

# TRACKING A BITE: A REVIEW

## ABSTRACT

Forensic Dentistry is the branch of dentistry which delineates the overlap between dental and legal professions. A Pediatric dentist plays an important role in forensic dentistry by applying his expertise in various fields such as child abuse and neglect, age determination, dental records, accidental or non-accidental oral trauma, and mass disasters by examination of the teeth and jaws structure for clues. These dental findings may be helpful in forensic identification wherein an unidentified individual can be identified. Lip prints and palatal rugae patterns can help in a person's identification. Teeth can also help in determining gender of the skeletonized remains using dental DNA. Forensic dentistry plays an important role in crime investigation in injury caused by dentition, such as bite marks. The aim of this article is to discuss the role of a pediatric dentist in various aspects of forensic dentistry/odontology and various procedures needed for examination, identification, and investigations.

## KEYWORDS

Age estimation, bite marks, forensic dentistry, forensic identification, pediatric dentist role.

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## INTRODUCTION

Forensis in Latin means before the forum (a place where legal matters are discussed).<sup>1</sup> Forensic Dentistry is defined as a branch of dentistry which, in the interest of justice, deals with the proper handling and examination of dental evidence, and with proper evaluation and representation of dental findings.<sup>2</sup> The father of forensic odontology Dr. Oscar Amoedo wrote first dissertation entitled *L'Art Dentaire en Legale* in 1898 which is considered as the first comprehensive book on forensic odontology.<sup>3</sup> Currently forensic dentistry/odontology has evolved as a separate specialty which relies on the knowledge of teeth and jaws, dental anatomy, and histology, radiography, pathology, dental materials, and various developmental anomalies. Forensic identification is a multidisciplinary team work that involves experts from law enforcement officials, criminalists, serologists, forensic anthropologists, forensic dentists, forensic pathologists, and other specialists, who help in establishing deceased identity, cause of death, factors contributing to death, and the time of death.<sup>2</sup>

### Role of a Pediatric Dentist

Using both physical and biological dental evidence, a Forensic dentist can identify human remains and bite marks. A pediatric dentist can play an important role in the identification of the bite marks. Dental trauma is a very common finding in children which is caused due to sports, accidents, or any abuse. A pediatric dentist can help in the investigations of legal officers by implementing his/her expertise in recognition of signs and symptoms of child abuse and identification of such victims. Also a pediatric dentist can contribute information to physicians about oral and dental manifestations of child abuse and neglect.<sup>2</sup> Pediatric dentist is also concerned with the maintenance of antemortem records which may be useful in dental identification later.

Proper recording of dental findings is an important step in management of the dental records. As a child undergoes continuous physiological changes, each and every finding should be recorded in detail. The dental record is a valuable legal document owned by the dentist. All the entries must be signed by the

recording personnel. Any changes in the record should not be erased at any cost. Else it should be corrected with a single line drawn through the incorrect material, so that the original entry will remain readable.<sup>4</sup> Dental records of a child patient has to be retained until he/she reaches the age of maturity. For adults, the record is usually kept for 7-10 years. Various dental records include different clinical tests, laboratory tests, prosthesis, study models, radiographs and photographs.<sup>5</sup>

### Dental Identification

Teeth are considered as one of the most indestructible structures and are usually resistant to postmortem decomposition. Human dentition is never ever similar in any two individuals. Morphology and arrangement vary in every person.<sup>1</sup> Hence teeth are considered to be more unique. This uniqueness make it a cornerstone in positive identification of living or deceased individual.<sup>2</sup> Dental impressions serve as an invaluable tool as they are found to be more unique than DNA. Similar kind of genetic makeup may be shared by identical twins, but their dental impressions differ.<sup>6</sup> Furthermore, most of the materials used in dentistry seems to be resistant to postmortem decomposition. Hence dental evidence is very much helpful in identifying badly burned, traumatized, decomposed, or any skeletonized remains in mass disasters.<sup>1</sup>

### Comparative identification

The postmortem dental remains are usually compared to the antemortem dental records to confirm the identity of the suspected individual. In children below 5 years of age, nil or minimal comparable data is available due to less number of filled/restored teeth and very few radiographic indications. Normal maturational changes in the growing period will alter the dental records. If the child has reached the age of 5-6 years, bitewing radiographs always act as a part of dental record even if there is absence of any filling/restoration or treatment needed is low.<sup>2</sup> Oral autopsies are done to remove tongue and contents of the floor of mouth in a tunneling fashion to obtain postmortem radiographs or records in comparative identification. Separate postmortem and antemortem units act as a part of this identification team.<sup>1</sup>

## Reconstructive identification/ Dental Profiling

When virtually no clue exists for the identification of the deceased, dental profiling is done to elicit ethnicity, race, sex, and age of the dead individual.

