, trait, or pattern that distinguishes a bitemark from other patterned injuries (e.g. the finding of four approximating linear or rectangular contusions) is a class characteristic of human incisors. Their dimensions vary in size depending upon what inflicted the injury (maxillary or mandibular) and whether primary or permanent teeth. The overall size of the injury will vary depending on the contributor's arch dimension. Thus, a bitemark class characteristic identifies the group from which it originates; human, animal, fish, or other species.(Forensic dentistry online)
Individual characteristic	Individual characteristic is a feature, a trait, or a pattern that represents an individual variation, rather than an expected finding, within a defined group. These are of two types which are explained below:
Arch characteristic	Arch characteristic is a pattern that represents tooth arrangement within a bitemark (e.g. a combination of rotated teeth, buccal or lingual version, mesio-distal drifting, and horizontal alignment) that contribute to differentiation between individuals. The number, specificity, and accurate reproduction of these arch characteristics contribute to the overall assessment in determining the degree of confidence that a particular suspect made the bitemark (e.g. rotation, buccal or lingual version, mesial or distal drifting, and horizontal alignment).(Forensic dentistry online)
Dental characteristic	Dental characteristics are features or traits within a bitemark that represent individual tooth variation. The number, specificity, and accurate reproduction of these dental characteristics (in combination with the arch characteristics) contribute to the overall assessment in determining the degree of confidence that a particular suspect made the bitemark (e.g., unusual wear pattern, notching, angulations, and fracture).
Distinctive characteristics	This term is variably defined as either rare or unusual. It can be explained as a variation from normal, unusual, infrequent and not one of a kind but serves to differentiate from most others. It can also be defined as one that is highly specific, individualized having a lesser degree of specificity than unique.

(Cited from Pretty IA 2006)

Table 2 : Severity of Bite Marks and their Forensic significance

Nomenclature	Features relating to different types of bite injuries	Forensic Significance
Very Mild Bruising	No individual tooth marks present, diffuse arches visible, may be caused by something other than teeth.	Low Forensic Significance
Obvious Bruising	Discrete areas associated with teeth but the skin remains intact.	Moderate Forensic Significance
Very Obvious Bruising	Small lacerations associated with teeth on the most severe aspects of the injury, likely to be assessed as definite bite mark.	High Forensic Significance
Laceration	Several areas of laceration, with some bruising, some areas of the wound may be incised, which is unlikely to be confused with any other injury mechanism.	High Forensic Significance
Partial Avulsion	Few lacerations present indicating teeth as the probable cause of the injury.	Moderate Forensic Significance
Complete Avulsion	Possible scalloping of the injury margins suggested that teeth may have been responsible for the injury. May not be a bite injury.	Low Forensic Significance

Forensic Dentistry Online [Internet] Bite mark guidelines [Cited 2009 October 10]

Conclusion

Analysing and comparing bite marks is basically made of two presumptions. The first one being that any human dentition has characteristic shape, size, and pattern, and any individualistic features within the particular arch (could be a broken tooth, or a developmental anomaly, or even a simple mal-eruption) (12) and the second one is that skin records these features with greater resolution such that it is adequate to be used in the identification, inclusion or exclusion of a suspect as a perpetrator. To come to conclusions, a reasoned scientific, validated approach is an essential starting point. The application of this validated approach in a rigorous structured way is the next step. There has been a degree of disbelief regarding the cogency of skin

bite mark analysis by expert witnesses. The dramatic increase in skin bite marks cases being heard by courts has resulted in great demand of research into this aspect of forensic dental investigations (31). Bite marks is one of the tools of identification in forensic odontology. The possibility of errors or mismatching makes this important tool less reliable (32).

The scientific approach is a “system” and its development must be carefully observed, recorded and analysed such that predictions may be made systematically based on the observations. Similarly, in forensic dental identification, especially when analysing bite marks, forensic odontologists must apply scientific methods to the analysis of a bite

mark in a systematic manner to provide courts with testable evidence.

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