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Research Article

Forensic Dentistry - The Role of the Dentist in Human Identification

Konstantinos Vlasiadis[1], Maria Koutsamani[2]

[1]Director Dentist, Dental Clinic, University Hospital of Crete, Scientific Collaborator, Health Planning Unit, School of Medicine, Crete, Greece

[2]Consultant Dentist, Venizeleio - Pananeio Hospital of Heraklion, Crete, Greece

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Abstract:

A dentist's role often involves screening, diagnosing, preventing, and treating a variety of oral diseases. However, it is equally important in both the medical and the judicial field through the identification of unidentified deceased individuals. For this reason, the science of Forensic Dentistry has been developed, the contribution of which is valuable, especially in cases of criminal acts or mass disasters, where the number of victims is high. Its work is characterized as demanding, in which case the immediate and effective action of specially trained and experienced professionals is necessary. The methods of identification used work with outline the collection, careful examination, radiographic and photographic imaging and recording of post-mortem evidence of teeth and their impressions on the skin alongside the jaws, the lips and the palatal rugae of mucosa in order to be compared with existing ante-mortem and to draw conclusions regarding the racial and age identification of the deceased as well as finding other useful information about him/her. The forensic dentist's contribution to the administration of justice is essential through keeping detailed records of patients and excellent cooperation with local authorities towards a valid and reliable identification process.

Keywords: Forensic dentistry, dentist, human identification

1- Introduction

Forensic odontology/dentistry is a science that utilises the knowledge of well-trained and experienced dentists qualified in forensic science who provide their expert opinion in identifying an unknown body or skeletal and other human remains. These professionals contribute to the identification of victims of mass disasters, crimes and physical abuse, as well as many other cases (1). A variety of methods are used, involving the collection, recording and analysis of bite marks, craniofacial injuries, lip prints, palatal rugae of mucosa, dentomandibular tissues and other data (2). Post-mortem data are carefully compared with the available ante-mortem data to determine unique individual identifying characteristics such as sex, age and race, as well as others such as nutritional and hygiene habits. The role of forensic dentists is a crucial one, overall, since the quality of the thorough examinations they carry out and the detailed records they collect, and the accuracy of the findings they extract, can aid or impede the process of identification (3).

2- Maxillofacial data analysis

During a forensic examination, dentists are required to fill out the odontogram of the victim. The odontogram, together with the radiographs, will help form a full picture of the condition of the mouth. This tool allows the determination of diagnoses, the description of any treatment plans implemented, and the recording and examination of any special dentoskeletal characteristics, dietary habits and dental hygiene. The odontogram is stored and used if necessary to identify unknown bodies, facilitating the process of sketching their dental profile (4). The identification of a body based on its orodental image is an extremely important method, as teeth are resilient to high temperatures, moisture and trauma (5). By extension, the presence of dentures, caries, fillings, erosion, root and jaw radiographs during excision, the type and quality of filling materials used and a wide range of other data are considered unique individual characteristics (Fig. 1).

An indicative example is the discovery of prosthetic alloy teeth, often found in individuals from the former Soviet Union. The role of the forensic dentist is, having first determined whether the teeth found are human or animal, to

record and examine the post-mortem data and compare them with any available ante-mortem records, in order to "chart the dentition" and assist in the identification process (2,6).

The thorough examination of teeth can reveal additional essential information about an individual, including race, profession, dietary and oral hygiene habits, age and sex (2). For example, a person of Asian origin may have mandibular molars with three roots, which can be a distinctive trait worth noting in unknown bodies. Moreover, any injuries to the orofacial region should be examined, such as fractured anterior teeth, fractured alveolar bone, and bruises or lacerations to the labial mucosae, the frenum and the rest of the oral cavity, to confirm or deny the possibility of their being accidental or due to assault (1).

The science of forensic odontology has also contributed to the successful identification of many victims of mass disasters (6-10). A striking example is that of the Indian Ocean earthquake and subsequent tsunami in 2004, when specialist dentists assisted in the rapid identification of huge numbers of victims (8,9). In such cases, of course, the establishment of a specially trained forensic dental identification team is recommended. This team should consist of the section for the collection, examination and processing of ante-mortem data (e.g. dental records, radiographs and casts), the section for the post-mortem clinical/radiographical examination of the bodies and recovered skeletal and other remains, recording the subsequent findings, and the section for the comparison of ante- and post-mortem data in order to prove a positive, probable, negative or uncertain identification (11).

