

Bite marks - A brief review

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ABSTRACT

Bite marks is usually referred to as a representative pattern left in an object or tissue by the dental structures of an animal or human. Analysis of bite mark and their characteristics plays an important role in identification in forensic cases. Analysis of bite mark is a long process and time-consuming work because each bite produces individual aspects and each bite is different from one another. The quality of certain bite mark is poor, so every single quantifiable aspect is the most important. Bite mark is observed primarily in sexual assault cases, criminal cases, homicides, and child abuse cases. This review describes the classification and characteristics in the analysis of bite mark.

KEY WORDS: Bite mark, Characteristics, Forensic dentistry

INTRODUCTION

Forensic odontology is a branch of forensic medicine that in the interest of justice deals with dental evidence presented in the courts of law. The oldest method of investigation based on forensic science was bite marks. A bite mark is a form of patterned injury, which is the physical result of a biting action applied to skin or other material such as food or other inanimate substrates. Biting is used by human being as both offence and defense. A forensic odontologist collects, documents, evaluates, and compares the bite mark evidence. Bite marks are considered as valuable alternative to fingerprinting and DNA identification in forensic examination. Bite marks may be found virtually on any part of the human body, common sites being the face, neck, arm, hand, finger, shoulder, nose, ear, breast, legs, buttocks, waist, and female genitals. In sexual assaults, the face, lips, breasts, shoulder, neck, thigh, genitals, and testicles are most involved. To identify the offender, the dental casts of suspected persons are prepared using dental materials and matched. Bite marks if analyzed properly can prove the involvement of a particular person or persons in a particular crime.^[1]

CLASSIFICATION OF BITE MARKS

Bite marks can be broadly classified as:

1. Non-human (animal bite marks) and
2. Human bite marks.

Based on manner of causation, the bite marks can be classified as:

1. Non-criminal as well as
2. Criminal

Which can be further be classified into:

- a. Offensive and
- b. Defensive bite mark.

The following classes that are of proven significance in practical application regarding bite marks are as follows:

- Class I: It includes diffused bite marks, which is having limited class characteristics and lacks individual characteristics, for example, bruise, diffused bite mark, a smoking ring, or a faint bite mark.
- Class II: This pattern of injury referred to as a single arch bite or the partial bite mark as it has some individual and some class characteristics.
- Class III: This classification incorporates both individual and additionally class characteristics. This bite has extraordinary evidentiary value and

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utilized generally for the comparison purposes. The main sites for this type of bite on the body are buttocks, shoulders, an upper arm, or the chest. The pressure and deep penetration of tissue are held to record the lingual surface of anterior teeth.

- Class IV: Mainly, avulsion or laceration of the tissues is caused by the bite. In this class, class characteristics and individual characteristics are not present. This type of bite is commonly found where there is avulsion of an ear or finger.^[2]

Cameron's Classification

1. The agents that produced the mark
2. The materials and substances that have exhibited the marks.

McDonald's Classification

1. Tooth pressure marks: By incisal edges of anterior teeth - stable with minimal distortion
2. Tongue pressure marks: Tongue pressure on palatal surfaces of the teeth, cingulae, or palatal rugae causes distortion of marks
3. Tooth scrape marks: Caused due to irregularities in teeth due to fractures, restorations, etc.
4. Complex marks: Combination of above marks.

Webster's Classification

1. Type I: Bites in chocolate which fracture easily with limited depth of penetration. Most prominent are incisal edges of the upper and lower anterior teeth
2. Type II: Good grip of material obtained by teeth piece is fractured from main material, for example, Apple; the outline of labial aspect of upper and lower incisors is recorded
3. Type III: Bite mark produced by biting through cheese. Here, an advantage is that it indicates a relative position of the upper and lower incisors in centric occlusion.

