Review article:

"Review on Forensic Odonto-Stomatology"

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Abstract:
Forensic Odontology has become an integral part of forensic medicine over the past decades that utilize dental tissue findings to serve the judicial system. Dental tissues remains can be used for identification as using them are cost effective, reliable and fast. Forensic odontology is a branch of dentistry that analyzes dental evidence to overlap the dental and legal profession. The tooth has been used as weapons and under certain circumstances, may leave information about the identity of the biter, age estimation and gender determination. Dentists 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.

Keywords: Forensic Odontology; Tooth; Identification; Dentistry

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Introduction

Dental structures are the most hardest, durable and sturdy tissues of the human body. The different dental patterns are typical for every person. Hence these dental structures are used in identification of individual, determination of sex where they person cannot be identified by their appearance. Dental identification in forensic field plays a primary role in the identification of remains when postmortem changes, traumatic tissue injury, or lack of fingerprint record invalidate the use of visual or fingerprint method.[1] Forensic odontology or dentistry is a growing and new field in forensic medicine. Forensic dentistry as "that branch of forensic medicine which in the interest of justice deals with the correct handling and observation or examination of dental proofs and with the proper analysis and display of the orofacial and dental findings."[2,3]The history of forensic dentistry goes long back. In court of justice, the dental structures evident has been used for the past many decades. The techniques used in forensic odontology has evolved through the evolution of humankind.[3,4]

Odnotometric analysis for forensic use by dental structures for identification began, people killed in during French and Indian wars skeleton bodies were identified by an artificial tooth. A dentist, identified dead body by a small denture that he had fabricated for him.[4,5]

Dental identification means are reliable and accurate to ensure a correct identification of individuals. To approach through a preliminary evaluation, antemortem and post-mortem examination, an expert of forensic dentist can develop all necessary information for conclusion regarding the correct identity by dental evidences.[5,6]

Demand for more and better-skilled forensic dental practitioners is rising at both the macro and micro levels. At the macro level, the need for trained forensic

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dental manpower in India should be quantified, while at the micro level, the skills required of forensic dental personnel to be hired/employed by a crime laboratory, a legal firm, or the law enforcing agencies like the police and judiciary as also the needs of the Armed Forces and para-military organizations should be defined. Person's identity is the backbone of civilization, and the identification of unknown person is always has been of supreme importance to the society. Not only is it important to identify the deceased to ensure appropriate funeral service, but also there are issues such as investigations in criminal issues, settlements of insurances, and military proceedings that can be determined only with a positive identification.[6,7,8,9]

Dental evidence

Humans dental identification involves either comparative method or post-mortem dental profiling as, a primary role in the identification of remains when post-mortem changes, traumatic tissue injury, or lack of a fingerprint proofs or records of invalidate the use of visual or fingerprint methods. The identification of dental remains are of primary importance because it is often preserved even after death of the persons when the person's body is skeletonised, decomposed, burned, or dismembered. Dental tissues are the most endurable parts in the human body and can be heated to temperature of 1600°C without noticeable loss of dental microstructure. Even in highly concentrated acids tooth structures are most durable. [10,11,12] Teeth can survive virtually intact long after other soft tissue and skeletal tissue have been destroyed by decay or incineration.

Identification by dental means is not a new technique, and not only identification also with age estimation, gender identification and mitochondrial DNA analysis for person's identifications. So many studies are conducted on age, gender and DNA analysis. Not only permanent dentitions also gender differences can be appreciated in deciduous dentition too.[13,14,15]

Species determination

Determination of species usually presents no difficulties unless only patchy evidence is found at the scene of crime. There may be fragments of teeth bearing mandible or, at worst, a small fragment of tooth not more than in few millimetres in size. Recently, it has been shown that determine the species by dentinal fluids contain specific information of species. These fluids may be compared with artificially antisera and counter current electrophoresis. This technique can determine species up to at least 12 months after death.[15,16,17]

Determination of age and gender

The need for age estimation has increased in recent years because there is increase in numbers of unidentified cadavers and human remain especially in metropolitan cities and age estimation for living individuals who do not have valid proof of date of birth with them. age estimation can be done by evaluation of developmental changes and degenerative changes. Developmental changes that occur to the human dentition while the teeth are growing and emerging into the oral cavity.[18,19] Degenerative changes: That occur once the teeth have erupted and begin to wear down like cemental annulations and volume of pulp cavity decreases due to secondary dentin formation.[20,21]

Determination of gender is very important subdivision of forensic odontology, which plays a major role in identification of the unknown individuals where the body cannot be identified like natural disasters; chemical and nuclear bomb explosion scenarios by using Craniofacial morphology and dimension, so many studies are conducted in determination of gender by using tooth measuring of buccolingual and mesiodistal dimensions is most reliable and simple method for gender determination. Both the dimensions are more in male than in female. Tooth morphology: In male, the distal accessory ridge in canines is more prominent than in female. Sex determination by dental pulp DNA analysis pulp: sex determination could be obtained from the studying the X and Y-chromosomes up to four weeks of the death because of dental pulp is covered by dental hard tissue this could be the reason to survive of dental pulp up to four weeks and also AMEL gene can be studied to determine sex from these samples.[6,21,22] lip prints-Cheiloscopy, palatal rugae pattern-Rugoscopy analysis can be done by using these soft tissues. A thorough knowledge and usage of the appropriate evidence from forensic scene enables proper identification of the individual.

