BITE MARKS: AN INSIGHT TO FORENSIC DENTISTRY

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ABSTRACT

Human bite mark analysis is by far the most demanding and complicated part of Forensic Dentistry. In some criminal trials, bite mark evidence has been the only evidence on which a conviction or acquittal has been achieved. It is thus important that forensic experts should consider the possibility of human bites while examining surface trauma in certain cases, particularly, alleged rape and child abuse cases. Although bite marks of an individual do have uniqueness due to specific characteristics and arrangement of the teeth, when it comes to bite mark analysis, it is complicated by numerous factors, being presented as a challenge to the Forensic Odontologists. The present paper describes the classification, characteristics, comparison techniques, analysis and technical aids used in the analysis of the bite marks.

KEY WORDS

Bite Mark, Crime, Evidence, Forensic, Odontologist, Teeth.

INTRODUCTION

"The criminal may lie through his teeth though the teeth themselves cannot lie"- Furness.(1) Bite marks analysis is based on the principle that 'no two mouths are alike'. They are thus, considered as valuable alternative to fingerprinting and DNA identification in forensic examinations. The term 'bite mark' is used in forensic field knowing that the marks are the result of the tooth impression in different materials. So in the literature bite mark is mostly used as description. The state of the dentition, the degree of breakdown and/or repair of the teeth may create a bite mark with a high level of individuality.(2) A bite mark is a mark created by teeth either alone or in the combination with other oral structures.(3) In other words, a bite mark may be defined as a mark having occurred as a result of either a physical alteration in a medium caused by the contact of teeth, or a representative pattern left in an object or tissue by the dental structures of an animal or human.(4) It is a vital area within the highly specialized field of forensic science and constitutes the commonest form of dental evidence presented in criminal court.(5) 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.(6) In cases of sexual assault, face, lips, breasts, shoulder, neck, thigh, genitals

Table: 1- Cameron and SIMS Classification

1. Agents:	a) Human b) Animal
2. Materials:	a) Skin, body tissue b) Food stuff c) Other materials

Table: 2- Mac Donald's classification

a) Tooth Pressure Marks	Marks produced on tissues as a result of direct application of pressure by teeth. These are generally produced by the incisal or occlusal surfaces of teeth
b) Tongue Pressure Marks	When sufficient amount of tissue is taken into mouth, the tongue presses it against rigid areas.
c) Tooth Scrape Marks	These are caused due to scraping of teeth across the bitten material. They are usually caused by anterior teeth and present as scratches or superficial abrasions.

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Table: 3- According To Degree of Impression

a) Clearly Defined	Significant Pressure
b) Obviously Defined	First Degree Pressure
c) Quite Noticeable	Violent Pressure
d) Lacerated	Skin Violently Torn From Body.12

Table: 4 - Based on the Manner of Causation

Non-Criminal	Such As Love Bites
Criminal	First Degree Pressure
Offensive	Upon Victim Byassailant
Defensive	Upon Assailant By Victim

and testicles are mostly involved. (7) These are encountered in a

Table: 5 - Based on the severity of the injury, there are seven types of bite marks

1. Haemorrhage	A Small Bleeding Spot
2. Abrasion	Undamaging Mark On Skin
3. Contusion	Ruptured Blood Vessels, Bruise
4. Laceration	Near puncture Of Skin
5. Incision	Neat Punctured Or Torn Skin
6. Avulsion	Removal Of Skin
7. Artefact	Bitten-Off Piece Of Body

number of crimes especially in homicides, quarrels, abduction, child abuse cases, sexual assaults, during sports events and sometimes intentionally inflicted to falsely frame someone. While bite marks on the body are intentionally caused, those found on food articles are usually unnoticeably left by the offenders at the scene of crime. Bite marks if analysed properly can be used to link a suspect to a crime. Bite mark analysis can elucidate the kind of violence and the elapsed time between its production and examination.(8)

Class characteristics

According to the Manual of American Board of Forensic Odontology (ABFO) 14, a class characteristic is a feature, characteristic, or pattern that distinguishes a bite mark from other patterned injuries. It helps to identify the group from which the bite mark originates. While evaluating the bite marks, the first step is to confirm the presence of class characteristics. The 'tooth

