

Orthodontist's Forensic Vision

Abstract

The responsibility of orthodontists in the practice of their profession and the richness of information found in orthodontic records, forensic case of an individual whose remains were incinerated can easily assessed using information from a panoramic radiograph and intraoral photographs taken during orthodontic treatment. The orthodontist can easily recognize and assess bite marks. Indexing and identification of bite marks has high evidentiary value in forensic odontology.

Key Words

Bite Marks, Rugoscopy, Cheiloscopy

Introduction

Forensic Odontology (Dentistry) is that specialty of dentistry which deals with the application of the knowledge of dental sciences to the furtherance of law and justice. It involves the recognition, correct handling, collection, recording, preservation, archiving, and presentation of dental records as evidence in a court of law or to other law enforcing agencies. Its primary scope is concerned with person identification, age estimation, dento-maxillo-facial disability estimation, domestic violence and child abuse, dental malpractice, fraud, or negligence claims, and occupational hazards in dentistry.

Though a relatively young branch of dentistry, especially so in India, forensic odontology plays a pivotal role in the identification of victims of mass disasters, crimes, terrorism, road traffic accidents and unidentified bodies.

The use of teeth as evidence is not recent. There are historical reports of identification by recognizing specific dental features. However, Forensic Odontology, as a science, did not appear before 1897 when Dr. Oscar Amoedo wrote his doctoral thesis entitled "L'ArtDentaire en MedecineLegale" describing the utility of dentistry in forensic medicine with particular emphasis on identification.¹ Dental identifications are based on two main processes. The first involves a comparative technique where ante mortem dental records are accessed, assessed and compared with the postmortem dental recordings of the deceased. The identification by this technique is only possible if dental

records are available in fairly satisfactory condition. In situations where ante mortem records are unavailable, the forensic odontologist is called upon to do a dental profiling which might help in narrowing the zone of search and make identification easier. Identification of the deceased is most commonly achieved visually by a relative or a friend who knew the person during life. This is performed by looking at characteristics of the face, various body features and/or personal belongings. However, this method becomes undesirable and unreliable when the body features are lost due to post- and peri-mortem changes (such as decomposition or incineration). Visual identification in those circumstances is subject to error. Methods of human identification that are acknowledged as scientific are fingerprint, DNA, dental and medical characteristics.²

The markers of dental records most commonly relied on by a forensic odontologist for dental comparison and relatively accurate identification are - recording the decayed, missing and filled teeth (DMFT), crown and root morphology, periodontal health, alveolar bone morphology, details on maxillary sinus, condylar and coronoid process and the TM joint. The diversity of dental characteristics is wide, making each dentition unique.³ The dental enamel is the hardest tissue in the body and hence withstands post-mortem changes and to some extent so would dental materials adjoined to teeth.

Dental aging is based on the chronology of formation and eruption of teeth. This

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helps in determining the age for persons up to 15 years-old in a fairly accurate manner. After 15 years of age, dental aging relies on modifications that take place during life, such as attrition, cementum formation and root transparency.⁴ The forensic dental profiling in the absence of ante mortem records would be able to provide inputs on age, sex, ancestry, race, socio economic status and dietary habits. Essentially it is quite clear that the key to accuracy in forensic odontology lies in

Record Keepings

Orthodontics is the specialization whose purpose is the prevention, supervision and guidance of the development of the masticatory system, the correction of dentofacial structures, including the conditions that require tooth movement for their treatment, and the establishment of esthetic harmony of the maxillary and mandibular structures of the face. Because of the complexity of cases and the considerable time spent working with orthodontic patients, orthodontists produce several dental records,

fundamental for the planning and performance of this type of treatment. These records usually include dental charts, which may be defined as the comprehensive document that contains all data about patient identification and history, answers to a health questionnaire, findings of general physical examinations and extra- and intraoral exams, treatment plan chosen and authorized by the patient and treatment outcomes. Patient records are also used as a file to store complementary tests required by the orthodontic treatment, such as radiographs, plaster impressions, photographs, tracings, and other specific documents. The storage of dental records enables the orthodontist to follow the clinical development of treatments under way and those already completed at any time. In Forensic Dentistry, the importance of these stored materials is associated with both issues of professional defense, in cases of law suits against dentists, and the identification of skeletonized, putrefied or incinerated cadavers. Considering the responsibility of orthodontists in the practice of their profession and the richness of information found in orthodontic records, forensic case of an individual whose remains were incinerated can easily be assessed using information from a panoramic radiograph and intraoral photographs taken during orthodontic treatment.

