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Role of Bite Mark Analysis in Forensic Odontology - Chasing the bite

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Abstract

The numbers of suspected bite mark cases examined by forensic odontologist are increasing in the recent years. Human bite mark analysis is most demanding and complicated part of forensic dentistry, involving identification of assailant by comparing record of their dentition with record of bite mark left on a victim. Like finger prints and DNA, bite marks are unique to individual such as distance and angles between teeth, missing, and teeth fillings. This type of impression evidence can be left in the skin of a victim and also in food, chewing gums, pens, pencil, etc., In some crimes, bite mark evidence is the only evidence on which conviction has been achieved, particularly alleged rape and child abuse cases. The current protocol for collection, management, preservation analysis, and interpretation of evidences should be employed if information is to be obtained for the court. To deal with bite-mark evidence a Forensic dentist is consulted. The aim of this paper is to give a brief overview of bite mark analysis and its usefulness in forensic odontology. This review highlights the importance of bite-marks as indispensable Forensic odonatological evidence. The aim of this article is to give brief overview of bite mark analysis, its clinical applications, and limitations.

Keywords: Bite mark, forensic odontology, crime, evidence, forensic photography

Introduction

Bite mark may be defined as mark made by teeth either alone or in combination with other mouthparts.[1] Bite marks are a form of pattern injury, which means that the configuration is caused by a particular object. Occasionally, bite marks are obtained on various types of food substances vegetables, chewing gum, fruits, chocolate. [2-4] Like fingerprints, the marks made by human teeth can be a tool for identification as this is unique in every individual. Bite marks disclose individual tooth imprints. In some cases, bite marks may allow identification of the biter.[5] Biting is considered to be a primitive type of assault and results when teeth are employed as a weapon in an act of dominance or desperation. As a result, bite marks are usually associated with sex crimes, violence fights, and child abuse.[6] Bites marks have also been recovered from scenes of theft. Hence, matching the bite mark to a suspect's dentition may enable the investigating officers to connect the suspect to the crime and excluding innocent. Humble (1933) used the transparencies for bite marks" comparison. [7,8] In 1982 Webster in an article of bite marks stated that bite marks have been reported in flesh, foodstuffs, and inanimate objects. The terminology used to describe food bite marks is very varied and thus gave classification of food bites in an effort to bring a degree of uniformity to the analysis of such marks. Bernstein [9] has described in detail about the application of photography in forensic dentistry. In 1986 Gleen M. Wagner in an article of bite marks identification stated that using tool-mark technology, comparisons are possible even in limited material. Computer enhancement of bite mark photo graphs increases a favourable comparison by further delineating unique characteristics of the arch and individual teeth. Whittaker and McDonald emphasize that bite mark analysis starts with the examination of the wound.[10] (1994) Aboshi et al.

reported the identification of suspect arsonist by means of bite marks in cakes which were found at the scene of the crime. A missing upper right central incisor was proved to be in patterned injury. Sweet (1995) is of the view that no two human bite marks can be identical.[11] Berlitz et al. (2000) reported a case of murder with a bite mark in a piece of cheese which was recorded. The pattern associated with comparison between the impression and a study model of the suspect was able to identify the perpetrator.

Franklin and Curtis have described in detail the method of bite mark OVERLAY Technique.[12] Sheasby and MacDonald (2001) have described in detail about the primary and secondary' distortions in the bite marks.[13] Richard (2001) has written that unique characteristics of biter's teeth are compared with that of the bite mark on the skin and which will help in identification.[14]

Classification of bite marks

In general, bite mark consists of superficial abrasions, or subsurface hemorrhage, or bruising of the skin because of bite.[2] The pattern of the injury is affected by the force and length in time of the bite, in combination with other mechanical and physiologic factors. Human bites may be classified in different ways, for example, defensive or offensive.[15]

MacDonald's classification is most cited. Mac Donald suggested an etiologic classification. It is pertinent to human bite marks but equally applicable to marks on other materials.

1. Tooth pressure marks: These are caused by incisal edges of the anterior teeth. They are stable and subjected to minimal distortion

2. Tongue pressure marks: Because of tongue pressure, impressions of the palatal surfaces of the teeth, cingulum, or palatal rugae may be produced. This causes distortion of marks

3. Tooth scrape marks: These are produced because of irregularities in the teeth due to fractures, restorations, etc.

4. Complex marks: These are a combination of the above types of marks. The shape depends on amount of tissue taken into a mouth.

Collection of bite mark evidence from the bite mark victim

Following information should be recorded both in living and deceased victim.

