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Forensic Odontology: Science, Skills and Future Prospects

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Abstract

Forensic odontology is a growing field with a lot of room for advancement. It has established itself as a necessary science in medical and legal problems, as well as in the identification of the deceased. Even if a person is skeletonized, degraded, burned, or dismembered, dental tissues are frequently retained. Using dental tissues, many methods have been devised to establish a person's age, sex, and ethnicity. In forensic dental identification, data gathering methods and auxiliary technology have experienced substantial changes. This article gives an overview of the changing trends in traditional approaches as well as new forensic odontology ideas.

Keywords: Forensic Odontology, age estimation, dental profiling, human identification, digital forensics.

Introduction

The Role of the forensic anthropologist focuses on applying detailed knowledge of the development, morphology, and variation of the human body as an aid to establishing, confirming, or indeed refuting personal identification.

Forensic science or criminalistics is the application of scientific processes or abilities to investigate an offence or check evidence that may be submitted in the court of law. Physical changes, surgical interventions such as scars and prostheses, signs of trauma, and persistent hard and soft tissue diseases that can leave unique macroscopic and microscopic lesions on surviving tissue are all secondary features. These additional criteria can be useful when seeking to identify a person and a combination of the above can be quite useful when confirming identification.[1]

Human dental identification occurs for a variety of reasons, the most common of which is when the body has been disfigured, such as in the case of a violent crime victim, a fire, a road traffic accident, or a workplace accident. Forensic odontology plays a crucial part in this procedure.[2] Through dental records, a dentist can assist those involved in criminal investigations by recognizing crime victims and tragedy.[3] Forensic dentistry is indeed a relatively new field of forensic science that involves using dental sciences to identify deceased people by comparing pre- and post-mortem data.[4] Although forensic odontology offers a new ray of hope in support of forensic medicine, this field in India, is still in its infancy.[5]

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American Academy of Forensic Sciences Classification[2]

Forensic anthropology is the study of human remains for the medicolegal aim of determining identification, and centres on a thorough understanding of the human body's growth, development and response patterns.

Criminalistics is concerned with the examination and comparison of evidence in criminal investigations, such as biological evidence, trace evidence, impression evidence, etc.

Digital forensics is a field of forensic science that deals with the recovery and study of material discovered in digital devices, which is frequently in relation to digital crimes using mobile devices and computer crime.

Forensic odontology is a discipline of dentistry concerned with the right handling and inspection of dental evidence, as well as the proper appraisal and presentation of dental results in order to aid in the administration of justice.

Forensic psychiatry is a subspecialty of psychiatry in which scientific and clinical expertise is applied to legal issues in civil, criminal, correctional, regulatory, or legislative contexts, as well as in specialised clinical consultations in areas like risk assessment or employment.

Forensic Anthropologists role focuses on applying detailed knowledge of the development, morphology, and variation of the human body as an aid to establishing, confirming, or indeed refuting personal identification.

According to American Board of Forensic Odontology[6]

Positive identification: Occurs when the antemortem and postmortem data match in sufficient detail and there are no inexplicable inconsistencies.

Possible identification: The antemortem and postmortem data are compatible, but it is unable to prove identity definitively.

Insufficient evidence: The information supplied is insufficient to draw a conclusion.

Exclusion: The data from the antemortem and postmortem examinations are plainly inconsistent.

Dental Records and its Significance (AM/PM RECORDS)

All subjective and objective information about the patient's chief complaint, illness history, clinical examination, dental charts, treatment, and subsequent follow-up(s) should be legally documented. Any charting inaccuracy might render the record useless.[7] Radiographs, including skull and panoramic radiographs, computed tomography, study and treatment casts, impressions, clinical photographs are also included in the dental record.[8]

Computerized digitalized electronic medical records represent a significant advancement in the preservation of study-related documents. Accurate dental records are a key aspect in determining an individual's identity.[9] In numerous European nations, the registration of dental data is required. To erase a patient's record, permission from the state's legislation is necessary.[10] Despite its numerous benefits, many Indian dentists do not keep dental records, or if they do, they are of low quality. According to a recent research by Astekar et al., just 38% of dentists in Rajasthan were keeping dental records.[11] Another research by Preethi et al. revealed that 21 percent of dental practitioners in Chennai did not keep any kind of dental record.[12]

In the event of a large-scale disaster, the "Disaster Victim Register (DVR)" protocol is necessary. AM forms (yellow coloured) and PM forms (pink coloured) should be filled out separately for subsequent comparison of the dental record. [13] The "DVI System International" software programme, developed by Plass Data helps to identify the victim manifest by accumulating electronic versions of AM data from every suspected victim's family and related family members, doctors, and dentists.[14] Dostalova et al. described a novel electronic imaging system called Dental Cross that is equivalent to dental records for positive identification.[15]