CHARACTERISTICS OF BITE MARKS

A human bite will often be elliptical or circular in formation and will display the specific characteristics of the teeth that have been used to make the mark. Likewise, a bite mark can be U-molded in appearance with a space in between to indicate where the biter has opened their mouth to a width necessary to get their teeth around a wrist or an arm. The mistreatment of teeth also has a large part to play in the identification of bite marks. Missing teeth, fractures, or malformed teeth all bear their own special characteristics and these show when a bite mark is examined.^[3]

Class Characteristics

Each type of tooth in the human dentition has class characteristics (tooth class characteristics) that differentiate one tooth type from the others. Class

characteristic is a feature, pattern, or trait which reflects a given group and is not related to a particular individual. It refers to the measurable features and shapes that help to differentiate an adult and child human bite mark. At times, they help to distinguish human bite mark from an animal or non-dental mark and also to identify the various teeth present in the pattern.

Thus, the two mandibular central incisors and the two mandibular lateral incisors are almost uniform in width, while the mandibular cuspids are cone shaped.^[4] The bite mark characteristics help in determining if the marks were from maxillary teeth or the mandibular teeth. As indicated by the bite mark characteristics, the maxillary central incisors and lateral incisors make rectangular marks, of which the centrals are wider than the laterals and the maxillary cuspids produce round or oval marks. The mandibular central incisors and lateral incisors also produce rectangular marks, but these are almost equal in width, whereas the mandibular cuspids produce round or oval marks.^[5]

The characteristics of individual teeth are as follows:

- Incisors: Rectangular shaped mark, sometimes with perforations at the incisal angle areas
- Canines: Triangular markings with apex toward labial and base toward lingual
- Premolars: Single or dual triangle with bases of triangles facing each other or coming together as diamond shapes
- Molars: Rarely leave bite marks, usually quadrilateral markings.

Individual Characteristics

Dental features are specific to an individual tooth and make one tooth different from another. The teeth of different individuals differ from one another with respect to their size, position in the dental arches, and shape. Individual differences might be shaped by different physical and chemical wounds influencing the teeth over the years such as attrition, abrasion, and erosion. The teeth might be influenced through caries due to poor oral hygiene, and there might be restorations of the carious teeth. The teeth are subjected to different abuse, for example, sports injuries, chemical injuries, biologic attacks, motor vehicle accidents, work environment accidents, and caries. After such damages have taken place, the teeth often need a restoration. These restorations or the injury itself produces distinctive and unique features within a tooth.^[1]

FACTORS AFFECTING BITE MARKS IN SKIN

The size and shape of bite mark are influenced by its location on the body because certain areas of the body

bend more, thereby distorting the surface area of the skin due to difference in viscoelasticity.

Some marks are made through clothing. Hence, clothing is considered a potential source of bite mark impressions and biological evidence from transferred saliva.

Loose skin/subcutaneous fat lead to a poor bite mark, whereas areas of fibrous tissue or high muscle content bruise less easily and demonstrate good bite mark. Infants, the elderly, and females tend to bruise more easily.^[6]

VARIATIONS AFFECTING BITE MARKS

Structure and vascularity of tissue injured: Bruising in loose and highly vascular tissues is more pronounced.

Children and the elderly: Bruise more easily due to loose, delicate skin in former, and loss of subcutaneous tissue in latter.

Victim's health status hypertension, coagulation disorders, and liver dysfunction may affect the extent of bruising.

Medications: Aspirin increases bleeding; steroids alters dispersion rate of bruising.

Mass and velocity of impact: Influences depth and surface of injury and rate of healing.

EVIDENCE COLLECTION

Demographics

Name, age, sex, race, case number, date of examination, and name of the examiners should be recorded.

Location of the Bite Mark

Describe the anatomic location, indicate the contour of the surface (flat, curved, or irregular), and state of the tissue characters, underlying tissue-bone, cartilage, muscle, or fat.

Shape of the Bite Marks

Whether it is round, ovoid, crescent, or irregular in shape.