1. Demographics: Patients name, age, and gender along with case number, date of examination, and name of examiners should be recorded

2. Location of the bite mark: Anatomic location, contour of the surface (flat, curved, or irregular) underlying tissue such as bone, cartilage, muscle, or fat should be recorded.

3. Shape of the bite mark: Shape of the bite mark such as round, ovoid, crescent, or irregular should be noted

4. Colour and size of the mark: Both vertical and horizontal dimensions should be recorded

5. Type of injury: Petechiae, contusion, abrasions, and laceration caused by bite mark should be noted

6. Nature of the human bite mark: Human bite marks are usually semi-circular or crescentic, with gap on either side. The teeth may cause clear, separate marks, or form a continuous or intermittently broken line. Bite marks may be abrasions, contusions or lacerations, or a combination of above any.

Guidelines required for the analysis of bite marks

To standardize the analysis of bite marks, 1986 the American Board of Forensic Odontostomatology (ABFO) established guidelines.[16]

The collection of evidence from the bite suspect commences only after proper consent has been acquired. The consent has to be signed by the suspect as well as the witness. A detailed history of the individual including history of dental treatments (after and just before the bite marks) has to be noted. The basic steps and tools used in the recording of bite marks are as follows.[6]

Photography

The most important evidence from bite mark victim is photography. It is performed by the forensic dentist or under the odontologist's direction to ensure accurate and complete documentation.

Extra oral photographs including full face and profile views, intraoral should include frontal views, two lateral views, and occlusal view of each arch, photograph of maximum mouth opening. All photographs should be taken with the camera perpendicular to injury. The bite marks are photographed at regular 24 h intervals on both deceased and living victim. Photographs of injury should be taken immediately. (Figure 1)

1. In colour or black and white

2. With and without the ABFO number 2 scale [Figure 1 &1.1]

3. On and off camera flash

4. Close-ups that can easily be scaled 1:1

5. Ultraviolet (UV) photography if injury is fading

6. An overall body shot showing the location of injury

7. If the bite is on a movable anatomic location, then several body positions should be adopted to assess the effect of movement. Colour or speciality filters may be used to record the bite site in addition to unfiltered photographs. Alternative methods of illumination may

be used. A ring flash, natural light, and overhead lighting can be utilized to off angle lighting. Video/ digital imaging may be used in addition to conventional photo Graphy.

Figure 1: Photograph of bite mark on right wrist with American Board of Forensic Odontology (ABFO) scale II

Swabbing of bite mark injury is important to recover trace evidence. Stains of saliva or human cells for a DNA analysis should be collected whenever possible. [6]

The human beings secrete “ABO” antigens through saliva during biting. Swabs should be taken from bitten area, control area, and oral cavity. In case of sexual assaults, oral swab should be taken for semen. Mouthwashes with water can be used to obtain test samples for spermatozoa. It is acceptable to use either cotton tip applicators or cigarette paper to gather this evidence.

Ultraviolet illumination

Bite marks which are not visible by naked eyes may become visible when examined under UV light in a dark room. This technique will demonstrate invisible bite marks up to 6 months after infliction.

Taking Impression and making models

Depending on constitution of the skin, the bite marks can be distorted, this can be problem when analyzing the bite marks. To prevent mistakes by the pattern associated comparison, it is recommended to simulate bites at similar body parts using the study casts of the suspect [6] or using digital technique for a stepwise dynamic comparison. [18,19]

Take two high-quality impressions of each arch. Alginate can be used for making impression, but preferred material is rubber-base and silicon-base impression material due to its dimensional accuracy [Figure 2]. Take registration in dental wax in centric occlusion, edge-to-edge bite, and in protrusive and lateral excursions of the jaws. Master cast is poured with Type IV dental stone, and duplicate casts should also be made [Figures 3 and 4].

Figure 2: Measurement of bite mark on an apple

Figure 3: Negative impression of the bite mark taken from the apple with putty and light body rubber-base impression material

