

Bite Marks in Forensic Dentistry – An Insight

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Abstract:- Bite marks, impressions of oral structures like teeth and soft tissues, left on objects by animals or humans, serve as important evidence in forensic cases for identifying individuals. They're commonly discovered in crime scenes involving sexual assault, homicide, child abuse, and even in sports-related incidents. Evaluating bite marks is crucial for identifying individuals in such forensic contexts.

Keywords:- Forensic Dentistry, Bite Marks, Methodology.

I. INTRODUCTION

- Forensic dentistry plays a crucial role in forensic science by focusing on matching a suspect's dental records with bite marks discovered on a victim.
- Comparable to fingerprints and DNA, bite marks exhibit individual uniqueness through factors such as tooth alignment, gaps, dental treatments, and missing teeth.
- Bite mark imprints can be evident on a victim's body or on diverse items like food, chewing gum, pens, or pencils. The advent of DNA analysis has brought in an impartial means of evaluating bite marks. (1,2).

II. HISTORY

- In 1692, during the Salem Witch Trials, the identification of a bite mark on a stolen cheese piece proved pivotal in unveiling the thief's identity, leading to the resolution of the case in America.
- Among the notable instances involving bite mark analysis that notably influenced its use in the legal system was the conviction of the serial killer Theodore (Ted) Bundy by the U.S. courts.

III. DEFINITION

- Bite marks depict the internal oral structures (like teeth and soft tissues) left on objects by animals or humans. Evaluating these marks is crucial in identifying individuals in forensic scenarios.
- Such marks are commonly discovered at different crime scenes, including instances of sexual assault, homicide, child abuse, and even in sports-related incidents. (3,4).

IV. CLASSIFICATION

Several classification systems have been proposed for categorizing bite marks. (5,6)

A. Cameron and Sims' Classification:

They categorize marks based on the agent (human or nonhuman) and the materials exhibited:

- Agent: Human or Nonhuman (Animal)
- Materials: Human skin, body, food, or other substances.

B. MacDonald's Classification

This system focuses on the cause of bite marks:

- Tooth Pressure Marks: Created by the pressure of teeth, often by the front teeth.
- Tongue Pressure Marks: Result from the tongue's pressure on tooth surfaces or structures like cingulae or palatal rugae, caused by tongue suckling.
- Tooth Scrape Marks: Formed by teeth's friction and scraping.

C. Webster's Classification:

This classification revolves around the depth of teeth penetration into food materials:

- Type 1: Involves fractured food items with minimal teeth penetration depth, for instance, hard chocolate.



Fig. 1: Bite mark analysis using the impression on the piece of chocolate

Type 2 Encompasses fractured food items where there's significant depth of penetration, such as marks found on fruits.



Fig. 2: Penetration of the teeth & its impression on the fruit i.e, apple

Type 3: Refers to food items where there's complete penetration depth along with slide marks, for instance, imprints on cheese.



Fig. 3: Slide marks and imprints on cheese for forensics

V. STEPS IN THE BITE MARK RECORD

A. Steps involved in recording bite marks:

➤ Acquiring Evidence from the Victim:

- **Consent:** Evidence collection from the victim requires obtaining explicit consent. This should be in written form, signed by the victim in the presence of a witness. (7,8)
- **History Documentation:** Gather a comprehensive history of the individual, including dental treatments, and assess any potential impacts on the bite mark due to factors like washing, contamination, embalming, or decomposition.
- **Photography:** Crucial for preserving bite mark evidence, photography offers the most reliable means of documentation. Photos should be taken perpendicular to the injury, preferably at 24-hour intervals for both living and deceased victims to account for changes.
- **Saliva Swab:** Essential for trace evidence recovery, swabbing the bite mark helps collect saliva or human cell stains for DNA analysis. This includes taking swabs from the bitten area, control area, and oral cavity. The saline washing technique involves rinsing the bite mark area with normal saline, collecting subsequent saliva, and observing the filtrate under a microscope.
- **First Aid:** Stop bleeding by applying pressure with sterile gauze or cloth. Clean the wound with mild soap if needed and apply antibiotic ointment before covering it

with sterile gauze.

➤ Acquiring Evidence from Suspect:

Prior to gathering evidence from suspected biters, ensure proper legal authorization like a court order, search warrant, or signed informed consent containing specific information on evidence collection. The odontologist should explain the procedures to the subject before conducting them.

