

BITE MARKS ANALYSIS

Forensic Odontology is a branch of forensic medicine that in the interest of justice deals with dental evidence presented in the courts of law. A Forensic Odontologist is involved in the analysis of bite marks on victims and presentation of bite mark evidence in court as an expert witness.

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. 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.

During sexual attacks including sexual homicide, rape and child sexual abuse, bite marks are clustered around parts of body associated with sexuality. Females are usually bitten on the breasts, nipples, abdomen, thighs, buttocks and pubis, while men are usually bitten on the back, arms, shoulders, chest and penis.

Definition:

American Board of Forensic Odontology (ABFO) defines bite-marks as *“a pattern left in an object or tissue by the dental structures of an animal or human”*.

Mac Donald described it as a mark caused by the teeth either alone or in combination with other mouth parts.

Hence a bite mark shows unique pattern of an individual's teeth, also it can help in excluding suspects to whom the mark does not belong to.

Areas of Bite Marks:

Areas of the body most likely to be bitten during assaults are-

- a) Breasts
- b) Arms
- c) Legs
- d) Face/ head
- e) Abdomen
- f) Back
- g) Shoulder
- h) Buttocks
- i) Female genitalia

- j) Hands/ fingers
- k) Chest
- l) Ears/ nose
- m) Neck
- n) Male genitalia

In cases of sexual assault, face, lips, breasts, shoulder, neck, thigh, genitals and testicles are mostly involved. Bite mark impression can be left on skin, chewing gum, pencils, pens and may also be found on musical instruments, cigarettes, cigar, food material like cheese, fruit, potato, and chocolate etc.

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.

There are seven types of bite marks;

1) Haemorrhage (a small bleeding spot):

Hemorrhage or bleeding is an acute loss of blood from a damaged blood vessel by biting. The bleeding can be minor, such as when the superficial vessels in the skin are damaged, leading to petechiae and ecchymosis.



2) Abrasion (undamaging mark on skin):

An abrasion is a superficial injury of the skin where the surface layer of epidermis is rubbed off either by a sliding force or by direct pressure. According to Gresham, abrasions can be subdivided into scratches, grazes and imprint abrasions due to pressure. Scratches demonstrate heaping of epidermis at the finishing edge of the scratch. Grazes are a form of scratch produced by injury from a rough surface and the pattern of grazing will depend on the nature of the surface. Imprint or pressure abrasions are produced by localized pressure to the skin.



Fig. 1 & 2 : Bite-mark consisted of an elliptical pattern of marks from individual teeth around a perimeter of abrasions and contusions

3) Contusion (ruptured blood vessels, bruise):

A contusion is usually caused by contact with a blunt object. The pressure of the contact disrupts capillaries allowing extravasation of blood into the dermis; the surface may or may not be intact. Blood will spread along normal tissue planes from the injury and a coloured area develops. Due to the breakdown of haemoglobin, the colour changes through a spectrum of red, brown, purple, green and yellow in the first week after injury. Gravity may cause the bruise to change position.

4) Laceration (near puncture of skin):

A laceration involves the splitting of the full thickness of the skin by a blunt injury. According to Gresham, lacerations are often accompanied by bruising and abrasion of the wound edges.



5) Incision (neat punctured or torn skin):

A condition by which a cut made through the skin and soft tissue.



6) Avulsion (removal of skin):

An injury in which a body structure is torn off by bite event.



7) Artefact (bitten-off piece of body):

A piece of flesh or body part is completely removed or 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.

The following classes that are of proven significance in practical application regarding bite marks are:

- ❖ **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 classification includes both individual as well as class characteristics. This 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. In this class, class characteristics and individual characteristics are not present. This type of bite is commonly found where there is avulsion of an ear or finger.

Cameron's Classification (1974)

- 1) The agents that produced the mark
- 2) The materials and substances that have exhibited the marks.

McDonald's Classification (1974)

- 1) Tooth pressure marks: By incisal edges of anterior teeth - stable with minimal distortion
- 2) Tongue pressure marks: Tongue pressure on palatal surfaces of the teeth, cingulae, or palatal rugae causes distortion of marks
- 3) Tooth scrape marks: Caused due to irregularities in teeth due to fractures, restorations, etc.
- 4) Complex marks: Combination of above marks.

