ejpmr, 2018,5(7), 165-168

SJIF Impact Factor 4.897

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

FORENSIC ODONTOLOGY

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Article Received on 20/04/2018 **Article Revised on 11/05/2018** **Article Accepted on 02/06/2018**

ABSTACT

Forensic dentistry is the application of dental knowledge to those criminal and civil laws that are enforced by police agencies in a criminal justice system. 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. Identification is done by the comparison of ante-mortem and post-mortem dental records and using the unique features visible on dental radiographs. Forensic dentistry is the proper handling, examination and evaluation of dental evidence, which can be presented in the interest of justice. The evidence that may be derived from teeth is the age and identification of the person to whom the teeth belongs. This is done by using dental records including ante-mortem radiographs and post-mortem photographs and DNA. The other type of evidence is that of bite marks, left on either the victim (by the attacker), the perpetrator (from the victim of an attack), or on an object found at the crime scene. Bite marks are often found on children who are abused.

KEYWORDS: Bite marks, Dentition, Identification.

INTRODUCTION

Forensic odontology is the study of dental applications in legal proceedings. The subject covers a wide variety of topics including individual identification, mass identification, and bite mark analysis. There have been many cases throughout history which have made use of bite marks as evidence. Bite marks are usually seen in cases involving sexual assault, murder, and child abuse and can be a major factor in leading to conviction. Biting is often a sign of the perpetrator seeking to degrade the victim while also achieving complete domination[1] over the victim. Bite marks can be found anywhere on a body, particularly on soft, fleshy tissue such as the abdomen or buttocks. In addition, bite marks can be found on objects present at the scene of a crime. Bite marks are commonly found on a suspect when a victim attempts to defend him/herself.

Bite mark analysis

Bite-mark evidence has been used as an aid in the identification of criminals in many instances. It is shown how perpetrators of violent injuries were detected from bite marks on the victim or the perpetrator, or on foodstuffs found at the scene of the crime, when the marks were compared to dental impressions taken subsequently.[2] Upon collection of dental evidence, the forensic odontologist analyzes and compares the bite marks. Studies have been performed in an attempt to find the simplest, most efficient, and most reliable way of analyzing bite marks. Bites can occur on both the victim and the suspect; teeth are used as weapon by the aggressor and in self defense by the victim. Although they are only a small portion of most forensic dentist's case load, bite marks represent the most challenging aspect of the discipline. In addition to the location of the bite mark the type of severity of the injury may give investigators clues as to the mental state of the offender. Bite marks may be found on the flesh of victims of a violent attack, particularly on the abdomen or buttocks. Alternatively they may be found on the suspect, left by the victim during self defense. Bite marks can be altered through stretching, movement, or change in environment after the bite. There is also no set standard to analyse and compare bite marks. Factors that may affect the accuracy of bite mark identification include time-dependent changes of the bite mark on living bodies, effects of where the bite mark was found, damage on soft tissue, and similarities in dentition among individuals[3]. Other factors include poor photography, impressions, or measurement of dentition characteristics.[3] Most bite mark analysis studies use porcine skin (pigskin), because it is comparable to the skin of a human, and it is considered unethical to bite a human for study. Limitations to the bite mark studies include differences in properties of pigskin compared to human skin and the technique of using simulated pressures to create bite

marks.[4] Although similar histologically, pigskin and human skin behave in dynamically different ways due to differences in elasticity.[5] Furthermore, postmortem bites on nonhuman skin, such as those used in the experiments of Martin-de-las Heras et al., display different patterns to those seen in antemortem bite injuries.[4] In recognition of the limitations of their study, Kouble and Craig[4] suggest using a G-clamp on an articulator in future studies to standardize the amount of pressure used to produce experimental bite marks instead of applying manual pressure to models on pigskin.[5] Future research and technological developments may help reduce the occurrence of such limitations.

Kouble and Craig[5] compared **direct methods and indirect methods** of bite mark analysis. In the past, the direct method compared a model of the suspect's teeth to a life-size photograph of the actual bite mark. In these experiments, direct comparisons were made between dental models and either photographs or "fingerprint powder lift-models." The "fingerprint powder lift" technique involves dusting the bitten skin with black fingerprint powder and using fingerprint tape to transfer the bite marks onto a sheet of acetate. When comparing the "fingerprint powder lift" technique against the photographs, the use of photographs resulted in higher scores determined by a modified version of the ABFO scoring guidelines.[5] Indirect methods involve the use of transparent overlays to record a suspect's biting edges. Transparent overlays are made by free-hand tracing the occlusal surfaces of a dental model onto an acetate sheet. The use of transparent overlays is considered subjective and irreproducible because the tracing can be easily manipulated.

