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Crime Investigation by Forensic Expert Based on Teeth

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Introduction

Forensic odontology is branch of dentistry which deals with the proper handling and examination of dental evidence with the proper evaluation and presentation of dental findings. The major arena of activity of forensic odontology is identification of human beings either living or dead. Areas of application include mass disasters, Criminalities, Cases involving abuse of children elderly, Dental malpractice and archaeology. Dental identification[1] report should consist of four basic sections like Introductory (administrative section), Postmortem evidence section, Ante mortem evidence, Opinion (conclusion section). Estimation of age and determination of sex of the victim or the remains are the important guides that help in process of identification. In this process teeth are the most reliable tools. Stages of development of teeth are the most dependable indicators in assessing the age of victim. Bite marks produced during assault of children or adults who are frequently associate with sex related crimes and child abuse are also important guides in process of identification.

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Age estimation

Dental age provides the most accurate indication during 18 -20 years of age. Age can be estimated in children and in adolescents by means of development and eruption of deciduous and permanent teeth up to 14 years. For most age estimation methods, the developing teeth are subjectively assessed on radiographs.[2] Maxillary central incisor proved to be a significant indicator of chronological age.[3] After the age of 14, the third molar is the only remaining tooth that is still developing and consequently dental age estimation methods have to rely on the development of this tooth until the age of 23. Strong relation of age with stages of root development of 3rd molar[4] teeth has been showed and suggested that age can be predicted with a statistical significant result for ages between 13 and 23. The staging of third molar crown and root mineralization can be accomplished easily and non-invasively through evaluation of dental radiographs. After this period, age determination is mainly done by visual examination, radiographic methods, and structural changes in teeth and by means of chemical methods.

Various methods utilized for the determination of age from the dentition are:

1. Visual method
2. Radiological examination
3. Histological methods
4. Biochemical methods

Factors used for age determination

Harvey lists the following factors in dental age estimation:

1. Appearance of tooth germs
2. Earliest detectable trace of mineralization
3. Degree of completion unerupted teeth
4. Rate of formation of enamel
5. Clinical eruption of teeth
6. Degree of completion of roots
7. Attrition of crowns
8. Formation of cementum
9. Formation physiologic secondary dentin
10. Transparency of root dentin
11. Gingival recession
12. Discoloration and staining of teeth
13. Influence of disease on eruption
14. Influence of sex on tooth eruption

Gustafson's method of age determination

This include six dental changes connected with ageing:

1. Attrition
2. Apical migration of periodontal ligament
3. Deposition of secondary dentin
4. Cemental opposition
5. Root resorption
6. Transparency of root dentin [5]

Attrition

There are many scoring methods in assesing aging by attrition, but according to different researchers it is not a reliable index as it is also affected by food habits, parafunctional habits, missing opposing tooth etc.

Deposition of secondary dentine

The size of the pulp chamber indicates the amount of secondary dentine formation. Moore used pulp diameter to crown diameter ratio for calculating age.[6] Kvall SI *et al*[7] have used pulp/root length, pulp/tooth length and pulp root width by periapical radiographs to estimate age. Both studies have not shown accurate age. Paewinsky, Pfeiffer and Brinkmann conducted a study of six teeth (including the maxillary central incisor) on digital orthopantomograms to correlate the measurements of pulp cavity with age.[8] It was found that the best correlations between the measurements and age were found at the cementoenamel junction.

Cemental apposition

Cementum is continuously deposited at the root end and seen as incremental lines. Many researchers have used cemental annulations to determine age of adults.

Dentinal root translucency

Apical zone of translucent dentine may be used as sole indicator of age because it is less influenced by pathologic process and environmental factors. It shows asymmetric distribution teeth in the left and right sides of the jaw. Causes of dentinal root translucency are fatty degeneration of the organic substances in dentine, increased intratrabecular mineralization.