The orthodontist can easily recognize and assess bite marks. Indexing and identification of bite marks has high evidentiary value in forensic odontology. The limitations being only the relatively small percentage of individuals seeking orthodontic treatment from amongst the general population, particularly in India.

The various methods employed in forensic odontology include bite marks, rugoscopy, cheiloscopia, tooth prints, radiographs, and photographs. Though the shortcomings with these various methods are few, the discrepancies associated with them are to be weighed cautiously to make forensic odontology a more accurate, reliable, and reproducible investigatory science.

Bite marks

History: Role of bite marks in FO (Forensic Odontology)

The first case solved by bite mark identification was the famous "Salem Witch Trials" in 1692 in United States. During the trial, the bite marks were

compared to the marks present on the body of the victims by a forensic odontologist.

"Ted Bundy" killed numerous people between 1973 and 1978 but was finally tried for the murder of Lisa Levy in Florida State University, through the bite marks that he inflicted on her body. He was later convicted by accurate identification matching of his bite marks with those found on the victim's body.

Mac Donald defined a bite mark as a mark made by the teeth either alone or in combination with other mouth parts⁵. Bite marks are found on human body or food or on materials such as wooden cabinet, bottle cap, cigar and cigarette holders, pipes and musical instrument mouth pieces^{6,7}. Usually bites are the result of sexual or physical assault by an adult on a child, rape or attempted rape, quarrels and fights among men⁷. Not all human bites are associated with homicides, sexual assaults or child abuse cases. They may be produced due to self-defense when defending against aggressive animal or self inflicted as tongue bite in epileptic fits or fall from heights⁸. Mac Donald's etiological classification⁵ of bite marks is as follows:

- a) Tooth pressure marks caused by incisal edge of anterior teeth
- b) Tongue pressure marks seen as impression of the palatal surface
- c) Tooth scrapes mark may be scratches and abrasions that can indicate irregularities in the teeth such as incisal fractures, restorations or attrition
- d) Complex marks are a combination of all the above, occasionally complicated by multiple bites.

Gustafson's clinical classification⁹ of bite marks is as follows:

- a) Sadistic or sexual bite is usually made slowly and is therefore well defined.
- b) Aggressive bite is made quickly with force and is caused by scribing across the tissue.
- c) Most aggressive bite results in tissue being bitten off usually and involves ears, nose, and nipples.

The American Society of Forensic Odontology (ASFO) & American Board of Forensic Odontology (ABFO) have given various guidelines for assessing similarities and discrepancies between the Ante-mortem and Post-Mortem dental features. According to the ABFO

guidelines, the bite marks are classified on the basis of:- (1) the relationship of the jaws, (2) the form and size of arches, (3) missing teeth, (4) spacing between teeth, (5) presence of supernumerary teeth, (6) observed rotations of teeth, (7) the width of teeth, and (8) presence of special features such as fractures and ridges.

Anatomical location The anatomical location of a bitemark is also crucial in determining its potential to be analysed. If one considers that the breast is by far the most commonly bitten location, this presents a considerable problem. Breast tissue is highly mobile and easily deformed and therefore it can be difficult to determine the position of the breast during biting or the effect of the bite force on the deformity of the tissue and hence the injury.^{10,11}

Bitemarks on the arm and leg can be similarly affected, depending on their position at the time of biting.^{10,11}

Presentation of bitemark injuries

Bitemarks will typically present as a semi-circular injury which comprises two separate arcs (one from the upper teeth, the other from the lower) with either a central area absent of injury, or with a diffuse bruise present.¹² It is not unusual to see only one arch of teeth on an injury and, if this is the case, it is most often the lower teeth that are present which relates to the mechanics of biting, i.e. the maxilla remains stable while the mandible moves until the teeth meet.¹² There are three main factors that influence the severity of a bitemark injury:

1. The force by which the original injury was inflicted
2. The anatomical location bitten
3. The time elapsed between infliction

The American Board of Forensic Odontology provide a range of conclusions to describe whether or not an injury is a bitemark. These are:

Exclusion - The injury is not a bitemark.
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.

