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Forensic Science

FORENSIC ODONTOLOGY: AN EMERGING TREND IN FORENSIC INVESTIGATIONS

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ABSTRACT Forensic odontology is an advanced science in forensic field that is concerned with dental evidences, which utilizes knowledge of dental science for proper collection, handling, careful examination, appropriate interpretation and preservation of dental evidences for future references that is helpful in forensic investigation and dispensation of justice in court of law. The forensic odontologist utilizes knowledge of dentistry in bite mark analysis, fixation of identity in mass disaster, age determination, domestic violence and child abuse cases. Thus the duty and responsibility of Forensic Odontologists have increased in recent years in various medicolegal cases. This article structured to give a brief review of application of dental knowledge in forensic investigations

KEYWORDS : Forensic odontology, Identification of individual, Bite mark analysis, Mass disaster,

Introduction:

As the era has advanced, new challenges before society and human beings increased. The heinous, violent and disastrous activities shatter the lives of victims and family members every day. The appropriate apprehension and prosecution of the perpetrator is essential for the maintenance of law and order. Identification of victims and accused of crime is very much important but in similar manner the identification of victims of mass disasters with the help of dental evidences is also a vital thing. The identification of an individual is grossly done by antemortem dental records, but if those are not available then postmortem collection of data and it's linking-delinking to individuality of person is important. [1]. Teeth are very important factor in identification because their certainty in eruption age related changes they can persist long after other skeletal structures have succumbed to organic decay or destruction by some other agencies such as fire.[2]

Forensic Odontology, as a science, did not appear before 1897 when Dr. Oscar Amoedo the father of forensic odontology wrote his doctoral thesis entitled "L Art Dentaire en Medecine Legale" describing the utility of dentistry in forensic medicine with particular emphasis on identification.[3] The forensic odontology plays major role in bite mark analysis, fixation of identity in mass disaster, age determination, domestic violence and child abuse cases. The duty and responsibility of Forensic Odontologists have increased in recent years to cover issues related to child abuse and domestic violence, human rights protection and professional ethics.

When antemortem dental records are unavailable and other methods of identification are not possible, the forensic dentist can assist in ascertaining the population pool to which the deceased is likely to belong and thus increase the likelihood of locating antemortem dental records.[2] This process is known as postmortem dental profiling, which help in ascertaining the age of deceased, ancestry , sex and socio-economic status occupation, dietary habits, habitual behaviors and occasionally on dental or systemic diseases. This will enable the more focused and well guided investigations in medicolegal cases.

Identification of individual

Identification is the fixing of individuality of a person. Identification is based on comparison between known characteristics of a missing individual termed ante-mortem data with recovered characteristics from an unknown body termed post-mortem data. The diversity of dental characteristics is wide, making each dentition unique.[5] The dental enamel is the hardest tissue in the body, and would thus withstand peri- and post-mortem damages, and so would dental materials adjoined to teeth. Being diverse and resistant to environmental changes, teeth are considered excellent post-mortem material for identification with enough concordant points to make a meaningful comparison.[3] For dental identification to be successful, ante-mortem data need to be available. This relies heavily on dental professionals recording and keeping dental notes, radiographs, clinical photographs etc. The availability of dental records will allow comparing the dental characteristics of the person during life with those retrieved from the person after death. In cases where dental records are not available, Forensic Odontology can still contribute to establishing the identity by creating a profile of how the deceased person was during life.

Dental aging is based on the chronology of formation and eruption of teeth. The techniques used to estimate age after eruption of teeth includes Gustafson's technique, incremental lines of Retzius, perikymata, prenatal and postnatal line formation, racemization of collagen in dentin, cemental incremental lines and translucency of dentin. Gustafson used six dental changes connected with aging namely, attrition, apical migration of periodontal ligament, deposition of secondary dentin, cemental opposition, root resorption and transparency of the root dentin.[6,7,8] Incremental lines of Retzius are caused by variation in the rhythmic mineralization of enamel prisms.[6] These rhythmic patterns may be altered by various external factors such as metabolic disturbances so that the lines may appear closer or the rest periods may be prolonged. The number and spacing of incremental markings at the enamel surface, known as perikymata, these are considered important indicators of dental growth patterns, as they provide information on crown formation times and the underlying developmental processes.[9] The major disadvantage of this method is the necessity to extraction or sectioning the tooth. It is not practical among living individuals. Dentinal translucency is one of the morpho-histologic parameters considered best for dental age estimation, not only in terms of accuracy, but also simplicity.[7]

Ancestry

Ancestry can be assessed by studying the facial skeleton and comparing the features with the main characteristics of the three racial groups: Mongoloid, Negroid, and Caucasoid. Gender can be determined by the results of the study of the skeleton and teeth. That means that differences in the shape, the contour and size of the teeth can provide conclusive evidence of the gender of the victim. Simply, African people have bigger teeth with thicker enamel most notable on crowns. They are often said to have complex massive teeth whereas, Europeans have simple mass reduced teeth which are pretty tiny in nature.

