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Dr. Kumar H
Assistant Professor, M.V.J
Medical College and Research
Hospital, Hoskote, Karnataka,
India

Dr. KS Pradeep Kumar
Professor, Dr. Patnam
Mahendra Reddy Institute of
Medical Science, Chevella,
Telangana, India

Forensic dentistry: Science, expertise, and prospects for the future

Dr. Kumar H and Dr. KS Pradeep Kumar

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Abstract

There is much possibility for development in the field of forensic dentistry. It has made a name for itself as a discipline that is essential to solving both medical and legal issues as well as locating the deceased. Dental tissues are typically kept even after a person has been reduced to bones, deteriorated, burnt, or dismembered. Several techniques have been developed to determine a person's age, sex, and ethnicity using dental tissues. Information collection techniques and supporting technologies have undergone significant advances in forensic dental identification. This article provides an overview of novel forensic odontology concepts as well as evolving trends in conventional techniques.

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

Introduction

The forensic anthropologist's job primarily entails using in-depth understanding of the morphology, development, and variety of the human body as a tool to establish, support, or even challenge personal identity.

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. 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.

A dentist can help people conducting criminal investigations by identifying crime victims and tragic events through dental data. Using dental sciences to identify the deceased by comparing pre- and post-mortem data, forensic dentistry is a relatively recent discipline of forensic science. Although forensic dentistry gives a fresh promise for forensic medicine, this area is still developing in India.

American Academy of Forensic Sciences Classification

Forensic anthropology is the study of human remains with the medical-legal goal of identifying them. It is based on a complete knowledge of the growth, development, and reaction patterns of the human body.

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 specialized clinical consultations in areas like risk assessment or employment.

Corresponding Author:
Dr. Kumar H
Assistant Professor, M.V.J
Medical College and Research
Hospital, Hoskote, Karnataka,
India

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

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)

The patient's primary complaint, medical history, clinical examination, dental records, therapy, and any later follow-up(s) should all be legally documented. Any charting error might invalidate the record. 7 The dental record also contains radiographs, including panoramic and cranial radiographs, computed tomography, study and treatment casts, impressions, and clinical pictures.

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.

Despite its numerous benefits, many Indian dentists do not keep dental records, or if they do, they are of low quality. According to recent research by Astekar *et al.*, just 38% of dentists in Rajasthan were keeping dental records.

Another study conducted by Preethi *et al.* found that 21% of Chennai-based dentists kept no dental records at all. 12 The "Disaster Victim Registry (DVR)" procedure is required in the case of a major disaster. For later comparison with the dental record, separate filling out of the AM forms (yellow) and PM forms (pink) is required. 13 By compiling electronic versions of AM data from each suspected victim's family and connected family members, physicians, and dentists, the "DVI System International" software tool created by Plass Data assists in identifying the victim manifest.

Dostalova *et al.* introduced Dental Cross, a revolutionary electronic imaging technology that can positively identify individuals and is equal to dental records. 15 WinID3 has shown to be helpful in analysing and comparing AM and PM dental record data in situations like the World Trade Center incident. The digital representation of a radiograph and a picture may be superimposed and compared using Adobe Photoshop and Mideo Systems case PACS16. Teeth

are often identified using two techniques. To start, previous dental records of the person whose death is being suspected are checked, and dental characteristics of the dead are compared and verified. If there are no prior records, a PM dental profile is carried out to give guidance on how to focus the search for the necessary AM materials.

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 behaviors, and dental/systemic diseases.

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.

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.

Age Estimation Two types of dental ageing techniques exist.