The first stage of any analysis is to

determine if the injury is a bitemark, and then to provide a statement on the forensic significance. If one or more suspect's dental casts are available, and the bitemark is suitable for analysis, then an overlay comparison can be conducted.

Bite marks- indexing

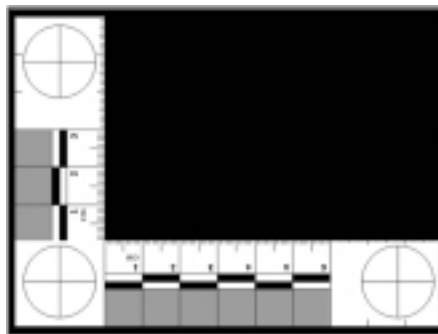
Bite marks can be best reproduced with the help of impression materials like hydrocolloids and light-body vinyl polysiloxane (VPS). Polyether has been also found to have excellent accuracy, long term stability, good elastic recovery and excellent tear resistance. Its excellent hydrophilicity ensures impressions with superior detail reproduction in wet surfaces, including areas difficult to access. The impressions can then be duplicated in die stone and used for assessment with ante mortem records.

Injuries of bite marks may be abrasions, bruises or lacerations. Teeth crush the superficial epithelium and leave its imprint, which can be photographed appropriately. It is imperative to take an early photograph as a bite bruise usually disappears in twenty minutes. However, infrared photographs can show deep-seated bleeding¹³. Lacerations having ragged edges are mostly found in cases of animal bite. Human bite mark is almost circular or oval, whereas animal bite mark is narrowing U-shaped¹⁴. Not all teeth are involved in a bite and usually consist of three or four upper teeth and one or more lower opposing teeth¹⁵. Bite marks investigation starts with the examination of wound and if identified as bite mark, to identify the teeth involved, notify any peculiarity of size, shape, position to detail the individual tooth features seen in marks and those seen in tooth of the accused, followed by photography¹⁶.

Further analysis of bite marks is done by superimposition of marked transparency of inked edges of the plaster model of teeth over the bite mark¹⁷⁻²⁰. Presently, scanning electron microscope and computerized axial tomography (CAT) technique is also used to develop precise registration of incisal edge for comparison of bite mark²¹

Identification of the bite mark can also be done with the help of accurate and high precision photography. The bite mark is photographed keeping the **ABFO No. 2 scale** adjacent to it. It is then digitized by scanning and accessing the images for comparison using a software program like ADOBE Photoshop 8.0. New

research is underway to allow digital comparison of teeth and bitemarks at a 3-dimensional level.²² This novel technique is aimed to overcome perspective distortion, a significant morbid factor in bitemark analysis that results from reducing 3-dimensional objects to 2-dimensional images.



American Board of Forensic Odontology (ABFO) NO.2 SCALE

Bite marks- UV photography-

Reflective ultraviolet photography (RUVF) is the latest advancement in the bite mark photography. This technique deals with the accurate visualization of bite marks which are impossible to be viewed even with the help of high definition photographs taken from different angles. RUVF records the reflection and absorption of long-wave UV light by the subject matter excluding exposure of the film by all visible light. Long-wave UV light penetrates deeper into the skin than does visible light, therefore, by placing a specially designed filter over the camera lens, one which will only allow a specific wave-length of UV light (less than 400 nanometers) reflective UV photographs can be taken. Since UV light penetrates deeper into the skin, the film will pick up the image of a bruise or bite mark, which has been absorbed too deep into the skin to be able to be seen using visible light.

