

Bitemarks in Forensic Odontology

Mounabati Mohapatra*, Priyanka Sarangi**, Sukanta Satapathy***

*Professor & Head, Dept. of Dental Surgery, All India Institute of Medical Science, Bhubaneswar, Orissa. **Assistant Professor, Department of Conservative Dentistry and Endodontics ***Senior Resident, Department of Prosthodontics, SCB Dental College and Hospital, Cuttack, Odisha.

Abstract

Forensic science is vast and dentists are privileged to play a prominent part of the investigating team, since the oral cavity area is small but highly resistant to destruction. Dentists should accept the challenge to play the part in investigation when called on by studying, doing research and keeping equipment ready. Forensic dentistry generally addresses the problem of identifying individuals based on the properties of teeth. Looking at the location, orientation, presence/absence, and dental work, people can be matched to dental records or bitemark impressions for identification. The present review describes the classification, characteristics, mechanism of production, and appearance of bite mark injuries, collection of evidence, comparison techniques, and technical aids in the analysis of the bite marks.

Keywords: Bite Marks; Forensic Dentistry; Identification; Crime.

Introduction

Teeth are often used as weapons when one person attacks another (or) when a victim tries to ward off an assailant. It is relatively simple to record the evidence from the injury and the teeth for comparison of the shapes, sizes & pattern that are present. Additionally traces of saliva deposited during biting can be recovered to acquire DNA evidence. If dentist are aware of the various methods to collect & preserve bitemark evidence from victims, it may be possible for them to assist, identify & prosecute violent offenders [1].

Bite marks analysis is based on the principle that 'no two mouths are alike'. Bite marks are thus, considered as valuable alternative to fingerprinting and DNA identification in forensic examinations. A bite mark is a mark created by teeth either alone or in the combination with other oral structures [2,3]. 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

Classification of Bite Marks

Bite marks can be broadly classified as non-human (animal bite marks) and those inflicted by humans. Based on the manner of causation, the bite marks can be non-criminal (such as love bites) as well as criminal which can further be classified into offensive (upon victim by assailant) and defensive (upon assailant by victim) bite marks [4, 5].

There are seven types of bite marks [6]; 'Haemorrhage' (a small bleeding spot), 'Abrasion' (undamaging mark on skin), 'Contusion' (ruptured blood vessels, bruise), 'Laceration' (near puncture of skin), 'Incision' (neat punctured or torn skin), 'Avulsion' (removal of skin), and 'Artefact' (bitten-off piece of body). These further can be classified into four degrees of impressions; 'Clearly defined' that results from the application of significant pressure, 'Obviously defined' which is the effect of first degree pressure, 'Quite noticeable' due to violent pressure and 'Lacerated' when the skin is violently torn from the body [7].

Corresponding Author: Mounabati Mohapatra, Professor & Head, Dept. of Dental Surgery, All India Institute of Medical Science, Bhubaneswar – 751019, Orissa.
E-mail: mounabatimohapatra@gmail.com

Received on 18.04.2017, Accepted on 01.05.2017

Several classification systems have been proposed for the bite marks.

1: **Cameron and Sims' Classification**

A simple classification based on the type of agent producing the bite marks and material exhibiting it.

Agent: Human and Animal

Materials: Skin, body surface, food stuff, other materials.

2. **MacDonald's Classification**

Most commonly followed classification and it is a etiological classification.

Tooth Pressure Marks: Marks produce on tissue as a result of direct application of pressure by teeth. Generally produced by incisal or Occlusal surfaces of teeth.

Tongue Pressure Marks: When sufficient amount of tissue is taken in to the mouth, the tongue presses it against rigid areas such as the lingual surface of teeth and palatal surface. These marks referred as suckling. There is a combination of sucking and tongue thrusting.

Tooth Scrape Marks: These marks caused due to scraping of teeth across the bitten material. They are usually caused by anterior teeth and present as scratches or superficial abrasions.

3. **Webster's Classification**

Classification based on the depth of teeth on the food stuff

Type 1: The food items fractures readily with limited depth of tooth penetration. e.g. Hard chocolate

Type 2: Fracture of fragment of food item with considerable penetration of teeth. E.g. marks on fruits

Type 3: Complete penetration on food items with slide marks. E.g. cheese

Characteristics of Bite Marks

Class Characteristics

According to the Manual of American Board of Forensic Odontology (ABFO) [8], 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 class characteristics' and the 'bite mark characteristics' are the two types of class characteristics [9].

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 [10]. 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 [11].

The bite mark characteristics help in determining if the marks were from maxillary teeth or the mandibular teeth. 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 [12].

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 [13]. 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 [14]. The teeth of different individuals differ from one another with respect to their size, their position in the dental arches and in their shape. 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 oral hygiene, and there may be restorations of the carious teeth [15]. The teeth are subjected to various insults such as sports injuries, chemical injuries, biologic attacks, motor vehicle accidents, workplace 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.