On the other hand, photocopier-generated overlays where no tracing is used is considered to be the best method in matching the correct bite mark to the correct set of models without the use of computer imaging[5]. While the photocopier-generated technique is sensitive, reliable, and inexpensive, new methods involving digital overlays have proven to be more accurate.[3] Two recent technological developments include the 2D polyline method and the painting method. Both methods use Adobe Photoshop. Use of the 2D polyline method entails drawing straight lines between two fixed points in the arch and between incisal edges to indicate the tooth width. Use of the painting method entails coating the incisal edges of a dental model with red glossy paint and then photographing the model. Adobe Photoshop is then used to make measurements on the image. A total of 13 variables were used in analysis. Identification for both methods were based on canine-to-canine distance (1 variable), incisor width (4 variables), and rotational angles of the incisors (8 variables). The 2D polyline method relies heavily on accurate measurements, while the painting method depends on precise overlaying of the images. Although both methods were reliable, the 2D polyline method gave efficient and more objective results.[3]

Identification of dead from the dentition

The major contribution of forensic odontology is in the field of identification[6], especially in mass disasters, such as aviation and marine catastrophes. In air crashes, dental investigation is the most successful single procedure leading to identification of mutilated and burned bodies. Apart from mass casualties, forensic odontology is frequently used in problems of individual identity that are the direct concern of the forensic pathologist, as accident, suicide and murder form the majority of such unidentified bodies. As with skeletal remains (of which dental evidence is part) there are two prime avenues of investigation.

1. General or reconstructive identity, which attempts to classify the unknown person by age, sex and race.
2. Comparative methods, which confirm or exclude the personal identity of the individual against ante-mortem dental records.

General or reconstructive identity

Unlike skeletal remains, the human origin of dental material is rarely in doubt. In badly decomposed or skeletalized bodies the jaws usually survive intact, though in dry skeletons, teeth may become loose and fall out, especially the single-rooted canines and incisors. Even in fragmented bodies and skeletons, the jaw remnants and teeth are readily recognizable, even by lay persons. Where teeth have dropped out and been recovered independently of a body, they are still usually recognizable as human, as opposed to most domestic or farm animals. In countries where large primates exist, there may be some confusion, but this is a rare problem. Having established the human origin, the next determination is sex and here teeth have a poor discriminating value, though the intact jaw is more helpful. Male teeth are usually larger, but this is generally not helpful. The difference in size between the upper lateral and upper central incisors is often greater in women, the male incisors being more equal in size. The female canines are usually smaller and more pointed relative to the male, more especially in the mandible than the maxilla. Girl's teeth tend to calcify and erupt earlier than boys. If the skeletal age is known, then more advanced tooth eruption in young persons is an indication of being female, though in these circumstances there are usually far better indicators of sex available elsewhere in the skeleton. The mandibular first molar often lacks a fifth cusp in the female, which is almost always present in the male. Extraction of pulp tissue from a tooth, even up to many months after extraction or death, can provide material for fluorescent staining for the female intranuclear F-body, but this has now been superseded by sex determination via DNA, if recoverable from the pulp.

Race is also a difficult criterion to determine from teeth. The best-known feature is the 'shovel-shaped' upper central incisors of Mongoloid races, first described in Leipzig by Muhlreiter in 1870. The posterior surfaces of

these teeth have a depression centrally, with two marginal bars, causing the back of the tooth to appear like a coal shovel with turned-up edges. The feature is found mainly amongst Chinese, Mongols, Eskimos and Japanese, but is also found amongst non-Mongoloid races in lesser numbers. Some 91 per cent of Chinese, Japanese and Tibetans have such teeth, 95 per cent of Native Americans, 84 per cent of Eskimos, 46 per cent of Palestinian Arabs and 90 per cent of Finns. It is rare amongst Negroids and Australian Aboriginals. In Caucasian races, the lateral incisors in the upper jaw are usually smaller than the central, especially in women, a feature absent or less marked in Negroid or Mongoloid races. Caucasians also have long pointed canine roots, a feature not seen in Mongoloids. Enamel pearls, small nodules of enamel on the tooth surface are much more frequent in Mongoloid teeth. Small nodules on the lingual surface of maxillary molars, called 'Carabelli's cusp', are most common in Caucasian races and rare in the other major racial groups. The condition of bull-tooth or 'taurodontism' is most common in Mongoloid peoples: here the pulp cavity of molars is wide and deep, and the roots are fused and bent. A congenital lack of the third upper molar is most common in Mongoloids, but can occur in any race. Negroid races tend to have large teeth and often have more cusps on their molars; even up to eight, with two lingual cusps on the mandibular first premolars as an additional common finding.

