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Bite Marks: A Forensic Odontological Evidence

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Abstract:

Forensic Odontology is the branch of applied science that deals with the proper handling, examination and evaluation of dental evidence which is used in the court of law. It plays a vital role in the identification of a person when other methods cannot be used such as in case of decomposed body or in case of mass destruction. Bite marks are found in offensive cases like sexual assault or in cases involving biting for self-defense. Bite marks should be photographed as soon as possible to prevent loss of evidence due to healing process of skin in case of living victim or decomposition in case of dead body or deformation in case of bite mark present on food, its casting should also be made for further comparison as it possesses fine details of the impression. Forensic odontologist plays a major role in the process of identification of the person utilizing different comparison techniques such as odontometric triangle method, image perception software method and special methods such as Vectron Method, Stereometric Graphic Analysis, Scanning Electron Microscopic analysis.

Key Words: *Bite Marks, Odontology, Identification, Analysis*

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Introduction

Keiser-Neilson in 1970 defined forensic odontology or forensic dentistry as "that branch of forensic medicine which in the interest of justice, deals with the proper handling and examination of dental evidence and also with proper evaluation and presentation of the dental findings" **(Priyadharsini *et al.*, 2015)**. Mac Donald in defined a bitemark as "a mark caused by teeth either alone or in combination with other mouth parts" **(Mac Donald, 1979)**.

Location of the Bite Marks: Bite marks can be found on food or human body or inanimate objects such as bottle cap, cigarette bud, cigar, pipes, etc. Generally, bite marks are found in crimes related to sexual or physical assault or in cases related to fights. Bite marks can be associated with offensive crimes such as homicides, sexual assaults, or child abuse cases and can be produced as a result of self-defense or they can be self-inflicted too for example in case of epileptic fits **(Gorea *et al.*, 2005)**.

The role of a forensic odontologist is to collect, preserve, evaluate, and interpret the bite mark evidence. By preparing dental evidence Forensic Odontologist assists legal authorities in different situations such as:

- Management and maintenance of dental records that include all the unique dental information: Dental identification is based on the foundation of these data.
- Identification of human remains by comparing antemortem and post mortem dental information: This data is useful in cases that involve the death of an individual or multiple death in mass disaster cases.
- Collection and analysis of bite marks on inanimate objects or injured tissue: This evidence is used to identify whether the bite mark was inflicted by a human or an animal.
- Recognition of the signs and symptoms of human abuse and the rights and responsibilities of the dental healthcare practitioner when reporting such abuse.
- Presentation of dental evidence as an expert witness in identification, bite mark, human abuse, malpractice, fraud, and personal injury cases in the court of law.
- Ascertainment of the age of the individual.
- Determination of the sex of the individual **(Neville, 113-119)**.

Classifications of Bite Marks: Mac Donald gave an etiological classification of bite marks:

a. Tooth pressure marks are caused by the incisal edge of anterior teeth.

b. Tongue pressure marks seen as the impression of the palatal surface.

c. Tooth scrapes marks may be scratches and abrasions that can indicate irregularities in the teeth such as incisal fractures, attrition, and restorations.

d. Complex marks are a combination of all the above which are sometimes complicated by multiple bites.

Gustafson also gave a clinical classification of bite marks:

a. Sadistic or sexual bite is well defined as it is usually made slowly.

b. Aggressive bite is caused by impressing across the tissue and is made quickly.

c. Most aggressive bite results in the tissue being bitten off usually involve ears, nose, and nipples **(Gorea *et al.*, 2005)**.

Forensic Importance of Bite Marks

Using a class and individual characteristics it is possible to identify a particular type of teeth. Class characteristics include rectangular marks produced by incisors, triangular or rectangular canines, amount of attrition, spherical or point-shaped premolars and molars whereas individual characteristics include fractures, spacing, alignment, fillings, false tooth, etc. **(Gupta *et al.*, 2014)**

Forensic Aspect of Bite Mark Analysis:

1. When bite marks are left in the food.

2. When bite marks are found on the criminal: in case of self-defense.

3. When bite marks are found on the victim: in case of sexual or physical assault and homicide **(Verma *et al.*, 2013)**.