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 [16].

Mechanism of Bite Marks

Three predominant mechanisms associated with production of bite marks are; tooth pressure, tongue pressure and tooth scrape. Tooth pressure marks are caused by direct pressure application by incisal edges of anterior teeth/occlusal edges of posterior teeth [17]. Severity of bite mark depends upon duration, degree of force applied and degree of movement between tooth and tissue. Clinical presentation of tooth pressure indicates pale areas representing incisal edges and bruising that represent incisal margins. Tongue pressure is caused when the material taken into mouth is pressed by tongue against teeth/ palatal rugae and distinctive marks are present due to tongue sucking/ thrusting. Tooth scrape is caused by teeth scraping against tooth surface commonly involving the anterior teeth. Clinical presentation can be in the form of scratches and abrasions. Scratches and abrasions that indicate irregularity and peculiarity of incisal edges are useful in identification [14].

Appearance and Factors affecting Bite Mark Injuries

An ideal human bite mark is doughnut shaped which consists of two 'U' shaped arches representing the mandibular and the maxillary arches separated from one another at their base. The individual arches are produced by the anterior six teeth. In practical scenario, human bite mark is mostly circular to oval in shape as compared to an animal bite which is usually 'U' shaped. When teeth of only one of the two arches come in contact with the skin during biting, then instead of the two 'U' shaped marks, only one 'C' shaped mark is produced by biting. Such types of bite mark patterns provide very less information to the investigator. The diameter of the bite mark injury varies and is usually between 25-40 mm in diameter. The size of an injury allegedly caused by human bite must fall within the known parameters of the human dentition. Due to the pressure created by the biting teeth and the negative pressure created by the tongue and suction effects, there is an extra-vascular bleeding which causes bruising in the centre of the bite mark injury. These bruising show colour changes over a period of time as the injury undergoes a healing process in the skin of a living individual [14].

Factors such as strength and force of the bite, intervening clothing, and relative movements or struggle posed by the victim have a bearing on the

depth of penetration and can alter the appearance of the bite marks [18,19]. Rarely atypical human bite presentations are reported that need careful analysis and explanations regarding its production [20,21].

The dermal properties, anatomical site of the bite, age of the victim and weight are responsible for the distortion produced by bite marks [22,23]. Body parts with loose skin bruises easily due to excess subcutaneous fat, lesser fibrous tissue and muscular tone [13-15]. More bruising is observed in children, females and elderly persons. More bruising in children is attributed to delicate, loosely attached skin and presence of subcutaneous fat. In an old person, more bruising is due to lesser elasticity and subcutaneous fat whereas easy bruising in females is due to delicate skin with more subcutaneous fat.

Collection of Evidence in Bite Mark Analysis

Collection of Evidence from the Victim

DNA present in salivary trace evidence can be obtained by swabbing the bite site. The double swab technique [20] involves moistening the site with a swab, moistened with sterile saline, and then removing of the moisture with a second dry swab and both swabs can be sent for analysis [24]. Then, DNA fingerprinting can be done from salivary trace evidence of biter's exfoliated epithelial cells.

An important element of dental forensic examination is photography [23]. Magistrates and investigators often require it, because pictures are able to show the maxillary and mandibular teeth, their characteristics, pathologies and dental treatment. Photographs of the bite mark surface are taken and tissue samples are collected from the victim. Close up photographs of bite marks are taken under high resolution and colour balance is maintained while using colour films. A colour photographic film is used whenever required [25]. A scale should be kept in the same plane and adjacent to the bite marks and chances of distortion should be negated during photography of the bite marks. Currently, photographic evidence is the most common initial method for recording the presence and the details of skin bite marks. The lighting conditions and reconstruction of the particular position of the body where the bite mark was given at the time of infliction of bite to reduce the postural effects and photograph components of the secondary distortion should be properly managed. It is suggested that the orientation of the camera should be set up at 90° to the centre of the wound to reduce distortion.

Collection of Evidence from the Suspect

Extra oral examination includes the examination of hard and soft tissues factors, TMJ status and facial asymmetry muscle zone. Maximum inter incisal opening, deviations in opening/ closing the jaws, occlusal disharmonies, facial scars, evidence of surgery and presence of surgery should also be well photographed. Intra orally, salivary evidence, examination of tongue for size and function, abnormality in form of ankyloglossia, periodontal examination and condition of teeth are examined [26].

Two impressions of each arch with ADA (American Dental Association) specified material is followed by obtaining dental casts with type II stone called MASTER CAST. Duplicate casts can be obtained from master cast [18]. Teeth and soft tissues should not be altered by carving, trimming or making other alterations. Sample bites are made into appropriate material simulating the type of bite under examination.