3- Bite mark analysis

Bite marks, found on a victim, a perpetrator or an object collected from a crime scene, are another special category of evidence with a distinctive pattern. Their uniqueness is particularly useful in identifying unknown bodies (12). More specifically, bite marks inflicted on people are injuries to skin tissue in the form of contusions or abrasions, while their identification, examination and evaluation is usually carried out in cases of self-defence and cases of sexual assault and abuse as an expression of rage, animalistic behaviour, or a strong desire for dominance (8,9).

The dentist is required to photograph, record and analyse the characteristics of a bite mark (e.g. shape, size, colour and precise location on the body), the type of injury caused (petechial haemorrhage, contusion, abrasion, avulsion, etc.) and the dentition itself (shape, size and arrangement of teeth and arches), evaluating all the available records (13). It is very important at this point to distinguish between human and animal bites. Animal bites are usually puncture injuries involving avulsion of skin and tissue, while with human bites there is crushing and contusion to the tissues (8).

Moreover, in order to preserve the nature of the injured area of skin, i.e. the indentations, an impression of the bite mark should be made. This will be used to produce a cast in stone or, for ease of use and greater stability of dimensions and thus greater precision, in polyether, rubber or silicone, used to compare the dentition of the attacker with that of possible suspects (13). Furthermore, experimental studies have shown that the recovery of DNA from the saliva and dentin found in bite marks can assist in the identification of bodies, but in the absence of practical application and bibliography any resultant finding must be considered unsafe (14).

It is worth noting that there have been cases in which bite marks were unique evidence of a person's guilt or innocence. For example, the American serial killer and rapist Theodore (Ted) R. Bundy was convicted on the basis of the analysis of bite marks found in a specific area of one of his victims' bodies. Nevertheless, opinions are divided as to the analysis and use of bite marks as reliable scientific evidence crucial to the outcome of a criminal investigation (1). This is because such marks need to be identified and recorded in time, as their clarity and shape can change rapidly on both living and dead skin tissue due to a range of factors, including the bite pressure exerted, the maxillary and mandibular angle, and the position of the body itself during the act of biting (9,15). The use of reflected ultraviolet photography as a modern imaging technique can record a better-quality 3D image of bite marks, increasing their reliability as evidence (12,15).

4- DNA analysis

Teeth are particularly resistant to incineration, decomposition, immersion, high temperatures and microbial action. They are therefore an excellent source of genetic material, the analysis of which can assist not only in the identification of an unknown individual but also in determining their sex (9,10,16). DNA is a valuable source of evidence when conventional identification methods fail and is obtained using polymerase chain reaction (PCR), an in vitro technique which allows the isolation of a specific sequence of genetic material. The DNA obtained from a tooth, usually a canine or molar, can be compared to ante-mortem samples taken from personal items such as toothbrushes or hairbrushes, from a stored sample of clothing/blood/biopsy/cervical smear, or from family members of the person to be identified (10).

More specifically, DNA can be obtained from odontoblastic processes of dentin, cellular cementum, neurovascular tissues of pulp, radicular canals, periodontal ligament, and alveolar bone. Adequate quantities of DNA are present especially in the crown body and in the root body and apical end. Cementum, particularly from the apical root ends and the furcation area, can be used for DNA recovery in situations requiring rapid sampling, such as mass disasters (10,16). Pulp is commonly used for DNA extraction because it is less likely to have been contaminated by nonhuman material, while it is protected from the external environment by dentin and the enamel. However, it must be borne in mind that pulp can undergo putrefaction if exposed to a moist environment, becoming completely destroyed and preventing its use in the identification process (7).

5- Determination of age

"Dental maturity" plays an important role in estimating the age of an individual, based on the number and sequence of erupted teeth (2,7,16). Four different categories of method are

used for this purpose: clinical or visual, radiographic, histological, and physical and chemical methods (6). These methods can further show the various stages of mineralisation and the formation process of the hard tissues of the teeth, assisting in a more precise determination of age. It should be noted here that tooth mineralisation provides a better estimate of age than bone mineralisation, as its stages of development are less affected by variations in the individual's nutritional and endocrine status. It is therefore widely used to determine age, particularly in unknown individuals (6,7).

When determining the age of a victim or defendant who has not reached adulthood, the simplest method is to examine the eruption status of the teeth in the oral cavity. Specifically, up to the age of 15, age determination is based on the degree of formation of crown and root structures, while after that age it depends on changes in the form of attrition, cementum formation, any implants, diastema or gaps, or root transparency (1,2). Kvaal and colleagues (1995) developed another method of estimating age in adults, by measuring the size of the pulp from periapical radiographs of the teeth depending on the sex of the individual; this method is still used effectively today (17).