### Ethnicity

Various nonmetric characteristics such as Carabelli's trait, shovelling, three cusped maxillary second molar, four cusped mandibular molars and mandibular molar groove pattern may help in finding the ethnic origin of the deceased depending on the presence or absence of the above mentioned features. Different features have to be considered together while concluding an ethnic origin.<sup>1</sup>

### Sex determination

Various methods are used for sex determination using teeth which includes visual/clinical method, microscopic method and advanced method.

**Visual/clinical method:** In young adults, buccolingual and mesiodistal dimensions of teeth are found to be helpful in sex determination. Among teeth greatest sexual dimorphism is exhibited by canines as it is less carious and highly resistant to postmortem changes. 86% of success rate in sex determination has been observed with Mandibular canine index (MCI), which is measured by calculating the ratio between mesiodistal mandibular canine crown width and intercanine width. The standard MCI value is 0.274. Higher MCI value indicates male and lower value indicates female.<sup>1</sup>

**Microscopic method:** Barr bodies are inactive X chromosome found in female somatic cell. They can remain in a dehydrated pulp for 1 year. When heated up to 100°C for 1 hour, these Barr bodies can show sexual diagnostic features. DNA analysis done to find out the presence or absence of Y chromatin is a definitive method for determining sex.<sup>1</sup>

Advance methods include use of AMEL gene and polymerase chain reaction (PCR).

AMEL gene codes for a major matrix protein secreted by ameloblasts called amelogenin.

AMEL gene is located on both X and Y chromosomes. Females will show two identical AMEL genes while males will show two genes which are not identical. DNA amplification done by PCR yields 100% success in sex determination.<sup>1</sup>

### Age estimation

Skeletal/craniofacial structures such as long bones, closure of fontanelle/sutures, and ossification of hand-wrist bones, and mandibular features can be used in age estimation. Age assessment in prenatal, neonatal, and early postnatal period can be very accurate as different events are like tooth-bud formation, completion of formation of primary teeth enamel and formation of permanent first molar. The indicator of birth, neonatal line indicates a live birth. Hence it has got legal implications in foeticide and infanticide.<sup>1</sup>

Tooth eruption and tooth calcification are important events in age estimation in case of children and adolescents. It is a convenient clinical method. It can be assessed both visually and radiographically. Modified Demirjian's method uses the development of teeth divided into ten stages each.<sup>3</sup>

A regression formula was formulated by Acharya for the age determination in Indian children. The formula is given below.

Male age =  $27.4351 - (0.0097 \times S2) + (0.000089 \times S3)$

Female age =  $23.7288 - (0.0088 \times S2) + (0.000085 \times S3)$

Gustafson's method is used for age determination in adults. The method includes assessment of various events namely attrition (A), secondary dentin deposition (S), loss of periodontal attachment (P), cementum apposition at the root apex (C), root resorption at the apex (R), and dentine translucency (T). Incremental lines in acellular cementum are used in age estimation. Hypomineralized bands in the incremental line indicate pregnancy, skeletal trauma, and renal disorders which can be related to person's life history, facilitating identification. Mineralized unstained cross-sections of teeth are used.<sup>1</sup>

Amino acid racemization is a biochemical indicator in age estimation. Aspartic acid has got a rapid rate of racemization (high in root

dentin). With increase in age aspartic acid spontaneously gets converted from L-type to D-type. Hence, at different ages there seems to have a constant change in the ratio of L-and D-aspartic acid which is used for the age estimation. Both incremental lines and aminoacid racemization estimates age within  $\pm 3$  years of actual age.

## Dental DNA for Identification

More than fingerprints, scars, and facial appearance DNA has got a greater chance of survival. It acts as a basis of all blood group types, red cell antigens, and protein isoenzymes. Teeth serve as an excellent source of DNA. Rich sources of DNA include odontoblasts, peripheral nerves, fibroblasts, undifferentiated mesenchymal cells, endothelial cells, and nucleated components of blood in pulpal soft tissue. By tooth sectioning, tooth crushing, or cryogenic grinding technique, dental DNA can be made use in identification of suspected individuals.<sup>7</sup>

## Palatal Rugae Pattern

"Palatal Rugoscopy" is an ideal parameter for identification as rugae usually do not undergo any change except in length. Rugae shows resistance to decomposition to an extent. They keep the same position throughout the life of an individual. It reappears even after trauma or surgery. Hence palatal rugae pattern is unique to every single person.<sup>8</sup>

