

# Forensic odontology: The prosthetic ID

Lt Col Poonam Prakash,  
Maj Kirandeep Singh,  
Brig SK Bhandari<sup>1</sup>

*Departments of Prosthodontics  
and Crown and Bridge and  
'Dental Surgery and Oral Health  
Sciences, Armed Force Medical  
College, Pune, Maharashtra,  
India*

**Address for correspondence:**  
*Dr. Poonam Prakash,  
Department of Dental Surgery  
and Oral Health Sciences,  
Armed Forces Medical College,  
Pune - 411 040, Maharashtra,  
India.  
E-mail: pnmprakash@yahoo.  
co.in*

## Introduction

In the present era of digital age and virtual reality, the human race has achieved and progressed enormously in terms of advancements in the field of medical sciences, engineering, and social sciences. In the bargain, these changes have affected the social lifestyle and have also increased the rate and the quantum of conflicts among individuals and the nations on a wider platform. These technological advances when used incorrectly lead to an increase in crime rates, terrorism, mass disasters, warfare, and road traffic accidents. The disastrous magnitude of these incidents makes it impossible to identify the victims. Focusing on national dignity, warfare has also changed drastically over a period of time. Ancient warfare used a mass amount of workforce to overpower the enemy, whereas the modern warfare is associated with a widespread use of explosive weapons that include biological, chemical, and nuclear weapons. In such circumstances, the bodies of affected soldiers are mutilated to such an extent that their correct identification becomes

## Abstract

The term “forensic science” involves forensic (or *forensis*, in Latin), which means a public discussion or debate. In a more modern context, however, forensic applies to courts or the judicial system. Combine that with science, and forensic science means applying scientific methods and processes to solving crimes. People can be identified by their fingerprints, foot creases, and from traces of their DNA from blood, skin, hair, saliva, and semen by DNA analysis. However, in situations where these records are unavailable or unusable due to the nature of the disaster, the dental records and aids prove to be useful for victim identification. This article aims at highlighting the importance of the dental records and the forensic odontology in the accurate and efficient identification of the conflict victims or deceased to serve as an important adjunct to the forensic medicine in a simplified manner.

**Key words:** Forensic odontology, identification tools, victim identification

a herculean task. The identification of the individuals is extremely important when the deceased is an antinational element in terms of national security. In armed forces, the identification is of even greater importance for the soldier to be recognized as a martyr after death and also carries emotional value to the family members.

Forensic identification is the application of forensic science, or “forensics,” and technology to identify specific objects from the trace evidence they leave, often at a crime scene or the scene of an accident. Forensic means “for the courts.”

According to the Federation Dentaire Internationale, forensic odontology is defined as the branch of dentistry which, in the interest of justice, deals with the proper handling and examination of dental evidence, proper evaluation, and presentation of dental findings.<sup>[1]</sup> Forensic sciences assist the investigating team in the identification

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of victim, cause of death, time of death, nature of injury, and the weapons used by the criminal.

## Discussion

Teeth in the oral cavity act as an epitome of the identity of an individual. The size, shape, form, and color of teeth vary from one individual to another. Although they are almost same in number in every individual, yet accounts for unique tagging of one's identity.

Various oral structures such as teeth, tongue, rugae, lips, and combined action of these render detailed specifications to a particular individual. These structures provide a vast information regarding age, sex, race, lifestyle, and habits of an individual, which helps in identification with marked authenticity.

Forensic odontology using odontological landmarks plays an important role in the identification of war casualties, mass disasters, conflict victim identification, and criminals.<sup>[2]</sup> Due to destructive action, lack of evidences at casualty site, odontological parameters with unique characteristics can provide innumerable information.<sup>[3]</sup> These situations pose a challenge for the forensic odontologist to show his/her credibility in the collection of proofs, to unriddle the mysteries of the deceased.

### Identification systems

Various dental identification systems use comparative approach between antemortem and postmortem remains, or reconstructive approach, i.e. postmortem dental profiling to conclude decisive results.

