Role of Bite Mark in Forensic Odontology – A Review

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Abstract: 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 and pattern that are present. However, this comparative analysis is often very difficult, especially since human skin is curved, elastic, distortable and undergoing edema¹. In many cases, though, conclusions can be reached about any role a suspect may have played in a crime. Additionally, traces of saliva deposited during biting can be recovered to acquire DNA evidence and this can be analyzed to determine who contributed this biological evidence. If dentists are aware of the various methods to collect and preserve bitemark evidence from victims and suspects, it may be possible for them to assist the justice system to identify and prosecute violent offenders.² This paper reviews the recognition and recovery of this evidence and provides insight into modern methods used to investigate bitemark evidence from heinous crimes.

Keywords: Forensic odontology, Bitemarks, photography radiographs, dental impressions

1. Introduction

Forensic Odontology is the application of dentistry in legal proceedings deriving from any evidence that pertains to teeth. OR Area of dentistry concerned with the correct management, examination, evaluation & presentation of dental evidence in civil/criminal legal proceedings in the interest of justice(Neville)³. Every human body ages in a similar manner, the teeth also follow a semi- standardized pattern. These quantitative measurements help establish relative age of person. Each human has an individual set of teeth which can be traced back to established dental records to find missing individuals.⁴Teeth is made of enamel (hardest tissue of the body) - withstand trauma (decomposition, heat degradation, water immersion, and desiccation) better than other tissues in body. Teeth are a source of DNA: dental pulp or a crushed tooth can provide nuclear or mitochondrial DNA that to help identify a person. ⁵Bite marks occur in a variety of crimes such as assault, rape, murder and child abuse.Mac Donald (1974) defined bite mark as 'a mark caused by the teeth either alone or in combination with other mouth parts'.9

2. History

Identification by teeth is not new. It goes back as far back as 66 A.D. at the time of Nero. As the story goes, Nero's mother Agrippina had her soldiers kill Lollia Paulina, ^{6.7} with instructions to bring back her head as proof that she was dead. Agrippina, unable to positively identify the head, examined the front teeth and on finding the discolored front tooth confirmed the identity of the victim.During the U.S. Revolutionary War, none other than Paul Revere (a young dentist) helped identify war casualties by their bridgework. ¹⁰Teeth are highly resistant to destruction and decomposition, so dental identification can be made under extreme circumstances. It was used on Adolf Hitler and Eva Braun at the end of World War II, the New York City World Trade Center bombing, the Waco Branch Davidien siege, and numerous airplane crashes and natural disasters. The U.S. has a fairly well-developed system of dental records system (the Universal System), so it's not surprising to find it used for the identity of remains or "Jane Doe" victims. You can also tell age solely by analysis of teeth - the Gustafson method¹⁸ (looking for six signs of wear) or the Lamendin method (looking at transparency of roots). With the Universal System, each tooth is assigned its own number from 1- 32 and the five surfaces of each tooth are also classified.¹¹

3. Definition and Classification

Bitemark

- A physical alteration in a medium caused by the contact of teeth.
- A representative pattern left in an object or tissue by the dental structures of an animal or human.

Cutaneous Human Bitemark: An injury in skin caused by contacting teeth (with or without the lips or tongue) which shows the representational pattern of the oral structures.

Prototypical Human Bitemark: A circular or oval (doughnut) (ring-shaped) patterned injury consisting of two opposing (facing) symmetrical, U-shaped arches separated at their bases by open spaces. Following the periphery of the arches are a series of individual abrasions, contusions and/or lacerations reflecting the size, shape, arrangement and distribution of the class characteristics of the contacting surfaces of the human dentition.