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

- 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

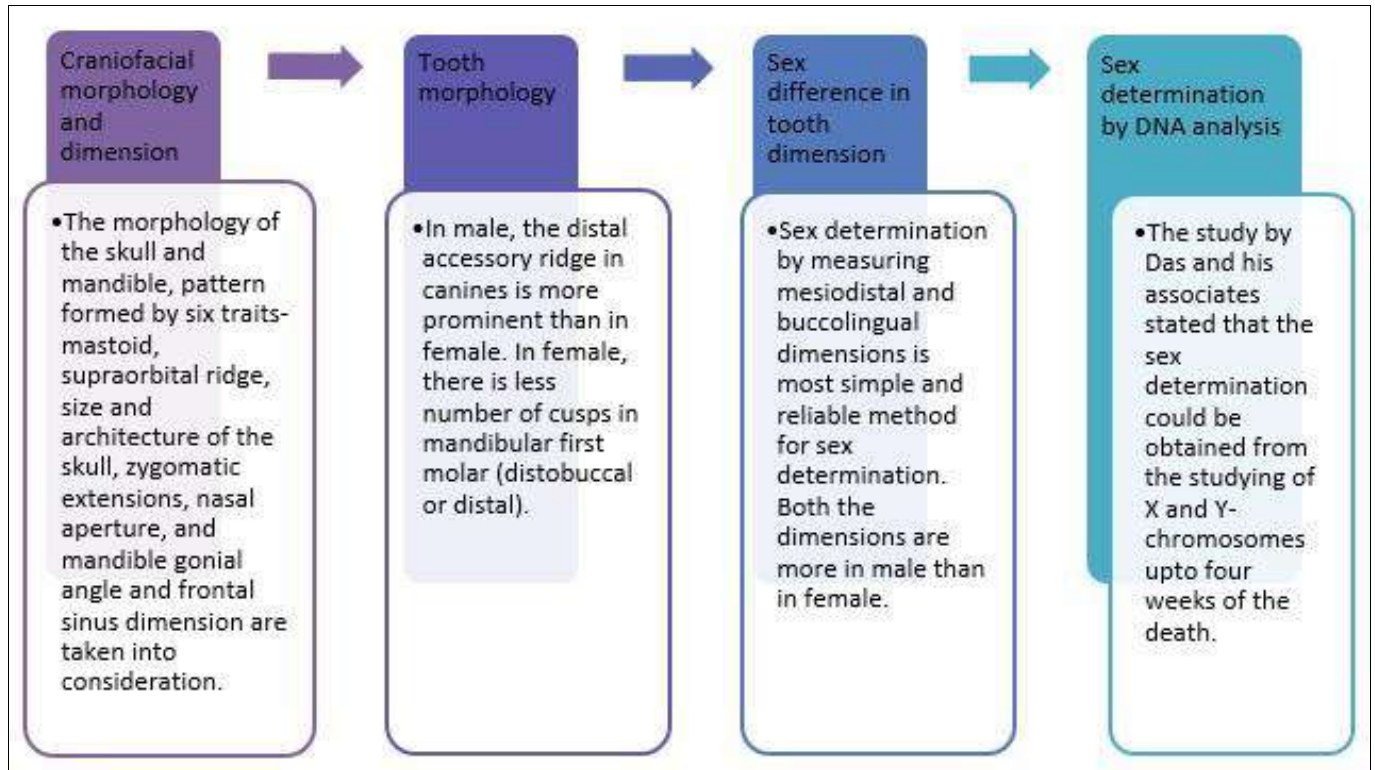
Age estimation is the important part in forensic odontology.



Sex Determination

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



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

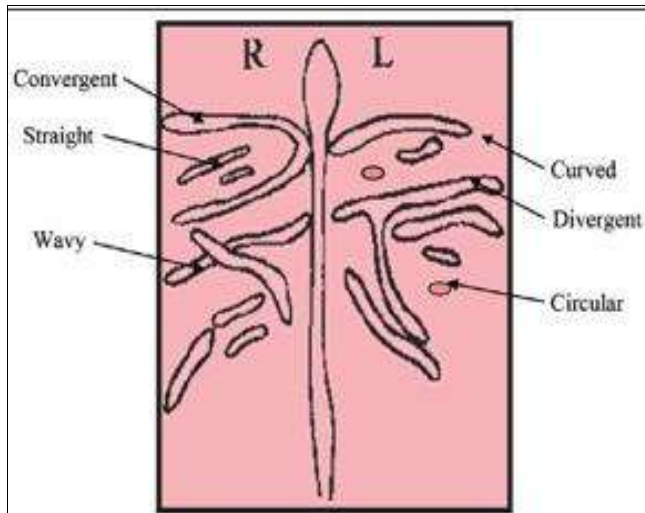
Chelioscopy is the term for the examination of lip prints. While being distinct to each person, it is not as reliable as fingerprints due to its changeable nature. Based on the groove pattern, Susuki and Tsuchihashi (1970) classified lip prints into five categories: entire undifferentiated straight, branching, intersected, reticular grooves

Lip Prints in Forensics

1. 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: Based on thickness of lips, 4 groups can be identified:

- Thin lips
 - Medium lips
 - Thick lips
 - Mix lips
4. 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.
 - Lip prints were discovered in a grocery store burglary case in 1988.

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.



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 recognized through a series of inquiries. This programmed may be used to identify bodies after single murders or after widespread tragedies.

Prospects

Dental identification is a tried-and-true method that has been proven effective. The use of 3-D imaging, facial and dental scanning, and the growing popularity of "selfie" photos are all potential solutions to these problems. There are discussions of include this subject in the Bachelor of Dental Surgery (BDS) curriculum in a number of nations since dental professionals need to have a solid grasp of forensics in order to address medico-legal issues in their future practices. When there is a higher likelihood of attaining agreement on the topics and etiquette to be taught, it seems sense to instruct people at the postgraduate level.

Conclusion

Forensic dentistry is essential, and every dentist should be aware of this in order to correctly record results and support investigative and legal organizations. Dental records are crucial for the accurate identification of casualties in large-scale disasters like earthquakes, floods, etc. Also, it helps with the identification of victims of terrorism and armed warfare. Thus, it is the dentist's social duty to maintain a reliable dental record for each and every patient. One of the subspecialties of forensic medicine, forensic odontology, has made a name for itself as a significant and essential service in the pursuit of justice in medicolegal situations.

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