Color and Size of the Mark

Both vertical and horizontal dimensions should be recorded in the metric system.

Type of Injury

Due to bite, different types of injuries may occur such as petechial haemorrhages, contusion, abrasion, laceration, incision, avulsion, artifact, etc. The type of injury should be recorded.

Evidence Collection from Victim

Documentation

A record of the bite mark, including the descriptive and narrative notes, is recorded. The documents contain the physical appearance, color, size, and characteristics of the bite mark.

Photograph

The photograph is taken from different angles. Photographs are taken from a distance to show the relationship of the bite mark with the rest of the body and close-up photograph is also taken for bite mark measurement. All images are taken in both black-and-white and color.

Various photography techniques include:

- Visible light photography
 - Digital photography
- Non-visible photography
 - UV photography
 - Infrared photography.

Swabs

Saliva which has been left behind after biting should be collected. A double swab technique can be used. First, cotton dampened with distilled water is wiped over the mark. Next, use a dry swab to collect the rest moisture present on the mark. Both the swabs are dried for 4–5 min before comparing.

Impressions

A proper impression should be taken with impression materials or polyether which is used in dental clinics. A plaster model can be made and used as a rigid support for impression materials.

Evidence Collection from Bite Suspect

Clinical examination

An overall examination of the oral cavity is done and documented. Specific findings such as fracture, pocketing, and missing tooth are noted.

Impressions

An accurate impression of the entire tooth is recorded with all features. It is recommended to make two molds using dental die stone and hard stone.

Bite sample

A sample of the suspect's bite is recorded with either baseplate wax or putty impression. The sample is preserved and a photograph of the sample is documented.

ANALYSIS OF BITE MARK

The exact identification of a living person using individual traits and characteristics of the teeth

and jaws is the basis of forensic science.^[7] The bite marks left on a person may be used to identify the perpetrator. Bite mark identification is based on the individuality of a dentition, which is used to match a bite mark to a suspected person. One can exactly match the bite marks to the accused biter's dentition.^[8] The most important step in bite mark analysis is to recognize a patterned injury as a human bite mark followed by pattern analysis of the bite mark which provides the individual information about the suspect or an offender and relates the person who is involved in the crime.

Bite marks with high evidence value that can be used in comparisons with the suspects' teeth will include marks from specific teeth that record different characters. The surface abrasion or subsurface hemorrhage caused by human bites appears as an arch. They are caused by the incisors, canines, and premolars. Contusions are the most common type of bite mark. It can be determined from the type of bleeding under the skin whether the victim was alive or dead at the time the bite mark was delivered.^[9,10]

It is important to have individual characteristics in the bite mark to identify the perpetrator. Use, misuse, and abuse of the teeth result in features that are referred to as accidental or individual traits. If individual traits are not present in the teeth in the bite marks, the forensic significance of the bite mark is reduced.^[9]

Bite marks are never viewed accidental, although some injuries caused by teeth (e.g., a child accidentally strikes his/her parent in the mouth leaving tooth marks on the hand) may be.

The American Board of Forensic Odontology provides a range of conclusions to describe whether or not an injury is a bite mark. These are as follows:

- a. Exclusion - the injury is not a bite mark.
- b. Possible bite mark - an injury showing a pattern that may or may not be caused by teeth could be caused by other factors, but biting cannot be ruled out.
- c. Probable bite mark - the pattern strongly suggests or supports origin from teeth but could conceivably be caused by something else.
- d. Definite bite mark - there is no reasonable doubt that teeth created the pattern.^[11]

PATTERN ANALYSIS IN BITE MARKS

It is the assessment of the bite pattern that often serves to be most revealing.

Comparison techniques for bite mark analysis can be classified as direct and indirect methods. They use life-size 1:1 photographs and models of teeth.

In the direct method, model from the suspect can be directly placed over the photograph of the bite mark to demonstrate concordant points. Videotape can be used to show slippage of teeth producing distorted images and to study the dynamics of the bite marks.