Gender

New approaches that involve the tools of molecular biology like DNA analysis can help ascertaining the gender of the cadaver. In addition the low rate of the appearance of pseudo-Y chromosome in samples from women, allow the assumption that the DNA analysis can help gender assessment. However details about the lapse of time after death cannot be gained with this method. The analysis of the DNA code is based on the polymerase chain reaction, RFLP, STR Methods.[7,8]

Modern forensics can obtain information about the gender of the

cadaver, with the analysis of specific genes in the DNA. The genes located on different chromosomes for males and females, can help in distinguishing between males and females. The amelogenin gene (AMEL) is located on the X chromosome in females and on the X and Y chromosome in males. The length of the gene on the X chromosome is 106 base pairs and on the Y chromosome 112 base pairs. Thus on a bar-code type display of the DNA the difference in the length of the two genes is visible. Sweet et al 7 in their published case report, used genotype analysis of tooth smear gained after cryogenic grinding of cadaver's teeth in order to compare the results with the antemortem PAP smears from the putative medical record of the individual.

Bite mark analysis

Human bite mark analysis is by far the most demanding and complicated part of Forensic Dentistry. Although bite marks of an individual do have uniqueness due to specific characteristics and arrangement of the teeth, when it comes to bite mark analysis, it is complicated by numerous factors, being presented as a challenge to the Forensic Odontologists.[10]

The American Board of Forensic Odontology (ABFO) and The British Association of Forensic Odontology (BAFO) has published guidelines which describe that evidence should be collected from both victim and suspect and represent a sound basis for such collection. Both in the living and deceased victims the following vital information should be recorded: Such as Name, age, sex, race, case number, date of examination and name of the examiners should be recorded. Location of the bite mark, contour of the surface, and state of the tissue Shape of the bite marks, Colour of the mark, size of the bite mark, Type of injury etc. The most important evidence from the bite mark victim is photography with and without the ABFO no.2 scale, in colour and black and white, Close-ups shots and UV photography. Saliva obtained from swabbing is used to determine the blood group antigens using absorption-elution or absorption-inhibition group testing. Identifi cation of saliva is done by demonstrating its amylase activity in hydrolysing a starch substrate.[11]

If the bite marks have penetrated the skin, an impression of the marks should be made.[12] Ordinary plaster of Paris or dental stone was used initially for the purpose, but it was seen that the water soluble substances in the material would leach out and delicate surface lesions would be destroyed. Therefore less damaging materials like rubber-base and silicone-base impression compounds are preferred now-a-days.13 There are two methods for making impressions, first is to pour the material covering the bite area. Place wire gauze and inject additional material over it and second is a special tray is constructed using cold cure confining to the shape of bite mark and impression is made.

The collection of evidence from the bite suspect must commence only after proper consent has been acquired. [4] The consent has to be written, signed by the suspect as well as a witness. A detailed history of the individual including history of dental treatments (after and just before the bite marks) has to be noted.[12] Evidence collection again begins with copious photography. Shots that should be taken include Overall facial shot; Close-up photograph of the teeth in normal occlusion & biting edge-to-edge; Photograph of the individual opening mouth as wide as possible; Lateral view. [12]

After the photographs, a thorough examination of the individual should be carried out. A full dental examination is carried out completing a detailed description of the teeth present and missing, the associated restorations and carious lesions and information on the degree of attrition of teeth and measurements of individual teeth and spaces. Any abnormalities in tooth form or arch form are noted together with the relationship of the opposing teeth and jaws.[14] The American Board of Forensic Odontology provides a range of conclusions to describe whether or not an injury is a bite mark. These are Exclusion, Possible bite mark, Probable bite mark, definite bite mark

Mass Disaster

Mass disasters can be defined as catastrophic events of such a scale that local resources assigned to cope with such types of event are overwhelmed. Major transport crashes, natural disasters and terrorist attacks result in considerable loss of life. Disaster Victim Identification (DVI) uses scientific methods to maximise the chances of successful victim identification. Where a forensic dental team has been present, its success in identifying the victims of the disaster has surpassed the application of other biological or biometric information. This is due to the presence of experienced and properly qualified forensic Odonto logists, and when ante-mortem dental records were available to them, the utilization of those dental data to confirm the identity by a comparison with the post-mortem findings.