Bite marks left on food at the scene of crime offers vital information about the perpetrator as they offer a three-dimensional impression of the suspect's dentition. The forensic value of these types of bite marks depends on the nature of the substrate which possesses the bite mark and its ability to dehydrate and deform at room temperature, the quality of the suspect's dental impression on food, and the time interval between collecting and preserving the evidence. Food deforms with time so the life size photographs of the impression should be taken as it serves as the permanent record of the bite mark evidence. The process of comparing bite marks of an individual with the one present on the food involves the analysis of size, shape, and spatial orientation of the individual tooth **(Pazhani *et al.*, 2015)**.

Bite marks of humans can be distinguished from that of animals by studying different aspects of the bite mark. In the case of animals, the dental arch is narrower than that of humans. Animal teeth are sharper and the indentations formed by them are smaller and deeper whereas in the case of humans, the dental arch is more U-shaped and broader and the indentations are broader, shallower, and blunter **(Gladfelter, 35)**.

The physical characteristics of bite marks that make a bite mark unique are:

- Shape of dental arch,
- Distance between canines,
- Alignment of teeth,
- Spacing between teeth,
- Rotation of teeth,
- Missing teeth,
- Wear patterns **(Pazhani *et al.*, 2015)**.

There are a variety of variables that affects the bite marks:

1. Structure and vascularity of tissue injured: Bruising in loose and highly vascular tissue is more pronounced.
2. Children and elderly: they are likely to bruise more easily due to loose and delicate skin in children and loss of subcutaneous tissue in elders.
3. Victim's health status: diseases like hypertension, coagulation disorders, liver dysfunction, may affect the extent of bruising.
4. Medications: aspirin increases the bleeding whereas steroids alter the dispersion rate of the bruising.
5. Mass and velocity of impact: they influence the depth and surface of injury and the rate of healing **(Rao *et al.*, 2016)**.

Methods

Methodology is followed by the description of bite marks including the demographics, location, color, surface, shape, and size of the bite mark.

1. A saliva smear is taken by using a cotton swab and taking the saliva from the indented bite mark.
2. Photographs in colored and black & white must be taken from all different angles, with different light filters such as infrared photography. A millimeter ruler should be placed beside or under the mark to give a record of the size.
3. Cast should be made in the laboratory with the impressions taken.

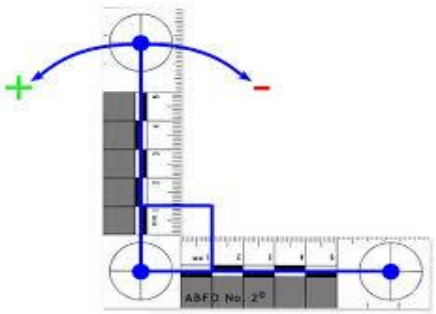

Figure 1- ABFO Scale 2 (Ferrucci *et al.*, 2015)

Recording of Bite Marks

While recording the bite mark on a living or deceased person there is some information that should be collected:

A. Demographics such as age, name, and gender of the patient, as well as the case number.

B. Location of bite marks must be noted.

C. Shape of the bite mark - Round, oval, crescent, irregular must be noted.

D. Color of the skin around the bite marks.

E. Size of the bite mark both horizontally and vertically should be recorded.

F. Type of injury - contusion, abrasion, laceration, or petechiae.

G. Complete nature and pattern of the bite mark.

Recording of bite marks in the case of the deceased must be done before the removal of dead body from the crime scene as bruises and impressions have the tendency to disappear very quickly, whereas in the case of living body bruises and impressions changes over the period of days and impression pass off. Bite marks in foodstuff distort due the moisture and temperature.

