

### **Forensic Odontology - Need To Emerge As A Separate Discipline In Dentistry**

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#### **Abstract**

Every individual's day begins with curiosity to know the issues happening around through papers and other media. In this day and age, as assaults are increasing more and more, most of the crimes are hidden or concealed due to the absence of proof. Dental diagnosis plays an important role in tragedies caused by natural and man-made incidents. The toughest and most durable tissues of the human body are the dental structures. The tooth has been used as a weapon and may leave data on the identity of the biter under some circumstances. Forensic dentistry assists in the detection and evaluation of the extent of injuries with the help of teeth. This article provides an overview about forensic dentistry and also attempts to explain its involvement in criminal investigations. It also enlightens about the present day situation in forensic dentistry.

**Keywords:** forensic, forensic odontology, lip prints, bite-marks.

#### **Introduction**

Over the past 100 years forensic dentistry has been an important part of forensic medicine and forensic science that is progressing rapidly<sup>1</sup>. The path of forensic dentistry begins in 49 A.D. with Agrippina, mother of the Roman

Emperor Nero. It was said that the mistress of Nero, Sabina, was relieved that the head presented her on a plate was of the wife of Nero as she was able to identify a black anterior tooth<sup>2</sup>.

The principal benefit of dental evidence is that it is always preserved after death, like other hard tissues. Also throughout life, the condition of the teeth of an individual changes and the mixture of decayed, missing, and filled teeth is identifiable and similar to a specific point of time. The most strongest part of the body is teeth that can be heated to a temperature of 1600 ° C without loss of microstructure<sup>2</sup>.

Forensic odontology according to federation dentaire international is defined as the branch of dentistry which in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental finding.<sup>3</sup>

Ever since, the number of recorded cases have increased in such a way that the name "forensic odontology" is popular not only to the dental practice but to legal authorities and other forensic groups as well. The forensic odontologist assists legal authorities through examination of dental description data in different situations. The topic can be

broadly classified into three fields of activity: civil or legal, illegal, and scientific research<sup>4</sup>.

### **Role of Dentist In Forensic Identification**

Dental identification plays a prime role in the identification of the remains<sup>5</sup>. Body may be deformed to such a degree that it becomes difficult for a family member to identify<sup>6</sup>. That's why **forensic dentistry has two objectives, namely**

1. The fairly easy one on finding the deceased and
2. The more difficult one is to recognize an attacker utilizing his or her teeth as weapons<sup>7</sup>.

### **Importance of Identification**

The steps involved in identification are

- A proper description of the dead and the living using the teeth and jaws are elements of forensic dentistry<sup>8</sup>.
- Evaluation of teeth and oral soft tissue injuries and identification of person in crime scenes and/or mass catastrophic events<sup>9</sup>.
- Identification and evaluation of the bite marks received with some extent in sexual harassment, juvenile sexual assault, and vulnerable occurrences in defense<sup>9</sup>.
- Age range is required<sup>9</sup>.

### **Role of Teeth In Identification**

#### **Sex Determination**

Sex determination is very useful in determining a dead person. It is achieved by examining DNA, comparing morphologies of head and by measuring the size of the tooth<sup>8</sup>. By measuring the mesiodistal and buccolingual dimensions of a tooth it becomes easy to determine the sex of an individual as the dimensions are more in males when compared to females<sup>10</sup>.

#### **Age Estimation**

Human dentition follows a sequence of development. The formation of all permanent teeth starts about 4 months after birth and continues till the beginning of the third decade of life<sup>4</sup>.

Dental ageing technique can be subdivided into

**Developmental Changes:** The sequence of formation and eruption of teeth gives a precise age estimation of an individual. In this method, each tooth is scored based on its developing stage and scores are compared with values corresponding to that particular age. Third molar tends to erupt around 17-19 years of age. It may be fully developed but impacted or completely absent. Only x-rays can give the exact measurement of this tooth<sup>10</sup>.

**Degenerative Changes:** Once the teeth have erupted and start wearing down which is mostly seen as people get older. We use pulp cavity volume, because it is seen that Pulp cavity volume reduces due to secondary dentine deposition with ageing<sup>10</sup>.

Age estimation is an essential part of forensic odontology, since a consistently accurate pattern of growth follows human dentition<sup>10</sup>.

### **Post-Mortem and Ante-Mortem Records**

Identification is based on comparison between known characteristics of a missing individual (*known as ante-mortem data*) with recovered characteristics from an unknown body (*known as post-mortem data*). Therefore, records such as written notes, casts, x-rays, etc. are used to confirm the identity of the person. In certain cases, recognition of a person is unknown because it becomes difficult to locate the ante-mortem records. In such cases a dental profile is created to find out the individual's identity which helps the odontologist to identify and details about age at time of death, race and sex<sup>11</sup>.

