Forensic Odontology - A Science within a Science

Vinej Somaraj, P. Ravishankar, A. Agnes, Archana Vaithiswari, Beryl Magdalene Thomas, M. G. Brigith Bell

Department of Public Health Dentistry, Rajas Dental College and Hospital, Tirunelveli, Tamil Nadu, India

ABSTRACT

Forensic odontology, a branch of forensic sciences, uses the skill of the dentist in personal identification during mass calamities, gender assault, and child abuse. Its role in the judiciary is of much importance by providing the required information, which will help the legal authorities to recognize negligence, malpractice, abuse, and identification of unknown individuals. The applications of forensic odontology in crime investigations include the identification of teeth that are used as weapons may provide information regarding the identity of the biter. Forensic odontology employs various methods that play a major role in the identification of individuals who cannot be identified individually or by other means.

Key words: Bite mark analysis, dentistry, disaster identification, forensics, gender determination

INTRODUCTION

Forensic odontology or forensic dentistry was defined by Keiser-Neilson, in 1970, as "that branch of forensic medicine which in the interest of justice deals with the proper handling and examination of dental evidence and also with proper evaluation and presentation of the dental findings." Forensic dentistry is the proper handling, examination, and evaluation of dental evidence, which will be then presented in the interest of justice. The evidence that may be derived from teeth is the age and identification of the person to whom the teeth belong. This is done using dental records including radiographs, antemortem and postmortem photographs, and DNA. It provides an important community service in both the civil and criminal jurisdictions.[1-3]

SCOPE AND PURPOSE OF FORENSIC ODONTOLOGY

Forensic odontologists assist the legal authorities in the following situations:
1. Identifying unknown human remains through dental records and craniofacial bones.
2. Age estimation of both the living and deceased.
3. Recognition and analysis of bite marks found on victims.
4. Analysis of orofacial trauma associated with personal abuse.
5. Gender determination.
6. Eliciting the ethnicity.
7. Analysis of dental malpractice claims.
8. Presenting evidence in court as an expert witness.[2]

DENTAL RECORD MANAGEMENT

The dental record is a legal document that records all diagnostic information, clinical notes, laboratory test, photographs, study casts, radiographs, treatment performed, and patient-related communications that occur in the dental office. The record of pediatric patients should be retained until the patient reaches maturity. Electronic records can be easily networked and transferred for routine professional consultation or forensic cases requiring dental records for identification. Computer-assisted management technology can assist in expediting the comparison of antemortem and postmortem dental record information.[2,3]

Identification in disasters
Identification of the deceased person is the most common role of the forensic dentist. Identification can be done by visual

Address for correspondence:
Dr. Vinej Somaraj, Department of Public Health Dentistry, Rajas Dental College and Hospital, Tirunelveli, Tamil Nadu, India. Phone: +91-7907277928. E-mail: v2vinej@gmail.com

recognition, property identification, and scientific methods such as fingerprinting, physical anthropologic examination of bones, dental identification, and serologic and genetic (DNA) comparison techniques. Forensic physical comparison of antemortem and postmortem dental data is used to establish that a found body and a missing person are one and the same to a high degree of certainty. The American Board of Forensic Odontologist recommends following conclusions regarding the dental identification.

Positive identification

There is sufficient uniqueness among the comparable items in the antemortem and postmortem databases, and no major differences are observed.

Probable identification

There is a high level of concordance among data but usually without radiographic support.

Presumptive (possible) identification

Enough information may be missing from either source.

Insufficient identification

There is insufficient supportive evidence available to compare.

Exclusion of identification

Clearly inconsistent.[4]

Dental identification procedures

Three types of dental identification procedures are considered:

Comparative identification

Comparing the dead individual's teeth with presumed dental records of the individual.

Reconstructive identification or dental profiling

Attempts to elicit the ethnicity or "race," gender, age, and occupation of the dead individual. It is undertaken when virtually no clue exists.

DNA profiling to oral tissues

This is used when the dental record is not available for comparison.[5]

MASS DISASTER

Mass disasters can be classified as natural calamities, accidents, and criminal attacks (terrorist bombings). Mass disasters are associated with multiple fatalities scattered throughout broad areas, may be associated with loss of antemortem records, remains may be hidden, dismembered, or mutilated, and proper facilities to carry out examination may not be available. The dental structures may be the only parts of the body not destroyed and even though they may be scattered over a wide area, such as occurs in aircraft accidents, terrorist attacks, partial incineration, fragmentation, and severe decomposition. Hence, properly trained individuals work as a team to deal with such disasters.

Dental identification uses the teeth, jaws, and orofacial characteristics as well as the specific features such as metallic or composite fillings, crowns, bridges, and removable prostheses as well as distinctive configuration of bony structures of jaw (mandible and maxilla), the presence and shape of teeth including the roots, configuration of maxillary sinuses, and long-standing pathology such as prior fractures and orthopedic procedures. In some cases, a single tooth can be used for identification if it contains sufficient identifying or unique features. Advances in photographic, radiographic, and computer technology have provided the forensic dental team with additional resources to enable recovery, documentation, storage, and comparison of forensic dental evidence.[6,7]

GENDER DETERMINATION

Forensic odontology plays a major role in gender determination. Gender can be determined based on the morphology of the skull and mandible along with DNA analyses of teeth.