Bite Mark Analysis and Identification

The exact identification of a living person using individual traits and characteristics of the teeth and jaws is the basis of forensic science [27]. 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 [28]. 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 provide the individual information about the suspect or an offender and relate 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 sub-surface haemorrhage 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 [29,30].

Physical Comparisons

There are a number of different methods used to physically compare the suspect dentition and the physical bitemark injury. Some of the methods are confocal scanning electron microscope, reflex scanning electron microscope, fingerprint dusting

powder, overlays, impressions and 3D Laser scanning of dental casts. Some of these methods such as computer generated overlays are peer reviewed and have a high degree of specificity and accuracy. Overlays are still the most common method employed by a majority of forensic odontologists. It is of great concern that computer generated overlays are still not being employed by the majority of forensic odontologists. There is no standard applicable [1, 31].

There are also many methods for the production of computer generated overlays. Some of these methods have a regional bias. There are two main techniques for production of computer generated overlays. They are 1. Naru Technique – preferred by Europeans and 2. Sweet Technique – preferred by Americans. Both these methods scored low reliability coefficients for area of individual teeth which is very worrying [1, 6].

Biological Techniques

Recovery of salivary DNA has been the main focus of biological techniques in bitemark analysis. The advantage of this method is that the DNA recovered from the saliva on the bitemark is usually sufficient to produce a profile. There are certain areas of concern. Extreme environmental circumstances are to be taken into consideration. The salivary DNA may be highly degraded. It can be assaulted by the environment [1]. A new area in biological techniques is the use of the bacterial fingerprint. There are over 2000 recorded species of oral bacteria and each individual has a unique bacterial population. A bacterial fingerprint or a bacterial profile can be generated by recording the different species of bacteria present. This can be used to create a database in future. As of now this technique can be used to match a suspect's bacterial profile. This technique is still nascent and has not undergone a lot of active research. There is a lot of scope for research in this area [1].

Uniqueness of The Human Dentition

The human dentition is unique. Occlusal (bite surface) profiles of all people are different from each other. There is just a small hypervariation that occurs in the dentition which is unique. This hypervariation can be used to create a dental occlusal profile database. This has its drawbacks. It is not constant throughout life as compared to DNA which is constant. To overcome this concern, the dental records of suspects can be routinely updated with a bite registration taken every year or so. This is also a new area and a lot of research has to be done in this field [1].

An upcoming area with a certain amount of research being done is "Anterior Teeth Rotation". Anterior teeth have a certain specific numerical rotational value. Tooth patterns observed on skin usually contain the anterior teeth indentations. Changes such as rotations or chippings or malplaced anteriors can help in the creation of a unique database [32].

Human Skin as Bite Registration Material

Skin is a very resilient and elastic material. The skin stretches during the bite due to elastic fibres in the dermis. This effect is only temporary. Due to damage control action taken by the skin cells, the skin reverts back to its normal position if it is not affected beyond its threshold limit. It also has the capacity to form a new layer of skin on the affected area if it is affected beyond its threshold [3].

There is usually an expansion, shrinkage or distortion of the skin in the area of the bite mark. This can affect the accurate recording of the bite mark. Considering this factor, photographic evidence in bitemarks is highly contentious. Some anatomic areas are prone to more distortion than other areas. This is the most important factor that prevents bitemark analysis from becoming a very accurate form of expert evidence [1].

Bitemark Severity Index

The bitemark severity index is a scale from 1 to 6 that measures the severity. The bitemark severity index should have certain ideal characteristics such as 1. Easy to use, 2. Be reproducible, 3. Be able to use on the living as well as the dead, 4. Universally applicable and 5. integration to allow future statistical analysis.

The bitemark severity index is scaled from 1 to 6 with 1 being very mild bruising, no teeth marks present, diffuse arches visible, may be caused by something other than teeth and of low or no forensic significance. The scale gradually progresses in severity with 6 being complete avulsion of tissue, possibly some scalloping of the injury margins suggesting that teeth may have been responsible for the injury and of low forensic significance. However forensic significance is low on either end of the scale with 3 and 4 having the highest forensic significance. The drawback of this index is its low knowledge levels with the crime scene police officers. Bitemarks distort easily so crime scene police officers need to be educated in the usage of this index which would prove useful to the forensic odontologist at a later stage [33].

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 human bite mark is capable of withstanding the extreme conditions of the environment and is a ready source of information that can be identified even in the deceased individual. 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.

