

Role of dental expert in forensic odontology

Departments of Forensic Medicine and Toxicology, and ¹Pathology, King George's Medical University, Uttar Pradesh, Lucknow, India

Anoop K. Verma, Sachil Kumar¹, Shiuli Rathore, Abhishek Pandey

ABSTRACT

Forensic dentistry has become an integral part of forensic science over the past 100 years that utilizes dental or oro-facial findings to serve the judicial system. This has been due to the dedication of people like Gustafson's, Keiser-Nielson, and Suzuki for this field. They established the essential role which forensic dentistry plays mainly in the identification of human remains. The tooth has been used as weapons and under certain circumstances, may leave information about the identity of the biter. Dental professionals have a major role to play in keeping accurate dental records and providing all necessary information so that legal authorities may recognize mal practice, negligence, fraud or abuse, and identity of unknown individuals. This paper will try to summarize the various roles of dental experts in forensic medicine.

Address for correspondence:

Mr. Sachil Kumar,
Department of Pathology,
King George's Medical University,
Uttar Pradesh, Lucknow - 202 002,
India.
E-mail: sachilvohra@gmail.com

Key words: Age estimation, bite mark, forensic dentistry, identification

INTRODUCTION

Forensic odontology (dentistry) is a new and growing section of forensic medicine. The journey of forensic dentistry starts from Agrippina, the mother of Roman Emperor Nero, in 49 A.D. when she recognized her rival Lollia-Paulina's discolored front teeth after her assassination.^[1]

Forensic odontology or forensic dentistry was defined by Keiser-Nielson 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 with the proper evaluation and presentation of the dental findings." Forensic science refers to areas of endeavor that can be used in a judicial setting and accepted by the court and the general scientific committee to separate truth from untruth.^[2]

Human identity is the mainstay of civilization, and the identification of unknown individuals always has been

of paramount importance to the society. Not only is it important to identify the deceased to ensure appropriate obsequies, but also there are issues such as criminal investigations, insurance settlements, and military proceedings that can be resolved only with a positive identification. The identification of a missing individual can aid tremendously in the process of grief resolution of the family and friends. Overall, in world-wide scenario; forensic dentists are playing an important role in human identification, bite mark analysis, maxillofacial trauma, and malpractices.

Identification

Dental identification assumes a primary role in the identification of remains when post-mortem changes, traumatic tissue injury, or lack of a fingerprint record invalidate the use of visual or fingerprint methods. The identification of dental remains are of primary importance when the deceased person is skeletonized, decomposed, burned, or dismembered. The principal advantage of dental evidence is that, like other hard tissues, it is often preserved after death. Even the status of a person's teeth change throughout life and the combination of decayed, missing, and filled teeth is measurable and comparable to any fixed point in time. Teeth are the most durable parts in the body and can be heated to temperature of 1600°C without appreciable loss of microstructure.^[3] Teeth can survive virtually intact long after other soft tissue and skeletal tissue have been destroyed by decay or incineration.

Access this article online	
Quick Response Code: 	Website: www.njms.in
	DOI: 10.4103/0975-5950.140147

Identification by dental means is not a new technique. It has been said that Nero's mistress, Sabina in 49 A.D. satisfied herself that the head presented to her on a platter was of Nero's wife as she was able to recognize a black anterior tooth. The modern era of forensic odontology is said to have commenced with the identification of the victims of the Bazar de la Charité fire, which occurred on May 4, 1897 in Rue Jean-Goujon, Paris. One hundred and twenty six members of the Parisian aristocracy perished after an ether-oxygen film projector ignited a rapidly destructive fire. All but 30 of the victims were identified visually or by personal effects, mainly jewellery, on the day after the fire.^[4]

Determination of species

Species determination usually presents no difficulties unless only patchy evidence is found at the scene of crime. There may be fragments of mandible bearing teeth or, at worst, a small fragment of single tooth no more than in few millimeters in size. Recently, it has been shown that dentinal fluids contain special species information. These fluids may be compared using counter current electrophoresis with artificially antisera. This technique can determine species up to at least 12 months after death.^[5]