In instances like the World Trade Center tragedy, WinID3 has proven to be useful in reviewing and comparing AM and PM dental record information. Adobe Photoshop and Mideo Systems case PACS[16] can be used to superimpose and compare the digital form of a radiograph and an image. Two methods are commonly used to identify teeth. To begin, prior

dental records of the individual suspected of being deceased are reviewed, and dental traits of the deceased person are compared and confirmed. If there are no previous records, a PM dental profile is performed to provide hints to restrict the search for AM materials required to identify the dead person.[17]

PM Dental Profiling

PM dental profile is used to narrow down the population group to which the dead is most likely to belong, which may aid in the discovery of AM dental data. When AM dental records are unavailable, the dentist does this procedure. This procedure may be used to gain information about the dead person's age,[18] ancestral background, sex, socioeconomic position, employment, habitual behaviours, and dental/systemic diseases. [19]

Identification by dental methods is critical since teeth are more resistant to deterioration than any other bodily tissue. As other methods of identification become less common, dental identification becomes more important because dental structures and restorations are sometimes the only elements of the body that are not damaged.The administration, inspection, appraisal, and presentation of dental evidence in civil and criminal procedures, as well as research, are all part of forensic odontology. [20,21]

Examination of Teeth

Teeth can withstand even the most severe climatic conditions, such as fire, making them a credible source for identification. Individual dentitions are like fingerprints, with variations in form, colour, location, age, etc.[22]

Age Estimation

Two types of dental ageing techniques exist.[23]

1) Developmental alterations: These are changes to the human dentition that occur when the teeth develop and emerge into the mouth cavity.

2) Degenerative changes: These happen after the teeth have erupted and are starting to wear down.

1) Developmental Changes[24]

a) FORMATION OF HARD TISSUE: Each tooth is rated according to its developmental stage, and the results are compared to values corresponding to a certain age.

b) Dental Expanding: To determine the age of an unknown individual, we can compare the subject's postmortem radiographs to the Schour and Massler eruption criteria.

c) The Third Molar Explosion: Third molar emergence usually occurs between the ages of 17 and 19. This tooth has a wide range of development; it may be fully grown yet impacted, or it may be totally missing.

d) Measurement of the Dentistry: This method was used as an alternative to the qualitative assessment, which involved measuring the length of the teeth.

2) Degenerative Changes[25]

Age estimation is the important part in forensic odontology.

Figure No. 1 Degenerative change sequence

Sex Determination[24]

In natural catastrophes, chemical and nuclear bomb explosion scenarios, sex determination is a highly significant branch of forensic odontology that plays a vital role in identifying unknown persons. There are four ways to do it:

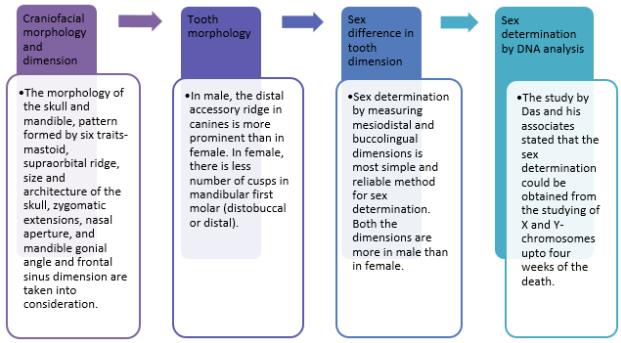

Figure 2: Sex determination methods

Bite Mark Analysis

The flexibility of the tissue, position of the bite mark, biting force, victim's age are all variables that must be determined in bite mark analysis. This task

is divided into two stages: bite mark recognition and biting mark analysis. Measuring the size of the tooth of the suspect and comparing it with bite mark can be done with metric analysis. [26] Dr. Ashith B Acharya, a forensic odontologist, used bite mark analysis to help solve the Delhi gang rape case (2012)

Chelioscopy and Rugoscopy[27]

The study of lip prints is known as chelioscopy. Because of its malleable nature, it is not as dependable as fingerprints, despite being unique to each individual. Susuki and Tsuchihasi divided lip prints into five types based on groove pattern (1970): complete straight, branched, intersected, reticular and undifferentiated grooves.