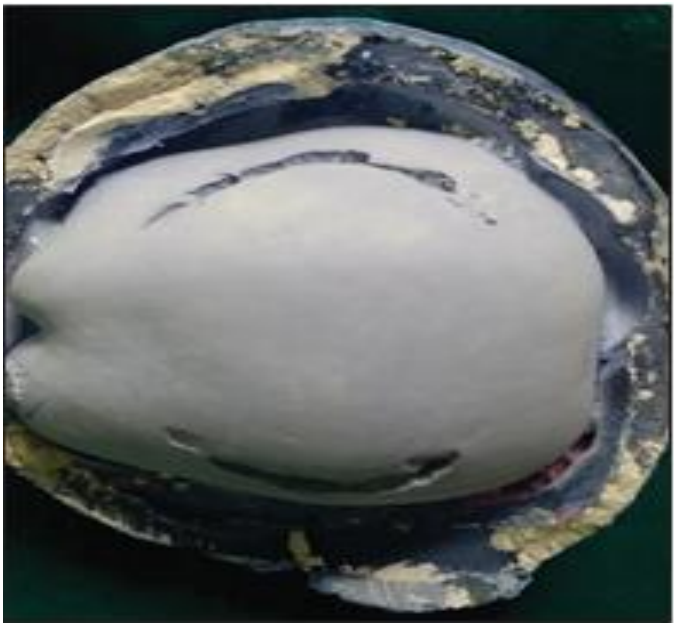

Figure 4: Positive impression of the bite mark taken with die stone from the negative impression

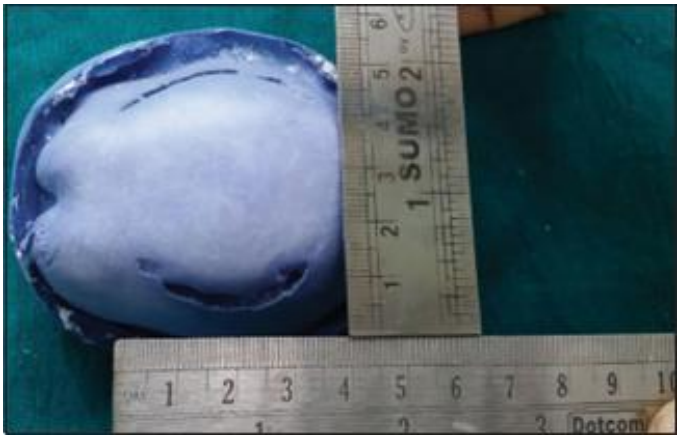

Figure 5: Measurement of bite mark on bite mark model

Sample bites

In case of dead victims, bite marks can be excised along with underlying tissue after fixing acrylic stent around bite mark to avoid shrinkage of tissue. The specimen is then stored in 4% formalin.

Methods of analysis of bite marks Odontometric triangle method

In odontometric triangle method (objective method), a triangle is made on the tracing of bite marks and teeth models by marking three points - A, B, and C. Points A and B are plotted on outermost convex points on the canine teeth. Center of two central incisors is selected as Point C. All three points are joined to form triangle ABC. Lines AB, BC, and CA are measured, and angles a, b, and c are calculated. This is done for both upper and lower jaw teeth model and compared with that of bite marks of wax, apple, and skin. Statistical analysis is carried out, and results are obtained (21,22)

Comparison technique

It has two types (1) direct and (2) indirect.[22] In direct method, models from the suspect can be directly placed over the photograph of the bite mark to demonstrate concordant points [Figures 5 and 6]. Videotape can be used to show slippage of the teeth producing distorted images and to study dynamics of the bite marks. Bite mark and study casts can be compared using three -dimensional (3D) pictures.[19]

Indirect method involves preparation of transparent overlay which is then placed over the scaled 1:1 photo graph and comparison is made.[23]

Figure 6: Comparison of the bite mark and teeth of study cast of the upper jaw of suspect

Figure 7: Comparison of the bite mark model and teeth of study cast of the upper jaw of suspect

Image perception software procedure

Comparing and analyzing photographs of bite mark with overlays of suspected biter's dentition using image perception software. A photograph of bite mark is opened with image perception software, and a region of interest is then selected. After such selection, colours can be added to different grayscale areas of the image. The coloured image of the bite mark is now layered over the original bite mark photograph using Photoshop of Adobe Systems. With image perception software, it is possible to depict a 2D picture as a 3D object. (24) Other special methods in bite mark analysis are

Vectron

This is used to measure distance between fixed points and angles.

Stereometric graphic analysis

This is used to produce counter map of the suspect's dentition.[24] A stereometric graphic plotting method permits the outline of the tooth mark or the biting edge of a tooth to be registered in great detail in all three dimensions in the form of a contour map.

Scanning electron microscopic analysis of bite mark wounds.

