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REVIEW ARTICLE

A Review on Current Trends in Forensic Odontology

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Abstract

Forensic Odontology, a branch of Forensic sciences, uses the competence of the dentist in personal identification during mass calamities, sexual assault and child abuse where con- ventional methods such as finger prints are not available. The importance of forensic odon- tology in the judiciary is fast growing and hence in depth knowledge in this field seems more than justified. (2020, Vol. 04; Issue 01: Page 40 - 45)

Keywords: Forensic odontology, Bite marks, DNA analysis

Introduction

The term “forensic” has Latin provenance -“forensis” from “forum,” which means a place where legal matters are consulted (1). Forensic dentistry includes the pro- cessing, evaluation, review and presenta- tion of dental evidence for providing scien- tific and objective data in legal processes to establish justice (2).

Forensic odontology can be defined as, the branch of dentistry that comprises the ac- tual handling and examination of dental evidence and assessment of dental find- ings for the interests of justice (1). Keiser- Neilson defined forensic dentistry as “that branch of dentistry that in the interest of justice deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings (3).

Dr. Oscar Amoedo published a short arti- cle in 1897 where he described the meth- ods of identification of victims of a fire in Paris. This was a breakthrough in the field of forensic dentistry which not only brought the title of ‘the father of the foren- sic odontology’ to this eminent Cuban- born professor, but also exposed this fas- cinating branch of Dentistry (or Odontol- ogy) to the international academic world. In 1903, a course on bite marks and ante- and post-mortem characteristics was of- fered in Tokyo, and served as basis for lec- tures between 1922 and 1936. Around 1952, few more references of teaching could be found in the literature. In 1958, Gustafson stated that Forensic Odontol- ogy was practiced ad hoc to meet emer- gency situations and teaching was neces- sary for the development of the field (4).

Dental identification has three different applications: (2)

1. Comparative identification – comparison between postmortem and antemortem dental records of an individual for deter- mining the identity of the person.
2. When the antemortem records are not available for the identification of the sub- ject, dental information serves as the way to narrow the search for an individual.
3. Identification of victims following mass disasters or catastrophes.

A general dentist should also possess basic knowledge of the role of the forensic pathologist, methods used in autopsy, the role of a dentist in the identification of a person and the importance of maintaining dental records of all patients.

Historical background

66 AD: Agrippina and Lollia Pauline case was the first documented case where teeth were considered as the evidences for iden- tification. It was the first case where den- tal records were used for identification.

1066 AD: King William is the first to use bite marks as identification method.

1191: M. Raja Jayachandra Rathore of Canouj who died on the battlefield in 1191, was identified by his false anterior teeth. This was probably the first case of identification using dentition from India. 1758: During French and Indian wars, Pe- ter Halket was killed in a battle near Fort Duquesne and his skeleton was later iden- tified by his son with his artificial tooth.

1776: At the battle for Breed's Hill in Bos- ton, Dr. Joseph Waren was killed and no- body was able to identify his face as he suffered from a fatal head wound. A den- tist, Paul Revere, identified Dr. Warren, who died in a revolutionary war, by a small denture that he had fabricated for him.

1995: Sansare and Dayal were the first to report forensic dental identification in In- dia through a review conducted by them in 1995 (5).

Uses of Forensic Odontology

1. Dental record maintenance

Forensic dental identification is based on the availability, adequacy, and accuracy of antemortem dental records. Maintenance of dental records is very much essential because it serves as the information source for the dentists as well as the pa- tients which may be required in medico- legal, administrative, and for forensic pur- poses. Comparative dental analysis plays an important role similar to fingerprints and DNA analysis. The dental records can be successfully utilized in many cata- strophic situations.

Dental records are available in various forms such as dental notes, dental charts, radiographs, photographs, and models. Maintenance of these records is manda- tory in the Western countries. The dental records were successfully utilized in many disasters such as world trade centre dis- aster, Indian Ocean tsunami disaster in December 2004, etc (5).

2. Dental imaging

Imaging technique can be used as an al- ternative method for forensic human iden- tification in the cases where previous rec- ords are not available for comparison. The radiographic images of the lamented can be obtained and compared with the avail- able antemortem radiographic image of the suspected person.

Historically, the use of radiographs in fo- rensic sciences was introduced in 1896, a year after the discovery of X-ray by W. C. Roentgen. It was used to detect the pres- ence of lead bullets inside the head of a victim. As dental radiographs are easily

available, it always serves as a vital clue for forensic identification. Different pa- rameters are used in dental radiographs such as- shape of the teeth and roots, teeth present, missing teeth, residual roots, supernumerary teeth, non-carious lesions such as attrition, abrasion, fractures, bone resorption due to periodontal disease, bone pathology, diastemas, den- tal caries, endodontic treatment, intra- radicular posts, intra-coronal posts, and dental prostheses. Conventional radiog- raphy, computed tomography and radio- visiography allow observation of coronal shape and size, pulp anatomy, crestal bone etc (6, 7). Cross-section of the areas produces multiple images and accurate analysis of the spatial relations of teeth roots and supporting structures can be done on ante- and post-mortem images. The frontal sinus configuration plays a major role due to its uniqueness for each individual and can be used as a parameter for individual recognition. The parameters used for comparison of frontal sinus im- ages are variations in its size, shape, symmetry, border outline, and number and presence of septa and cells (6).

Thus, the use of radiographic techniques provides the occult dental information for the use in forensic odontology.