#### *Comparative approach*

The comparison of antemortem and postmortem finding for identification has been established since long.<sup>[4]</sup>

The earliest reported dental identification case was that of Lollia Paullina in 4 AD, who was killed by the soldiers of Agrprime, the King of Claudius, and she identified her levered head by inspecting Lollia's unique dentition.

Bagi BS (1977) stated that body of Hitler and his mistress Eva Braun were identified by his dentist using dental records.

When INS Sindhurakshak (2013) caught fire, charred dead bodies of 18 crew members were identified using their antemortem records.

The dental structures are strong enough to withstand high impact and are protected from getting damaged in destructive incidents due to their high inorganic content in the composition.<sup>[5]</sup> A range of conclusion can be reached when reporting a dental identification using a comparison of postmortem reports with antemortem records, which can be in the form of written notes, study casts, radiographs, or photographs to confirm the identity.

The American Board of Forensic Odontology recommended the comparison to be concluded as:

1. Positive identification: Antemortem and postmortem data match in sufficient details with no explainable discrepancies
2. Possible identification: Antemortem and postmortem records are consistent, but because of the quality of either postmortem remains or the antemortem evidence, it is not possible to establish an identity positively
3. Insufficient evidence: Information is insufficient to draw a conclusive result
4. Exclusion: Records are inconsistent in many features.

### Postmortem dental profiling

When antemortem dental records are unavailable and other methods of identification are not possible, postmortem dental identification is done to reveal information from the collection of oral samples such as saliva, tooth fragments, and shattered pieces of the maxilla and mandible along with other evidences from the accidental site that help in the identification of individuals by providing information about the age, sex, and race of victims.<sup>[6]</sup>

### Estimation of age, sex, and race

#### *Estimation of age*

Age estimation is an important aspect of victim identification in forensic odontology.<sup>[7]</sup> Various parameters of age estimation include dental age estimation, skeletal maturation, and anthropometric measurements. Among these, teeth act as the most reliable aid in age estimation. The clinical, histological, and radiological techniques can be utilized for age estimation with the help of various dental landmarks at the following three intervals:

1. Age estimation in prenatal, neonatal, and early postnatal child
2. Age estimation of children and adolescents
3. Age estimation in adults.

Clinical evaluation includes assessment of the presence or absence of teeth, visual changes in tooth structure, and periodontal status of teeth. Radiographic methods assessing the stages of crown and root formation are helpful in determining the age. The morphology of facial skeleton such as shape and position of the bone is specific at a particular age. Histological methods such as determination of the thickness of enamel and dentin, deposition of secondary and peritubular dentin, and various incremental lines help in predicting the age.<sup>[8]</sup> Pathologic age depends on various conditions, diseases, and processes that result in alteration within tissues over a period of time. Pathologic age can be estimated by examining factors such as transparency of root, wear and tear of the tooth structure, and morphological changes in the temporomandibular joint.

Physiologic age is determined by changes which occur with growth and development. The age that investigators are most

interested is chronologic age, the time from birth to death. Forensic dentists normally take into account the estimates of a person's pathologic and physiologic age to derive an assessment of the most likely chronologic age at the time of death.

#### *Sex determination*

Sex can be determined from the size, shape, and form of teeth. According to dentogenic concept given by Frush and Fisher, masculine and feminine characteristics contribute to the shape of teeth among males and females.<sup>[9]</sup> Odontometrics is commonly used by the forensic scientists for the determination of sex.<sup>[10]</sup> The morphology of bones such as acute gonial angle of the mandible in females distinguishes them from males. Extraction of DNA from pulp and the presence of F-bodies on Y chromosomes and Barr bodies on female X chromosomes are useful in the determination of sex.<sup>[11]</sup> Certain sex-specific genes such as AMELX and AMELY genes encode for females and males, respectively.<sup>[12]</sup>

#### *Identification of race*

According to anthropologists, biologists, and geneticists, all human beings are derived from a single species, i.e. Homo sapiens. Worldwide, the following four major groups of race are considered: Caucasoids, Mongoloids, Negroids, and Australoids, whereas in Peninsular, three major ethnic groups of Malaya, China, and India, are considered. Characteristics such as narrow arch, presence of cusp of Carabelli in 37% of population, and chisel-shaped anterior teeth distinguish Caucasoids from other races.<sup>[13]</sup> The presence of midline diastema and supernumerary teeth is more prevalent in Negroids. Other ethnic races such as Mongoloids may present such features, but they are more common in Negroids.