Indirect method involves preparation of transparent overlay of occlusal or incisal surfaces of teeth which are then placed over the scaled 1:1 photographs of the bite injuries, and a comparison is undertaken. If overlay analyses are restricted to those bite marks displaying unique characteristics, the process in the hands of an experienced odontologist can be highly accurate.

There are five main methods of bite mark overlay production:

- Computer based
- Two types of radiographs
- Xerographic and
- Hand-traced.

For many years, hand-traced overlays were the method of choice. According to Sweet and Bowers, computer-generated overlays were by far the most accurate in terms of both tooth area and rotation. Results demonstrated that both the main techniques were reliable, and the choice of method was down to personal preference.

Odontometric triangle method: In this objective method, a triangle is made on the tracing of bite marks and teeth models by marking three points, two on the outermost convex points of canines and one in the center of the upper central incisors. Three angles of the triangles are measured and compared.

Other special methods in bite mark analysis are as follows:

- Vectron - is used to measure distance between fixed points and angles.
- Stereometric graphic analysis - this can be used to produce contour map of the suspect's dentition.
- Experimental marks - may be produced on pig skin, Baker's Bough, or rubber for analysis.
- Scanning electron microscopic analysis of bite mark wounds.
- Image perception technology.

However, while the overlay production method has been shown to be reliable, the application of these to the bite mark photographs and the assessment of degree of match have not much scientific support.

Again, a range of conclusions is available to odontologists to describe the results of a bite mark comparison:

- Excluded - discrepancies in bite marks and suspect's dentition.

- Inconclusive - insufficient forensic detail or evidence to draw any conclusion on the link between the two.
- Possible bite mark - An injury showing a pattern that may or may not be caused by teeth could be caused by other factors but biting cannot be ruled out.
- Probable bite mark - The pattern strongly suggests or supports origin from teeth but could conceivably be caused by something else.
- Reasonable medical certainty - suspect is identified for all practical and reasonable purposes by the bite mark.

Human anterior teeth are unique and this asserted uniqueness is replicated on the bitten substrate in sufficient detail to enable a match to a single individual to the exclusion of all others. While many cases have bite marks with good unique details, in majority, it is not, and therefore, caution should be taken while assessing any bite mark injury using pattern analysis.^[11]

Bite Marks and DNA

With the advent of the DNA sequencing in 1977, followed by the development of polymerase chain reaction in 1983, DNA technology has an outstanding position in forensic sciences. Saliva deposited during biting has DNA present which can be an important alternative hub in bite mark analysis. DNA from the cellular material present in the biter's saliva can be differentiated from the DNA of the victim's skin. It has been reported that this evidence is stable on intact skin for at least 60 h following deposition. Walsh *et al.* did the first separation of DNA from saliva and saliva-stained materials in 1992.^[12]

While the recovery of DNA from saliva has been reported, it is not always assured. It has been proposed that the presence of nucleic acid-degrading enzymes (nucleases) within saliva can rapidly degrade DNA, especially if it is on a living victim, as the skin's ambient temperature accelerates the process. The human mouth contains over 500 distinct species of bacteria, and every individual will have a slightly different combination, dependent on, for example, oral hygiene status, dental status and the presence or absence of a prosthesis. Therefore, One research group has suggested that the genotypic identification of oral streptococci may be of use in bitemark analyses.

Therefore, it appears that the technique is a valuable addition to forensic dentistry although its use will be limited by the access to the expertise and equipment to undertake it.^[11]

CONCLUSION

Bite mark is an important and plays a major role in forensic dentistry which solves a lot of crime and also in identification of persons in criminal activities. The bite mark identification is a potentially valued aspect in forensic dentistry. The field of forensic dentistry is expanding, and the need for individuals trained in the recognition, collection, and analysis of this type of evidence is increasing day by day.

AUTHORS' CONTRIBUTIONS

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