

FORENSIC ODONTOLOGY: THE NEW DIMENSION IN DENTAL ANALYSIS

Abstract

Forensic odontology a branch of Forensic sciences uses the skill of the dentist in identification during mass calamities ,sexual assault and child abuse¹.Identification of human remains is essential for various section as including legal, criminal, humanitarian and social grounds.¹Dental remains used for identification as it is cost effective, reliable and fast. Forensic odontology is a branch of dentistry that analyses dental evidence to overlap the dental and legal profession. Forensic information from soft tissues of the oral cavity, forensic methods of age estimation, therapeutic and molecular aspects of Forensic odontology have been elaborated.¹

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I. INTRODUCTION

Natural disasters and crimes still occur in the modern world along with advancements in science and technology.¹

Keiser-Neilson described forensic dentistry or forensic odontology as "that branch of forensic medicine which, in the interest of justice, deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of the dental findings" in 1970.⁵

II. HISTORY

The first person to be the focus of a forensic study was a female Emperor Nero, who was identified after her death due to the unusual arrangement of her teeth¹. Another example from 1775 involves Paul Revere recognizing revolutionaries by their dental work and teeth. Joseph Warren's remains was identified thanks to a walrus tusk that was used as a pontic for his missing maxillary canine.⁴ In 1977, a fascinating case regarding the identification of Hitler and Eva Brauma's bodies was made public. By using radiography, prostheses, and dental data, they were identified.⁴

On September 11, 2001, a sad catastrophe occurred in the United States, killing thousands of people at the World Trade Center. The victims' identities were determined via DNA. In order to identify some victims using DNA samples, the victims' tooth brush extracts were used⁷.

III. USING TOOTH AS A FORENSIC EVIDENCE TOOL

Using one's teeth to identify them: The morphology and arrangement of teeth are a distinctive pattern for each individual, making them helpful in identifying a certain person. Dental identification procedures are used to confirm the identity of the deceased. These procedures use dental evidence, such as dental caries, missing teeth, restored teeth, prosthetics, changes in tooth shape, such as taurodontism and talons cusp, and developmental defects, such as amelogenesis imperfecta and dentinogenesis imperfecta, as well as color changes, such as dental fluorosis. Every dentist must therefore maintain track of their patients' information for this reason.¹

Antemortem dental records' accessibility, sufficiency, and accuracy are crucial aspects of forensic dental identification. dental comparisons, like fingerprints and DNA.

Dental identification techniques can be categorized into the following categories, per the American Board of Forensic Odontology:¹¹

- 1. Positive Identification:** It can be determined that it is from the same person because the antemortem and postmortem data are consistent.
- 2. Possibility of Identification:** Although the equivalent items in the antemortem and postmortem databases share commonalities, neither source provides enough details to permit certain identification.

3. **Insufficient Identification Evidence:** The presumed identity of the deceased cannot be ruled out notwithstanding the lack of appropriate supporting evidence for comparison and certain identification. The identification is then deemed to be inconclusive.
4. **Exclusion:** Comparable entries in the antemortem and postmortem databases have unexplained variances. Sometimes there are comprehensible discrepancies, such as changes in restorations over time, tooth avulsion brought on by trauma at death, or post-mortem treatment that was not documented in the antemortem record. It is possible to explain the variations in any of these situations while maintaining identity.
5. **Investigating Crimes with Teeth: Bite Marks:** A bite mark, which is defined as "a mark caused by teeth either alone or in combination with other mouth parts," is an important piece of forensic evidence in a criminal inquiry.¹²

IV. CLASSIFICATION OF HUMAN BITES

Human bites can be classified in a number of ways, including as defensive or offensive¹⁵. MacDonald suggested an etiology-based classification.

Although it also applies to stains on other surfaces, it is pertinent to stains from human bites.

- **Tooth pressure marks:** The incisal margins of the anterior teeth are what cause this. They are steady and little distorted.
- **Tongue pressure impressions:** Due to tongue pressure, the palatal surfaces of the teeth, the cingulum, or the palatal rugae may leave impressions. As a result, marks are altered.
- **Scrape marks on teeth:** These happen when teeth have anomalies due to fractures, restorations, etc.
- **Compound marks** are a combination of the markings discussed above. The shape is dependent on the amount of tissue.