The age of the person is one of the most useful findings disclosed by the teeth, especially in the first two decades of life. The sequence of deciduous or 'milk' teeth is well known, overlapping the appearance of the permanent dentition. This is only an average timetable, however, and is modified by several factors, such as sex, race and climate. Again, dental expertise is needed to refine the accuracy of such estimations. The determination of age from fetal teeth is also a matter for embryologists or dentists with specialized knowledge of this period. After the third molar has erupted in the third decade of life, then age determination becomes much more difficult. Much research has been done in forensic odontology and the name of Gustafson is well known in this respect. His criterion for age in adult life comprises six factors.

1. Occlusal attrition of the tip of the tooth
2. Secondary dentine deposition in the apex of the pulp cavity
3. Apical migration of the attachment of the periodontal membrane
4. Increase in root transparency - the best single indicator
5. Root resorption
6. Accumulation of cementum around the root.

This method, as later modified by Johanson (1971), is said to give age accuracy within 5 years either side of the true age.

The standard textbooks on forensic odontology and original papers should be consulted for the details. Returning to general features of age, obvious pointers are the state of the teeth in respect of wear, hygiene and color, which may deteriorate with advancing age. Much depends upon the care with which they have been maintained, however, though marked occlusal attrition tends to go with increasing age, unless a rough diet has accelerated the wear. In Western Europe, gross occlusal attrition, sometimes down to gum level, is seen in old skeletal material. This usually indicates that the bones and teeth came from someone alive in the mid-nineteenth century or earlier, before modern milling methods removed abrasive stone dust from flour. Edentulous jaws also suggest advancing age but, especially in former years before more conservative dentistry, even young adults often had total tooth clearances for caries. Once the teeth have gone, there is a general atrophy of the alveolar margins, but this is a poor criterion of age because of the great variability in the time when teeth are lost. Newer techniques for age estimation include the variation with age of racemization of amino acids, especially aspartic acid, but this is a very specialized area.

Comparative identification from teeth

Establishing personal identity requires the matching of observed features with pre-existing dental records, the latter almost always obtained from previous diagnostic and therapeutic surveillance. For this method to be applied there must be.

1. Some collateral evidence to indicate either who the unknown body might be, so that records can be sought.

2. Alternatively, a circumscribed population must be searched for records that may match the unknown. Such a population may be the known passengers on an aircraft or ship or a cohort of missing persons maintained on some register. It is practically impossible to search a large population, such as a whole country or even a city. Attempts were made in Britain to computerize dental records from the National Health Service so that a wide search could be made, but the completeness and quality of data was such that the scheme was found to be impracticable.

3. The unknown person must have had dental attention in the past. The dentist or hospital must be known; the records must be traceable and, when found, must contain sufficient clinical information to provide adequate identifying features. The recovery of dental radiographs is a most useful adjunct. Unfortunately, these criteria are not always satisfied.

The dental records are needed to provide a description of the dentition and jaws at a date as late as possible before the finding of the body. Work may have been done on the deceased during life since the last record was made, if the person had been treated elsewhere and the

information not recorded. Where a record does not conform to the dental state of a body who was expected to be a match, it is obvious that such discrepancies can be of two types.

1. If the record indicates some condition that is irreversible but which does not exist in the body, then that excludes matching. For example, if the record states that certain teeth have been extracted, yet they are still present in the jaws, then any hope of correspondence must be abandoned.

2. If fillings are present in the teeth, which are not shown in the records, then these may have been made later and not recorded. Of course, no discrepancies of point 1 must be present for those of point 2 to be acceptable.

COCLUSION

With increase in crime rate and also with the number of homicides and suicides going up, it becomes equally important to identify the culprits, along with the measures to minimize these incidents. Expertise in identification of the persons in mass disasters helps in rendering greatest service to their families. In our country, options to expose the dental students to various aspects of forensic odontology in the beginning years of their graduation are needed. Teaching advanced techniques in the form of practicals, thus exposing the students to these techniques, and correlating these techniques to forensic odontology keeps them motivated and helps them to update in this arena instead being left ignorant in the midst of technological advancements. In our country, the existing doctor patient ratio as such is less and the forensic odontologist population ratio is all the more minimal. We should strive to incorporate this subject as compulsory in the undergraduate curriculum thus bringing wider awareness among budding dental professionals and reinstating their role in the field of forensic odontology. The existing method of teaching forensic odontology under the banner of oral pathology has to be expanded further, and not only the students but also the faculty members of various departments are to be encouraged to participate in this promising and responsible field.

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