Variations of the Prototypical Bitemark: Variations include additions, subtractions and distortions.^{15,16,21}

Additional features: Central Ecchymosis (central contusion) - when found, these are caused by two possible phenomena: a)positive pressure from the closing of teeth with disruption of small vessels. B)negative pressure caused by suction and tongue thrusting like 1.Linear Abrasions, Contusions or Striations - these represent marks made by either slipping of teeth against skin or by imprinting of the lingual surfaces of teeth, Double Bite - a "bite within a bite" occurring when skin slips after an initial contact of the teeth and then the teeth contact again a second time. Weave Patterns of interposed clothing and Peripheral Ecchymosis - due to excessive, confluent bruising.

- 2) Partial Bitemarks like one-arched (half bites), one or few teeth and unilateral (one-sided) marks due to incomplete dentition, uneven pressure or skewed bite.
- 3) Indistinct/Faded Bitemarks like Fused Arches collective pressure of teeth leaves arched rings without showing individual tooth marks ,Solid - ring pattern is not apparent because erythema or contusion fills the entire center leaving a filled, discolored, circular mark and Closed Arches - the maxillary and mandibular arch are not separate but joined at their edges.Latent - seen only with special imaging techniques.
- 4) Superimposed or Multiple Bites.
- 5) Avulsive Bites.

Unique: This term is variably defined as either one of a kind or rare and unusual. In its most conservative interpretation the following connotations apply: of such distinctiveness that no other person could have made an identical pattern, to the point of persuasion of individuality. attributable to only one individual, unequaled.

Distinctive: variation from normal, unusual, infrequent, not one of a kind but serves to differentiate from most others ,highly specific and individualized.

Possible Bitemark: 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.

Probable Bitemark: The pattern strongly suggests or supports origin from teeth but could conceivably be caused by something else.

Definite Bitemark: There is no reasonable doubt that teeth created the pattern; other possibilities were considered and excluded.

Bite marks can be classified by four degrees of impression into seven types: 1. hemorrhage - small bleeding spot .2.abrasion - undamaging mark on skin.3. contusion ruptured blood vessel, bruise.4.laceration - punctured or torn skin.5.incision - neat puncture of skin.6.avulsion - removal of skin7. artifact - bitten-off piece of body

Contusions are the most common type of bite mark, and incisions offer the best three-dimensional image of the teeth. When avulsions and artifacts can be combined, you've also got three-dimensional imaging. The Marx case involved very clear three-dimensional bites. The forensic science of analyzing degree of impression involves, the specification of "violence", and this kind of testimony can be taken as evidence of the defendant's state of mind, aggravating circumstances, or especially heinous behavior.¹⁸

Bite marks on a live body also have different characteristics from those on a dead body, so a forensic dentist might be able to assist with things like time of attack and/or time of death. Generally, the better the bite mark, the better an expert can make a comparison. The Illinois appellate case of People v. Milone (1976) establishes this principle in that, to be admitted, dental evidence must be agreed upon by the scientific community as "good quality". This means that bite mark evidence usually meets the Frye standard, at least in this regard. 19,20,23

4. Methods to Preserve Bitemark Evidence

- a) Saliva Swabs of Bite Site: Saliva swabbing of the bite site should be obtained whenever possible. Obviously, certain circumstances may preclude the collection of this evidence. If the region had been washed prior to the opportunity to swab this procedure would not be possible. If swabbing the area would damage or alter the pattern, it should either not be done or accomplished only after all other preservation methods have been employed. It is acceptable to use either cotton tip applicators or cigarette paper to gather this evidence. Other appropriate mediums may be used to collect this information. Control swabbing should be taken from other regions or portions of the object or in- individual that was bitten.²²
- b) Photographic Documentation of the Bite Site: The bite site should be photographed using conventional photography and following the guidelines as described in the ABFO Bitemark Analysis Guidelines. The actual photographic procedures should be performed by the forensic dentist or under the odontologist's direction to insure accurate and complete documentation of the bite site. Color print or slide film and black and white film should be used whenever possible. Color or specialty filters may be used to record the bite site in addition to unfiltered photographs.²⁶

5. Impressions of Bite Site

- 1) Victim's Dental Impressions :When the bite site is accessible to the victim's dentition impressions of the victim's teeth should be obtained. Impressions of the bite site should be taken when indicated according to the ABFO Bitemark Analysis Guidelines. A backing material should be used to maintain the contour of the impression site.
- 2) Tissue Specimens :The bite site should be preserved when indicated following proper stabilization prior to removal. The resection of the tissue should follow all other evidence collecting procedures. 10% Formalin is a common fixative used.