The degree of correlation of a particular set of the teeth with a certain bite mark is proportional to the number of characteristics common to both. However, individual characteristics are much more significant because they are less likely to occur purely by chance in a given population. Since the scanning electron microscope can readily demonstrate individual characteristics when they are present, it can be an extremely useful tool for the forensic odontologist. (25)

The ABFO provides a range of conclusions to describe results of bite mark comparison:[26]

- Excluded: Discrepancies in bite marks and suspect's dentition
- Inconclusive: Insufficient forensic detail to draw any conclusion
- Possible biter: Teeth like the suspects could be expected to create a mask like the one examined but so could other dentition.
- Probable biter: Suspect most likely made the bite; most people in population would not leave such bite

- Reasonable medical certainty: Suspect is identified for all practical and reasonable purposes by the bite mark.

Difficulties in bite mark analysis

- Subjective element in fabrication
- Subjective element in comparison
- Distortion through skin elasticity, anatomical location, and body positioning is recurring problem
- Loss of data, contamination.

Discussion

Bite marks are a form of "patterned injury" which means that the configuration is caused by particular object.[27] Biting is considered to be a primitive type of assault and results when teeth are used as a weapon in an act of dominance or dispersion.[28] Bite marks may be caused by humans or animals; they may be on tissue, food items, or objects. As no two fingers are identical, neither two mouths nor two teeth are exactly identical.[29] The first person who published an analysis of bite mark case is So Rup. He called the method "odontoscopy," analogous to the fingerprint identification called "dactyloscopy." By this method, plaster cast of the teeth of suspect is obtained, dried, and varnished after which the incisal edges and occlusal surfaces are coated with printer's ink. Upon this inked surface, a sheet of moistened paper is pressed, and print is transferred from it to transparent paper. This print is placed over life-size photograph of the bite mark and compared. Sorup's method was later criticized.[30] The most famous bite mark case of the 20th century involved serial murderer Ted Bundy who killed at least 100 women. On January 15, 1978, a case was reported of two young girls who were raped and brutally killed by serial killer Ted Bundy. There was no solid evidence available for conviction. Analysis was conducted for an odd bite mark on the left buttock of victim. The suspect was told to provide dental impression. This was matched with mark found on victim's body. Ted Bundy was found guilty and was convicted.

Bite mark evidence has played an important role in judicial system. In some criminal cases, bite mark evidence is the only evidence on which a conviction has been achieved. The scientific basis of bite mark analysis is rooted in belief that no two humans have identical dentition in respect to size, shape, and alignment of the teeth.

Although bite mark of individual has uniqueness when it comes to analysis, it is complicated by numerous factors.[29] The investigators of bite marks should have knowledge of any mark or bruise which have characteristics which closely resemble the injuries have produced by teeth require substantial information.[28] The forensic value of bites in nonhuman materials is based on nature of material itself and in case of perishable items, how long ago the bite took place. Once teeth impressions are taken, these can be compared against bite mark data and matched for up to 76 comparison factors. These include whorls, indentations, abrasions, striations, distance between cuspids, tooth width and thickness, alignment, and mouth arch.[27] The forensic odontologist is now able to combine information from conventional analysis and pseudo-3D images to investigate the bite mark and attempt to establish its origin with a higher degree of certainty. The availability of additional colouring of selected areas with similar intensity values as well as rendering 2D photographs as pseudo-3D images may enable the researcher to analyze the image more extensively and come to accurate conclusions regarding source of bite.[26] Use of DNA in bite marks was pioneered into eliminate subjectivity associated with conventional analysis.[27,28] However, it is proposed that the

presence of nucleic acid degrading enzymes within saliva can readily degrade DNA in living victim as the skin's temperature accelerates the process.[30]

In bite mark analysis, two simultaneous and opposite paths develop. The inclusive path is one in which the unique features of suspected biter's dentition show a strong link with the bite mark injury in a tooth-by-tooth and arch-to-arch comparison with pattern recorded in the bitten skin or object. The exclusive path is one in which the suspected biter's dentition does not show link with the bite mark injury in an arch-to-arch and tooth-by-tooth analysis.[30]

Conclusion

The field of bite mark science is expanding, and need for individuals trained and experienced in the recognition, collection, and analysis of this type of evidence is increasing. The conclusion from bite mark analysis can assist crime judicial system; thus, it is an important tool in crime investigation. The serious nature of crimes in which bites are found often dictates that "Forensic Standards" should be established for gathering and interpretation of evidence. Errors in recording, comparison, analysis, and interpretations of bite marks may lead to serious consequences. With recent advances in research, more objective methods of bite mark analysis such as salivary DNA recovery and bacterial genotyping have become mainstay of investigation in such crimes. Further efforts to reduce subjectivity in standard physical techniques are required.

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