## Lip Prints

Lip prints obtained from an individual are permanent and unchangeable. Study of lip prints is known as Cheiloscopy. From the 6th week of intrauterine life identification of lip pattern is possible. So these patterns can act as an important evidence left at the crime scene. Any major trauma to lips result in scarring and also surgical treatment affects the size and shape of lips. Depending on the pressure applied or direction of pressure application, lip prints differ in their appearance.<sup>8</sup>

## Bite Marks

Application of Forensic odontology in crime investigation includes identification of bite

marks caused by dentition. Bite marks are often associated with child abuse, violent fights, sex crimes, sporting events and sometimes self-inflicted too.<sup>9</sup> A Pediatric dentist should be able to meticulously observe and document bite marks. He/she should have thorough knowledge about such findings and their significance. Bite marks can be found on an injured tissue or an inanimate material such as foodstuffs and can accurately depict the unique pattern of the biter's teeth.<sup>10</sup>

Initially, bite marks appear as indentations due to the pressure applied by teeth. But these indentations will soon disappear due to elasticity of skin and later edema occurs over the bitten area. Which obscures the bite marks completely. When this edema subsides subcutaneous bleeding is seen as contusions or bruises. Lacerations can be seen when the bite intensity is more. The most extreme form is avulsion where a part of a tissue is bitten off.<sup>1</sup>

Milk teeth bite marks consists of smaller, rounded, bow-like arches and spacing between them. Generally bite marks appear as circular/elliptical with a central ecchymosis. Classical features/appearance of bite marks for incisors (rectangular marks), canines (triangular/rectangular), premolars and molars (spherical/point) differ from each other. Individual characteristics such as fractures, rotations, crowding and spacing are also very helpful in identification of the suspect. A classical bite mark presents as oval or circular mark consisting of two opposing arcades, separated by a small open space at their bases with a diameter of 25–40 mm. Central bruising with clear tooth marks, and individual dental characteristics give a strong evidentiary value.<sup>9</sup>

Following confirmation of the injury a bite mark investigation should be done. Bite mark investigation include collection of evidence from the victim and records from the suspect. Dental record of the bite mark includes photography, impression, models, and saliva swab collection. Photographs should be taken first as it should not affect any other records such as impressions and taking swabs.<sup>11</sup> Two types of photographs have to be taken, one for an orientation and the other a close-up view. Photographs should be taken for 3 consecutive days for documentations.<sup>10</sup> Polyvinyl Siloxane impression is used to record the bite mark immediately after swabbing it.<sup>2</sup> Recognition of any uncommon features of bite mark helps in accurate identification.

Inter canine distance method is usually recorded to recognize primary dentition and permanent dentition. Distance <30mm belongs to a child and a distance above 30 mm belongs to an adult.<sup>9</sup> Other methods used include odontometric triangle method and comparison technique. Odontometric triangle method is an objective method. In this method a triangle is made by marking three points A, B, and C on the bite mark tracings and teeth models. Point A and point B are marked on the outermost convex points on the canines and centre of the two central incisors is marked as point C. These three points are joined to form a triangle ABC. The lines AB, BC, and CA are measured, and corresponding angles a, b and c are also calculated. This is done in both upper and lower casts. The values obtained are compared with the bite marks on wax, apple or skin. Data analysis is done statistically and the results are obtained.<sup>12,13,14</sup>

In comparison method comparison of bite mark measurements are made with suspect's impression models. Direct comparison is done by placing suspect's model on the bite mark whereas in indirect method suspect's model is traced onto clear acetate and compared with the photographs taken.<sup>11</sup> nowadays computer software programs have been developed which can be used for comparison.<sup>1,15</sup>

In odontometric triangle method (objective method), a triangle is made on the tracing of bite marks and teeth models by marking three points A, B, and C. Points A and B are plotted on outermost convex points on the canine teeth.

Center of two central incisors is selected as Point C. All three points are joined to form triangle ABC. Lines AB, BC, and CA are measured, and angles a, b, and c are calculated. This is done for both upper and lower jaw teeth model and compared with that of bite marks of wax, apple, and skin. Statistical analysis is carried out, and results are obtained.

## CONCLUSION

Wide variations exist in size, shape, structure, form, cusp locations/projections of teeth, and in facial profile and chin relations which is unique to every individual. This uniqueness of dental records help in identification. A pediatric dentist can play an important role in bite marks analysis, injuries, and child abuse and proper management, examination,

evaluation and preservation of child dental evidence in criminal or civil legal proceedings in the interest of justice.

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