

Forensic Odontology-A Review

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Abstract

Forensic dentistry may be defined as that branch of forensic medicine that applies dental knowledge to civil and criminal problems. It is the branch of Forensic sciences which utilizes the skill of the dentist in the processing, review, evaluation and presentation of dental evidence with the purpose of contributing scientific and objective data in legal processes. The methods of collecting the data utilizes the developed technologies and have undergone significant transformation. The methods used include, dental imaging techniques, bite-mark analysis, DNA analysis using oral tissues, cheiloscopy, and rugoscopy in addition to facial reconstruction, denture identification, comparison microscopes, and tongue prints which are the recent inputs in the field of forensic odontology. This article provides an overview of the recent trends in conventional forensic methods and also provides an insight into the recent concepts used in this field.

Keywords: *Forensic odontology, DNA Analysis, Bite Marks*

Introduction

The word forensic is derived from the ancient Roman “forum” the home of the law courts – and means “relating to the law.” Forensic dentists are involved in assisting investigative agencies to identify recovered human remains in addition to the identification of whole or fragmented bodies; forensic dentists may also be asked to assist in determining age, race, occupation, previous dental history and socioeconomic status of unidentified human beings. So a forensic dentist requires knowledge encompassing a number of disciplines, since the dental records obtained can identify an individual and can contribute to the information needed by the government to establish neglect, fraud or abuse. The role and

importance of forensic dentistry in the judiciary is fast growing and hence knowledge in this field is needed by the general practitioner¹.

It is difficult to establish the identification of a dead person, when the body is disfigured or mutilated beyond recognition as a result of criminal activities, accidents, natural disasters, fire, and when the body is in unrecognizable, decomposed state. It is in these situations forensic dentists play a major role. Forensic anthropology, fingerprinting, forensic odontology (FO), radiology and DNA typing can be used for identification of the victims. The identification of a person by means of dental identification is one of the most reliable methods. Dental identification has always played a key role in natural and manmade disaster situations¹.

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Dental identification

The common methods used for individual identification are using visual identification, personal information (such as height, build, age, presence or

absence of hair), medical information (such as scars, tattoos, birthmarks, implants, amputations, prosthesis), footprint records from a chiroprapist/podiatrist, clothing, personal effects, fingerprints, DNA profiling and dental identification. Dental ID, like fingerprint ID, can be used as a definitive means to identify human remains, as and when required. It has several significant advantages, when used properly. The dental evidence tends to survive much better than does soft tissue evidence as the teeth are the hardest substance in the human body and are even harder than bone. They are resistant to the environmental effects that can easily damage the soft tissue evidence, as they are calcified. It should be noted that teeth are not destroyed by immersion in water, by desiccation, fire or by decomposition. In general teeth are destroyed by heat, if the temperatures increase more than 1000°F. As the roots of the teeth are encased in the alveolar bone, it provides an additional layer of protection².

Traditionally, comparisons have been made between postmortem dental records and the antemortem (living) records for the presence of dental fillings, endodontic treatments, crowns or bridges, radiological studies to verify the clinical findings, the presence of malocclusions or dental fractures to determine whether both records correspond to the same individual. Several identification techniques are used by forensic dentists, including rugoscopy, cheiloscopy (lip prints), the obtainment of imprints, or the use of molecular techniques such as polymerase chain reaction (PCR) for analyzing the DNA contained in dental pulp tissue. Dental identification can be performed by examining the previous dental records of the deceased person to identify the similarities and confirm the same^{1,2}.

Problems in dental identification³

The dentist may encounter problems with dental identification because of the lack of an organized structure and adequate knowledge. They may use multiple systems to identify the procedure provided for a patient and to indicate the nature of the treatment. The forensic dentist should be familiar with all the types of common treatments and materials including the charting and numbering system. They should be able to differentiate the normal functional wear and other age related changes from the abnormalities. In general,

the changes are not distinct over a short period of time, but over an extended time period the small changes can accumulate to produce significant differences³.

Dental identification can have three different applications:

(a) Comparative identification, in which the postmortem dental records are compared with the antemortem records of an individual in order to establish whether both records correspond to the same person.

(b) The obtainment of dental information to narrow the search for an individual when the antemortem records are not available and there are no possible data referred to the identity of the subject.

(c) Identification of victims following mass disasters or catastrophes.

In general forensic odontology can be used in three areas as follows: (1) diagnostic and therapeutic examination and evaluation (2) The identification of individuals, (3) Identification, examination, and evaluation of bite marks. They can also be used to determine age, sex, and ethnicity of the person of interest.

According to American board of forensic odontology dental identification can be divided into four types⁴:

1. Positive identification: The ante-mortem and postmortem data match to establish that it is from same individual;

2. Possible identification: The ante-mortem and postmortem data have few consistent features, but because of quality of the records it is difficulty to establish the identity;

3. Insufficient evidence: The data is not enough to from the conclusion;

4. Exclusion: The ante-mortem and postmortem data clearly inconsistent.

Bite mark analysis

The forensic dentist should document the available bite marks and its characteristics to correlate with the suspect. When the marks are analyzed, all the possible characteristics which may influence the bite including fractures, shape of the teeth, congenital malformations,

should be accounted for. The anatomical location, severity, and quality of the bite marks play a significant role in the identification of the individual. It should be noted that the biting surfaces of the individual groups of teeth are unique and related to the function. As the bite mark findings may deteriorate from the site of the actual bite, it should be documented as quickly as possible. In case of bites which are not visible to the naked eye, it should be identified using ultraviolet light illumination and should be recorded. It is advised to get an second precise impression of the bite surface to register all the irregularities produced by the teeth upon the skin. This can be done with the help of vinyl polysiloxane, polyether or other impression materials recommended for the obtainment of imprints for fixed prostheses. As dry saliva is hard to detect the amylase test is needed to identify its presence. Before the evidence evidence from the bite suspect is collected, a proper consent should be obtained. A detailed history, photographs, the details of extra- and intra-oral examination along with high-quality impressions of the upper and lower arches should be collected along the impression. Bite marks are compared by measurement of size, shape, and position of the individual teeth. Overlays are most used for this purpose. In addition to all these methods, salivary DNA recovery and bacterial genotyping from the bite marks are the most recent ones and have become the backbone of forensic investigation⁵.