Collection of Bite Marks

Saliva should be collected using cotton swabs from the bitten areas, as human beings secrete ABO antigens through saliva. Stains of saliva can be collected for DNA analysis and act as trace evidence. The sample should be stored in a frozen state.

Photography

- **Visible Photography**

Digital photography must be done to avoid any errors, ABFO number 2 scale should be used to record the size of marks. Photographs should be taken in every angle such as close-ups as well as overall body shots, also with or without the flash.

- **Infrared Photography**

This type of photography is used on injured tissues or crushed objects, as the IR technique uses light resorption properties in areas of bruising. It also captures the bleeding pattern below the skin of the bite mark.

- **Ultraviolet Photography**

UV photography helps to enhance the details of bite mark injury present on the skin and appears healed in visible light.

- **Casting**

Alginate, silicones, paris, dental stone, and others are materials used for casting making. Full arch impressions of the bite mark are made. There is another method known as '3D Scanning of the dental arch' method, in this method the dental arch of the suspect can be directly scanned using an intraoral scanner. 3D scanning is very efficient as it consumes less time and contains storage options **(Molina & Martin, 2015)**.

Comparison Techniques

There are various methods for comparison of bite marks:

- **Odontometric Triangle Method**

This is an objective method, in which a triangle is made on the traced bite marks, three points A, B, and C are marked. A & B points are marked on the outermost convex points of canine teeth, the centre of two central incisors are marked as point C. These three points together make a triangle. Lines AB, BC, and CA are measured, and angles between them are measured. This is done for the upper and lower jaw, results are recorded and compared.

a. Direct Method

In this method, models from the suspect can be directly placed over the photograph and the bite mark to demonstrate concordant points, bite marks, and study casts can be compared using this method **(Singh *et al.*, 1988; West & Frair, 1989)**.

b. Indirect Method

It involves the preparation of transparent overlay which is then placed over the scaled 1:1 photographs and comparison is made. This method is also known as 'Acetate method' **(Singh *et al.*, 1988; West & Frair, 1989)**.

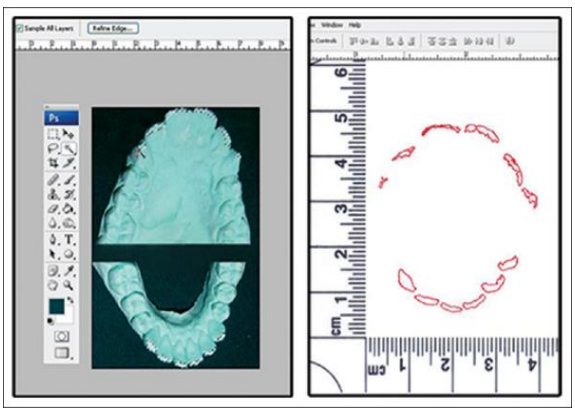

Figure 2 - Direct Cast Technique - Computer assisted Overlay (Djea pragassam *et al.*, 2015)

- **Image Perception Software Procedure**

New method used for comparison and analyzing photographs of bite marks with overlays of suspected biter's dentition using image perception software. A photograph of the bite mark is opened with image perception software, and the region of interest is then selected. Colored image of the bite mark is layered over the original bite mark photo. Using this software, it is possible to depict a 2D picture as a 3D object **(Singh *et al.*, 1988)**.

Special Methods

1. Vectron: This method is used to measure the distance between angle and fixed points.
2. Stereometric Graphic Analysis: It is a plotting method that allows the detailing of the outline of the tooth and the biting edge of a tooth in 3D, in the form of a counter map.
3. Scanning Electron Microscopic Analysis of Bite Mark Wounds **(Velden, *et al.* 2006; Masthan, 70-89; Pretty, 2003)**

Discussion

Bite mark is considered as an injury with a specific pattern that can be recognized and established, these are considered as weapons used in sex crimes, homicides, Child abuse, Assault and Battery crimes or on physical evidence. The scientific basis of bite mark analysis is that no two bite marks are the same, though it is a complicated belief according to observations of few scientists. Now, there are various methods to collect and examine a bite mark pattern used by investigators and forensic scientists.