Craniofacial morphology and dimensions

Forensic anthropologist and forensic odontologist work together for the identification of the morphology of skull and mandible. They are concerned with the analysis of the calcified structure of the body, i.e., bones and teeth which are the craniofacial complex. The key identification tools are used to distinguish from one person to another population which are also used to determine the age, race, and gender of the person.[2,3]

Gender determination using tooth size

Teeth can be differentiated by measuring the mesiodistal and buccolingual dimensions. In most cases, the canine has shown the maximum gender difference. Premolars, maxillary molars, and maxillary incisors show significant differences.[8]

Gender determination by DNA analysis

Forensic DNA analysis for gender determination shows accurate results. Gender can be determined with minute quantities of DNA (20 pg) and from very old tooth specimen. Amelogenin (AMEL) is the major proteins that are secreted by ameloblasts of enamel. Modern DNA extraction methods can isolate genomic DNA from dental cells and the gene amelogenin (gender-linked gene). On microscopic examination, the cells from the pulp show Barr bodies in females. AMEL gene coding for the highly conserved protein is shown on X-chromosome and Y-chromosome in humans. For exonic sequences, two allies are similar and differ

for intronic sequences. Therefore, for female, two identical genes (XX GENES), and in males, two non-identical genes (XY GENES) are shown. The X- and Y-specific AMEL genes are 106 and 112 base pairs in lengths which provide discrimination between males and females AMEL. Distinct between human male and female AMEL gene is specific, sensitive, and cost-effective. Polymerase chain reaction (PCR) is the method of amplifying small quantities of relatively short target sequences of DNA using sequence-specific oligonucleotides primers and thermostable Taq DNA polymerase. DNA from teeth is prepared by ultrasonication and PCR amplification.[8,9]

AGE ESTIMATION

Age estimation is one of the forensic sciences and should be an important part of the identification process. Human dentition follows a reliable and predictable developmental sequence usually begins at the 4th month and is continued till the beginning of the third decade of life when the development of permanent teeth is completed. Using radiographs, the morphologic stages of mineralization are observed. Use of attrition and the growth of third molars are suggested as means of aging who are above 18 years.

Other techniques such as incremental lines of cementum, occlusal wear of tooth, and radiographic examination method to determine the measurement of pulp size and specific six teeth are observed by periapical radiograph. Newer techniques such as aspartic acid racemization and translucent dentin proved to be highly accurate in adult age assessment. The following are the popular age determination methods:
1. Moore method
2. Demirjian method
3. Dentin translucency method
4. Gustafson's method.[10-12]

ETHENIC RACE DETERMINATION

By focusing on some findings on teeth, ethnic race can be identified. In Mongoloid and American Indians, posteriorly concave upper incisors and grooves on the rear surface of upper incisors (shovel-shaped appearance) while almost 100% of Europeans have a flat lingual surface on the incisor teeth. Almost 100% of Japanese has ridges on the lingual surface on the incisor teeth. Besides, the lower first molar of Caucasoid appears long with more tapering form while Negroid molars are small and square. These are some of the unique findings in some races.[2,3]

BITE MARKS

Bite marks have been defined by Mac Donald as "a mark caused by the teeth either alone or in combination with other mouthparts." He classified bite marks as:

1. Tooth pressure marks
2. Tongue pressure marks
3. Tongue scrape marks.

Bite mark appearance
Tooth pressure during bite causes indentations (persists for a few minutes). Edema and subcutaneous bleeding over the bite area can be viewed and are called as contusion or bruises. Depending on skin color, bite mark appears as reddish or purplish discoloration. The most extreme form of bite mark injury is avulsion.[2]

Bite mark investigation
Case demographics, visual examinations, photography-orientation photographs, close up photograph, saliva swab, and impressions are the procedures followed for bite mark investigation. 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 in addition, bite samples, i.e., suspect's bite is recorded in centric occlusion using either a wafer of base plate wax or a sample of silicone putty material designed for this purpose. It is photographed immediately after it is recorded.[13,14]

CHILD ABUSE

Child abuse has been defined by Vale as "any act of commission or omission that endangers or impairs a child physical or emotional health and development." Child abuse may be broadly classified as physical abuse, gender abuse, emotional abuse, and neglect of child. Ocular injuries can be caused by belt buccal or a slap from the strap, or otherwise can cause trauma resulting in tearing of labial mucosa from gingiva or tearing away of labial and lingual frenum. Physical trauma may also result in teeth avulsion. Gonococcal and syphilitic lesions in the mouth are shown in gender abuse along with bite marks.[13,15]

CONCLUSION

Forensic odontology mainly depends on the fact that physiological variations, pathogenesis, and effects of therapy of dental hard and soft tissues are unique to every individual. A forensic dentist is concerned with the handling and collation of dental evidence and assists law enforcement agencies in the detection and resolution of criminal and civil proceedings. It is very useful in medicolegal conditions. Forensic odontologist must have the basic knowledge of the role of a forensic pathologist and the methods used in the autopsy, as dental evidence is the most valuable and reliable method.

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