Forensic Odontology

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ABSTRACT

Forensic odontology is a specialized field of dentistry which analyses dental evidence in the interest of justice. Forensic odontology embraces all dental specialities and it is almost impossible to segregate this branch from other dental specialities. This review aims to discuss the utility of various dental specialities with forensic odontology.

Key words: Dental specialities.   Relationship.   Forensic odontology.

INTRODUCTION

Forensic odontology is that branch of dentistry which deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings in the interest of justice.[1] This branch has been utilized for many years for the identification of victims and suspects in mass disasters, abuse and organized crimes.[2] Forensic odontology embraces all dental specialities and forensic dental field work requires an interdisciplinary knowledge of all dental specialities.

The widely accepted classification of forensic odontology is based on the major fields of activity i.e. civil, criminal and research by Avon.[3] More recently the author has published a new working classification for forensic odontology based on the relationship of various dental specialities with forensic odontology.[4]

The present review investigates in-depth about each speciality and its relationship with forensic odontology. The dental specialities considered in the review are oral pathology and microbiology, oral medicine and radiology, oral and maxillofacial surgery, paedodontics, periodontics, conservative dentistry and endodontics, prosthodontics, orthodontics and finally community dentistry.

Oral Pathology and Microbiology: Oral pathology and microbiology is the speciality of dentistry that deals with the diseases affecting the oral and maxillofacial regions. This speciality is utilized for age estimation studies using ground sections of teeth. Ground sections are the sections prepared without using any chemical and thus maintaining normal anatomy and constituents. The histological technique is more appropriate for post-mortem situations and also significant in estimation of age of early development of dentition.[5]

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The techniques used to estimate age by means of teeth include 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.[4]

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.[2] 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, are considered important indicators of dental growth patterns, as they provide information on crown formation times and the underlying developmental processes.[7]

The prenatal and postnatal line formation is considered as an indicator of birth.[8] These lines are present in both enamel and dentin of deciduous teeth and permanent first molars which indicate the development during the transitional period between intra uterine and extra uterine environments. So it can be used to assess the amount of prenatal and postnatal enamel formation. In the dentin incremental lines of Von Ebner and contour lines of Owen are present. These lines are used to estimate age of the neonates or foetus at death. The extent of racemization of aspartic acid in coronal dentin of normal permanent teeth can be used to estimate the age of an individual at the time of death.[9] As age advances L-aspartic acid will change into D-aspartic acid.

The incremental lines of cementum will help to determine the age of adults.[10] A major disadvantage of this method is the necessity to extract or section 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.[11]
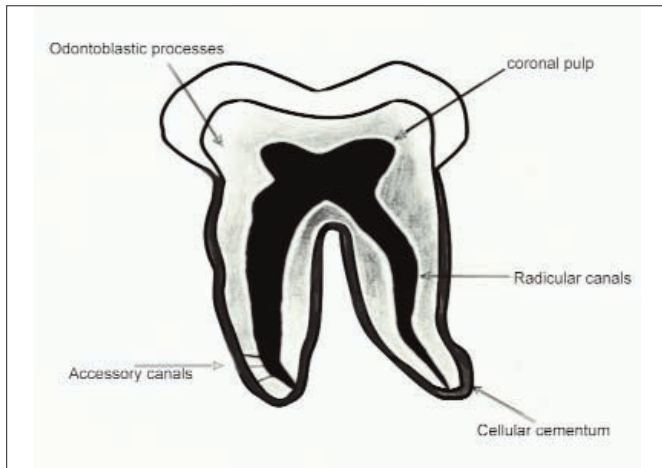
Figure 1: Schematic diagram showing sites within the tooth where DNA can be extracted.

Root dentin starts to become translucent due to the increased intratubular calcification. Dentin translucency will increase with age. Disadvantages of this method include underestimation of age in older age groups due to slowing down of dentin sclerosis and irregular junction at translucent and non-translucent zones will make difficulties in measuring the length.

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 (Figure 1). 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.[12] 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 tumours and cysts of oral cavity.[4]

Oral Medicine and Radiology: Oral medicine and radiology is the speciality of dentistry that deals with the nature, identification and management of diseases affecting the oral and maxillofacial regions. This speciality is utilized for age estimation studies using radiographic method. The parameters used to estimate age by radiographic method include secondary dentin formation, changes in the orientation of mental foramen and inferior alveolar canal, eruption and formation of mandibular third molar, trabecular pattern in jaws, pulp/tooth area ratio of teeth and pattern of lamina dura.[4]

Deposition of secondary dentin can be assessed using periapical radiograph to estimate age. Measurements such as pulp diameter to crown diameter ratio and pulp/tooth area ratio are calibrated to assess secondary dentin formation.[13,14] Further, the examination of the mandible will help in assessing the age of the individual approximately (i.e. by the orientation of mental foramen and inferior alveolar canal in the mandible). Third molars are the most variable teeth in the dentition and they remain the most reliable biologic indicator available for estimation of age during the middle teens and early twenties.[15] Age estimation is also assessed from root development of mandibular third molars in comparison with skeletal age of wrist joint.[16] Trabecular pattern in jaws is considered useful in age estimation. Trabecular pattern can be assessed in mandible using periapical and panoramic radiographs.[17,18] Pattern of lamina dura is also considered useful in age estimation.