Table: 6- Based on the pattern

Class I	It includes diffused bite marks, which is having limited class characteristics and lacks individual characteristics. Such as 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 pattern of bite has great evidentiary value and used mostly for the comparison purposes. The main sites for this type of bite on the body are buttocks, shoulder, an upper arm or the chest. The pressure and deep penetration of tissue is held to record the lingual surface of anterior teeth.
Class IV	Mainly, avulsion or laceration of the tissues is caused by the bite.

class characteristics' and the 'bite mark characteristics' are the two types of class characteristics.(15)

In a bite mark, the front teeth which include the central incisors, lateral incisors and the cuspids are the primary biting teeth according to tooth class characteristics.(16) Each type of tooth in the human dentition has class characteristics (tooth class characteristics) that differentiate one tooth type from the others. Thus, the two mandibular central incisors and the two mandibular lateral incisors are almost uniform in width, while the mandibular cuspids are cone shaped.(17)

According to 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.(18)

Individual characteristics

Individual characteristics are deviations from the standard class characteristics. They are the specific features found within the class characteristics which can be a feature, a trait or a pattern that represents an individual variation rather than an expected finding.14 Dental patterns, features, or traits may be seen in some individuals and not in others such as rotation, buccal or lingual version, and mesial or distal drifting of teeth etc. Dental characteristic is specific to an individual tooth and makes one tooth different from the other.(19) The teeth of different individuals differ from one another with respect to their size, their position in the dental arches and in their shape (Figure 1). Individual differences may be formed by various physical and chemical injuries affecting the teeth over the years like attrition, abrasion, erosion, the teeth may be affected by caries due to poor

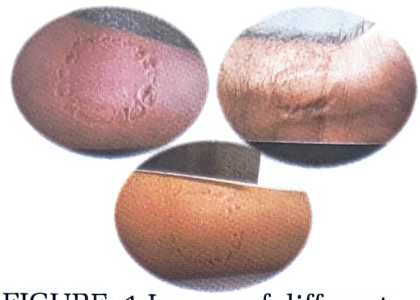
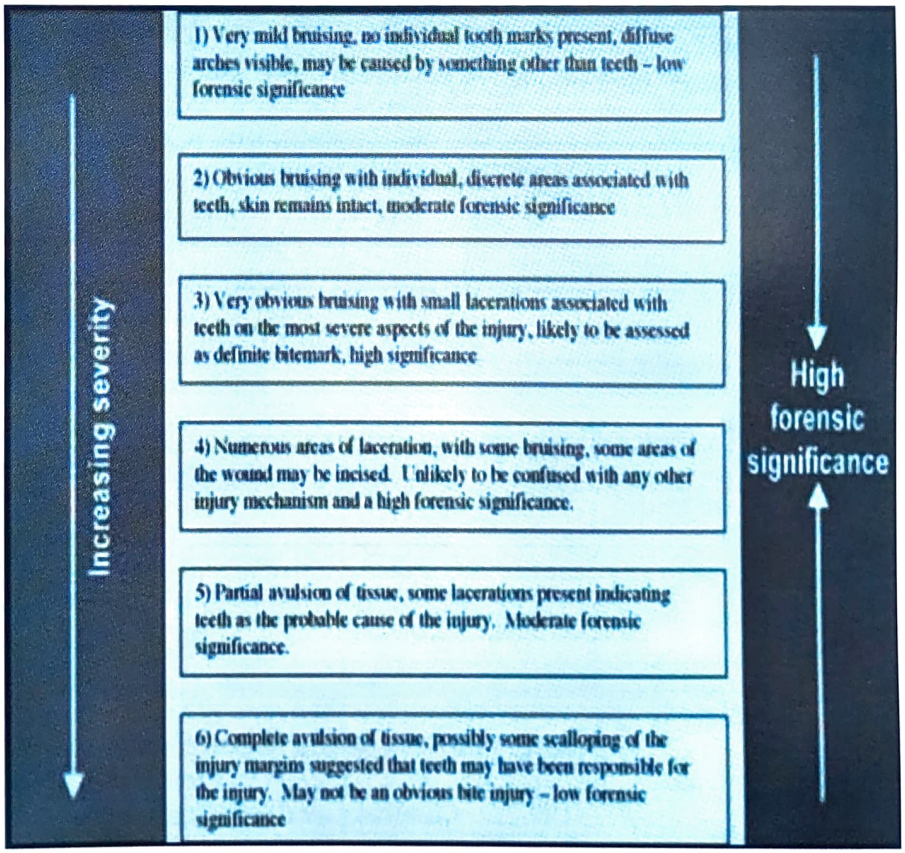