Webster's Classification (1982)

- 1) Type I: Bites in chocolate which fracture easily with limited depth of penetration. Most prominent are incisal edges of the upper and lower anterior teeth

- 2) Type II: Good grip of material obtained by teeth piece is fractured from main material, for example, Apple; the outline of labial aspect of upper and lower incisors is recorded
- 3) Type III: Bite mark produced by biting through cheese. Here, an advantage is that it indicates a relative position of the upper and lower incisors in centric occlusion.

Factors Affecting Bite Marks in Skin:

1. Some marks are made through clothing. Hence clothing is considered a potential source of bite mark impressions and biological evidence from transferred saliva.
2. Loose skin/subcutaneous fat lead to a poor bite mark. Whereas areas of fibrous tissue or high muscle content bruise less easily and demonstrate good bite mark. Infants, elderly and females tend to bruise more easily.
3. The size and shape of bite-mark is affected by its location on the body, because certain areas of the body bend distorting the surface area of the skin due to high viscoelasticity.

Various Physical Characteristics of a Bite Mark Pattern:

The amount and degree of detail recorded in the bitten surface varies from case to case. First it is important to determine which teeth made the marks. The term 'characteristic', is a distinguishing feature, trait, or pattern within the mark. It is of two types, class characteristic & individual characteristic.

Class characteristic is a feature, pattern, or trait which reflects a given group and is not related to a particular individual. The biting surfaces of teeth are related to their function like incising, tearing or grinding. Front teeth are the primary biting teeth in bite marks.

The two upper central incisors are wide, lateral incisors are narrower and cuspids are cone shaped. The two lower centrals and two laterals are uniform in width and lower cuspids are cone shaped. The upper jaw is wider than the lower jaw. The characteristics of individual teeth are:

- **Incisors:** Rectangular shaped mark, sometimes with perforations at the incisal angle areas
- **Canines:** Triangular markings with apex towards labial and base towards lingual
- **Premolars:** Single or dual triangle with bases of triangles facing each other or coming together as diamond shaped
- **Molars:** Rarely leave bite marks, usually quadrilateral markings.

An individual characteristic is a feature, pattern, or trait that represents a variation from the expected finding in a given group, like a rotated, damaged, or broken tooth that differentiates two different dentitions and is helpful in determining the dentition that caused the bite injury or mark.

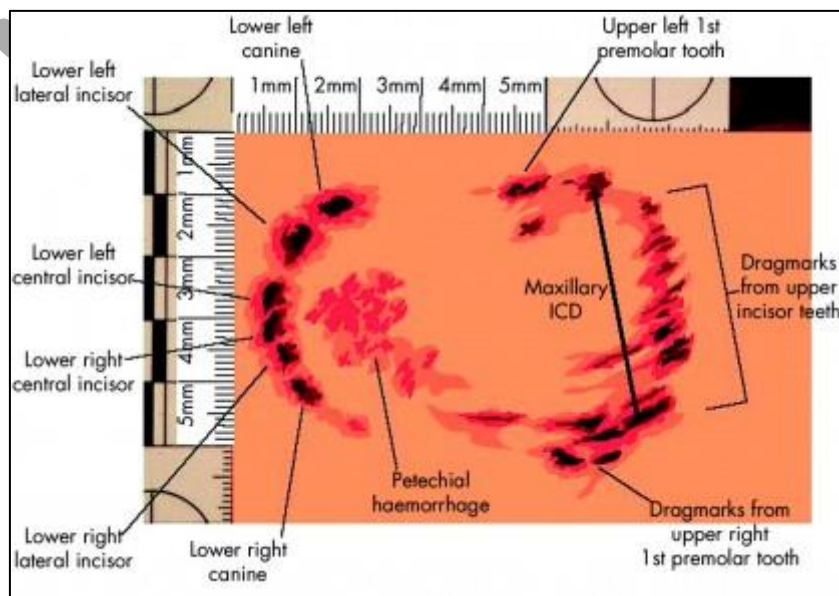
Cases with class characteristics are used to confirm the events of a crime & those with individual characteristics can identify an individual source. Thus depending on the characteristics it is possible to use terms like “unique”, “possible bite mark”, “definite bite mark”, “positive match”, “consistent with” and “probable biter”. For a positive identification to be made there must be marks left by four or five approximate teeth.