A very promising method of age estimation of unidentified children or adolescents has been developed by Cameriere et al. (2016), based on the "relationship between age and measurement of the open apices in teeth". Once it has been investigated further and applied in practice to larger population samples, this method may provide more accurate and therefore more reliable results (18). However, in higher ages where the apices are fully formed, other measurement techniques are used, such as the measurement of sclerotic or translucent dentin. Of course, even when full dental records are not available, the science of forensic dentistry can still contribute to the identification process by tracing a profile of the deceased in life, with reference to dental hygiene habits, diet, socioeconomic status and age (1).

6- Lip prints (Cheiloscopy)

Like fingerprints, palm prints and footprints, lip prints are unique (except in the case of monozygotic twins), remaining unchanged over the course of an individual's life and providing valuable information, particularly in the identification of unknown bodies (19). These prints are found at the crime scene and can be taken either directly from the lips of the deceased or from clothing, glasses, cigarettes and other objects. They must be collected within 24 hours of the time of death in order to reduce inaccurate information that might result from possible post-mortem alterations of the lips (20).

More specifically, lip prints are made up of regular lines and fissures in the form of wrinkles and grooves at the junction of the internal labial mucosa and the external skin. Their examination is known as "cheiloscopy". Specific lip print patterns are classified based on the number of types of line found. These lines may be vertical, intersecting, branched or reticular, while if there is more than one pattern the print is considered undetermined (21). The pattern also depends on whether the mouth is open or closed. If it is closed, the lips present well-defined grooves, whereas if it is open, lip prints are difficult to take and interpret due to ill-defined and/or altered grooves. The identification process is further complicated when the print only shows the shape of the lines, unless it reveals particular individual features such as scars, cracks, etc., which can be utilised (9,19).

In confirmation of the above, lip prints have also been stated to assist in sex determination: studies have found that women's lips usually present a vertical pattern or one of intersecting lines, while branching or reticulated patterns are more often found in men. Moreover, with reference to their anatomical features, specifically thickness and position, which are also subject to analysis, lips may be horizontal, elevated or depressed. Lip thickness also varies according to race: for example, thin lips are common in European Caucasians, while medium lips (from 8-10 mm) generally predominate in individuals of Asian origin, while thick lips are a common characteristic of African Americans (9,16,19). Overall, the role of the dentist is also considered extremely important in the analysis of lip prints to identify a person (22).

7- Rugoscopy – Study of palatal rugae and clefts

When attempting to identify an individual, the forensic dentist can also carry out a thorough examination of the individual's palate, using an identification technique based on the study and analysis of the number, shape, length, direction and merging pattern of the palatal ridges or rugae (23). These are anatomical ridges, wrinkles or folds on the anterior portion of the palate, immediately posterior to the upper anterior teeth and the incisive papilla, on either side of the midline (24). They are present throughout a person's lifetime from the third month of intrauterine development, while they are unique to everyone (including monozygotic twins) and protected by the lips, teeth, Bichat's fat pad and the maxillary bones, meaning that they are less affected by decomposition and incineration (5,25).

Furthermore, the palate may present clefts, congenital morphological anomalies which may, however, prove useful to an experienced dentist. This is a category of cases of "incomplete fusion of the palatal tissues", which present specific characteristics and can be used in conditions where a deceased person cannot be identified by fingerprints or dental records (26,27). It is worth noting that rugae patterns change with age and due to various external factors such as orthodontic interventions, tooth extraction, cleft palate or periodontal surgery, and impacted canine eruption, which the scientist must take into account during the identification process (28). However, the examination of palatal rugae and clefts is generally seen as a reliable identification method, as relevant studies show (16,25,29).

8- Conclusions

In conclusion, as this study demonstrates on the basis of the bibliography, the science of forensic dentistry can be of great value in the identification of an unknown body, contributing in a variety of ways. Special mention is made of the value of

genetic material, the study of the teeth, mandible, maxilla and palate, as well as cheiloscopy and bite marks, all of which contribute to the recovery and recording of unique individual characteristics and the determination of age and sex, thanks to which a deceased person may be identified. Further research and practical application of these identification techniques is, of course, urgently needed in order to increase the reliability of the findings and, by extension, the efficiency and speed of the identification process, particularly in cases of mass disasters, accidents, physical abuse and other types of crime. Dentists should keep accurate and detailed patient records, keeping them up to date and providing all the necessary information in order to contribute to the crucial work of identification, in cooperation with the local authorities.

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