References

1. Furness J. A new method for the identification of teeth marks in cases of assault and homicide. *British Dental Journal* 1968; 124:261-267.
2. MacDonald DG. Bite mark recognition and interpretation. *Journal of Forensic Science Society* 1974; 14:229-233.
3. Whittaker DK, MacDonald DG. *A Color Atlas of Forensic Dentistry*. London: Wolfe Medical Publications; 1989.
4. Wagner GN. *Scientific Methods of Identification*. In: *Forensic Dentistry*. New York: CRC Press; 1997. p.1-36.
5. Sweet D, Pretty IA. A look at forensic dentistry- Part 2: Teeth as weapons of violence- identification of bite mark perpetrators. *British Dental Journal* 2001; 190:415-418.
6. Lessig R, Wenzel V, Weber M. Bite mark analysis in forensic routine case work. *Experimental and Clinical Sciences International Online Journal* 2006; 5:93-102.
7. Levine LJ. Bitemark evidence. *Dental Clinics of North America* 1977; 21: 145-158.
8. Wagner GN. Bitemark identification in child abuse cases. *Pediatric Dentistry* 1986; 8:96-100.
9. Endris R. *Praktische Forensische Odontostomatologie*. Heidelberg: Kriminalistik Verlag; 1979.
10. McKenna CJ, Haron MI, Brown KA, et al. Bitemarks in chocolate: a case report. *Journal of Forensic Odontostomatology* 2000; 18:10-14.
11. Saglam AS, Gökdemir K, Kedici PS, et al. Bitemarks

- in forensic odontology. *Journal of Forensic Odontostomatology* 1998; 16:30-34.
12. Rötzscher K, Pilz W, Solheim T. Bissspur – Zahnspur. In: Madea B, Brinkmann B, editors. *Handbuch gerichtliche Medizin*, volume 2. New York: Springer Berlin-Heidelberg; 2003.p.1699-1728.
 13. ABFO, American Board of Forensic Odontology - Diplomates Reference Manual; June-2010.
 14. Knight B. *Forensic Pathology: 2*. Arnold Publishers; 1996.
 15. Clark DH. *Practical Forensic Odontology*. USA, Maryland: Elsevier-Butterworth Heinemann Ltd; 1992.
 16. Kanchan T, Menezes RG. Double human bite—A different perspective. *Journal of Forensic and Legal Medicine* 2009; 16:297.
 17. Vale GL. Dentistry, bite marks and investigation of crime. *Journal of California Dental Association* 1996; 25: 29-34.
 18. Dorion RB. Bite Mark Evidence. *Journal of Canadian Dental Association* 1982; 48:795-798.
 19. Stavrianos C, Vasiliadis L, Papadopoulos C, et al. Loss of the Ear Cartilage from a Human Bite. *Research Journal of Medical Sciences* 2011; 5:20-24.
 20. Sweet D, Lorente JA, Lorent M, et al. An improved method to recover saliva from human skin: the double swab technique. *Journal of Forensic Sciences* 1997; 42: 320-322.
 21. Pretty IA. The barriers to achieving evidence base for bite mark analysis. *Forensic Science International* 2006; 159:110-120.
 22. Rawson RD, Vale GL, Herschaft EE, et al. Analysis of Photographic Distortion in Bite Marks: A Report of the Bite Mark Guidelines Committee. *Journal of Forensic Sciences* 1986; 31:1261-68.
 23. Vale GL, Sognaes RF, Felando GN, et al. Unusual Three-dimensional Bite Mark Evidence in a Homicide Case. *Journal of Forensic Sciences* 1976; 21:642-665.
 24. Lessig R, Benthaus S. *Forensische Odontologie*. *Rechtsmedizin* 2003; 13:161-8.
 25. Bush MA, Miller RG, Bush PJ, et al. Biomechanical factors in human dermal bite marks in a cadaver model. *Journal of Forensic Sciences* 2009; 54:167-76.
 26. Pretty IA. *Forensic Dentistry: 2. Bite marks and Bite Injuries*. *Dental Update* 2008; 35:48-50.
 27. Cottone J, Standish SM. *Outline of Forensic Dentistry Yearbook*, Chicago IL: Medical Publishers, 1982.
 28. Rothwell RR. Bite marks in forensic dentistry: a review of legal, scientific issues. *Journal of American Dental Association* 1995; 126:223-232.
 29. Wright FD, Dailey JC. Human bite marks in forensic dentistry. *Dental Clinics of North America* 2001; 45: 365-97.
 30. Williams PL, Warwick R, Dyson M, et al. *Gray's Anatomy*. New York: Churchill Livingstone 1989.
 31. Velden AV, Spiessens M, Willams G. Bite mark analysis and comparison using image perception technology. *Journal of Forensic Odontostomatology* 2006; 24:14-17.
 32. Page M, Taylor J, Blenkin M. Reality bites— A ten-year retrospective analysis of bitemark casework in Australia. *Forensic Science International* 2012; 216: 82–87.
 33. Pretty IA, Sweet D. A paradigm shift in the analysis of bite marks. *Forensic Science International* 2010; 201:38-44.
-