Dental tissue is often preserved indefinitely after death. Dental identification assumes a primary role in the identification of remains when postmortem changes, traumatic tissue injury or lack of a fingerprint record invalidates the use of visual or fingerprint.[3] A complete charting of dentition using Federation Dentaire Internationale (FDI) system or any other nomenclature should be done.[1] The type of dentition (either permanent or deciduous) and surfaces of teeth involved should be evaluated. Teeth, periodontal tissues and normal anatomical features are assessed in comparative dental identification. Periapical and bitewing radiographs are routinely used for identification purposes. Moreover, the stages of healing and chronology after tooth extraction and/or post-traumatic loss will be valuable for referencing the duration of alleged injury.

Comparison of antemortem and postmortem radiographs are the most accurate and reliable method of identification. Odontograms (symbolic pictorial description of dentition) form a basic outline to compare dental characteristics at the simplest level.[1] The fundamental principles of dental identification are those of comparison and of exclusion. Unfortunately in the present scenario, dentists often maintain poor dental records, resulting in confusion that makes dental identification impossible. A mixed case retrieval method is proposed for the knowledge reuse of dental records based on case-based reasoning.[19] It is demonstrated that this method is very effective in terms of reducing the time of writing medical records and improving the efficiency and quality. This method is also proven to be an effective aid for diagnoses and provides a new idea for the management of medical records and its

applications. Cheiloscopy is the study of lip prints. Lip prints are probably unique to the individuals and are recorded using lipstick.[20] The recording of human lip prints is problematic because of their highly deformable nature. Another factor to be considered is the existence of some pathological conditions such as congenital lip pits, lymphangioma and cheilitis which can invalidate the lip print study.

Oral and Maxillofacial Surgery: Oral and maxillofacial surgery is the speciality of dentistry concerned with the surgical and adjunctive treatment of diseases, injuries and deformities of the oral and maxillofacial region. This speciality is utilized for identification of individuals through maxillomandibular and dentoalveolar fractures, surgical repairs and implants and craniofacial superimposition.[4] Usually the assessment of accidental or deliberate damage to the teeth and jaws comes within the scope of the oral surgeon. However, in many instances where this damage may be relevant to a criminal activity; the oral surgeon has to appear before the court for medicolegal investigation.

Craniofacial superimposition is established as a method of identification complimentary to fingerprinting. Photographs may be compared with images of skull and radiographs may be compared with skull to reconstruct face.[21] The reliability of the technique is largely depending upon the experience and subjective judgement of the expert making the superimposition. Current research is exploiting recent developments in computer technology to refine this technique.[22,23] In oral autopsy, LeFort I osteotomy procedure is done to get full access to teeth and intraoral structures.[24]

Paedodontics: Paedodontics is the speciality of dentistry concerned with the treatment of dental disease in children. This speciality is utilized for age estimation studies which include eruption sequence, Schour and Massler chart, Demirjian's method using dental maturation chart and Nolla's stages of calcification.[4] Tooth eruption and tooth calcification are the two events that can be used to measure dental age in children and adolescents.[5] Radiographical evidence of formation of crown and root completion has been utilized for this age group. Small variations in tooth formation and eruption among persons has made dental estimation of chronological age the primary method of age determination for younger persons.[25]

Schour and Massler's chart is to estimate dental age in developing dentition. This chart permits direct comparisons with radiographs. Demirjian's method based on seven teeth is used for determining dental maturity scores, establishing gender specific tables of maturity scores and development graphs.[26] Nolla's stages of calcification are based on the radiographic identification of morphologically distinct stages of calcification.[27] As mandated reporters, dentists play an important role in recognizing child abuse. Majority of the dentists lack the adequate knowledge about recognition and reporting issues of suspected cases of child abuse.[28] The dental office should maintain complete and legible records on file for the potential forensic identifi-cation of a child.

Periodontics: Periodontics is the speciality of dentistry dealing with diseases of the gums and other structures around the teeth. This speciality is utilized for age estimation studies which include periodontosis (gum recession), root transparency and root length.[29,30] This speciality is also utilized for identification of individuals through gingival morphology and pathology, periodontal ligament morphology and pathology and status of alveolar bone.[4]

Conservative Dentistry and Endodontics: Conservative dentistry and endodontics is the speciality of dentistry concerned with the etiology, prevention, diagnosis, and treatment of conditions that affect the tooth pulp, root, and periapical tissues. This speciality is utilized for identification of individuals through restorations and root canal fillings.[4] Presumably, individuals with numerous and complex restorations are often easier to identify than those individuals with little or no restoration.[3] Restorations play a significant role to aid in the identification process, as various restorative materials have varying resistance to high temperatures.[31]

Prosthodontics: Prosthodontics is the speciality of dentistry that deals with the replacement of missing teeth and related mouth or jaw structures by artificial devices. This speciality is utilized for identification of individuals through dentures and prostheses, denture marking, bite mark analysis and palatal rugoscopy.[4] Dental impressions such as vinyl siloxane and polyether are commonly recommended for recording bite mark evidence.[32] It is recommended that the casts should be prepared using type II dental stone and additional casts should be made by duplicating the master casts.[33] Palatal rugoscopy is the study of palatal rugae and their uniqueness to individuals, can provide reliable source of identification.[34] Palatal dimensions are appreciably larger in males than females.

