

REVIEW ARTICLE

Forensic Odontology And Its Role In Medico-Legal Affairs

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ABSTRACT

Forensic odontology is an evolving science with a greater scope of development. It has established as an indispensable science in medico-legal matters and in the identification of the dead person. Identification of human remains is essential for various reasons including legal, criminal, humanitarian and social grounds. The dental tissues are often preserved even if the deceased person is skeletonized, decomposed, burnt, or dismembered. Various methods have been developed to determine age, sex, and ethnicity of the person, using dental tissues. This article provides an overview of the conventional forensic methods and also provides an insight into the recent concepts used in this field.

Keywords- Forensic odontology, Bite marks, DNA analysis, chieloscopy

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

The word forensic is derived from the ancient Roman "forum" the home of the law courts – and means "relating to the law."²

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."³ 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 practitioner.²

DENTAL IDENTIFICATION

Human identity is the mainstay of civilization, and the identification of unknown individuals always has been of paramount importance to the society. 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. Identification by dental means gains more importance because the dental tissues are often preserved even if the deceased person is skeletonized, decomposed, burnt or dismembered.² Teeth are resistant to the environmental effects that can easily damage the soft tissue evidence, as they are calcified. Teeth are the most durable parts in the body and can be heated to temperature of 1600°C without appreciable loss of microstructure.⁴

Several identification techniques are used by forensic dentists that includes 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. 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 situations.⁵

According to American board of forensic odontology dental identification can be divided into four types-⁶

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.

TOOTH AS A TOOL FOR FORENSIC EVIDENCE

Morphology and arrangement of teeth is unique for every individual. 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.⁷

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.⁸

Acharya et al have demonstrated that dental profiling is another integral part of forensic dentistry which aids in person identification by identifying ethnicity, gender and age. Shovelling, cusp of carebelli, three cusped maxillary second molar, winging, cusp 5, 6, 7, mandibular groove pattern, four cusped mandibular molars vary with ethnicity.⁸ Metric traits of teeth such as buccolingual and mesiodistal dimensions of teeth and morphology of canine and molars can also be used in gender identification.⁹

BITE MARKS ANALYSIS

The anatomical location, severity, and quality of the bite marks play a significant role in the identification of the individual. Generally, bite marks consist of superficial abrasion, and/or sub-surface hemorrhage, or bruising of the skin because of the bite (Endris 1979).¹⁰

Various steps in bite mark investigation include preliminary questions, evidence collection from the victim, case demographics, visual examination, photography, saliva swab, impression making, evidence collection from suspect, bite mark analysis, comparison and drawing conclusion.¹¹

Male victims are most often bitten on the arms and shoulders, while female victims are most commonly bitten on the breasts, arms, and legs. The biting surfaces of the individual groups

of teeth are unique and related to the function. And also, it shows individual characteristics such as fractures, rotations, missing, or extra teeth. In addition, the width of the dental arches could be related to the age of the attacker.¹² The information such as demographics (name, age, sex, date, etc.), location, size, shape, color, type of injury, and swabs should be collected from the bite victim. In case of bites which are not visible to the naked eye, demonstration using ultraviolet light illumination technique can be performed. The collection of evidence from the bite suspect must have a proper consent, detailed history, photographs, the details of extra and intraoral examination along with high quality impressions of the upper and lower arches.¹¹

The process of comparing bite marks includes analysis and measurement of size, shape, and position of the individual teeth. The fabrication of overlays is the most common comparison method used. The methods used to fabricate overlays are hand tracing from study casts, hand tracing from wax impressions, hand tracing from xerographic images, the radiopaque wax impression method, and the computer based methods such as using the image perception software.¹³ 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 investigation.¹¹

PALATAL RUGAE

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. The ridges present in the anterior part of the palate on either side of the midpalatal raphe are referred to as palatal rugae. Thomas et al has classified rugae pattern as diverge, converge, curve, wavy, straight and circular.¹⁴

Rugae patterns change with age and other environmental influences such as orthodontic movements, tooth extraction, cleft palate surgery, periodontal surgery, and impacted canine eruption.¹⁵ Materials and methods used to analyze the rugae patterns includes, photographs and impression of maxillary arch, computer software programs (for e.g., RUGFP ID), calcirugoscopy or overlay print, stereoscopy (through which three-dimensional [3D] image of palatal rugae can be made), stereophotogrammetry (which is comparatively accurate).^{15,16}

LIP PRINTS (CHEILOSCOPY)

Lip prints are an important forensic evidence in the scene of crime similar to finger prints. The study of lip prints is called cheiloscropy. 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.¹⁶ 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 interpret.¹⁷ Lip prints can be obtained using cellophane tape or a scotch tape which are pressure sensitive.

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.

The oral cavity is a useful source of DNA. The latter is obtained from saliva, the oral mucosal cells and the teeth. In teeth, DNA is found in the pulp tissue, dentin, cement, periodontal

ligament and alveolar bone. Saliva contains sloughed epithelial cells from the inner surface of the lips and oral mucosa; this is a potential source of DNA.¹⁸

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.^{2,6,16}

FACIAL RECONSTRUCTION

Face is crucial for human identity and is a boon to the human kind. Forensic dentistry functions only in cases where the face of the person is destroyed by some means. In such cases, the only part retained may be the skull and the other bones. 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. Skull data are then imaged as a fully shaded 3D surface.¹⁹ The face can be drawn with the help of computer software (for e.g., Vitrea 2.3 version volumetric visualization software). 3D-CT imaging has been found to be more accurate than imaging performed directly on CT slices and 2D-CT image reconstruction.²⁰ Although exact picture of the face may not be made, this method splendidly helps in identifying the individual.

COMPARISON MICROSCOPES

The use of microscopes in forensic sciences has an impact on the accuracy. Examination of teeth under microscope can confirm sex by the presence or absence of Y-chromatin.²¹ The phase contrast microscope is useful in analyzing the cemental annulations for age estimation. In case of comparison of the samples, the conventional microscope consumes more time in readjusting the focus and in achieving different views. To avoid these problems, Virtual Comparison Microscopes (VCM) were developed which helps in analyzing the specimens simultaneously. It 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 appearance.²

TONGUE PRINTS

Tongue is unique to each person in its shape and surface textures and is the only internal organ that can be protruded and easily exposed for inspection. 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 and every 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.^{16,23}

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. Forensic odontology can therefore be regarded as one of the most important areas of forensic science as far as "person identification" is concerned. New researches have to be encouraged in the field of forensic dentistry which will pave way for incorporating newer technologies in establishing the human identity.

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