Study of palatal rugae (Rugoscopy)

Palatal rugae comprises about three to seven ridges radiating out tangentially from the incisive papilla. These ridges can be classified as curved, straight, wavy, and branched. The pattern of these rugae is considered unique to an individual. In instances where postmortem dental identification is not possible, as in edentulous mouths, palatal rugae can be used as supplement. Postmortem identification is not possible without the ante-mortem records. Complex rugae patterns that cannot be classified under

one particular group can cause intra or interobserver errors. Kapali et al.²³ have observed that denture wear, tooth malposition, and palatal pathology can cause alterations in rugae patterns

Examination of lip prints (Cheiloscopy)

The external surface of the lip has numerous elevations and depressions that form a characteristic pattern, referred to as lip prints. Using lip prints for personal identification in forensic odontology is an accepted method in the criminal justice system worldwide. Impressions are made from the middle portion of the lower lip, an area always visible in any trace made, and the characteristic patterns are studied. Various factors can alter lip print recording. Lip prints have to be obtained within 24 hours of the time of death to prevent erroneous data that would result from postmortem alterations of lip²⁴

Examination of tooth prints (Amelography)

Ameloblasts lay down the enamel rods in an undulating and intertwining path. This is reflected on the outer surface of the enamel as patterns of the ends of a series of adjacent enamel rods. This study of the enamel rod end patterns is termed as amelography by Manjunath et al²⁵ and could aid as an identification tool in decomposed or burned bodies as enamel can resist decomposition

Radiographs

Dental features do change over time and for this very reason, dental based identification is considered less reliable compared to other biometric methods like finger prints. But in victims where there is complete decomposition, radiographs may be the only available biometric method. Various morphological and pathological alterations can be studied from the radiographs. In morphology based studies, root morphology comparatively aids better identification than crown morphology.²⁶

Photographs

Photographs are valuable substitutes for written records and can overcome language barriers. However, photographs have considerable inherent limitations and stringent requirements are needed for accurate reproduction. The basic difficulty arises when three-dimensional

objects are replicated as two-dimensional photographs, which can create distortion, and color change.

The landmark case of an orthodontist serving as a Forensic Odontologist was in the early months of 1994 in which numerous human remains were exhumed in connection with what came to be known as the 'Cromwell Street murders' or the 'Frederick and Rosemary West' case. In the case, a young female was murdered and some of her teeth were missing, potentially presenting difficulties for comparison with information available at the time of her death. Orthodontist at the Forensic Dental Laboratories at Cardiff used high resolution photographs of the skull and superimposed over the females face. Moreover, they also replaced a labially tipped upper lateral incisor and finally proved the skull to be the same as that of the missing girl.

Conclusion

It would not be unjustified to state that the orthodontist by virtue of his training and the stringent demands of his profession is adept at record keeping. Routine pre treatment diagnostic record assimilation is ingrained in the orthodontist from the very days of the post graduate training. Detailed case history recording by an orthodontist comprises of medical history, previous dental history alongside intraoral and extra oral examination. The orthodontist is quick at assessing and recording details of cephalic and facial index which provides vital inputs into anthropometric parameters. His unmatched knowledge about the various aspects of the teeth which include the position and angulations of various teeth, inter canine and inter molar width and various aspects regarding implication of 2D & 3D radiographs, gives him an edge in the field of forensic odontology.

In cases where it is impossible to identify the body of a person on the basis of soft tissue examination only, it becomes important to assess the hard tissues i.e. the maxilla and the mandible in various planes for a correct match. Cases where the body of the individual is severely burnt or is impossible to identify on the basis of various soft tissue appearances, would require a more complex assessment of the relatively unchanging hard tissues, which are the maxilla, mandible, the dentition, & cranial base. The process of tracing maxilla, mandible and cranial base, in various planes and

assessing them with respect to various analysis present to identify the deviation from normal, can readily help the forensic odontologist to match with the post-mortem records of the individual.

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