Forensic dentistry - Focal player in forensic science

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Abstract

Forensic Odontology is ever evolving advancing branch of dentistry. It is subspecialty of dentistry concerned with diagnostic and therapeutic examination and evaluation of injuries to jaws, teeth, and oral soft tissues. It also helps in identification of individuals, especially casualties in criminal investigations, mass disasters, sexual assaults, child abuse cases, and in personal defense situations.

The term forensic implies court of law. It is basically that branch of dentistry which in the interest of justice. The principal basis of the dental identification is that no two oral cavities are alike and the teeth are different in every individual.

Dental features such as tooth shape and size, restorations, pathologies, missing tooth, position of the tooth and other dental anomalies give every individual a unique identity.

Keywords: Forensic odontology, Forensic dentistry, Dental Identification, Sex determination, Age estimation.

Introduction

According to Federation Dentaire Internationale (FDI) Forensic Odontology is defined as that branch of dentistry which is concerned in the interest of justice, deals with handling and examination of dental evidences, with the proper evaluation and presentation of dental findings.[1]

Based on Field of Activity Avon classified Forensic Odontology into three types which include Civil, Criminal and Research Forensic Odontology.[2]

Civil	Criminal	Research
It is concerned with mass disasters, malpractice and different frauds	It is concerned with identification of person from there dental remains	It is concerned forensic odontology training for dental and medical professionals.
Such as in cases of airline accidents, train accidents, earthquakes, teen marriages and accident victims	Such as in case of suicide, rape, homicides through different methods like rugoscopy, cheiloscopy.	Such as in crime and police departments.

Table 1: Avon classification of Forensic Odontology.

Identification

Personal Identification of dead person is important for legal, financial, social and, humanitarian reasons. Various methods of identification can be traditional methods like recognizing individual body, and property such as jewellery and clothing. Physical features of deceased may also help in identification of individual such as previous scar or fractures, but physical features may change over time.[3] Dental identification like other hard tissues it is mostly preserved even after death. The dental status of an individual changes throughout life and combination of decayed, missing and filled teeth can be measured at any point of time.[4]

Figure 1: Showing anterior teeth fractured and discolored after car crash and fire.

Dental identification

Comparative identification	Reconstructive identification
Oral autopsy-post mortem (pink form)	Identifying ethnic origin from teeth
Securing ante-mortem records (yellow form)	non metric traits
Comparison	Sex determination
Conclusion	DNA Analyses of teeth
Writing final report:	Metric features
Positive identification	Age estimation from dentition
Possible identification	Aging in prenatal, neonatal and early post-natal
Insufficient evidence	Age estimation in children and adolescents
Exclusion	Age estimation in adults

Table 2: Difference between comparative and reconstructive identification.

Comparative dental identification

It is used compare and confirms that remains of descendent and that of person represented by ante-mortem dental records are of same individual.

Steps of identification are as follows

- Oral autopsy
- Obtaining dental records
- Comparing post and ante-mortem dental data

- Writing a report and drawing conclusion.

Oral autopsy

It is also called as necropsy or post-mortem; it involves examination of deceased person with the help of dissection of different organs as to determine the cause of death of that person. Detailed oral examination is important part of the post-mortem procedure and all information pertaining to body is entered into the modified Interpol post-mortems dental odontograph.

Figure 2: Showing Modified Interpol Postmortem Odontograph.

In this form all the information related to the body of the individual is mentioned.

Obtaining dental records

As name suggests, it contains complete information on dental status of an individual during their lifetime. The dental record contains information in the form of radiographs, dental charts, casts and photographs. So, all available dental record of the person must be entered onto the modified Interpol antemortem odontography.[5]

Figure3: Showing Modified Interpol Antemortem Odontograph

In this form contents of all the available dental records of the individual are mentioned.

Comparing post and ante-mortem dental data

This includes comparison between post-mortem and dental records that are available, features that are compared include bony structures, morphology of tooth and dental restorations.

Writing a report and drawing

Conclusion

The AFBO has defined the categories for a dental identification

Positive Identification

The ante mortem and post mortem features is correspondent to each other giving sufficient detail to establish that they are from same individual.

Possible Identification

when the ante mortem and post mortem features are concordant but there is lack of quality in either ante - mortem or postmortem features, so it is not possible to confirm dental identification.

Insufficient Evidence

when the available ante mortem and post mortem information is insufficient to form a conclusion.