FIGURE: 1 Images of different bite marks on skin

Shape of Dental Arch	Broad U- shaped; circular or oval	Narrow anterior aspect, V – shaped & elongated.
Injury pattern	Commonly bruising; laceration and avulsion less common	Severe laceration and avulsion; greater skin damage
Site	Breast, abdomen, nipple, thigh, back, shoulder	Extremities such as feet, legs, hands, arms, exposed skin



Bite Marks Severity And Significance Scale. 15 (figure: 2)

oral hygiene, and there may be restorations of the carious teeth and These restorations or the injury itself produces distinctive and unique features within a tooth.(20)

Individual characteristics of bite marks may be affected by the type, number and peculiarities of the teeth, occlusion, muscle function, individual tooth movement and TMJ (Temporomandibular joint) dysfunction in the perpetrator.(21)

Bite Mark Analysis, Comparison and Evaluation:

The first stage of analysis is to determine if the injury is a bite mark, and then to provide a statement on the forensic significance.17 While evaluating the bite mark firstly the cause of the mark has to be determined, since bite marks may be caused by nonhumans or humans.22 (Table:7)

GUIDELINES FOR THE ANALYSIS OF BITE MARKS

To standardize the analysis of bite marks **The American Board of Forensic Odontostomatology (ABFO)** established the following guidelines in **1986**:(23)

1) History - Obtain history of any dental treatment subsequent to, or in proximity to, the date of the bite mark.

2) Photography- Extra-oral photographs including full face and profile views, intraoral should include frontal views, two lateral views and an occlusal view of each arch. Often it's useful to include a photograph of maximal mouth opening. If inanimate materials, such as food stuffs, are used for test bites the results should be preserved photographically. Place a scale beside the bite mark and make a note of distance at which photograph was taken. UV light photographs can see the damage deeper into the tissue and can capture the spacing, size and shape of teeth. A blood group determination is possible in bite marks in human tissue as well as in food stuffs on account of saliva left in bite mark.

3) Extra-oral examination- It includes observation and recording of soft and hard tissue factor that may influence biting dynamics. Measurements of maximal opening and any deviations on opening or closing should be made. The presence of facial scars or evidence of surgery should be noted, as well as the presence of facial hair.

4) Intra-oral examination - Salivary swabs should be taken. The tongue should be examined to assess size and function. The periodontal status should be noted with particular reference to mobility. Prepare a dental chart if possible.

5) Impressions - Take two impressions of each arch using material that meet the American Dental Association specifications. The occlusal relationship should be recorded.

6) Sample bites - Whenever possible, sample bites should be made into an appropriate material, simulating the type of bite under study.

7) Study casts - Casts should be prepared using Type II stone according to manufacturer's specifications, using accepted dental techniques. Additional casts should be made by duplicating the master casts. These casts can be made from a variety of materials like silicon rubber, plastic and powders. Subjects, made a bite on a sample of bite registration wax sheet Bites are made with an incisive action to get impression of the incisal edges and a portion of the labial and lingual surfaces of upper and lower incisors and

Table: 7- Difference between human and non human bite marks

Characteristic features	Human	Non human (Carnivore)
Size, shape and arrangement of teeth:	Incisor teeth producerectangular marks whereas canine teeth produce triangular marks in the cross-section.	Puncture the skin and the cross-sectional size of the tooth is small and circular.
Size of Dental Arch:	Width of adult arches from canine to canine is 2.5-4cm. Children arches are smaller than the adults	Number of incisor teeth and the distance between individual teeth may be greater with animal bites. Dogs And Cats arches are smaller than children.

canines. Subjects are told to bite on apple or to bite on their own flexor surface of forearm. Impressions of upper and lower arch are taken and plaster cast made. Only central incisors and canine are preserved and the rest are trimmed. In case of a deceased person, the bite mark be excised for further forensic bite mark analysis or the whole body may be taken to a facility where it can be examined. Each model and bite marks on bite registration wax, apple and skin is photographed with scale besides using SLR camera with extension tube for close up photography. Each photograph is enlarged keeping the scale so as to get life size photography while printing. 1:1 photography is done for bite marks and teeth model.

