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Forensic Odontology: A Review Of Literature

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Abstract

The definition of forensic dentistry or forensic odontology is the branch of forensic medicine concerned with the proper management and inspection of dental evidence and with the right appraisal and presentation of the dental findings in the interest of justice. Identification of humans, age prediction, sex determination, and detection of bitemark perpetrators are all components of forensic odontology. The need for dental identification mainly relates to legal, religious, societal, and financial justifications. Owing to the strong physical characteristics of the teeth, many methods could be used for personal identification, including comparative dental identification, postmortem dental profiling, DNA analysis, and bitemark identification. To be more specific, comparative dental identification is one of the most well-known forensic odontology techniques. Teeth together with restorations and other abnormalities are examined, and developmental diagrams are compared.

Keywords: Forensic odontology, Dental identification

Introduction

Forensic odontology or dentistry was defined 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" (Keiser-Neilson, 1980). In 1453, there was the first dental identification reported case of the Earl of Shrewsbury, who fell in the Battle of Castillon (Rai *et al.*, 2012). Turning to mass forensic identification by dentition, the method was initially used in Paris for identifying victims of the fire of the Bazaar de la Charité. Dr. Oscar Amoedo wrote an article regarding the identification procedures used in that disaster. The article was then published in Dental Cosmos in 1897. Dr. Amoedo was recognised as the father of forensic odontology (Bruce-Chwatt, 2010).

Forensic odontology mostly assists with identifying the specific deceased individuals by estimating the age and time of death along with determining sex. Moreover, there are various methods used in dental identification. These methods consist of comparative dental identification, postmortem dental profiling, and the analysis of DNA as well as bite marks (David Sweet, 2001).

Roles Of Forensic Odontology

Identification of the living or deceased individuals

Dental identification is essential when identifying disfigured bodies is not feasible as a result of violent damage (Malkowski, 1972). This is due to the fact that hard tissues, including teeth, are preserved after death and can even withstand a temperature of 1600 °C (Adams, 2013).

According to Pretty and Sweet, 2001, there are several common reasons for identifying human remains. To begin with, the identification is for criminal reasons; the victim must be positively identified before investigating a criminal death. Regarding some religious beliefs, if the bodies are not confirmed dead, those bodies cannot be buried, and the victims' partners cannot remarry. The identification of missing individuals can also bring

emotional relief to family members. In addition, social and monetary reasons are also taken into consideration. In terms of social reasons, there is a society's duty to preserve the human rights of victims. Monetary reasons include disbursement of life insurance proceeds, estate transfer, settlement of probate, and execution of wills (American Dental Association [ADA], 2020).

Age Estimation

The prior known attempts of using teeth for age indication were initiated in England. Edwin Saunders, a dentist, was the first to publish information about dental implications in age assessment. He presented a pamphlet named "Teeth A Test of Age" to the English parliament in 1837 (Stavrianos, 2008).

Human dentition follows a predictable developmental sequence. Progress influenced by internal and environmental factors is also useful in assessing the age of each individual (Noble, 1974). The use of radiographs entails observations of the morphologically distinct stages of mineralization, the degree of formation of root and crown structures, the stages of tooth eruption, and the intermixture of primary and adult dentitions (Gatliff, 1984).

Age is determined by analysing tooth development, scoring each tooth and comparing it with developmental charts (Kapali *et al*., 1997). The third molar development is a factor that dentists use for assigning age to young adults; however, its accuracy has been in question (Mincer *et al*., 1993). As for degenerative changes, the pulp cavity reduces because of the deposition of secondary dentine with ageing (Thomas, 1983). Furthermore, periodontal disease progression, excessive wear, restorations, extractions, bone pathosis and complex restorative work are possible factors for indicating older individuals (Pretty and Sweet, 2001).

The need for age estimation has increased as a result of greater numbers of unidentified cadavers and human remains, especially in metropolitan areas. This method can be used for assessing the age of living individuals who do not have a valid proof of date of birth (Kotra Shetti *et al*., 2011).

Sex Determination

Mesio-distal and bucco-lingual tooth dimensions, termed linear measurements, were used for determining sex (Bakkannavar S.M., 2012). These linear dimensions are more in males than in females (Divakar, 2017). However, diagonal measurements could be used for measuring rotated, crowded and proximally restored teeth (Joseph A.P., 2013).

Furthermore, the presence or absence of Y chromatin and DNA analysis could confirm sex with the use of microscopic examination of teeth. The appearance rate of Y chromatin was calculated in the dental pulp with the staining by Quinacrine Mustard (Adachi, 1989). According to Adachi, the average appearance rate of Y-chromatin in the male dental pulp was 42.2% immediately after the tooth extraction, 34.8% after one month, 27.9% after 3 months, 20.8% after 6 months, 20.6% after 1 year, 19.1% after 18 months and 11.4% after 2 years. In contrast, the appearance rate of the pseudo-Y chromatin spot in the female pulp was less than 4.2% throughout the two-year observation. In addition, cytological smears stained with Papanicolaou (PAP) stain obtained from the putative decedent's medical records were used as a reference DNA sample when traditional dental records are not available (Sweet *et al*., 1999).

Methods Of Forensic Dentistry

Comparative dental identification

Pretty and Sweet (2001) mentioned the central dogma of dental identification as the comparison of postmortem dental remains and antemortem dental records, consisting of written notes, study casts, radiographs, and other sources to confirm identity.

The American Board of Forensic Odontology (2017) has suggested the categories and terminology for body identification by dividing them into four types.