Exclusion

when the ante mortem and post mortem data is clearly irreconcilable.[6]

Reconstructive identification

Identifying ethnic origin from teeth

Each individual is unique in feature so defining a person's race from dentition is difficult task, but some dental features are more prominent in one group than the other group and these features only helps in identifying the individuals racial or ethnic origin. Broadly there are three major races, which are Caucasoid, Mongoloid, and Negroid.Caucasoid mostly have narrow v shaped arch and crowding of teeth, the anterior teeth of Caucasoid look like chisel shaped with small lingual surface, another common feature is cusp of carabellei present on mesiopalatal cusp of maxillary permanent first molars.

Negroids are characterized by having small size teeth with some spacing between them, midline diastema is also commonly seen. Third molars are usually present and other feature usually seen is increased incidence of supernumerary teeth.In Mongloids lingual surface of incisors have fusion with lateral or marginal ridges which forms raised cingulum and deep lingual fossa. Also ridges fades towards incisal portion of teeth forming shovel and scoop shape appearance.[7]

Figure 4: Showing Shoveled shape Incisor

Sex determination

Genderdetermination

Morphological method	Microscopic method	Advanced method
Hard Tissue Analysis • Tooth size • Canine dimorphism • Root length and crown diameter • Dental index • Tooth morphology Soft Tissue Analysis • Cheiloscopy • Rugoscopy	Use of Barr bodies used for gender determination	Sex determination using PCR Enamel protein used for sex determination

Table 3: Different methods of genderdetermination.

Clinical method

Tooth size

Mesiodistal and buccolingual dimensions of tooth can be used for sex determination. There is difference in male and female tooth crown dimension in both permanent and deciduous dentition. Mandibular canine shows greatest difference in dimension with larger teeth in males than females.

Canine dimorphism

Permanent canine teeth and their intercanine distance helps in sex determination through the dimorphism. The dimensions of canine teeth have been studied by methods, such as the measurement of linear dimensions such as mesiodistal width, Buccolingual width and inciso-cervical height, Fourier analysis (Minzuno, 1990), Moire topography (Suzuki et al., 1984).[8]

Root length and crown diameter

Sex determination can be done with eighty percent accuracy by measuring root length and crown diameter by using an optical scanner and radiogrammatic measurements.

Another index, the mandibular canine index. Using the

mesiodistal dimension of the mandibular canines, these researchers obtained the formula:[(Mean m-d canine dimension + (Mean m-d canine dimension in female + standard deviation [SD]) in males − SD)]/2.

Dental index

Aitchison presented incisor index (Ii), which is calculated by the formula Ii = (MDI2/MDI1) ×100, where MDI2 stands for the maximum mesiodistal diameter of the maxillary lateral incisor and MDI1 stands for the maximum mesiodistal diameter of the central incisor. This index is higher in males, confirming the suggestion of Schrantz and Bartha that the lateral incisor is smaller than the central incisor in females.

Tooth morphology

It includes some features of tooth related to its structure such as distal accessory ridge, number of cusp in mandibular first molar can be used in sex determination[9]

Soft tissue analysis

It includes the study of lip prints called as cheiloscopy and study of palatal rugae patterns called as rugoscopy.

Cheiloscopy

The word chelios is Greek word which means lip. Cheiloscopy is forensic method used in the study of lip prints. Lip prints can be identified at sixth week of intrauterine life and lip prints do not change after that.[10]

Suzuki and Tsuchihashi's Classification:

• Type I: Clear-cut grooves that runs vertically across the lip

• Type I′: The grooves are straight but disappear half-way and do not cover the complete breadth of the lip

• Type II: The grooves are branched

• Type III: The grooves intersect

• Type IV: The grooves are reticulate
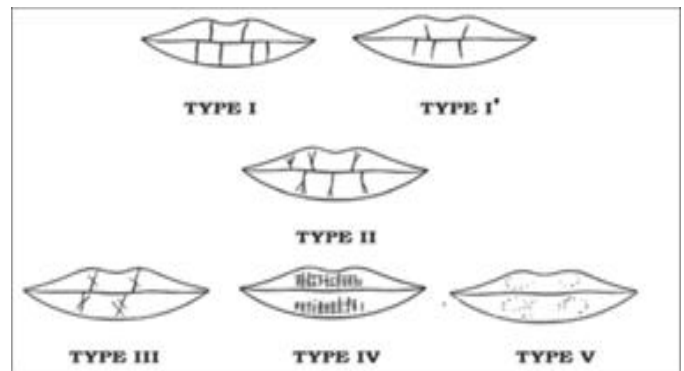
• Type V: Undetermined.

Figure 5:Showing lip print classification

Rugoscopy

It is the study of the pattern on the palatal rugae used for identification of a person. Palatal rugoscopy was first given by Trobo Hermosa, in 1932. It is helpful in forensics due to its internal position, stability, and perennity.