- ❖ **Types of Distortions:** Two associated terms are primary and secondary distortion. Primary distortion depends on dynamics of the bite. Secondary distortion is of three types: time related distortion, posture distortion, and photographic distortion. The longer the time interval after the mark is made, the less distinct the mark will be in both living and dead. In the living, bruising occurs. In the dead, the body begins to decompose and shrinkage by rigor mortis occurs.

Bite Mark Morphology:

The human bitemark is classically a circular or oval mark (bruise) with central sparing, ranging from that made by a limited part of the dental arcade (for example marks left by the anterior teeth from canine to canine of the upper and lower jaws, separated by gaps at each side), or a more forcible bite leaving 2 concave ‘bows’ (with the concavities facing each other) with gaps at each end and having a suction mark in the middle.

Lower incisors tend to anchor the skin whilst upper anterior teeth bite down onto the tissue. There may therefore be a static line or curved mark left by the lower incisors and canines (these incisors are all the same width, unlike those of the upper jaw – a useful feature in distinguishing upper and lower jaws) with a more dynamic mark left by the



teeth of the upper jaw, with scrape marks present.

Where the skin is bruised during the biting process, the marks made will distort over time, as the bruising diffuses into surrounding soft tissues. Speed of examination is therefore of the essence, before distortion obscures individual teeth marks within the bite. Abrasions within the mark, however, retain their morphology, and can be useful features for the forensic odontologist to find.

The clarity of the bitemark is affected by the location of the body part being bitten, in particular whether the area is curved, and its degree of flexibility. Bitemarks are usually formed during a highly dynamic process – the biter and the person being bitten will be moving about during the assault, and this leads to a degree of distortion. Bitemarks may therefore not present themselves as regular curved marks, but as a complex wound featuring multiple arcades, bruises and abrasions.

There are several well described mimics which should be borne in mind when faced with a potential bitemark, including defibrillator pad marks, the bottom of a glass bottle, the heel of a shoe, jewellery and children's toys.

EVIDENCE COLLECTION:

- ❖ **Demographics:** Name, age, sex, race, case number, date of examination and name of the examiners should be recorded.
- ❖ **Location of the Bite Mark:** Describe the anatomic location, indicate the contour of the surface (flat, curved or irregular) and state of the tissue characters. Underlying tissue-bone, cartilage, muscle or fat
- ❖ **Shape of the Bite Marks:** whether it is round, ovoid, crescent or irregular in shape.
- ❖ **Colour and Size of the Mark:** Both vertical and horizontal dimensions should be recorded in metric system.
- ❖ **Type of Injury:** due to bite mark may be Petechial haemorrhages, Contusion, Abrasion, Laceration, Incision, Avulsion, Artefact etc. Whether the surface of the skin is smooth or indented should be noted.
- ❖ **Photographing of the Bite Mark:** This is an important step during investigation as the photograph of bite-mark should be accurately produced. The use of digital camera instead of traditional allows the Odontologist to reduce the margin of error.

Evidence Collection from Victim:

Documentation

A record of the bite mark, including the descriptive and narrative notes, is recorded. The documents contain the physical appearance, color, size, and characteristics of the bite mark.

Photograph

The photograph is taken from different angles. Photographs are taken from a distance to show the relationship of the bite mark with the rest of the body and close-up photograph is also taken for bite mark measurement. All images are taken in both black-and white and color.

Various photography techniques include:

- Visible light photography
- Digital photography
- Non-visible photography
- UV photography
- Infrared photography.

Swabs

Saliva which has been left behind after biting should be collected. A double swab technique can be used. First, cotton dampened with distilled water is wiped over the mark. Next, use a dry swab to collect the rest moisture present on the mark. Both the swabs are dried for 4–5 min before comparing.

Impressions

A proper impression should be taken with impression materials or polyether which is used in dental clinics. A plaster model can be made and used as a rigid support for impression materials.

Evidence Collection from Bite Suspect

Clinical examination

An overall examination of the oral cavity is done and documented. Specific findings such as fracture, pocketing, and missing tooth are noted.

Impressions

An accurate impression of the entire tooth is recorded with all features. It is recommended to make two molds using dental die stone and hard stone.

Bite sample

A sample of the suspect's bite is recorded with either baseplate wax or putty impression. The sample is preserved and a photograph of the sample is documented.