1. Positive identification: The antemortem and postmortem data sufficiently match with no incompatible discrepancies.
2. Possible identification: The antemortem and postmortem data have compatible characteristics; nevertheless, the quality of either the postmortem remains or the antemortem evidence may not be clear so it is not plausible to definitely confirm the individuals.

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3. Insufficient identification: The obtained information is not enough to state a conclusion.
4. Exclusion: The antemortem and postmortem data are conflicting.

Postmortem Dental Profiling

There is widespread agreement on applications of postmortem dental profiling, particularly that it is developed when the tentative identification of the individual is not available, contributing to the incapability to locate antemortem records (Pretty and Addy, 2002). This method is conducted to aid investigators in restricting the extent of the possible population of individuals (Pramod *et al*., 2012).

A close analysis of the skull's structure and shape can help determine the race and sex of a person to some extent. A forensic dentist may be able to classify the person as belonging to one of the three main racial groups, Negroid, Mongoloid, or Caucasoid, based on these characteristics of the skull. Other characteristics, such as the cusps of Carrabelle, Shovel-shaped incisors, multicusped premolars, talon's cusp, taurodonts, etc., may help identify the race in addition to the shape and form of the skull (Shekar *et al*., 2009). Furthermore, the deceased's age, ancestry, sex, and socioeconomic level may often be analyzed from a postmortem dental profile. It is sometimes applicable to include details on a person's career, eating habits, routine behaviours, and occasionally even dental or systemic disorders (Pretty and Sweet, 2001).

DNA Analysis

Teeth are considered an exceptional source of DNA material due to their resistant characteristics (Schwartz *et al*., 1991). Polymerase chain reaction (PCR) is employed for amplifying DNA at pre-selected and specific sites. It is possible to compare the DNA preserved in and extracted from the teeth of an unidentified person to a known antemortem sample (stored blood, hairbrush, clothing, cervical smear, biopsy, etc.) as well as to a parent or sibling (Sweet and DiZinno, 1996). DNA materials comprise genomic DNA and mitochondrial DNA. Each cell's nucleus contains genomic DNA which is the source of most forensic applications. According to Sweet and Hildebrand (1998), there has been the recovery of genomic DNA from human teeth by cryogenic grinding. For additional forensic examination, it may be necessary for some circumstances to preserve as much natural tooth structure as possible. However, in the majority of cases, after thorough recording, it is possible to break the tooth or section it longitudinally or horizontally in order to access the DNA-rich core. Turning to mitochondrial DNA, there is a high copy number in each cell as a result of the high number of mitochondria which are present in most cells. Apart from this, mitochondrial DNA is maternally inherited. Thus, siblings and all of their maternal ancestors share the same DNA sequence owing to this maternal inheritance pattern (Hutchison *et al.*, 1974).

Identification OF Bitemark Perpetrators

Human bite marks depict diffuse bruising, abrasions, lacerations, through to complete avulsion of tissue and often in combination (Hinchliffe, 2011). According to the American Board of Forensic Odontology (2018), standards and guidelines for evaluating bitemarks are established. With regard to bitemark analysis, the first steps are to confirm that the patterns are human bitemarks. The following steps are determining the orientation of the marks caused by maxillary and/or mandibular teeth and summarizing the features, including class characteristics of dentition, arch and dental characteristics, and anomalies, along with other abnormal features. During the process of evidence collection, intraoral examination should be performed with persons of interest who may or may not be associated with the event. Photographs of the patterns are taken with a reference scale while bitemarks should also be swabbed with the double swab technique, using a wet cotton swab followed by a dry cotton swab for salivary DNA evidence (Sweet *et al*., 1997). Dental impressions are collected from the bite suspects, using materials such as vinyl polysiloxane or polyether (Pretty and Sweet, 2001). The most accurate technique of comparing the suspect's teeth with photographs of bitemarks is the method using a computer (Sweet *et al*., 1998). Lastly, the final step is to form a conclusion.

Conclusion

The roles of forensic odontology are comprised of identification of individuals, age estimation, and sex determination. First, the identification of individuals could be used for both living and deceased people.

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Teeth are hard tissues that are preserved after death and could resist a high temperature. There are criminal, religious, social and monetary rationales for performing dental identification. The developmental sequence of human dentition is used for predicting age. Therefore, the use of radiographs is for morphological observation. Teeth are then analysed and compared with developmental charts. Moreover, tooth restorations, extractions, and other abnormalities could indicate older individuals. As for sex determination, mesio-distal and bucco-lingual tooth dimensions of males expand to a greater length compared to those of females. DNA analysis of Y-chromatin could verify sex by using microscopic examination of teeth. Examining the dental pulp, the average appearance rate of Y-chromatin in males is revealed to be higher than that of pseudo-Y chromatin in females. Regarding the methods of forensic odontology, comparative dental identification is one of the most well-known means. It uses antemortem dental records and postmortem dental remains for comparison. The American Board of Forensic Odontology divided body identification into four categories which are positive, possible, insufficient identification and exclusion. However, when the tentative identification of the individual is not available, postmortem dental profiling may be used. In addition, genomic and mitochondrial DNA could be extracted from the teeth for DNA analysis. The DNA of an unidentified person's teeth could be compared to a parent or sibling as well as to a known antemortem sample (stored blood, hairbrush, clothing, cervical smear, biopsy, etc.). Lastly, the identification of bitemark perpetrators involves determining the orientation of the marks caused by maxillary and/or mandibular teeth and summarizing the features, including class characteristics of dentition, arch and dental characteristics and anomalies. Using a computer provides the highest accuracy of comparison between the suspect's teeth and the photographs of bitemarks.

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