Sex determination

Determination of sex is a great problem for forensic experts when only fragments of body are recovered. Forensic dentist can determine sex of remains using teeth in such conditions. Various features of teeth like morphology, crown size, root lengths are characteristics for male and female. PCR amplification will assist in accurately determining the sex. Bar coding system is a way of transferring data to the computer and huge data can be stored as a record. Bar coding can be easily incorporated during acrylization of the denture and thus could be used in individual identification.[9]

Measurements of the mandibular ramus tend to show higher sexual dimorphism, and

differences between the sexes are generally more marked in the mandibular ramus than in the mandibular body.[10] The mean values of parameters like maximum ramus breadth, minimum ramus breadth, Condylar heightD maximum ramus height, Projective height of ramus, Coronoid height showed that all dimensions were higher for males compared to females.[11]

Estimation of Sex by various methods

Visual or clinical method

Mandibular canines show greatest dimensional difference with larger teeth in males than in females. The mesiodistal width of canines of both the jaws is significantly greater in males than females.[12] A study by Kaushal *et al* found a statistically significant dimorphism in the mandibular canines in 60 subjects in a North Indian population, where the mandibular left canine was seen to exhibit greater sexual dimorphism.[13,14] They also concluded that if the width of the canine is greater than 7 mm, the probability of the sex of the person under consideration being male was 100%.

Microscopic method from pulp tissue

Whittaker and co-workers determined sex from necrotic pulp tissue. Up to 5 weeks sex determination can be done with high degree of accuracy. Duffy *et al* have shown that Barr bodies and F bodies of Y chromosomes are preserved in dehydrated pulp tissue up to one year and pulp tissue retain sex diagnostic characteristics when heated up to 100^0 for one hour. The study showed that the presence of Barr body in buccal mucosal cells can be demonstrated with a fair degree of accuracy using acridine orange confocal microscopy. The sex of the individual can be determined accurately with other advantages offered, such as the rapidity of processing and screening a specimen that results in saving of time. It was observed that in the male samples, the percentage of Barr-body-positive cells ranged from 0-3%. In the female samples, the percentage of Barr-body-positive cells ranged from 18-72%, and all the females showed the presence of Barr bodies.[15]

Advanced methods

Sex determination from blood and teeth by PCR amplification reveals specific sequencesing males and females, Pulp tissue retain sex diagnostic characteristics. Amelogenin found in human enamel as different pattern of nucleotide sequence in males and females.

Bite mark evidence

Bite marks are defined as marks made by teeth either alone or in combination with other mouth parts. Bite mark is a form of patterned injury, they are mostly produced during assault of children or adults who are frequently associate with sex related crimes and child abuse.[16] Sexually oriented bites appear to have been inflicted slowly and deliberately with suction applied to a tissue by tongue and lips. Child abuse cases are either anger bites or sexually oriented bites. Self inflected bites mostly found on fore arms of children caused by themselves. Bitemarks are categorical identification evidence, the dynamics of biting, the anatomical location of the bite, and failures in wound records can introduce distorted images and mislead crime investigation. The elasticity of polyether[16] impression material, casts can compensate for primary or secondary distortions, so that there is a better degree of match when positioning the subject's dental cast. Hence polyether is an alternative impression material and is an excellent option for creating positive casts of the wound for physical dynamic comparison.[17]

In the presence of clinical signs, such as ecchymosis, lacerations, and abrasions, on the victims in elliptical or ovoid pattern, a suspicion of bite marks should be considered. Bite marks may have a central area of ecchymoses (contusions) caused by 2 possible phenomena:

(1) positive pressure from the closing of the

teeth with disruption of small vessels or

(2) negative pressure caused by suction and tongue thrusting. Bites produced by dogs and other carnivorous animals tend to tear flesh, whereas human bites compress flesh and can cause abrasions, contusions, and lacerations but rarely avulsion of tissue.[18]

Mcdonald classification of bite marks

- Tooth pressure marks are caused by incisal edges of anterior teeth
- Tongue pressure marks, because of tongue pressure, impression of palatal surfaces of teeth or palatal rugae are produced.
- Tooth scrape marks are produced due to irregularities of teeth fractures or restorations
- Complex marks are combination of above types of marks.

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