However, Forensic dentists use a variety of identification methods, including rugoscopy, cheiloscropy (lip prints), imprinting, or using biochemical methods such as polymerase chain reaction (PCR) to examine the DNA in dental pulp tissue<sup>12</sup>.

### **Rugoscopy**

Palatal rugoscopy, or palatoscopy, is the study of palatal rugae that establishes the identity of a person also known

as Plicapalatinae, or palatine rugae<sup>9</sup>. Palatal rugae consist of three to seven ridges radiating from the incisive papilla. The ridges can be curved, smooth, wavy, and branched. The shape of rugae varies from person to person<sup>13</sup>. Because it is a stable and permanent landmark, it is used for human identification<sup>14</sup>. Previous documents, samples, and preservation of dental casts and records are necessary to give rugoscopy some importance<sup>7</sup>. However, visual comparison of ante-mortem and post mortem rugae patterns are obtained from the dentures<sup>8</sup>.

### **LIP PRINTS (Cheiloscopy)**

Lip prints are natural lines and fissures found in the human lip between the inner labial mucosa and the outer skin; usually in a manner it is similar to that of fingerprints<sup>15</sup>. Recording a lip print is helpful in forensic investigation, based on lip traces<sup>16</sup>.

The pattern of lips depends on whether the mouth is opened or closed. The lip in closed-mouth position displays well-defined grooves, whereas in open-mouth position displays the grooves in a relatively ill-defined manner and makes it difficult to interpret. Although lip prints are unique, when the lines are not clear, identification of an individual based on this trace is extremely difficult unless the trace contains more individual characteristics like scars, clefts, etc<sup>13</sup>.

### **Bite Marks**

Biting is a form of attack connected with cases of sex assaults and violence. A typical human bite in the form of an elliptical or circular injury represents the dentition. When bitten, the pressure applied on the skin's surface compresses and leaves a mark on it. These marks correspond to the dentition of the suspect which helps during the investigation<sup>8</sup>. Although bite marks are found mostly in females on the breasts and legs due to sexual attack, whereas in males it is found primarily on the arms and shoulders<sup>12</sup>.

- In more violent bites-The attacker will suck the soft tissues and the incisal surface of teeth appears on the skin which might cause hemorrhage or post injury edema<sup>10</sup>.
- In less violent bites-the skin cannot be penetrated so the marks will be in oval shape from anterior teeth<sup>10</sup>.

### **DNA Identification**

Since dental tissues are immune to environmental hazards, they form an excellent source of DNA material<sup>17</sup>. The oral cavity is a good source for DNA as it contains saliva, oral mucous membranes and teeth. In teeth, DNA can be obtained from pulp tissue, cementum, periodontal ligament and alveolar bone. Pulp tissue has been most commonly used, as it is easily available and doesn't have any harmful DNA contamination. Forensic dentists should implement innovative methods, as various sources are available for extracting DNA from biological samples; however no standardized guidelines have been formed till date<sup>10</sup>.

### **Radiographs**

The most precise and effective method of identification of victims is the combination of ante mortem and postmortem radiographs. In certain cases a single tooth may be all that remains, and a correct diagnosis can be made by comparing the radiographs<sup>4</sup>. Apart from regular findings such as decayed, missing, filled, and broken teeth, different stages of wound healing in sockets for extraction, degree of root development, and bone trabecular pattern in the jaws help in identifying. In our country, ante mortem records are limited and, when available, it may be incomplete<sup>13</sup>.

### **Molecular Analysis**

Molecular approaches are extremely reliable, reproducible specific and extremely effective in forensic science. However there are disadvantages in this approach. Errors may occur in the selecting, processing, and interpretation of samples. Any bacterial contamination of DNA can change the interpretation<sup>11</sup>. Since morphological patterns

differ with time and external influences, molecular DNA analysis is the best tool for gender identification<sup>14</sup>.

### Role of Dentures In Identification

Forensic analyses through assessment of prosthesis receive more significance, as dentures and other prosthetic devices should be labeled to provide vital clues for identifying patients<sup>5</sup>. Most often, dentures (full or halfway) may be found inside or near the scene where the body is located. They are usually helpful in investigation. The labeled or marked dentures are therefore of greatest use for identification. The dental marking should include the patient's name<sup>18</sup>. There are two methods used for identification

- Surface marking methods
- Inclusion methods

### Surface Marking Methods

In this method "Scribing or Engraving" is placed on one of the surface of the denture. In "Embossing," the master cast is scratched with the surname and initials of the patient, and in turn is transferred on to the surface of the denture. These letters may cause constant tissue irritation and it may lead to malignancy<sup>19</sup>. [Figure 1]



Figure 1: Embossing

### Inclusion Methods

In this method, it is possible to use metallic or non-metallic materials, micro labels, and microchips to mark dentures. The benefit over surface marking methods is that, they are more permanent in comparison<sup>19</sup>.