6. Evidence Collection of Suspected Dentition

- a) **Dental Records:** Whenever possible the dental records of the individual should be obtained in accordance with the ABFO Bitemark Analysis Guidelines.
- b) **Photographic Documentation of the Dentition:** Photographs of the dentition should be taken by the forensic dentist or by the odontologist's direction. A scale such as the ABFO No. 2 scale should be utilized when using a scale in these photographs. Video or digital imaging can be used to document the dentition when utilized in addition to conventional photography.

Clinical Examination

- 1) Extraoral Considerations
 - Maximum vertical opening and any deviations should be noted whenever possible.

- Evidence of surgery, trauma and/or facial asymmetry should be noted.
- TMJ function may be checked in addition to the previous observations.
- Muscle tone and balance may also be checked in addition to the previous observations.
- 2) Intraoral Considerations
 - Missing and misaligned of teeth should be noted.
 - Broken and restored teeth should be noted.
 - The periodontal condition and tooth mobility should be noted whenever possible.
 - Previous dental charts should be reviewed if available.
 - Occlusal disharmonies should be noted whenever possible.
 - The tongue size and function may be noted in addition to the previous observations.
 - The bite classification may be noted in addition to the previous observations.

A. Dental Impressions

- Dental impressions, following the ABFO Bitemark Analysis Guidelines, should be taken by the forensic dentist or by the odontologist's direction.
- Bite exemplars should be obtained in addition to the dental impressions.
- Saliva Samples
- Saliva swabbings should be obtained if appropriate.

Bitemark Analysis Guidelines: Both in the case of a living victim or deceased individual, the odontologist should determine and record certain vital information.^{9,23}

- Demographics :Name of victim ,Case Number ,Date of examination ,Referring agency,Person to contact ,Age of victim, Race of victim ,Sex of victim, Name of examiner(s)
- Location of Bitemark: Describe anatomical location ,Describe surface contour: flat, curved or irregular ,Describe tissue characteristics (Underlying structure: bone, cartilage, muscle, fat Skin: relatively fixed or mobile)
- 3) Shape :The shape of the bitemark should be described; e.g. essentially round, ovoid, crescent, irregular, etc.
- 4) Color :The color should be noted; e.g. red, purple, etc.
- 5) Size :Vertical and horizontal dimensions of the bitemark should be noted, preferably in the metric system.

ABFO Standards for "Bitemark Terminology": The following list of Bitemark Terminology Standards have been accepted by the American Board of Forensic Odontology.^{25,25} 1) Terms assuring unconditional to the terminology.

- 1) Terms assuring unconditional identification of a perpetrator, without doubt, on the basis of an epidermal bitemark and an open population is not sanctioned as a final conclusion.
- 2) Terms used in a different manner from the recommended guidelines should be explained in the body of a report or in testimony.
- 3) Certain terms have been used in a non-uniform manner by odontologists. To prevent miscommunication, the following terms, if used as a conclusion in a report or in testimony, should be explained:

- match; positive match.
- consistent with.
- compatible with.
- unique.
- 4) The following terms should not be used to describe bitemarks:
 - Suck mark (20% of diplomates still use this antiquated term).
 - Incised wound.
- 5) All boarded forensic odonatologists are responsible for being familiar with the standards set forth in this document.

7. Photography

Imaging of the patterned bruise of a bite mark is a variable in the process of bite mark analysis that the investigator can control. The technique and equipment employed by the operator will influence the quality of the photographic evidence.