Determination of gender and race

Ancestry can be accessed by studying the facial skeleton and comparing the features with the main characteristics of three racial groups: Mongoloid, Negroid, and Caucasoid.^[6] Once ethnicity has been attributed, perhaps the most important of parameters to determine from a skeleton is the gender of an individual. If the gender of a bone is successfully determined, approximately 50% of the population is immediately eliminated from the process of identification. In general, the determination of gender is not a difficult problem when the complete skeleton is available but bony remains are not always found in this condition. For example, in airplane crashes bone can be broken into many pieces and only a small segment may be available to make identification. The tools of molecular biology, like DNA typing of genomic or mitochondrial DNA for the detection of gene polymorphisms and a specific repetitive sequence of the DNA in order to match these results with putative antemortem findings, become very popular.^[7,8]

DNA analysis in forensic dentistry

Using DNA analysis, it is possible to establish the sample that is isolated from the biological material such as blood, semen, hair roots, tissue, teeth, bone, and saliva. The successful isolation of DNA from both saliva and salivary-stained material occurred in 1992.^[9] Saliva contains sloughed epithelial cells from the inner surface of the lips and oral mucosa; this is a potential source of DNA.^[10] Numerous enzymes from a variety of sources are present in saliva.

The *Streptococcus salivarius* and *Streptococcus mutans* are present in the saliva and on the teeth. In Polymerase chain reaction (PCR) technology, the streptococcal DNA sequence provides a means with which to identify the bacterial composition from bite marks and can be matched exclusively to those from the teeth responsible.^[11]

The dental pulp from the given specimen of the tooth can be used for DNA analysis. Recent tooth specimen could be expected to provide good sources for the determination of blood groups. The presence of ABO blood grouping antigens in soft and hard dental tissue make it possible to determine the blood group typing and there by assist in identifying even a highly decomposed body. However, the effect of autolysis, dehydration, and loss of pulp antigens or high number of errors due to foreign antigen borne by bacteria in carious teeth may lead to variation in the study.^[12]

Whittaker and Rawle advocate that the antigenicity of powdered dentine and cementum of extracted human teeth remains unaltered without regard to the environmental conditions for a period of 1-6 months after extraction.^[13] This supports the idea to use precipitin reaction, i.e., the reaction of an antigen with a fixed amount of serum containing antibody, in order to assess the origin of tooth fragments found, for example, at the area of a natural disaster.

Facial reconstruction and facial superimposition

If the post-mortem profile does not elicit the tentative identity of the deceased, it may be necessary to reconstruct the individual's appearance during life. This is the responsibility of forensic artists who utilize the dental profile to help the facial reconstruction. The use of ante mortem photographs to permit facial superimposition of skeletal and teeth features have been used in case of identification. The technique requires the availability of suitable antemortem photographs showing the teeth. Often, angulations and magnification impose difficulties in positioning the images.^[14]

Age determination based on dental data

The age estimation is the important part of forensic odontology. 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 development of all the permanent teeth is completed. The use of radiographs is characteristic of techniques that involve observations of the morphologically distinct stages of mineralization. Such determinations are also used on the degree of formation of root and crown structures, the stages of eruption, and the intermixture of primary and adult dentitions.^[15]

The age of children can be determined by the analysis of tooth development and subsequent comparison to development charts, usually to an accuracy of approximately 1.6 years. The use of attrition and development of the third molar have been suggested as means of ageing for those individuals over 18 years of age, but both are unreliable. Newer techniques like aspartic acid racemization and translucent dentine have been proposed and proved to be highly accurate in adult age assessment.^[16,17]

The two criteria that can be utilized for age determination in adults are assessment of volume of pulp cavity and of third molar of development. The reduction in the size of pulp cavity resulting from a deposition of secondary dentine with aging as assessed by radiography can be taken as a guide to estimate the age of an individual.^[18-20]

Matching of teeth image by cone beam computed tomography and X-ray micro focus CT

The cone beam^[21] computed tomography (CT) and X-ray micro focus CT^[5] can be used to obtain pulp and tooth volume ratio.^[22] X-ray provides two-dimensional information at low resolution while cone beam CT technique allows the three-dimensional structure of the root canal of the extracted tooth. It works with the same scanning principle as in medical computed tomography (CT) is utilized; however, the spatial resolution is orders of magnitude higher.