#### **Odontological landmarks**

Odontological landmarks which are used in forensic laboratories to identify victims of war, disaster, and crime include the following:

##### *Bite marks*

The value of bite mark evidence is that it corroborates or disproves the involvement of the alleged bitter in the crime, assuming that the person who made the peri/postmortem bite was the one who committed the crime.

Cameroon has devised a classification of types of bite marks in the widest field and divided into:

- i. The agents that produce the mark such as humans, animals, mammals, or reptiles
- ii. The materials and substances that exhibit the marks.

In the process of bite mark analysis, the characteristics of the suspected individual's dentition are compared with the bite mark pattern over the material. Bite marks are one of the important parameters that are considered to be individualistic and used by forensic odontologists in solving criminal cases.<sup>[14,15]</sup>

#### *Cheiloscopy*

This is a forensic investigation technique, which uses lip traces to identify humans.<sup>[16]</sup> Lips are not as smooth as mucosa; they have elevations and depressions on their surface. Lip prints are unique to every individual like fingerprints. Lip print maybe presented as an evidence for person identification and in legal proceedings. Lip print at the scene of crime can be retrieved from clothes, cigarettes, water bottles, and over the skin. In comparative dental identification, the distinctive feature of lip prints can be used, however twins may have similar lip pattern.

#### *Rugoscopy*

Palatal rugae refer to the soft-tissue elevation in the anterior part of the hard palate, on each side of the mid palatine raphe behind the incisive papilla. Rugae pattern remains same throughout life as they reappear after trauma or surgical removal. Rugae can be used as a predictable source of identification as they are protected by lips, cheek, and tongue and thus shielded from fire and mass disaster.<sup>[17]</sup> Rugae can be used in the sex determination of victim as males have better developed rugae compared to females. Thomas and Kotze classified rugae into:

- Primary rugae
- Secondary rugae
- Fragmentary rugae.

#### *DNA profiling*

It is based on the fact that although all human beings have almost a common DNA molecule, part of it differs in every individual. Forensic odontology can make use of DNA profiling by extracting DNA from saliva, mucosa, and teeth. Tooth acts as an important source of DNA because it is protected inside the tooth, whereas in other sources such as bone, it undergoes decomposition and cannot be used for profiling.<sup>[18]</sup>

#### **Role of prosthodontists in forensic odontology**

Although dental records play an important role in forensic odontology for the identification of victims, criminals, and casualties, when the situations are extreme such as disasters, fire accidents, or terror attacks, bodies are shattered or decomposed to such an extent that it is impossible to identify the individuals from the commonly used odontological parameters. Here comes the role of prosthodontist, who can incorporate various labeling in the prosthesis which contains data pertaining to one's identity. These prostheses can provide various identification clues about an individual. Various techniques for labeling or marking prostheses in completely edentulous patients include:

##### *Bar code*

Bar code represents data by varying the widths and spacings of parallel lines [Figure 1]. These barcodes can be scanned with optical scanners or bar code readers, which can provide valuable information about an individual. Barcode has been incorporated in the prosthesis and under a thin layer of

clear acrylic, which can be easily scanned and will help in the retrieval of data which are already encoded in the bar code.<sup>[19]</sup> Another advantage of this modality is that additional information such as clinical, radiographic, and photographic records of the patient can be stored. The limitation is that data will be accessible only to the dentist who has generated the bar code and will not be universally available on a central portal.

#### *Memory cards*

Micro SD cards containing information can also be incorporated in the denture flanges by trimming a portion of the dentures equisize to that of Micro SD card and then covering it with autopolymerizing acrylic resin [Figure 2]. These cards contain data that can be retrieved later if required, which could help in the identification of the deceased.<sup>[20]</sup> This modality has an additional advantage over the bar code that whenever required, data can be retrieved by any of the concerned individual.