Forensic photography requires accurate results when depicting an object in its 2D representation. Consistency is required in framing of the object in the centre of the image, the sharpness of the focus and, absence of photographic distortion. Consistency of colour and tonal range are equally important. Care must also be taken to eliminate any unwanted or distracting shadows. High-end digital singlelens-reflex (DSLR) cameras are used to achieve these results, equipped with a range of lenses and separate flash systems.

Colour representation and reproducibility- The same photo image on different monitors can look very different if the monitors are not professionally calibrated. Further variation is produced on printing the digital image: often the printed image does not represent what appears on screen. The latest digital SLR cameras have very high pixel counts.

Lenses fall into two categories:

- **Prime lenses-** have fixed focal length. A 105mm lens provides fine detail that is needed to demonstrate individual teeth marks accurately. Lens with lower focal length (example- 20 mm), produces noticeable barrel distortion.
- Zoom lenses- have a range instead of fixed focal length and are commonly supplied with a camera when sold as a kit. Zoom lenses should be avoided when photographing bite marks because the operator can often change the focal length without realising.

Mobile phones with cameras should be considered a last resort for use in recording patterned injuries such as bite marks. Although they have sensors with large pixel counts, the lenses have short focal lengths. The lens distortion will reduce the quality of the photographic evidence. Sometimes, a mobile phone may be the only option available to the operator and may provide important information to the investigation.

A rigid scale, such as the ABFO no. 2, L-shaped scale, is essential for photography of any patterned injury. The scale allows the investigator to make consistent measurements of the bruise. Without this scale being placed correctly and photographed with the injury, the subsequent measurements will be subject to error and affect the analysis resulting in inadmissible evidence for court.

It is important to use the same scale when taking photographs of the bite mark and making recordings of the suspect's dental cast, to minimise unwanted measurement error. The scale should have a matt finish to reduce reflection. 26

Colour chart

An accurate colour chart is needed when photographing the bite mark to ensure correct colour calibration when using a computer. For consistent results a colour chart should be visible in every image that is taken because slight changes in the distance between the flash and subject will have an influence on brightness within the image and will create slight variance in the colour.

Digital image file formats

The lossless (little compression) type of format used by the camera is either the TIF (Tagged Image File) format or a RAW image format. Many forensic photographers use only RAW files when creating photographic evidence. Thus integrity of the evidence is maintained as all original data is reconstructed faithfully at all stages in the workflow, from viewing to archiving of the image.

The JPEG file format uses a heavier compression, meaning that, to reduce the size (in megabytes), parts of the data from the image file are removed. The JPEG format can introduce changes to the appearance of the image itself. Artefacts can appear around the edges of an object in the digital image. If image enhancement is needed, then further loss of detail is introduced. Changes brought about by image compression may cause issues for the forensic investigator when analysing the images. To preserve the continuity of the sequence all images must be kept. There is no acceptable reason to delete images; even if some images do not depict important information, the continuity of the sequence should be preserved. Using of a ring flash is recommended for intraoral photography. Flash devices positioned on top of the camera or to one side will cause shadows to fall over parts of the dentition and obscure information.

8. Conclusion

Human bite mark analysis is by far the most demanding and complicated part of forensic dentistry. There is no dependable way of stating that one or more tooth marks seen in a wound are irrefutably unique to just one person in the population. Bite mark distortion through skin elasticity, anatomical location and body positioning is a recurring problem. With the recent developments regarding expert testimony, the need for accurate, reliable, reproducible and above all objective methods for bite mark analysis and comparison has never been greater. Although more research is needed to explore the possibilities of image perception technology, its possibilities to visualise more details in a bite markphotograph are promising. The availability of additional colouring of selected areas with similar intensity values as well as rendering 2-Dphotographs as pseudo 3-D images may enable the researcher to analyse the image more extensively and come to a more accurate conclusion regarding the source of the bite. However, bite mark analysis alone should not be allowed to lead to a guilty verdict, but it will offer the opportunity to exclude a suspect from a crime when data do not correspond.

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