In natural disasters, large numbers of people may lose their lives and when this happens in wealthy countries (or countries with many wealthy visitors), it is commonly the role of the forensic odontologist to assist with such identifications, along with deoxyribose nucleic acid (DNA) scientists and fingerprint police members. But when the dead are not identified, this can produce a wide range of adverse psychological effects on the survivors and the next-of-kin (NOK) that can be manifested in a number of ways for years into the future, including suicide. When conventional dental identification methods fail, DNA (deoxyribonucleic acid) material from teeth can provide the necessary link to prove identity. Teeth represent an excellent source of DNA material and DNA is found within distinct locations of the tooth. DNA preserved in and extracted from the teeth of an unidentified individual can be compared to a known antemortem sample or to a parent or sibling. The principal laboratory techniques used to compare and evaluate fragments of DNA material from a suspect or victim are restriction fragment length polymorphism (RFLP) and polymerase chain reaction (PCR) analyses.

The method currently preferred to extract as much high quality DNA as possible is a method called cryogenic grinding. This technique involves cooling the whole tooth to extremely low temperatures using liquid nitrogen and then mechanically grinding to fine powder. The major disadvantage of this method is that the tooth needs to be completely crushed. This speciality is also utilized for identification of individuals through developmental disturbances of teeth, regressive alterations of teeth and tumors and cysts of oral cavity. [15]

The identification of deceased victims in those circumstances necess itates putting a hierarchy system consisting of an ante-mortem, post-mortem and reconciliation teams. Those teams are headed by team leaders, with liaison officers to coordinate the work. The results are reported to an identification board which is headed by a commander, who in most cases is a senior police officer. Forensic Odontologists have contributed to the resolution of many mass disasters. The 2004 Indian Ocean tsunami is probably the most eminent example on the success of Forensic Odontologists in identifying large number of victims in short time. Nearly half of the victims in Thailand were identified by dental characteristics method alone. [3]

Domestic violence and Child abuse

The World Health Organization (WHO) has declared that violence is a major and growing public health problem across the world. This landmark declaration meant that healthcare providers are involved in detecting and managing cases of violence, including abuse to vulnerable populations, i.e. children, elderly and women. The WHO further distinguishes four types of violence; physical, sexual, psychological and neglect. All forms of violence can manifest in the oro-facial region, and are hence should be of concern to dentists. Prevalence of physical violence, as a cause of maxillofacial injuries, ranges from 3.3% to 41% in various countries. This wide range is probably due to different reporting thresholds in different communities. The true prevalence of violence is thus difficult to establish because of not or under-reporting this problem. Injuries due to abuse can manifest in the oro-facial region in various forms, including fractured anterior teeth, fractured alveolar bone, lacerations of the labial and buccal mucosae, lacerations to the frenum and bruises to the lips, face and neck. Non-accidental injuries have certain characteristics which help in their recognition .[2,3,6]

Facial reconstruction

The morphology of the mouth is an area of the face where there is more reliance on artistic interpretation. Orthodontic and anatomic literature suggests that the form of the mouth is related to the occlusion of the teeth, the dental pattern and the facial profile. Where the upper teeth are more prominent than the lower teeth, the upper lip will be more prominent than the lower lip and vice versa, and different occlusion patterns will suggest different lip patterns. There are some standards for determination of mouth shape, such as placement of the fissure at the mid-line of the maxillary incisor crowns and the mouth corners on radiating lines from the first premolar-canine junction, or with

intercanine distance as 75% of overall mouth width, or the mouth corners positioned below the infraorbital foramina . There is also a positive correlation between upper lip thickness and maxillary enamel height, and between lower lip thickness and mandibular enamel height; sets of regression formulae can be utilized for White European and Indian subcontinent populations. [3,16]

Conclusion:

A standardized system for the record of the dental status of individuals is necessary in order to help the process of human identification after an accident or a mass disaster. Additionally the training of specific groups, the organization of multidisciplinary groups and the international cooperation are of high importance in forensic medicine. Thus the duty and responsibility of Forensic Odontologists have increased in recent years in various medicolegal cases, so these personals must be additionally supplied with facilities to enrich the research in advanced direction.

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