The coronal pulp cavity ratio is a reliable biomarker for age assessment in the forensic context, especially in the living individuals of unknown data.^[22]

Radiographic examination

Radiographs and dental casts are useful tools for medico-legal records. The forensic odontologist produces the post-mortem records by careful charting and written descriptions of the dental structures and radiographs. Radiographs should be marked with holes to prevent confusion-one hole for antemortem films and two holes for post-mortem films.^[23]

A range of conclusions can be reached when reporting a dental identification. The American board of forensic odontology recommends that these be limited to the following four conclusions:^[24]

- Positive identification: The ante- and post-mortem data match in sufficient detail, with no unexplainable discrepancies, to establish that they are from the same individual
- Possible identification: The ante- and post-mortem data have consistent features but, because of the quality of the either the post-mortem remains or the antemortem evidence, it is not possible to establish the identity positively
- Insufficient evidence: The available information is insufficient to form a basis for a conclusion

- Exclusion: The antemortem and post-mortem data are clearly inconsistent.

Bite marks and lip prints

Biting is often a sign of a perpetrator seeking to degrade the victim while achieving complete domination.^[25] Generally, bite marks consist of superficial abrasion, and/or sub-surface hemorrhage, or bruising of the skin because of the bite (Endris 1979).^[26] Bite mark examination is the one aspect of forensic odontology requiring an immediate response by the forensic dentist. The bite mark may be a result of either a physical alteration in a medium caused by the contact of the teeth, or a representative pattern left in an object or tissue by the dental structures of a human or animals. The marks, single and multiple in nature may be of varying degrees of severity, ranging from a mild making of the tissues to deep perforation of the epidermis and dermis.^[27] To avoid discrepancy and to increase the validity of bite mark analysis, American Board of Forensic Odontologist (ABFO) has created a bite mark methodology guideline to collect and preserve the marks. The guideline is not a mandate, but a list of generally accepted methods.^[28] To record a bite mark, an exact photographic documentation and a one-to-one transfer to transparent paper or acetate sheet are indispensable. Swabbing of the bite injury is important to recover trace evidence. Stains of saliva or human cells for a DNA analysis should be collected whenever possible (Wright and Dailey 2001^[29], Lessig and Benthaus 2003^[30]).

The use of lip prints for human identification was first suggested in 1950.^[5] Chelioscopy is the study of lip prints. Although unique to an individual like fingerprints, it is not as reliable because of its deformable nature. Susuki and Tsuchihashi have classified lip prints into many types depending on the pattern of grooves as type I (vertical), type II (branched), type III (intersected), type IV (reticular), and type V (other). Gender differences with certain types predominant in females (I and II) and in males (III and IV) are found.^[31,32]

The study of the investigation of bite marks and lip prints, which may be produced in both sexual and non-sexual assaults, homicide, and also in non-biological materials and objects left at crime scenes, requires the employment of specialized techniques of photography, impression taking, and electric microscopy. In these procedures, the proper collection and handling of material is important to ensure the security of the chain of evidence to comply with legal requirements for its acceptability as evidence in court of law.^[17,24]

Healing process

The healing process of bite marks can be useful in determining the time of the bite mark, is inflicted relative to the time of death in cases where death has occurred

because of strangulation. As all healing processes cease upon death, the redness of the bite mark relative to the redness of bruises on the neck indicate the timing of the infliction of the bite mark relative to the murder.^[33]

CONCLUSIONS

The role of forensic dentistry plays a major role in the identification of those individuals who cannot be identified visually or other means. The unique nature of our dental anatomy and the placement of custom restorations ensure accuracy when the techniques are correctly employed.

Unfortunately, in developing countries like India, forensic dentistry is not developed up to the mark and services of forensic dentists are not being utilized. The Government should instruct the Indian dental association and other responsible agencies to direct the dental surgeons of the country to maintain the dental records and debris of tooth material in case of restorations of the patients treated by dental surgeons. So the preserved material may be used in identification of deceased individuals.

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How to cite this article: Verma AK, Kumar S, Rathore S, Pandey A. Role of dental expert in forensic odontology. *Natl J Maxillofac Surg* 2014;5:2-5.

Source of Support: Nil. **Conflict of Interest:** None declared.