Review Article

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Identifying the Crime Using Bite-mark an Effective Method: A Literature Review

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Abstract

Retinal pattern, finger prints and DNA are unique and bite marks are often registered at the assault cases of the skin of the victims and effective method which is very helpful in identifying the criminals. Human bites are an alternative. The challenge in forensic dentistry is analysing the bite in human beings because the distortion of the human bite won't give the exact mirror image of the bite, which complicate the investigators to identify the crime. Human bite changes with the time when the measurements taken. Hence, a broad search of published literature was performed electronically using the keyword human bite, identifying crime, human bite analysis technique from *January 1974* to *December 2018*. Medline, Google scholar and text books. This article analyzis the methods of human bite recording and for identifying the criminals in forensic sciences.

Keywords: Distortion; Forensic dentistry; Human bite.

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Introduction

There is a marked raise in assaulted cases in the society and many of them have human bite which has been identified by the forensic dental surgeon. Bite-marks also have seen in the food substance or inanimate objects at the crime location. Bite-marks may be found during assault and abuse of child or adults related with sex related cases.[1] In some criminal cases only the human bite evidence has been seen which may be found in the living or the dead individuals, where the person may be a victim or perpetrator of the crime. Bite-mark may also be defined as all traces left on the victim due to the biting act.[2]

Bite-mark is described as a mark created by the teeth, or combination with other oral parts. Bite-marks can be seen in foodstuffs, flesh and on variety of other materials.[3] Bite-mark investigation started with the inspection of the wound and copying of it, then only it can be used to identify the crime, if it is positively decided as a bite mark. If the wound can be orientated similar to the teeth are positioned in the dental arched to make a firm statement that the wound is a bite-mark. Frequently however, an individual wound will show limited detail and it will be appropriate to identify it only as a possible bite-mark. Advances in forensic sciences have made crime detection scientifically feasible.

Location of bite-marks

Bite marks can be found on any surface of the body (Table 1).[4,5]

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Table 1: Common Sites

Non-sexual	Homo (sexual)	Hetro (sexual)
Arm	Breast	Breast
Leg	Neck	Upper back
Fingers	Cheek	Axilla
Hands	Arm	Arm
Chest	Thigh	Genitalia
Ears	Abdomen	Nose
	Genitalia	Buttocks

Classification of bite-marks

Tooth pressure marks: These markings are caused by the penetration of anterior teeth into the skin. They are stable and subjected to least alteration.

Tongue pressure marks: Sometime impressions of the palatal surfaces of the anterior teeth, cingulam or the palatal rugae may be created by tongue pressure.

Tooth scrape marks: They are produced by the fracture tooth or filling of the anterior teeth.

Complex marks: They have the impressions of all variety of marks which depends on the amount of tissue pierced into the oral cavity.[6,7]

Classification of bite-mark on food

Type 1 bites are those found in material that fractures readily with limited penetration of tooth. They record the incisal edges of anterior teeth upto *1* to *2 mm*.

Type 2 bites produced by the teeth, and then the bitten piece is removed by cutting it from the material.

Type 3 bites are bite right through and through the material. The dimensions of the bite may be increased because the mark showed the more mesio-distal width and not the incisal edge length.[8]

Nature of human bite-mark

Human bites are usually semi-circular or crescentic in shape which is produced by the imprint of the front teeth with a space at either side due to the separation of maxilla and mandible. The teeth may give a definte, separate marks or form with continuous or intermittently broken line. Bite marks may be in the form of abrasions, contusions or lacerations or a combination of any two or three. Rarely, the bite-mark may be linear in pattern, due to the scraping of the skin causing parallel tracks.[9]

Methods of recording of bite-marks

Photography: For identifying the bite mark, photographis the most commonly used method which does not affect by any other recording like impression on models, and taking swabs etc.

Impression and models: The proper way of recording the details of suspect's dentition is to obtain apositive replica of the teeth and directly compare it with the impression of the bite-mark before it shrings.

Collection of swabs: CDE antigens can be seen in the human saliva during biting. Swabs should be taken from the bitten area, normal area and oral cavity. The bitten area should be sectioned and preserved in 10–20% formalin solution.[10]

UV illumination: Bite-marks which are not seen by naked eye may become visible while examining under UV light in a dark room, because, in a wound, the melanin pigment of the skin shifts to the periphery or margin of the wound, which makes the margins of the teeth bite marks prominent when UV light is focussed on the site of the bite. This technique will demonstrate invisible bite-marks up tosix months after infliction.[11]

Methods of analysis of bite-marks

The American Board of Forensic Odontology has made certain guidelines for analysing the bite-mark.[12]

Odontometric triangle method: It's an objective method of identifying the crime in which triangle is made by tracing of bite-marks by marking two points on the outer most convex point of canines and one in the centre of the upper central incisors. The angles of the triangles are measured and compared with bizygomatic and bigonial width from which the responsible for the mark can also be easily measured.[13,14]