The following details about the surviving and deceased victims should be noted.

1. Collection of Bite Marks Evidence

- **Patient Demographics:** It is important to capture case numbers, examination dates, examiners' names, patients' names, ages, and genders.
- It is important to observe the bite mark's anatomical location, surface shape (flat, curved, or uneven), and any underlying tissue, such as bone, cartilage, muscle, or fat.
- The shape of the bite mark, including its roundness, ovoidness, crescent-shape, and irregularity, should be noted.
- **Mark color and size:** It's crucial to take care of the mark's horizontal and vertical dimensions.
- The type of injury, such as petechiae, contusions, abrasions, and lacerations caused by bite marks, should be documented.
- The kind of bite mark made by a human: Semicircular or crescentic bite marks are also possible.

2. Directives for Analyzing Bite Mark : The American Board of Forensic Odontostomatology (ABFO) issued the guidelines in 1986 to standardize the evaluation of bite marks.¹²

The following are the fundamental steps and tools needed for recording bite marks photographs.¹⁴

The photos are considered the most important victim evidence.

When shooting images, the camera should always be held perpendicular to any wounds. After an injury, images ought to be taken right away.

- Both in color and black & white
- Using and not using the ABFO number 2 scale.
- External and built-in flash
- Close-ups that are simple to scale to 1:1
- Using UV photography to record fading wounds
- A body-wide photograph displaying the injury
- If a movable anatomical location is the site of the bite.

- **Gathering of Swabs:** Swabbing bite mark injuries are essential to obtaining trace evidence. Saliva or human cells should be obtained whenever possible for DNA testing.¹⁴

- **UV illumination:** When examined under UV light in a dark environment, bite marks that are imperceptible to the human eye may become apparent. With this technique, bite marks will be visible up to six months after the incident.¹²

- **Impressions and Models:** Depending on the makeup of the skin, the bite markings may change, which could make them difficult to examine. To prevent mistakes brought on by the pattern-associated comparison, it is advisable to imitate bites at similar body locations using the suspect's study casts or by using digital technologies for a stepwise dynamic comparison^{16,17}.

- **Example Bites:** After fixing an acrylic stent to stop tissue shrinkage in cases involving deceased victims, bite marks and the underlying tissue may be removed. The specimen is then preserved in 4% formalin after that.

3. Bite Mark Analysis Methods: Triangle method for dental measurement - It is an objective method that entails joining the three locations designated A, B, and C along the bite mark to form a triangle, which is then traced. tips A and B are marked on the most convex tips of the canine teeth. A point C is placed in the midst of the two central incisors, and the three points are then connected to form the triangle ABC. This is carried out on both the upper and lower jaws. Results are produced by using statistics.

Comparison approach: The two kinds are direct and indirect.

- **Direct Method:** With this approach, suspect models can be placed over images of bite marks right away. Bite marks and study casts can be compared using three-dimensional (3D) pictures.

To facilitate comparison, the indirect method includes the production of a transparent overlay that is subsequently applied to scaled 1:1 photographs.

- **Software Technique for Visual Perception:** To compare and analyze photos of bite marks on teeth with overlays of potential dentition, new software was developed. Using image perception software, a 2D image can be represented as a 3D object.
- **Additional Original Methods for Biting Mark Analysis Include:** The Vectron is used to determine the angles and separations between fixed locations. The suspect's teeth are counter-mapped using stereometric graphic analysis. Using scanning electron microscopy to examine the bite mark wound. The ABFO provides several interpretations to explain bite mark comparison results:²¹
 - Disagreements between the bite marks and the suspect's teeth are excluded.
 - Inconclusive: Insufficient forensic data to draw a conclusion.
 - Potential biter: Someone with teeth and a dentition similar to the suspects' could create a mask that looked like the one that was seen.
 - Reasonable medical certainty: Suspect has been recognized as the bite's most probable offender (probable biter).
- **Additional Original Methods for Biting Mark Analysis Include:** The Vectron is used to determine the angles and separations between fixed locations. The suspect's teeth are counter-mapped using stereometric graphic analysis.
- **Biting Marks might be Difficult to Examine.**²¹
 - Creation is subjective
 - A component of subjective comparison
 - Distortion brought on by the skin's suppleness, anatomical arrangement, and body positioning is a persistent problem.
 - Data contamination and loss.
- **The Palatal Rugae are Further Oral Tissue Evidence:** The palatal rugae pattern is crucial for forensic information since it is unique to each individual, much like a finger print.