DNA analysis in forensic dentistry

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. Since morphological patterns vary with age changes and any external environment, the best-suited method in the identification of gender with confirmation is by molecular analysis of DNA For example, in airplane

crashes bone can be broken into many pieces and only a small segment may be available to make identification. The extracted DNA from the dental tissues of an unidentified person can be compared with the antemortem DNA samples. DNA stored in blood, hairbrush, clothes, cervical smear or biopsy sample can provide a good source of antemortem DNA. 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.[21,22,23]

DNA fingerprinting tool is being increasingly used in analyzing various conditions related to forensic evidence science. Major source of DNA in the body is Tooth with act as because it has ability to resists and withstands to undergo changes immediately once other tissues starts decomposing. Some authors suggest that teeth are better sources of DNA than skeleton bones. highly vascularised pulp of tooth contains DNA, odontoblastic process, Pulpal accessory canals, and cementum. Studies conducted on dental pulp can also be used for analysis of DNA and is good source for determination of blood groups. The presence of ABO blood grouping antigens in soft and hard tissues make possible to determine blood group of highly decomposed remains. The DNA from the teeth is not only acts for primary identification but it can also be use as reference sample to relate the other tissue fragments. As dental vital tissue is surrounded and protected by hard tissue that is dentin and enamel, it will be the best source of DNA for molecular level of identification forensic dentistry.[23-27]

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 material occurred in 1992. Saliva has sloughed epithelial cells from the inner surface of the oral mucosa(upper and lower lips); this is a potential source of DNA by PCR method. Numerous enzymes from a variety of sources are present in saliva in cases of bite marks.[27,28,29]

Blood Grouping From Dental Pulp

The dental pulp tissue of the tooth can be used for molecular analysis. Recent tooth specimen could be expected to provide good sources for the determination of blood groups. The evidence of ABO blood grouping antigens in soft tissue that is pulp and hard dental tissue make to determine the blood group typing and there by assist in identifying even a highly decomposed body. However, there may be false positive or negative result will encounter due to the effect of putrefaction by the destruction of cells or tissues by their own enzymes, especially those released by lysosomes, dehydration, and loss of pulp antigens or carious teeth may lead to variation in the study. The blood typing from both hard and soft tissues of teeth by AE method can be used for identification. Though blood grouping does not give a positive identity but only a positive non-identity, it has been used to positively identify individuals. In view of particularly significant positive results of ABO blood groups obtained from dental pulp.[29,30,31]

The antigen from powdered form of dentine and cementum hard tissue extracted human teeth remains unaltered without regard to the environmental conditions for a period of 1-6 months after extraction. [32-37] 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.

Dental Record for Legal Documentation

Maintaining of dental record is a legal document owned by the dentist, and containing of subjective and objective information including treatment done about the patient. Results of the dental examination and supporting oral and surrounding structures must be recorded and maintained. In addition, records of laboratory tests, study casts, clinical photographs and radiographs become important components of the record, and should be kept for 7 to 10 years. Computer-aided dental records are becoming more common and obvious advantage of the these electronic records are that can be easily networked and transferred for routine professional consultation or forensic cases requiring dental records for identification. the maintenance of dental records should be in written form or on a electronic database, following the principles of record management ensures that all dental information that may be required to resolve a forensic problem is properly maintained and retrievable.[38,39,40]

Dental Radiographs and identification

Comparison of dental radiographs in antemortem and post-mortem is the most accurate and reliable method of identifying remains. examinations such

as distinctive shapes and types of restoration, root canal treatment, root and tooth morphology and sinus and angle of jawbone patterns can be identified only by examination of radiographs. In some cases a individual tooth may be all that remains, and upon analogy of radiographs, a positive description can be made. Original antemortem dental radiographs are of immense value for comparison; therefore it is essential that all routine exposed radiographs during the course of a dental treatment can made be adequately with proper fixed and washed so that they remain viewable in later years. Identification becomes a problem when few restorations are available for antemortem–post-mortem comparison in the present situation, very less people have dental restorations and replacements because of the success of precaution interruption. At some stages of the development of human dentition, digital dental radiographic superimposition can be used for identification, allowing comparison between relationships of the root and support structures of the teeth in antemortem and post-mortem records.[35,38,40,41]

The cone beam computed tomography (CT) and X-ray micro focus CT can be used to obtain tooth and pulp volume ratio. X-ray administer two-dimensional intelligence at low resolution while cone beam computed tomography method acquiesce the three-dimensional morphological record for the root canal of the exfoliated tooth. It works with the same scanning principle as in medical computed tomography 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.[10,37,42]

Bite marks

Bite marks are forms of 'patterned injury', formed by particular object. Bite marks are also called as 'tool marks'. Bite mark may also be formed as a mark made by the teeth either alone or in combination with other lip prints or mouthparts.