VI. CLINICAL EXAMINATION

- **External Examination:** This involves documenting the condition of both hard and soft tissues outside the mouth. This includes assessing factors like maximum mouth opening, any irregularities during opening or closing, the status of the temporomandibular joint (TMJ), dental alignment issues, muscle condition, facial symmetry, presence of facial scars or signs of medical procedures, and noting facial hair. (9,10)
- **Internal Examination:** Salivary swabs are taken, and observations are made regarding missing or damaged teeth. The tongue's size, function, and any abnormalities like ankyloglossia, bifid tongue, tongue or lip piercings are assessed. Additionally, the periodontal condition is examined, particularly focusing on tooth mobility.
- **Dental Impressions:** Using materials specified by the American Dental Association (ADA), two impressions of each dental arch are taken to create master casts using

type II stone. The relationship between the upper and lower teeth during biting is recorded. Duplicate casts can be made from the master cast, with one set used as direct evidence and the other for comparison purposes. Impressions are taken both with and without removable prosthetics, if present, without altering tooth or tissue records.

- **Bite Samples:** A bite in the centric occlusion is recorded using approved materials, such as Aluwax or Copra wax, following ADA standards. These samples are immediately photographed and retained for future comparison.

VII. METHODS OF ANALYSIS

The Odontometric Triangle Method is a systematic approach where three specific points are marked on both the bite mark's outline and dental models. These points correspond to the outermost parts of the canine teeth and the midpoint between the upper central incisors. They are then connected to create a triangle. By analyzing the lengths and angles of these lines on both upper and lower dental models and comparing them with the evidence marks, conclusive results are obtained after a thorough examination. (11,12)

A. Comparison Techniques:

- **Direct Method/Cast on Photo Method:** This technique involves directly comparing photographs with models or utilizing finger print powder to lift marks from the skin. The finger print lift technique entails dusting the bitten area with powder, transferring the marks onto acetate using finger print tape. (13,14)
- **Indirect Method - Overlay:** This method includes creating transparent overlays to record the suspect's bite edges. Transparent overlays are formed by tracing the dental model surfaces onto acetate sheets, which are then overlaid on scaled 1:1 photograph for comparison. However, this technique is considered subjective, prone to manipulation, and lacks reproducibility. The four methods for creating bite mark overlays are computer-based, radiopaque wax, xerographic, and hand-traced. (15,16)

B. Factors Influencing Severity of Bite Marks Force

➤ Original Injury Inflicted:

Negative pressure created by biting teeth and tongue leads to bleeding outside blood vessels, causing bruising at the center of the bite mark. These bruises undergo color changes during the healing process in a living person, reflecting various stages of injury recovery. (17,18)

➤ Degrees of impression:

There are four levels of impression that help identify the type of violence:

- Significant pressure
- First-degree pressure
- Violent pressure
- Skin torn violently from the body

➤ Anatomical Location:

Bite marks differ across body sites due to tissue mechanical properties; for instance, softer breast tissues create different marks than the back. Body parts with looser skin, less fibrous tissue, more subcutaneous fat, and varying muscular tone show easier bruising. Skin tension and movement influence the bite mark's appearance. Children exhibit more bruising due to delicate, loosely attached skin and subcutaneous fat, while elderly individuals show increased bruising due to reduced elasticity and fat. Women tend to have more subcutaneous fat and delicate skin, influencing bruising. (19,20)

➤ Time of Examination:

The appearance and duration of bite marks depend on the force and duration of the biting. Bruising may appear within four hours and vanish after thirty-six hours. Abrasions within the mark remain distinctive and aid identification. As swelling reduces and tissue repair begins, bite marks become more visible over time.

C. Recent Advances - Digital Methods Image Perception Software Procedure:

Using image perception software, a specific area of interest in a bite mark photo is selected. Different grey values are assigned particular colors, aiding forensic odontologists in identifying regions with similar grey values. This process isolates the bite mark region by excluding certain pixel intensity areas. A detailed duplicate of the bite mark is generated and superimposed onto the original photo using Photoshop. (21,22)

D. Automated Dental Identification System (ADIS):

ADIS is a computerized program used in postmortem victim examinations based on oral features. It offers precision and time efficiency compared to traditional methods. It examines and analyzes digital radiographs and dental images, which might be challenging to assess visually. ADIS shortlists multiple digitized dental records similar to the subject's.

E. 3D Reconstruction of Bite Marks:

Utilizing 3D-CBCT over traditional methods minimizes sample handling, reducing alterations in the original crime scene bite mark. It simplifies data storage and retrieval, provides better bite mark reproduction, reduces angular distortions, and ensures record permanence. This method objectively assesses dental code occurrence frequencies. Match strength between postmortem and ante mortem dental codes relies on dentist clinical experience. It compares databases of missing persons and criminals, aiding in determining the uniqueness of specific dental arrangements or fillings a person may have. (23,24).

