Review Article

Forensic Odontology - "Dentist as a Third Eye"

Nikhil Raj, Jeena Sebastian, GK Shakunthala, B Siva, P Shibu[1]

From the Department of Oral Medicine and Radiology, Mahe Institute of Dental Sciences, Chalakkara, Puducherry, [1]Department of Oral Pathology, Pariyaram Dental College, Pariyaram, Kerala, India

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Abstract

Forensic odontology plays a key role in the identification of those individuals who cannot be identified visually or by other means. Forensic odontology involves the management, examination, evaluation, and presentation of dental evidence in criminal or civil proceedings, all in the interest of justice. The unique nature of dental anatomy and placement of custom restorations ensure accuracy when the techniques are correctly employed. Forensic odontologist must also have the basic knowledge of the role of a forensic pathologist and the methods used in autopsy, as dental evidence is the most valuable and reliable method. Dental professionals play a major role in keeping accurate dental records and providing all necessary information so that legal authorities may recognize malpractices, negligence, and child abuse and also identify an individual. In this article, we will discuss such evolvement of the subject. This review is based on the information collected from standard research articles and literature from textbooks. Data were thoroughly evaluated and formatted.

Key Words: *Age estimation, bite mark analysis, dental records, forensic odontology, mass disaster, sex determination*

Introduction

Each person's day starts with crave to know the happenings around him through newspapers and other media. In today's world, crimes and rapes are increasing disastrously, and most of the crimes are unrevealed due to the lack of evidence. In these situations, forensic odontology plays a major role in the identification of those individuals who cannot be identified visually or by other means. This review is based on the information collected from standard research articles and literature from textbooks. Data were thoroughly evaluated and formatted.

According to Federation Dentaire Internationale, forensic odontology is that branch of dentistry which in the interest of justice deals with proper handling and examination of dental evidence and presentation of dental findings.[1]

Keiser-Nielsen has defined forensic odontology as "a branch of dentistry which deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings in the interest of the dentist."[1]

This branch gives very importance to dental evidence for the identification of victims and suspects in many criminal cases and in mass disasters. It plays a major role in the identification of man-made or natural disasters. Many cases which may not be identified by visual recognition or even fingerprints can be identified using various techniques of forensic odontology. It primarily deals with identification based on the features which are present in a person's dentition.[2-4]

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Based on the fields of activity, Avon classified forensic odontology into three fields.[3]

- Civil
- Criminal
- Research.

Role and Importance of Forensic Dentistry

- Management and maintenance of dental records
- Identification of the human remains
- Collection and analysis of patterned marks
  - Lip print analysis
  - Palatal rugae identification
  - Bite marks
- Assisting at the scene of mass disaster
- Age estimation of both living and dead persons
- Presentation of dental evidence as an expert witness in identification, bite mark, human abuse malpractice, fraud, and personal injury
- Assessing the sex of skeletonized remains
- Eliciting the ethnicity/population affinity and assisting in building up a picture of lifestyle and diet of skeletal remains at forensic and archeological site.[1-4]

a. Management and maintenance of dental records: Documentation of all unique dental information which

Address for correspondence:
Dr. Nikhil Raj, E-mail: nikkies87@gmail.com

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acts as a foundation on which dental identification of the patient is completed and potential malpractice litigation is reduced. Most people visit the dentist in their lifetime, so there is high chance that antemortem record can be found and matched with the victim. Forensic dentist can obtain the patient's details from the private dentist and can compare the findings in an unknown person[3-7]

b. Identification of the human remains: It is done through the comparison of antemortem and postmortem dental findings in cases such as mass disasters or individual death:
A positive identification of living and dead using the teeth and jaws is the cornerstone of forensic dentistry. It requires the collection of dental information from the recovered remains. Once this is established then the comparison is made with dental findings of missing or suspected individuals. There are two basic types of identification, unknown and confirmation. Unknown is where there is no identification of the body. Confirmation means that it is confirmed as a particular person. Forensic odontology is the best method to identify burned or decomposed bodies.[8]

Steps for personal identification:

- Comparative antemortem and postmortem records
  Dental identification includes missing teeth, dental caries, restorative materials, prosthesis, and pathological lesions of head and neck.
- Reconstructive postmortem dental profiling:
  It includes decedent's ethnic origin, sex, and age. By analyzing the genetic and environmental influences on teeth by metric and nonmetric analysis, ethnic origin of the person can be identified.
- By DNA profiling methods
  When the antemortem records of the dead person are not available tooth is used to identify the person by extracting DNA, and then it is compared with the close relatives.
- Denture identification
  Denture with label will serve as good evidence in person identification. Dentures which are not labeled will be fitted to the cast if it is available which is obtained by a treating dentist and compared.
- Sex determination
  Done by DNA analysis using X and Y chromosomes. Sex determination can also be done by measuring the tooth size and comparing the craniofacial morphology.[3,4,8]