In the recent years, there has been a rapid increase in the number of suspected bite mark cases examined by the Forensic Odontologists.[38,39] The comparing of bite marks with a suspect's dentition includes analysis and measurement of position, shape and size of the individual teeth. Overlays is the method of comparison involve the fabrication, and different ways to produce overlays from suspect's teeth. Hand tracing from dental study casts, wax impressions, xerographic images, the radio opaque wax impression method and the computer-based method.[40,43,] studied the accuracy of these bite mark overlay production methods and concluded that the computer-generated overlays provided the most accurate and reproducible exemplars.[41]

Role of forensic odontology in determination of age and gender of children

Estimation of age in children by craniofacial bone structures and skeletal structures such as long bones, closure of fontanelle/sutures, and ossification of hand-wrist bones, and mandibular features like angle of mandible and mental foramina can be used in age estimation[42]

Assessment of age during prenatal, neonatal, and early postnatal period can be very accurate due to various events taking place such as primary tooth germ formation, development of deciduous teeth, first evidence of calcification of tooth, enamel formation completion, eruption and permanent first molar formation. Neonatal line is termed as indicator of birth. The presence of neonatal line indicates a live birth. However, false result can be obtained as it takes around 3 weeks after birth to form. It has legal implications in feticide and infanticide.[2,8]

In children and adolescents, neonatal line, tooth eruption and tooth calcification, these events are important in age estimation. Convenient clinical method and can be assessed visually and radiographically, helpful in observation for several years, and not altered by local factors.[43]

DNA analysis for the presence or absence of Y chromatin is definitive method of determining sex. Advance methods include use of AMEL gene and polymerase chain reaction (PCR). AMEL gene codes for "amelogenin" a matrix protein secreted by enamel forming cells called ameloblasts. This gene is located on X- and Y-chromosomes. Females will show two identical AMEL genes while as males show two nonidentical genes. DNA amplification by PCR gives 100% success in sex determination. Presence of barr bodies in dehydrated pulp tissue containing female X chromosome [8,44]

Identification of an assailant by comparing a record of their sets of teeth with a record of a bite mark left on a victim. Auxiliary uses in legal issues for dental experts include the recognition of individual remains, medico-legal computation of anguish to oral tissues, and affidavit about dental dereliction. While the practice of individuals recognition is well entrenched, corroborate and proven to be

authentic, the practice of bite mark analysis is less well accepted. The assumption of recognition an injury as a bite mark is complex and, depending on severity and anatomical location, highly subjective. Following the recognition of an injury as a bite mark, the comparison of the pattern produced to a speculate dentition is even more antagonistic and an area of great debate within contemporary odontological practice. Like fingerprints and DNA, bite marks are unique to an individual – such as distance and angles between teeth, missing teeth, fillings and dental work**.** This type of impression evidence can be left in the skin of a victim and also can be in food, chewing gum and other miscellaneous items such as pens and pencils. The advent of DNA analysis and its recovery from bite marks has offered an objective method of bite mark analysis.[38]

More research is required to confirm the fundamental science of bite mark comparison, some of the basic problems inherent in bite mark analysis and interpretations like uniqueness of the human dentition has not been scientifically established, pattern to human skin and the ability of the skin to maintain that uniqueness has not been scientifically established, scope or extent of distortion of bite mark patterns on human skin has not been demonstrated, standard for the type, quality, and number of individual characteristics required to indicate that a bite mark has reached a threshold of evidentiary value has not been established.[38, 39] 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 curative processes desist upon death, the redness of the bite mark analogous to the redness of contusion on the neck demonstrate the timing of the castigation of the bite mark relative to the murder.[45]

Conclusion

The role of forensic dentistry plays a major role in the identification of those individuals who cannot be identified visually or other means. Forensic odontology is not a recent branch of dentistry. It is of forensic science. The use of teeth, dentures and other aids have revolutionised forensic science. The teeth and facial bones are resistant to fire, burns, even in highly concentrated acids and can be still recovered from disaster sites for use. DNA recovery from dental pulp and other structures of tooth has become easy with advancements in PCR techniques; hence genetically correct identification of persons has become easy. gender and age estimation using biochemical markers are some of the recent advances in this field that gives scope for future research and standardisation. Forensic odontology can therefore be regarded as one of the most important areas of forensic science as far as "individual identification" is concerned. Despite breakthrough in science and technology, natural calamities and crimes continue to persist in human life. Identification of human remains is essential for various reasons including legal, criminal, humanitarian and social grounds. This article reviews the how teeth helps in the field of forensic odontology as well as forensic investigations while highlighting the role of the dentist too.

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Authors' Contribution

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