Then the comparison of bite marks and teeth model is done by two methods

Odontometric triangle method (Objective) and Superimposition method. (Subjective)

In Odontometeric triangle method (Objective method) - a triangle is made on the tracing of bite marks and teeth models by making three points- A,B,C. Points A & B are plotted on the outermost convex point on the canine teeth. Center of upper two central incisors is selected as point C. And all the three points are joined to form a triangle ABC. Lines AB, BC, CA are measured and angles a, b, c were calculated. This was done for both upper and lower jaw. Of teeth model and compared with that of bite marks of wax, apple and skin statistical analysis is carried out and results are obtained.(24)

The grading for **Superimposition Method (Subjective)** given are:

Grade A Fully superimposition

Grade B Partially superimposition

Grade C No superimposition

Bite marks and DNA- Use of DNA in bite marks was pioneered in an effort to eliminate the subjectivity associated with conventional analyses.(21) 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 readily degrade DNA, especially if it is on a living victim, as the skin's ambient temperature accelerates the process.(25) As human mouth contains over 500 distinct species of bacteria, and every individual will have a slight different combination, dependent on oral hygiene status, dental status and presence or absence of prosthesis. One research group has suggested that the genotypic identification of oral streptococci may be of use in bite mark analysis.(22) 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.(26)

Pattern analysis in bite marks

It is the assessment of the bite pattern that often serves to be most revealing.27 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 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 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.(22)

Other special methods in bite mark analysis:26

- **Vectron–** used to measure distance between fixed points and angles.
- **Stereo metric 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 dough or rubber for analysis.
- **Scanning Electron Microscopic** analysis of bite mark wounds
- **Image perception technology**

Conclusions in Bite Mark Analysis

Bite marks are never considered accidental. The American Board of Forensic Odontology provides

a range of conclusions to describe whether or not an injury is a bite mark. These are:

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.(28)

Difficulties in bite mark analysis:

Accuracy of the bite imprint: The impression may not be accurate due to irregularity of the bitten areas on the human skin and the poor quality of the material and time duration between infliction of the bite mark and creation of the model.

Permanency: The dentition is capable of major changes in configuration, with and without professional intervention. Various restorative materials can change the character of the bitten surfaces or actual position of the individual's teeth. Disease process e.g. caries or periodontal diseases can change the configuration.

Uniqueness: Singular nature of an individual dentition is often assumed, but it has not been definitely established.(24)

Applications of Bite marks

Violent crimes: Such marks may be encountered where the attacker may bite the victim or the victim biting the attacker during defensive responses. In the aggressive type, the teeth are used as a weapon and the bite is said to be forceful and rapid. In sexual bites, the teeth are used to grip during sucking, and the bite is said to be forceful and slow.

Child abuse cases: The bite marks may be present in any area of the body. The common sites are the arms, hands, cheeks, buttocks, trunk and shoulders.

Sporting events: Here the bite marks are produced when the victim manages to bite the assailant during any type of sports or games.

Self inflicted bite marks: Mostly found on the forearms of the children caused by themselves. Self inflicted bite marks are also seen in Lesch Nyhan Syndrome, an X - linked recessively transmitted disease with insensitivity to pain.

At the site of crime : In some cases, the criminals happen to have their teeth marks on the substance left at the scene. Such bite marks may be encountered on inanimate objects like food stuffs or fruits etc.(17)

CONCLUSION

Bite mark analysis is an important aspect of forensic dentistry that is invaluable in solving crimes and in identification of persons involved in criminal activities. The science of bite mark identification is quite new and potentially valuable. Bite marks if analysed properly not only can prove the participation of a particular person or persons in crime but also help in exoneration of the innocent. The field of bite mark science is continuing to develop, and so is the need for those who are trained and experienced in the identification with regard to the cases relating to the bite marks.

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