c. Assisting at the scene of mass disaster Dental identification has been regarded as one of the primary identifiers in the Interpol disaster victim identification protocol. Sometimes, it may prove to be the only method that can be used to make or disprove identification.[9]
By definition, the term disaster means a sudden occurrence that exceeds the resources available in a community to deal with it. Mass disaster is a disorganized event which is initiated by a destructive force which results in multiple fatalities that require identification.
Dentists play a vital role in mass disaster. Identification of the victims in mass disaster is not only humane but also helps in the civil and criminal investigation.
Forensic odontology team will recover the remains at the mass disaster site, and postmortem examination is carried out by examining of all dental structures, photographs, reconstruction of the fragmented remains (excision of the jaw), charting and documentation of restorations, and anomalies. Antemortem records are collected and compared with the postmortem findings, and the positive identification of the deceased is made.[10]
Sex determination: Forensic odontology plays an important role in establishing the sex of the victims with bodies mutilated beyond recognition due to major mass disaster. Sex can be determined based on data from morphology of skull and mandible, metric features as well as by DNA analyses of teeth.[8]

d. Age estimation of both living and dead persons
Estimation of the age at the time of death can be done, which will narrow the possible identities. Age determination is very important in setting of a crime investigation or mass disaster. Related to dentistry, age changes in teeth are attrition, periodontal disease, secondary dentin deposition, root translucency, cementum apposition, root resorption, color changes, and increase in root roughness. Age estimation is the final step in the triad of dental profiling. There are many methods to estimate the age which gives the information about estimated year of birth and also chronological age of the person at the time of death. Age estimation is done by following methods.
   1. Morphologic methods
   2. Radiographic methods
   3. Histological methods
   4. Biochemical methods.

It is one of the measures of physiologic development that is uniformly applicable from infancy to late adolescence. It gives very important information about the age of a victim whether he is a juvenile or adult involved in crime. It also helps to sort out many civil issues regarding the property. Age estimation plays a major role in maintaining or obtaining forensic case work which involves dead victim identification as well as crimes, employment, education, and marriage.

Gustafson's method - in 1950, Gosta Gustafson developed a method for age estimation based on morphological and histological changes of the teeth. They assessed regressive changes such as attrition (A), secondary dentine deposition (S), loss of periodontal attachment (P), cementum apposition at the root apex (C), root resorption at the apex (R), and dentin translucency (T).[11,12]

Dentin translucency method is done by calculating the decreased diameter of dentinal tubules due to intertubular calcification. The difference in refractive indices between intratubular organic and extratubular inorganic material is equalized, resulting in increased translucency of the affected dentin.[8,12]

Age estimation from incremental lines of cementum is possible using mineralized, unstained cross-sections of teeth, preferably mandibular central incisors and third molars. The accuracy is claimed within 2–3 years of the actual chronologic age.[13]

Radiographic age estimation methods

Human dentition follows a reliable and predictable developmental sequence, beginning about 4 months after conception and continuing to the beginning of the third decade of life when the development of all the permanent teeth is completed. The use of radiographs is characteristic of techniques that involve the observation of the morphologically distinct stages of mineralization.[3,14]

These are the various methods of age estimation through radiographs:

1. Schour and Massler method
2. Moorree's method
3. Demirjian's method
4. Nolla's method
5. Foti's method
6. Olze method.

Schour and Massler's method and Moorree's method are mainly used to estimate the age of children and young adults using age estimation charts, also called as Atlas method.

Demirjian *et al*. tried to simplify chronological age estimation that assesses the mandibular left side teeth. The development of mandibular left teeth was divided into 10 stages numbered "0"–"9." Stage "0" denotes that tooth calcification is yet to begin; Stage "5" indicates crown completion, whereas stage "9" represents the completion of tooth calcification.[12]

Nolla's method: In this chronological age estimation, assessment of both maxillary and mandibular teeth was done. The development of teeth was divided into 10 stages numbered "0"–"9." Stage "0" denotes that tooth calcification is yet to begin; Stage "5" indicates crown completion, whereas stage "9" represents the completion of tooth calcification.[12]

Foti's method: It is a type of radiographic age estimation method done mainly in children and young adults by counting the number of erupted 1st, 2nd, and 3rd molar and also the tooth germs except the 3rd molar. The criteria of tooth eruption are that line lying over the erupting tooth cusps has to reach over the line joining the mesial and distal cementoenamel junction of adjacent teeth. This will be applied to the regression formula.[13]

Olze method is another type of radiographic age estimation using 3rd molars stages of tooth development Stage An occlusal plane covered with alveolar bone, Stage B alveolar eruption; complete resorption of alveolar bone over occlusal plane, Stage C gingival emergence; penetration of gingiva by at least one dental cusp, and Stage D complete emergence in occlusal plane. These values are applied to Olze age estimation chart, and the mean scores are added up and their average is calculated to estimate the age.[14]

Presentation of dental evidence as an expert witness in identification, bite mark, human abuse malpractice, fraud, and personal injury including collection and analysis of patterned marks

Forensic dentists who are associated with identification and crime investigation are usually required to provide testimony in the court of law in the capacity of an "expert witness."