It is accurate to say that any items that records information about the suspect's teeth can serve as a basis for comparison in the identification. These have included study models, old dentures, custom bleach trays and custom splints.[3] The author has reported a case of identification of a suspect using artificial denture.[35] It was the first case identified with the help of forensic odontology in the Kerala State in India. There are different methods suggested for marking dentures in the identification. These have included engraving methods, inclusion methods, metal inserts and micro-

chips.[36] The author has proposed a simple method in denture identification using lead foil in the intraoral periapical radiograph as an inclusion agent.[37] The introduction of uniform system of naming and coding the dentures by dentists will be of immense help in identification.[35]

Orthodontics: Orthodontics is the speciality of dentistry that deals with the prevention or correction of irregularities of the teeth. This speciality is utilized for identification of individuals through tooth rotation and malposition, orthodontic appliances and orthodontic reconstruction.[4] Orthodontic reconstruction can be done in a murder victim using electronic superimposition technique. Race identification is very useful in disasters where different races may be involved. Cephalic index helps to identify the race (Table I).[4]

Table I: Indices in orthodontics.

1. Sexual dimorphism:

a. Mandibular canine index

$$\text{Mandibular canine index} = \frac{\text{Mesiodistal crown width}}{\text{Intercanine arch width (Cusp tip)}}$$

b. Mandibular first molar index

$$\text{Mandibular first molar index} = \frac{\text{Mesiodistal crown width}}{\text{Intermolar arch width (Central pit)}}$$

2. Race identification:

a. Cephalic index

$$\text{Cephalic index} = 100 \times \frac{\text{Breadth of the cranium}}{\text{Length of the cranium}}$$

Gender dimorphism can be studied using mandibular canine index and mandibular first molar index (Table I).[4] The mandibular canines are considered to demonstrate the greatest percentage of gender dimorphism amongst all teeth in their mesiodistal width.[38] Mandibular canines can be considered as the key teeth for identification since they are the last teeth to be extracted with respect to age. Apart from canines, the first molar would be the tooth most likely to exhibit the greatest univariate sexual dimorphism.[39] This speciality is utilized for age estimation studies through cephalometrics.[4] Cephalometric parameters will vary with age and it has also role in racial differentiation studies.[40] In the estimation of pubertal state, dental status is assessed by orthopantomograph (OPG) X-ray and the skeletal status is determined by hand wrist X-ray.[4]

Community Dentistry: Community dentistry is the speciality of dentistry that deals with the community and its aggregate dental or oral health rather than that of the individual patient. This speciality is utilized for identification of individuals through endemic fluorosis.[4] Endemic fluorosis is a geographic factor; for example it is more prevalent in Kanyakumari district, Tamil Nadu and Nalgonda district, Andhra Pradesh in India.[41,42] The presence of fluorosis of teeth in an unidentified person gives a clue that the person is from an endemic area and this will help in identification. The prevalent groups of dental caries, periodontal disease and oral cancer in a population, the type of restorative material used and the design of the restoration may give some important information concerning socioeconomic grouping.[4]

Mass disasters can be classified into natural calamities, accident and criminal attacks (terrorist bombings). The identification of large numbers of casualties in mass disasters is complex and the identification process is fundamentally the same as that in routine comparative dental identification.[43] Human identification in mass disasters will continue to benefit from advances in technology.

Malpractice is a broader term referring to the failure to exercise skill, knowledge or care with resultant injury to the patient.[25] Dentist is considered negligent when he does not provide the duties to the patient. Charging for materials or procedures that were not used or performed are examples of fraud. In cases of dental fraud and malpractice, the dentist may serve as expert witness to make inferences about physical facts based on ordinary experience.[44] Dentists may be called upon to examine and give opinion regarding suspected elderly abuse cases.[45] Dentists may serve as expert witness to give opinion regarding tooth loss in homicide cases, since the loss of tooth is designated as grievous hurt under section 320 of the Indian Penal Code (I.P.C). Relevant variations of this grievous hurt as organ loss or function loss are applicable in other penal systems.

CONCLUSION

To sum-up, experienced dental specialists should link together and provide guidance for the research studies in forensic odontology. Perhaps this review might help the dental specialist to understand the forensic implications of his speciality and to do research in the parent speciality.

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