DNA analysis

DNA analysis is a new tool used in the field of forensic odontology, gains importance when conventional identification methods fail due to the effects of heat, traumatism or autolytic processes, distortions, and difficulties in analysis. There are many biological materials such as blood, semen, bones, teeth, hair, and saliva that can be used to accomplish DNA typing. With the advent of polymerase chain reaction which allows enzymatic amplification of a specific DNA sequence even in a negligible amount of source material, forensic identification using DNA analysis becomes increasingly popular with investigators.

The oral cavity is a useful source of DNA. The latter is obtained from saliva, the oral mucosal cells and the teeth. The main DNA source is blood, though

in some situations this type of sample is not available for analysis. In teeth, DNA is found in the pulp tissue, dentin, cement, periodontal ligament and alveolar bone. Forensic dentists should incorporate these new technologies, since a number of methods are available for the extraction of DNA from biological samples, though no standardized protocols for their use have been established to date^{4,5}.

Cheiloscopy

Cheiloscopy is a forensic investigation technique which deals with identification of humans based on their lip traces. Like the prints present in the finger, palm and foot, and lip prints are also unique and do not change during the life of a person. Lip prints provide enough information for forensic investigations as the lips also possess furrows and grooves. Lip prints can be obtained at the crime scene either directly from the lips of the deceased or from the clothing, cups, glasses, cigarettes, windows, or doors. Lip prints have to be obtained within 24 h of death to prevent erroneous data that would result from postmortem alterations of lip. Lip print pattern depends on whether mouth is opened or closed. In closed mouth position, lip shows well-defined grooves; whereas in open mouth position, the grooves are relatively ill defined and hard to interpret⁶.

Recent studies have proven lip prints as a superior tool compared to fingerprints and mandibular canine index in gender determination. Lip prints can be obtained using cellophane tape or a scotch tape which are pressure sensitive.

Rugoscopy

In case of teeth loss, due to reasons such as trauma, palatal rugae pattern serves as an alternative method for identification because of its uniqueness. As rugae is internally placed in the oral cavity and is protected by tongue and buccal pad of fat, it remains undisturbed from heat and other assaults. Rugae patterns change with age and other environmental influences such as orthodontic movements, tooth extraction, cleft palate surgery, periodontal surgery, and impacted canine eruption^{7,8}.

Materials and methods used to analyze the rugae patterns includes, photographs and impression of maxillary arch, computer software programs (for e.g., RUGFP-

ID), calcorrugoscopy or overlay print, stereoscopy (through which three-dimensional [3D] image of palatal rugae can be made), stereophotogrammetry (which is comparatively accurate)^{5,8}.

Facial reconstruction

Face is crucial for human identity and is a boon to the humankind. Forensic dentistry functions only in cases where the face of the person is destroyed by some means. Skulls can remain unaltered even for millions of years and can provide an inimitable means of identification. The cranial appearance is very much helpful in determining the sex of the individual. Computerized facial reconstruction method uses a laser video camera interfaced with a computer or with CT scanning. The face can be drawn with the help of computer software (for e.g., Vitrea 2.3 version volumetric visualization software). Although exact picture of the face may not be made, this method helps in identifying the individual^{5,9}.

Comparison microscopes

Examination of teeth under microscope can confirm sex by the presence or absence of Y-chromatin. The phase contrast microscope is useful in analyzing the cemental annulations for age estimation. A prototype Virtual Comparison Microscope (VCM) is a device which helps in analyzing the specimens simultaneously and utilizes images of deformed bullets, bullet fragments, and various types of rifling from the company's BulletTrax-3D system. With the VCM, it is easy to find significant markings in any direction while maintaining a consistent appearance⁵.

Tongue prints

Tongue is unique to each person in its shape and surface textures and is the only Use of tongue prints for forensic identification is at budding stage now. For this technique to be successful, the antemortem photograph or impression of the tongue should be available. The lingual morphological aspects can be preserved using the alginate molding technique for duplicating the minute details which are unique for each individual. The lingual impression, together with its photographic image, may constitute secure methods for forensic dentistry identification. Tongue biometric template can be made using three views such as left lateral view, right

lateral view, and profile view^{5,10}.

Conclusion

Forensic odontology is an upcoming branch of dentistry with a lot of scope for development. At the crime scene, the forensic odontologists play a major role in investigating and interpreting the dental evidence. The unique nature of the dental anatomy and the custom restorations ensure accuracy when the techniques are appropriately employed⁵. A consistent effort has to be made to computerize all the data available to facilitate comparison. Efforts have to be made to maintain the dental records which will serve as antemortem data. Each dental professional has a responsibility to understand the forensic involvements associated with their dental practice. The practicing dentists and the dental students should be made aware of the available technologies and its use in forensic dentistry. New researches have to be encouraged in the field of forensic dentistry which will pave way for incorporating newer technologies in establishing the human identity⁴.

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