#### *Lenticular cards*

These cards contain an image with an illusion of two or three overlapped pictures combined with a lenticular lens. These cards can be incorporated on either palatal on the lingual flange of the mandibular denture. Several studies have been done to evaluate the change in color of the image by dipping it in water for several months, but no changes were seen.<sup>[21]</sup>

#### *Aadhaar card number*

This is a unique identification number which is mandatory for every citizen of India, in which one's personal information is encoded and updated from time to time [Figure 3]. This number can be either laser printed or etched on any surface of the prosthesis, which can be read, and data can be retrieved from government offices.<sup>[22]</sup> This could be the most advantageous modality as the information is easily accessible and can be obtained from any part of the country.

#### *Engraved, fixed, and removable restorations*

Information such as name or blood group of the patient can be engraved on the metal restoration, which could help later on in situations such as mass disasters or fire accidents, in which metal portions might have been intact in the patient's oral cavity.<sup>[23]</sup> The disadvantage of this modality is that limited information can be engraved, whereas they do not provide any accessory information about any individual.

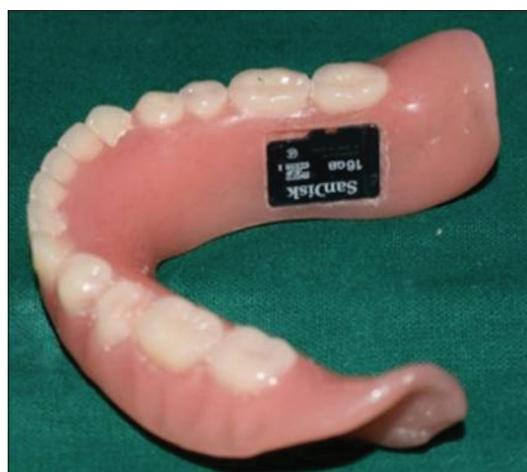
#### *Fingerprint in prosthesis*

This unique characteristic of every individual can be traced on a paper which can be laminated and incorporated in the prosthesis, and on the other side, digital data of the same are recoded and stored. If any suspected individual needs to be identified, such data could be retrieved from the patient's denture and can be matched.

Various aids for patients with fixed dental prosthesis include:



**Figure 1:** Bar code



**Figure 2:** Micro SD card



**Figure 3:** Aadhaar card number

#### *Microchips*

Micro-sized chips containing digital information can be incorporated within the tooth structure, and information can be retrieved by advanced technology instruments, which could help in the identification of the individual.



**Figure 4:** Radiofrequency identification tags

Tooth structure provides greater protection to chips by the virtue of greater resistance to high temperature, acid attacks, humid, and saline environment.

#### Radiofrequency identification tags

These radiofrequency identification tags are incorporated in the cervical area of the tooth structure which can be read, and information can be retrieved which was fed at the time of incorporation [Figure 4]. These tags work on the principle of electromagnetic field, so they can be read without their removal from the tooth structure. The advantage includes that the reader is not required to be in contact with the tag, and information can be retrieved from vicinity.

#### Coded dental implants

Dental implants with a specific coded number on either implant body or abutment can be used, which could disclose the identity of an individual from the remains after any untoward incident. The limitation of these coded dental implants is that information will be confined to a particular commercially available system.

## Conclusion

Thus, it is concluded that forensic odontology, though a nascent branch in the academic field of dentistry, has a wide scope and utility. Forensic dentists play an important role in the field of victim identification along with the medical experts. Prosthodontists can play a vital role in the conflict victim identification by incorporating various digital markers in the prostheses, which could be of great help for the investigating authorities. An important step in this synergistic approach would be the incorporation of forensic odontology in the curriculum and increasing the awareness about the importance of maintaining antemortem records of the individuals among the medical and dental practitioners, as well as to the patient himself/herself. This simple endeavor can go a long way in the accurate and timely identification of the victims, thereby saving the golden man-hours of distress in such situations.

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#### Conflicts of interest

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