According to Thomas et al., rugae patterns might be diverge, converge, curve, wavy, straight, or spherical.²² According to V S K Shetti et al. (2011), palatal rugae are trustworthy instruments for classifying the Indian population.²³ M. Ohtani et al. (2008) looked studied the limitations of using palatal rugae for person identification in edentulous people.

Similar to how finger prints are utilized in forensics (cheiloscopy), lip prints are also employed.

Tsuchihashi et al. have suggested six different sorts of groove patterns for the lip.

Clear-cut vertical grooves that span the entire lip are classified as Type I; Type I' is similar but does not; Type II is defined as branched grooves; Type III is defined as intersected grooves; Type IV is defined as reticular grooves; and Type V is defined as non-morphologically distinct grooves. Tongue Prints –

The tongue is an organ that receives both nerve and blood vascular supply. Like any other organ, the skeleton is supplied with blood arteries, nerves, and muscles. Each person has a different tongue shape and surface textures.

V. FORENSIC AGE ESTIMATION METHODS

The order of eruptions, radiographic features like tooth germs, the start of mineralization, the degree of crown and root completion, the degree of root resorption of deciduous teeth, open apices, pulp to tooth ratio, volume of pulp chambers and root canals, third molar eruption, and digitization of available radiographs all help in estimating the age of the dentition. Histologic features like neonatal line, incr. Dentition is used to estimate age in three age groups: prenatal, natal, and postnatal; children and adolescents; and adults.

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The 14 phases of mineralization are used by the Moorer, Fanning, and Hunt method, which determines age, to generate single- and multirooted teeth.

Using the Demirjian, Goldstein, and Tanners technique, it was established that the seven mandibular permanent teeth that need to be thoroughly examined are the canine (C), lateral incisor (I2), central incisor (I1), first molar (M1), second molar (M2), and first premolar (M1).

The 10 phases of the Nollas method were used to evaluate the mineralization of permanent teeth in the maxilla and mandible.

VII. ADVANCES IN AGE ESTIMATION RECENTLY

According to study by Helfman P.M. et al., L aspartic acid racemizes to D aspartic acid as dentin ages. This can be used as a starting point when estimating age.

The increase in atmospheric carbon 14 levels between 1955 and 1963, which was brought on by nuclear weapons ground testing, is the foundation for determining age. A bomb pulse is the name for this phenomena.

Forensic facial reconstruction is a rapid, non-invasive, and successful method for identifying people from skeletal remains. Recent Trends in Forensic Odontology Facial Reconstruction. Two-dimensional (2D) and three-dimensional (3D) reconstruction methods are the two categories of reconstruction methods.

1. Various Manual 3D Reconstruction Techniques Include:

- The Tissue Depth Method was created by Krogman in 1946.
- Russian anatomical method.
- British Procedure/Manchester
- 3D forensic facial reconstruction using computers

2. Methods for Identifying Dentures: Denture marking falls into the categories of surface marking and inclusion approaches.

The method of surface marking entails engraving or etching an identification mark onto the surface of a denture.

The denture foundation can be included using techniques like adding paper, onion peel, or labels before polymerization.

VIII. LIMITATIONS OF RESEARCH IN FORENSIC ODONTOLOGY

- Ethical issues with forensic science sample collection.
- It costs a lot to apply molecular and biochemical techniques in forensic dentistry.

IX. CONCLUSION

Forensic dentistry has long been a part of forensic science. Forensic science has advanced greatly with the aid of teeth, biopsy samples, saliva, dentures, and other techniques.

DNA recovery from tooth samples has becoming much easier thanks to advancements in PCR techniques. Age estimation using biological markers and the study of amelithic writing are two of the most recent advancements in this field. Even dentures and bridges marked with identity numbers and initials can be used to identify persons in major disasters. Forensic odontology is the area of forensic science that is most important for "person identification".

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