F. Characteristics of Bite Marks

- Bite marks, typically displaying a distinctive horseshoe pattern from the front teeth of both upper and lower dental arches, are mostly caused by humans or animals. Usually, the lower front teeth are more evident in these marks, attributed to jaw movement during biting.

- Identifying bite marks involves examining their overall appearance, individual traits, and the location of the injury, as outlined by Sweet. These marks often appear circular or elliptical on the skin, with a central area of bruising due to tongue pressure.
- Class characteristics denote unique shapes associated with each type of tooth— Incisors are rectangular, Canines are triangular, while Premolars and Molars exhibit spherical or pointed shapes. Individual traits include fractures, rotations, and gaps, among others.

G. Mechanism of the bite marks

Bite mark injuries exhibit a wide range of appearances, from minor cuts to substantial sub-epithelial haemorrhages or skin bruising. The injury's manifestation on the skin after a bite depends significantly on the force and duration of the bite, as well as various mechanical and physiological factors. Human bite marks typically appear as U-shaped arches, superficially made by teeth, potentially accompanied by blood accumulation. Dental prostheses may leave distinct marks. (25,26)

Three primary mechanisms create these marks: tongue pressure, tooth pressure, and tooth scraping.

The Bite Mark Severity Index, graded from 1 to 6, gauges the severity of bite marks. This index possesses specific ideal attributes—it's user-friendly, reproducible, applicable to both living and deceased individuals, and universally accepted. It incorporates statistical tools for assessment. A severity scale of 1 indicates minimal bruising, absence of individual tooth marks, diffused visibility of arches, and an injury potentially caused by non-human dentition, holding very low or no forensic significance.

H. Controversies surrounding bite marks analysis

The controversies around bite mark analysis have intensified due to criticism from both legal and scientific circles. Some legal experts argue that bite mark evidence lacks scientific validity and should not serve as decisive proof in court. They point out issues like the absence of standardized methods, subjective interpretation, and the potential for examiner bias, questioning the reliability of bite mark analysis. Within the scientific community, concerns revolve around the reliability and consistency of bite mark examinations, alongside legal challenges. Studies have revealed that forensic odontologists often interpret identical data differently. The credibility of bite mark analysis as a forensic science has been challenged due to insufficient scientific rigor, limited research, and a lack of empirical evidence demonstrating its accuracy. (27,28)

I. Legal challenges and admissibility of bite mark evidence

Bite mark evidence's acceptance in court has faced intense scrutiny, subject to evaluation under criteria like Daubert and Frye, which guide the admissibility of scientific evidence. This examination delves into the challenges bite mark evidence encounters during trials and highlights pivotal court decisions that have shaped its admissibility. The Daubert standard, established by the US Supreme Court, mandates judges to assess the scientific basis, methodology, and relevance of expert testimony.

Court rulings have significantly impacted the admissibility of bite mark evidence. For example, the 2009 case of *Melendez Diaz v. Massachusetts* mandated cross-examination for laboratory analysts, including those involved in bite mark analysis, stressing the importance of ensuring the reliability of scientific testimony in court. (29,30)

Given these challenges, some countries are reevaluating the admissibility of bite mark evidence. Courts now scrutinize bite mark evidence more thoroughly, demanding a higher standard of scientific rigor before its admission.

J. Advancement of Bite Mark analysis

Collaboration across disciplines has significantly advanced bite mark analysis. This approach involves forensic odontologists, pathologists, medical experts, statisticians, and researchers from related fields, working together to address the complexities of bite mark examination.

Efforts toward standardization are crucial to improve the consistency and impartiality of bite mark analyses. Professional bodies and the forensic community recognize the need for standardized procedures and guidelines to direct forensic odontologists conducting bite mark examinations. (31,32)

These tools aid in automating analysis, identifying patterns, and conducting unbiased comparisons. Ongoing research aims to enhance the validity and reliability of bite mark analysis through interdisciplinary collaborations, validation studies, and the use of statistical models.

The field of bite mark analysis can advance further by integrating technological advancements and embracing a multidisciplinary approach, ensuring its credibility and effectiveness in forensic investigations.

VIII. CONCLUSION

Establishing national and global databases dedicated to bite mark analysis can simplify data sharing, facilitate comparative studies, and foster research collaborations. These databases can contribute to comprehensive repositories covering diverse populations, improving the accuracy and reliability of bite mark comparisons.

The future of bite mark analysis relies on education, collaboration, integration of new technology, and a stronger scientific foundation.

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