Lip print analysis

Lip print is unique for individuals. It serves as useful evidence in forensic odontology.

Lip prints are normal lines and fissures in the form of wrinkles and grooves present in the zone of transition of the human lip, between the inner labial mucosa and outer skin, examination of which is known as cheiloscopy. Lip print recording is helpful in forensic investigation that deals with identification of humans, based on lip traces.[15,16]

Palatal rugae in identification

This includes tracing the rugae patterns from post- and antemortem dentures on the clear acetate and then superimposing these tracings on photographs of plaster models. Computer software program, where digitized images of the palate on which characteristic points were plotted on the medial and lateral extremities of rugae. The plotted points were assessed by the software program and the information stored, sequentially, corresponding to the fixed position. Visual comparison of ante- and postmortem rugae patterns are obtained from the dentures.[17] Determined the shape, size, number, and position of the palatal rugae. The most prevalent palatal rugae shape was sinuous followed by curve, line, point, and polymorphic varieties.[18] Have observed that denture wear, tooth malposition, and palatal pathology can cause alterations in rugae patterns.[19] From their studies concluded that different patterns of rugae are genetically determined, and so can be rather used in population differentiation than individual identification.

Bite marks

Forensic odontology mainly deals with the analysis of bite marks, which is used to scientifically link the dentition of suspect with a bite mark. Mac Donald had defined bite marks as a mark caused by the teeth either alone or in combination with other mouth parts.[20]

Biting is a primitive type of assault, which is always associated with sex crimes, violent fights, and child abuse. During a bite, the pressure is applied to a skin surface causes compression and leaves indentations. These indentations are matched to suspect's dentition which enables the investigator to connect the suspect to the crime.[20]

Presentation of bite mark injuries

The injuries caused by teeth can range from bruises to scrapes to cuts or lacerations. A representative human bite is described

as an elliptical or circular injury that records the specific characteristics of the teeth.[21] The injury may be shaped like a doughnut with characteristics recorded around the perimeter of the mark. Alternatively, it may be composed of two *U*-shaped arches that are separated at their bases by open space. It is possible to identify specific types of teeth by their class characteristics and individual features.[20]

Evidence collection from the bite victim

The best opportunity to collect the evidence may be when it is first presented and was observed. If a suspected bite mark is criminal in nature, it should be reported to the police. The list of procedures to properly collect the evidence includes: (1) Case demographics, (2) visual examination of the bite mark, (3) photography, (4) saliva swabs collection, and (5) impression taking.[8]

Evidence collection from the bite suspect

Evidence collected from a victim of a bite mark should be complemented with evidence from a suspect of the perpetrated bite. It includes clinical examination, photographs of the suspect's teeth in occlusion and in open bite positions, impressions of maxillary and mandibular teeth made with rubber-based material, saliva swab preferably from the buccal vestibule should be obtained for comparing with the swab collected from the bite mark, and bite sample should be photographed immediately after it is recorded.[8]

Recognition of signs and symptoms of human abuse

- Intimate partner violence
- Elder abuse
- Child abuse - Any act of commission or omission that endangers or impairs a child's physical or emotional health and development.[4,8]
    - Physical abuse
    - Sexual abuse
    - Emotional abuse
    - Neglect of the child.

Assessing the sex of skeletonized remains

Determination of sex is very important in the identification of a dead person. It is done by DNA analysis and by comparing the morphological changes of the skull and pelvis. When there are only skeletal findings available, then the bones are evaluated to determine the sex based on the morphology of the bone.[4,8]

Eliciting the ethnicity/population affinity and assisting in building up a picture of lifestyle and diet of skeletal remains at forensic and archeological site

Ethnicity of the population can be studied by applying the forensic anthropological methods. By evaluating the odontological features will help to find out the lifestyle and diet of the individual. For example, if the individual belongs to African origin then the skull features appear to be broad with round nasal cavity, rectangular palate and orbits, jaw protrusion, and megadontic teeth. Ethnicity can be influenced by genetic and environmental condition on teeth. It will be metric and nonmetric dental traits.[4,8]

Conclusion

Forensic odontology depends on sound knowledge of the teeth and supporting structures. It plays a major role in the identification of those individuals who cannot be identified visually or by other means. Teeth and the materials used for restoration are resistant to decay. Hence, the dental hard tissue gains importance in identification of alive or dead person. The unique feature of dentition and the restoration will provide accurate results when the techniques are correctly employed. Forensic odontology allows the dentist to help in solving the medicolegal cases and to maintain law and order in the society.

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Conflicts of interest

There are no conflicts of interest.

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