In the study, they worked on 30 students (6 males, 24 females) of the University of Dundee, UK, aged between 20 to 50 years. They used polyvinylsiloxane as an impression material and took an impression of the upper and lower jaw. They obtain a digital file by scanning the impressions with the use of a printer - The Envision TEC Perfactory DLP, also obtained 3D models from a device known as the NextDent 3D model by digital light processing. The model was articulated using a dental die stone and a vise grip sheet metal plier.

They made the subject to sit in different positions and bend their left arm, in different positions, and a touch mark or simulated bite mark was made on the arm resting in different positions. Photos were taken and required metric measurements were recorded and analyzed. **(Dama *et al.*, 2020)**

In the study carried out in the Department of Oral Medicine and Radiology at Haldia Institute of Dental Sciences and Research, India. They worked on 60 samples with the age group 20-40 years of same race and ethnicity, the subjects were asked to bite gently on modeling wax and bite registrations were recorded, barium chloride and the dental stone was used to prepare positive replicas of the bite marks. Radiographs were scanned and images analyzed using the computer-assisted method. They used 'Sidexis Next Generation Software' to measure the parameters. The Kruskal-Wallis test was used to compare the bite marks of males and females, they found the p-value less than 0.01and was considered significant **(Maji *et al.*, 2018)**.

In their study, they used indirect methods for the analysis of bite marks and proved computer-assisted methods to be better **(Gopal and Anusha, 2018)**.

In the work carried out by Reinprecht et al. they suggested maxillary inter canine distance between 24.1 mm and 43.0 mm represents a human bite mark, this contributed significantly in cases of crime in South Africa **(Reinprecht *et al.*, 2017)**.

In the 'Comparative study on two methods for bite mark analysis' by **Nima A. Osman *et al.***, they took dental impressions of fifteen volunteers and also asked participants to bite food such as apple, eggplant, and chocolate, they prepared the dental cast for the same using vinyl polysiloxane and dental stone and compared both the impressions also known as manual docking technique, assigned the scoring according to the match, also used indirect method technique, also known as computer-assisted overlay technique. Analysed by using the Kruskal-Wallis ANOVA test. They suggested that the reliability of both techniques are in equality for bite mark analysis **(2017)**.

Problems in Bite Mark Analysis

1. Distortion of accuracy due to elasticity of skin, position of body and location of bite mark.
2. Dentition is not stable through the course of life; it might change which leads to major changes in configuration and instability.
3. There are many scientists who have established bite marks as a weak ground for investigation with scientific reasons.

In the study done by **Micheal J. Saks *et al.*** he had given various claims to prove the unreliability of bite mark and about its weak foundation **(2016)**.

Conclusion

The analysis of bite mark evidence can assist in providing crucial leads in an investigation and help in solving crime and serving legal justice. The forensic odontologist plays a very important role in recognizing, handling, examining, and evaluating the evidence. The various techniques of collecting the bite marks include the first being, photographing the evidence received, which can be visible photography, infrared photography, ultraviolet photography, or can be done with the help of various Casting materials. The comparison is done through the Odontometeric Triangle method involving direct and indirect procedures and with Image Perception Software Procedure. There are various special methods also applied namely, Vectron, Stereomteric Graphic Analysis, and scanning electron microscopic analysis of the bite mark wounds. All these techniques help to identify the uniqueness of the bite marks which are, dental arch's shape, inter-canine distance, teeth alignment, and spacing, missing and rotating teeth, and the wear patterns that the teeth have gone through in their time. The unique physical characteristics of the dentitions of the individuals enable forensic odontologist to compare and identify the individual.

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