Lip Prints in Forensics

Lip prints are frequently discovered in cases of sexual assaults, burglaries, murders and other crimes. Following are the aspects that can be determined using lip prints.[28]

2. Personal identification: The lip prints are unique and if found at the crime scene can play a significant role.

3. Race determination: On the basis of thickness of lips, 4 groups can be identified:[29]

- Thin lips
- Medium lips
- Thick lips
- Mix lips

3. Sex determination: Lip prints have been used in a variety of investigations to determine sex. According to a study done by Vahanwala et al, some patterns are often frequent in one of the sexes:

- Type II is dominant in males in the 2nd quadrant that is upper lip (left side)
- Individuals with all quadrants having unlike patterns are commonly found in males whereas having same patterns in all four quadrants are seen in females.
- Lip prints are studied in postmortem cases and important in identification of corpses.[30]

Case studies where lip prints proved to be useful:

- Cheiloscopy proven to be useful in solving a burglary case in Poland in 1966.[31]
- Lip prints were discovered in a grocery store burglary case in 1988.[32]

Rugoscopy is the study of the patterns of the palatal rugae. Rugae patterns are classified as "branches and unification" depending on the length of origin, according to Thomas and Kotze in 1983.[33]

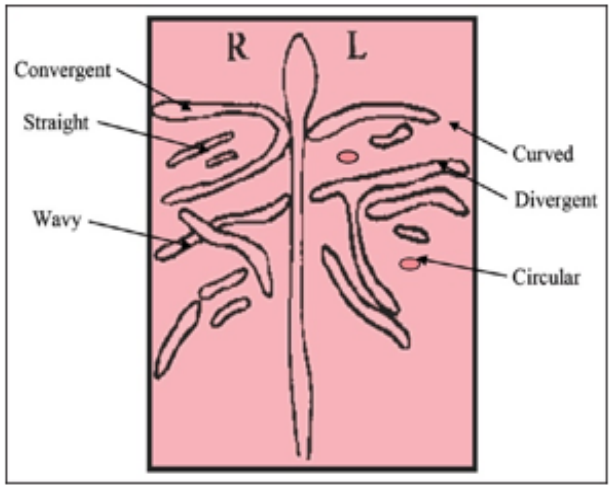

Figure No. 3 Palatal rugae pattern

Tongue Prints[34]

The tongue is a vital organ that provides both geometric shape and physiological texture information. Analysis of form and texture reveals noticeable distinctions between individuals, highlighting the tongue's individuality and making it a useful tool in personal identification.

A comprehensive study for identification can be performed by taking an imprint of the dorsal surface and lingual lateral margins with neo-colloid impression material that can be immediately placed from the level of the oral commissures up to the lingual tip. (Figure 4)

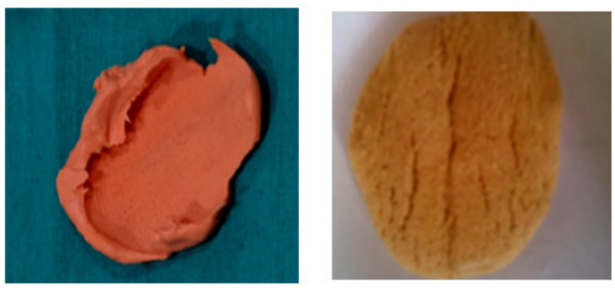

Figure 4: Impression of tongue along with the poured replica in dental stone

Dental Implants in Forensic Identification[35]

Dental implants are increasingly being employed in dental identification. Recent advancements such as implant recognition software, radiographic recognition of dental implants, and batch number evaluation assist the forensic odontologist in identifying the victims.

Radiographic recognition of dental implants

Intraoral radiography, 3D imaging, CT, and panoramic images are some of the modalities available for detecting dental implants in the deceased.

Identification of dental implants through the use of implant recognition software (IRS)

IRS works on the idea of gathering positive data and storing it in a stand-alone database, with the possibility of an implant system being recognised through a series of inquiries. This programme may be used to identify bodies after single murders or after widespread tragedies.

Future Prospects[36]

Dental identification is a well-established procedure that has been tested and validated. 3-D imaging, face and dental scanning, and the rising usage of "selfie" photographs are all possibilities for addressing these challenges. In a number of countries, there is talk of inclusion of this course in the Bachelor of Dental Surgery (BDS) curriculum, as dental practitioners need have a thorough understanding of forensics in order to handle medico-legal matters in their future practises. It seems logical to teach individuals at the postgraduate level, when there is a better chance of reaching some sort of consensus on what themes and protocols should be covered.

Conclusion

Every dentist must be aware of the necessity of forensic dentistry in order to properly document results and assist investigative and legal agencies. In mass catastrophes such as earthquakes, floods, etc. dental records are extremely significant in the positive identification of fatalities. It also aids in the identification of victims in conflicts and terrorist attacks. As a result, it is the dentist's societal obligation to keep a safe and accurate dental record of every patient. Forensic odontology is one of the branches of forensic medicine, which has established itself as a significant and necessary service in medicolegal situations in the pursuit of justice.

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