Comparison technique: Model from the suspect canbe directly placed over the photograph of the bite of the human to demonstrate concordant points. Video clip scan be used to show slippage of teeth

producing distorted images of the dynamics of the bite-marks.[15]

Uniqueness: The unique nature of human dentitionis often assumed, but it has not been definitely established.[16]

Overlay method: The overlay had been used to analyze bite-marks in the past. The tooth exemplar was used to produce the biting surface, the data are transferred to a clear acetate sheet. They are usually compared to the hurt on skin or pattern. The perimeter of biting surface of each tooth and the inner aspect will be transparent in hollow volume overlay.[17]

Image perception software procedure

A photograph of a bite-mark is started with the image perception software with the selected region, after such selection different grey colors can be added to the image. The assigning of selected colours to grey values enables the forensic scientist to select regions with similar grey values or to enhance subtle differences of grey values in the picture. The human eye can identify only 40 shades of grey in a monochrome and hundreds of different colours.[16] This will make it easier to determine the pixel intensity and detail image of bite-mark. Now the coloured image of the bite-mark is layered over the original bite-mark photo using Adobe.[18,19] Receiver Operating Characteristic (ROC) analysis provides a graphical representation positive and false positive cut-off points.[20]

Guidelines for the analysis of bite-marks

To standardize the bite-mark analysis the American Board of Forensic Odontostomatology (ABFO)[21] established the following guidelines in 1986:

1. History of any dental treatment subsequent to, or in proximity to, the date of the bite mark.
2. Extraoral photo should show the full face and profiles, intraoral should include frontal views, two lateral views and an occlusal view of each arch and a photograph with maximal mouth opening. If inanimate materials are used for test bites which should be preserved photographically and notify the distance at which photograph was taken. UV light photographs can see the damage into the deeper tissue can capture by the UV light photo includes spacing, size and shape of teeth. A blood group determination is possible in bite marks on the left saliva of the bite-mark.
3. Soft and hard tissue around the mouth may influence biting dynamics. Measurements of maximal opening and any deviations on opening or closing should be made. The presence of facial scars or facial hair and evidence of surgery should benoted.
4. Salivary swabs should be taken and the tongue should be examined to assess size and function. The periodontal status should be noted then prepare a dental chart if possible.
5. Two impressions of each arch and the occlusal relationship should be registered.
6. Sample bites should be made in an appropriate material to simulate the type of bite.
7. Study casts should be prepared using Type II stone and additional casts should be made by duplicating the master casts with silicon rubber, plastic and powders.

   Levine[22] suggested Aluwax bites to get impression of the incisal edges and aportion of the labial and lingual surfaces of upper and lower incisors and canines. Subjects are told to bite on apple or to bite on their own flexor surface of forearm. 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.

Distortion of bite-mark

1. *Primary distortion:* The two factors of primary distortions are the dynamics of the biting processes and the detailed featured of the tissue. Dynamic distortion and tissue distortion are complex unpredictable phenomenon which are closely related because of their simultaneous occurrence during the episode of contact between the dentition and skin.

2. *Secondary distortion:* Time related, it also may be due to posture distortion and photographic distortion.

Discussion

Analysis of bite-mark can be difficult for the experienced forensic odontologists whether a bite-mark was produced by a child or adult is dependent upon a number of factors which may include size, shape, size of individual tooth marks and recognition of individual teeth. In the era of common orthodontics interventions, despite of the age of patient, the remark similar to above should be added the incidence of bite-marks expertise's still increase. The comparison of the ability of experts and non-experts to differentiate between adult and child human bite-marks using Receiver Operating Characteristic (ROC) analysis.[23] Bite marks can be analyzed using various techniques which could be either direct or indirect techniques. Direct technique involves the use of a model of the suspect's teeth which is then compared to life sized photographs of the bite-mark, while indirect technique involves the use of transparent overlays, on which the biting edges of the suspect's teeth are recorded.[24]

The success of forensic 3D photogrammetry evaluation of a bite-mark or other patterned injuries, depends primarily on the proficiency in the preparation and subsequent photographic recording of these objects. Patterned injuries can be visually recorded in a short-time using relatively simple camera. FPHG is a no touch or non-invasive 3D documentation and analysis method without distortions. On screen one to one fit and match experiments with objects to be correlated to one another can be performed in virtual space, thus preserving the integrity of the original objects.[25]

Comparison of distortion between male and female showed that men exhibited more distortion in two of the three positions. A definitive conclusion could not be drawn because there was an irregular gender distribution.[26] The distance with its high false positive rates and very low true positive rates, is unreliable individually as well as in association with other parameters in metric method of analysing bite-mark. Hence, forensic experts while analysing bite-marks using metric method.[27]

Conclusion

Bite marks are very important to identify the crime and the bite mark distortion would impact the accuracy and reliability of bite-mark interpretation. So, attempts should be made to establish standards for gathering evidence and interpretation of evidence. However, bite-mark analysis will give opportunity to exclude a suspect from a crime when the data do not correspond.

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