The rugae pattern is classified based on their length, shape, direction, and unification, proposed by Lysell and later modified by Thomas and Kotze [9]
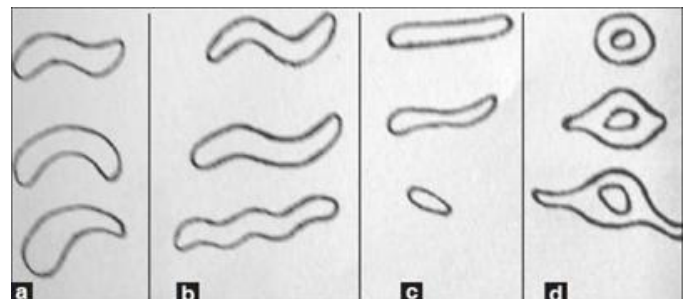

Figure6: Showing classification of rugae based on (a) curved (b) wavy(c) straight(d) circular

Microscopic method

Use of Barr method for sex determination can be done in conditions like fire and bombing where other methods cannot be used, as Barr bodies are stable at higher temperatures. When chromosomes are stained with quinacrine mustard, they fluoresce differentially along their length when seen under ultraviolet light. Barr bodies, are small well-defined bodies found in nuclei of cells in females and are stained intensely by nuclear dyes. Duffy and co-workers in 1991 examined human dehydrated pulps from extracted teeth to assess sex

chromatin from fibroblasts in artificially mummified and heated pulp tissues and they discovered that there is high sex chromatin stability.[11]

Advanced method

DNA analysis of teeth

Molecular analysis of DNA is one of the best ways for sex determination.DNA can be extracted by various methods such as by cryogenic grinding or by opening of root canals and scraping the pulp area and then it is analyzed by methods like Polymerase chain reaction (PCR), microarrays.[10]PCR works by amplifying small quantities of relatively short targeted sequences of DNA using oligonucleotide primers and thermostable Taq DNA Polymerase.[12]

Sex determination from enamel protein

Amelogenin or AMEL is an important protein in human enamel. It has different patterns of nucleotide sequence in both males and females. AMEL protein in females is located on the X chromosome and for male it is located on Y chromosome. Females have two identical AMEL genes and males have two non-identical AMEL genes. This helps in determination of sex with small DNA sample.[13]

Age estimation from dentition

Dental age estimation in children and adolescents

Depending on the presence or absence Mamelons present on the incisal edge of the permanent incisor teeth. The presence or absence of mamelons helps to differentiate between primary and permanent dentition. They are more prominent in permanent maxillary central incisor and more persistent in females than males. Depending on the presence of teeth Schour and Massler modified Kronfeld's table of development and chronology of the growth of human teeth. Schour and Massler studied the development of deciduous and permanent teeth, from 4 months to 21 years of age and published the numerical development charts for them. It has three characteristics: Teeth that have erupted, amount of resorption of roots of primary teeth, amount of development of permanent teeth.

Demirjian's method

It is most common method used for dental age estimation of a person lying in the age group of 2–20 years. It consists of ten developmental stages ranging from stage 0 to stage 9, and each stages has different score for boys and girls separately. The average sum should be hundred for all the teeth. The standard error rate in the Indian population of Demirjian's method is ±1.17 for male and ±1.6 for female. The mandibular arch was selected due to the better quality of image as it is not superimposed by dental and cranial anatomy.[14]

Various methods of age estimation are Guftson's method, Johansson method, maples method.

Gustafson's method

The first technique for age estimation was given by Gosta Gustafson in 1947 and 1950. This method is a morph histological method and it is applicable on single-rooted teeth only. The age changes are:

- Attrition of the enamel (*A*)
- Secondary dentin deposit (*S*)
- Alteration/recession of periodontal ligament (*P*)
- Cementum apposition (*C*)
- Root resorption (*R*)
- Transparency/translucency of dentin (T)

$A_n + P_n + S_n + C_n + R_n + T_n$ = total score (Y) (n = score of individual criteria)

An increase in total score (Y) corresponds linearly with increase in age.[15]

Conclusion

Forensic odontology is very essential field of dentistry as it helps in age and gender determination during mass destructions and it can also help in process of

identification of a person by a forensic investigator in the case of child abuse, nuclear bomb explosions and crime investigations. Thus, forensic odontologist may play an important role in identification of an individual. Each practitioner has a responsibility to maintain legible and legally acceptable records and help forensic Odonto logist in investigation process whenever necessary.

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