3. Bite mark analysis

The bite mark is defined as the physical alteration in or on a medium caused by the contact of teeth. In few of criminal cases it is seen that suspect or victim has left his or her teeth marks on another per- son or inanimate object (8). Bite marks on human tissues can be observed in violent incidents such as sex-related crimes, child abuse cases and homicidal cases. There will be an outer edge of arches along with series of abrasion, with or without laceration that reflects the size, shape and arrangement of class characteristics of in- cisal or occlusal surfaces of dentition (9). In case of more aggressive bites, the as- sailant may suck the soft tissues into the mouth so that images of palatal and in- cisal surfaces of teeth may appear which show laceration of tissue and petechial hemorrhage in the mid portion of the wound. In case of less aggressive bites, the skin may not be completely penetrated so there can be oval mark mostly of anterior teeth (5).

The biting surfaces of the individual groups of teeth are unique and related to the function. It also shows individual characteristics such as fractures, rota- tions, missing or extra teeth. In addition, the width of the dental arches could be re- lated to the age of the attacker (8).

The anatomical location, severity and quality of the bite marks have significant role in the identification of the individual. In case of bites which are not visible to the naked eye, demonstration using ultravio- let light illumination technique can be per- formed.

The collection of evidence from the bite suspect must have a proper consent, de- tailed history, photographs, extra- and in- tra-oral examination information along with high-quality impressions of the upper and lower arches (10). The process of com- paring 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, besides that hand tracing from study casts, hand tracing from wax impressions, hand tracing from xero- graphic images, the radiopaque wax impression method, and the computer-based methods such as using the image percep- tion software are used. In addition to all

these methods, salivary DNA recovery and bacterial genotyping from the bite marks are the most recent investigative tech- niques (11).

4. DNA analysis

DNA analysis is a boon in the field of fo- rensic odontology, having great im- portance when conventional identification methods fail due to the effects of heat, traumatism or autolytic processes, distor- tions and difficulties in analysis. Various biological materials such as blood, semen, bones, teeth, hair, and saliva can be used to carry out DNA typing. PCR (polymerase chain reaction) allows enzymatic amplifi- cation of a specific DNA sequence even in a negligible amount of source material, fo- rensic identification using DNA analysis becomes increasingly popular with inves- tigators (12). In the field of forensic sci- ences, the genomic DNA and mitochon- drial DNA (mtDNA) are used. The genomic DNA is found in the nucleus of each cell in the human body. The teeth are an excel- lent source of genomic DNA. mtDNA can be used when the extracted DNA samples are too small or degraded, such as those obtained from skeletonized tissues (13). The amplified DNA is then compared with the antemortem samples such as stored blood, hair brush, clothing and biopsy specimens (14). This is a reliable tool and provides information about the physical characteristics, ethnicity, place of origin and sex of the person. These tests are ac- cepted as judicial proofs for investigation of paternity and human identification. Some of the advanced techniques in DNA profiling are Restriction Fragment Length Polymorphism Typing, Short Tandem Re- peat (STR) Analysis, Y-Chromosome Anal- ysis, X-Chromosome STR, Single Nucleo- tide Polymorphism Analysis, mtDNA Anal- ysis, Gender Typing and DNA methylation analysis (13).

5. Cheiloscopy

Cheiloscopy is a forensic investigation that deals with identification of human based on lip traces. While using teeth as ante- mortem record, sometimes, loss of teeth and destruction of restorations may lead to complication in differentiating the ante- mortem records and postmortem records (8). Like fingerprint, Lip print wrinkle pat- tern has individual characteristics (15). The wrinkles and grooves on the labial mucosa form a characteristic pattern called lip prints. The 1967 Santos was the first person to classify lip grooves. There are four types of lip grooves: Straight line, Curved line, Angled line, Sine shaped line. Recent studies have demonstrated lip prints as a better tool compared to finger- prints and mandibular canine index in gender determination. Lip prints can be obtained within 24 hours of death, using cellophane tape or a scotch tape which are pressure sensitive. Lip print pattern changes with opening or closing condition of mouth. In closed mouth position, grooves are well-defined; whereas in open mouth position, the lip shows ill defined grooves which are hard to interpret (10). **6.Rugoscopy**

Rugae is internally placed area in the oral cavity protected by tongue and buccal pad of fat and remains undisturbed from any type of assaults or trauma serves as an alternative method for identification. Ru- gae patterns change with age and other environmental influences such as ortho- dontic movements, tooth extraction, cleft palate surgery, periodontal surgery and impacted canine eruption. It can be as- sessed by photographs, impression of

maxillary arch, computer software pro- grams (for e.g., RUGFP-ID), calcorrugos- copy or overlay print, stereoscopy (through which three-dimensional [3D] image of palatal rugae can be made) and stereophotogrammetry (16).

Conclusion

Besides above said methods there are nu- merous newer modalities of identification for human remains, which are in budding stage now such as- facial reconstruction, denture identification method, compari- son microscope and tongue prints.

This article aims to deliver an overview into the importance of forensic odontology with an importance of various methods how to do so. Maintenance of the dental records should be done which will be served as antemortem data. Each dental professional has a responsibility to under- stand the forensic involvements associ- ated with their dental practice and should be aware of the available technologies and its use in forensic dentistry. New re- searches have to be encouraged in the field of forensic dentistry which will make new path for incorporating modern tech- nologies in establishing the human iden- tity.

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