Features of a suspect's dentition useful in bite mark analysis

- Shape of the dental arch (any rotations, abnormal positions, gaps or missing teeth)
- Number of teeth present in each jaw (odontogram)
- Presence of dentures/ sharp denture clasps
- Distortion of occlusal surfaces during biting (occlusal registration)
- Occlusal level of teeth within the jaw
- Broken/ fractured teeth (particularly incisal fractures that may be responsible for abrasions)
- Any prominent teeth
- Biting pattern at various angles including bite overhang

Traditionally, the process of superimposition involved inking the occlusal surfaces of the suspect's teeth (on a model) and marking the teeth 'bite' pattern onto an acetate sheet. This sheet would then be placed over a true 1:1 photograph of the bitemark, and the sheet moved around to see if there was any match between the two.

With the advent of faster computer processing ability, photographic software packages such as Adobe's Photoshop® has taken centre stage in the 'overlay' process. Scaled photographs of both suspect dentition and bitemark can be superimposed by a relative 'fading in and out' of one over the other. The process can be documented at each stage, and easily reproduced, without harming the evidence itself.

Mechanism of Bite Marks:

A bite mark occurs mainly due to pressure of teeth on skin. It is accompanied by mandibular closure and suction of skin (as a negative pressure). Upper jaw is usually stationary and holds and stretches the skin and lower jaw is moveable and gives the most biting force. A human bite mark is an elliptical or circular injury with specific characteristics of the teeth. If there is a single "C" shaped mark, then only one jaw (lower jaw) was involved. The diameter of injury ranges from 25-40 mm.

Bite Marks Analysis, Comparison and Evaluation:

Any analysis involves two steps, first the discovery and preservation of evidence and second involves evaluation, comparison and findings of the recovered evidence. In

examination and analyzing of bite-marks, first it should be determined if the injury is a bite-mark and whether it is caused by human teeth. Consistency of marks with the time of the crime should be determined. To standardize the analysis of bite marks the American Board of Forensic Odontology (ABFO) established the following guidelines in 1986:

- 1) **History:** Thorough history of any dental treatment carried out after the suspected date of the bite mark should be taken.
- 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, a photograph of maximal mouth opening.
- 3) **Extra-oral Examination:** Soft tissue and hard tissue factors that may influence biting dynamics. Measurements of maximal opening and any deviations on opening or closing should be noted.
- 4) **Intraoral Examination:** Examination of tongue and periodontal status like mobility of teeth. In case of recent marks, they should be swabbed for DNA from saliva left in the wound.
- 5) **Impressions:** Two impressions of each arch using materials that meet the American Dental Association specifications. The occlusal relationship should be recorded.
- 6) **Sample Bites:** Sample of suspects bite in centric occlusion using wafer of base plate wax or silicone putty material. The sample is photographed immediately & used for future comparison.
- 7) **Study Casts:** are prepared using type II stone.

On the other hand, 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.

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. 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.

- 1) **Size, shape and arrangement of teeth:** Human incisor teeth produce rectangular marks whereas canine teeth produce triangular marks in the cross-section. Animal bites (dogs, cats) usually puncture the skin and the cross-sectional size of the tooth is small and circular. Number of incisor teeth and the distance between individual teeth may be greater with animal bites.
- 2) **Size of Dental Arch:** Width of adult arches from canine to canine is 2.5-4cm. Children arches are smaller than the adults whereas “dogs and cats” arches are smaller than children.
- 3) **Evaluation of the bite mark photographs:** Attempts should be made to thoroughly analyze the bite marks in vivo and in vitro rather than mere superimposition of marks in the photographs over the models.
- 4) **Evaluation of the arches:** Shape of the arch should be noted. Central lines of upper and lower arches should be established.
- 5) **Suction marks:** The presence of suction marks in the centre of the arch marks is a sign of bite marks of human origin. But now it is considered that suction marks are caused due to injury to the blood vessels when compressed between the jaws of the biter.
- 6) **Characteristics in the mark:** Ascertain the characteristics of individual marks within the arch. Areas of injuries may indicate occlusal level of particular tooth or sharp cusp. Tooth numbers should be identified. Placement of tooth marks in the arch and missing teeth should be noted.

Problems in Bite Mark Analysis:

Doubts have been raised about the accuracy of the bite imprint as skin is considered a poor medium for accurate impressions due to curves and other irregularities producing intrinsic distortion. Thus comparison of a person's teeth to bitemark on a victim's body is prone to error leading to false implications of persons in crimes they did not commit.