ID-BAND: A stainless steel metal band can be used to mark the dentures. Titanium foil and Ho Matrix Band are the most widely used fire resistant materials. Stainless steel has strong biocompatibility and high resistance to corrosion in the oral environment, and causes no allergies. The band is coated with clear, trimmed acrylic resin, and finished in the conventional way<sup>19</sup>[Figure 2].

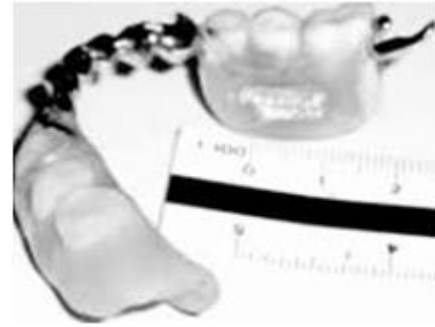


Figure 2 : ID-band

### Paperchips

This approach is comparatively less expensive alternative using a sheet of paper called "onion skin". The suitable surface of acrylic resin adjacent to the palate between the edge and the middle of the palate is moistened on a small brush with a monomer. Clear or pink polymethyl methacrylate (PMMA) is then spread over the paper [Figure 3]. However; this method is not used commonly as it cannot survive in fire accidents<sup>19</sup>.



Figure 3: Paper chips

### Laseretching

Copper vapor laser will etch identification of a patient onto the metal surface of a "partial denture." It can easily label

the cobalt-chromium components on the dentures. The process is usually costly, and the technique requires specialized equipment and technicians<sup>19</sup>.

#### Electron microchips

Patient's information is engraved onto a disk, which is radio opaque and is well sealed with acrylic resin<sup>19</sup>. The chip measures 5×5×0.6 mm. and is embedded in acrylic resin which works well under high temperatures (600 ° C) The chip's main disadvantage is that they can only be signed by the manufacturer and not by the dentist<sup>15</sup>.

#### Radio –Frequency Identification Tags

Radio-frequency identification (RFID) tags are a decorative, effective method of marking inside dentures. To place the tag in the denture no special training is required<sup>15</sup>. It helps the wearer to be detected easily and accurately without impacting the esthetics. As it is expensive it is probably not preferred by many dentists<sup>19</sup>.

#### Lenticular Systems

A modern approach for recognition of dentures is the Lenticular Card: it is a polyethylene terephthalate, comprising of the first flip image of the patient's name, sex and age, and a second flip image of the patient's address and driving license number, which can be inserted into a prosthesis<sup>20</sup>. Lenticular card displays no signs of degradation when placed in water for a period of up to four months and cannot withstand fire accidents if the card is not placed in posterior region<sup>15</sup>. [Figure 4].



Figure 4: Lenticular System

#### Denture Bar-Coding

A bar code consists of a series of bars and spaces that are printed in specified ratios and are easily readable. It is a tedious process of printing a number code on paper, in turn taking pictures of the same thing and moving on to a piece of silk negatively.

The system will push the paint through the silk and will appear in a picture of an industrial porcelain oven after heating up to 860° C for 30 minutes<sup>19</sup>[Figure 5]. Denture bar-coding offers reliable details and is resistant to high temperatures, and oral solutions that are widely used. Reading the bar code therefore requires costly special equipments<sup>15</sup>.



Figure 5: Barcoding in a denture

#### Photographs

The denture marker is useful in countries with low literacy rates where the easiest identification tool is a photograph. However, photographic marker and bar code were resistant to only about 200–300°C<sup>15</sup>.

#### Dental Implants

Despite being strong, extreme tooth loss can occur. The only physical identification data available might be the temperatures and characteristics of recovered dental implants, if any. High corrosion resistance, high structural strength, and high melting point physical properties imply the preservation of intact implants after most physical assaults<sup>17</sup>.

Berketa et al. did a study to determine what changes occur following cremation to bone supported dental implants placed within sheep mandibles. Berketa et al. did an analysis to decide whether, after extreme heat exposure in a furnace, the batch number was still recognizable. The outcome indicated that there was an intact batch number identifiable on the removal of the crest. They lack the individualization needed for their use as identifiers of the deceased, as the implants are machine-made. If the companies that create implants put individual serial numbers on these implants rather than batch numbers, then there is the potential for a new approach to identifying the deceased to be developed<sup>17</sup>.

### **The Current Scenario of Forensics In India**

The role of dentistry has increased with the course of time as most often teeth and dental restorations are the only means of recognition, specifically after catastrophic devastating events, accidents and fires, where facial structure and fingerprints are completely lost<sup>7</sup>.

Since the various inquiry groups lacked effective and efficient management, many suspects are mass cremated without recognition<sup>20</sup>. Forensic science has recently emerged as a new ray of hope in helping forensic medicine nevertheless, in India, this essential and indispensable field of forensic medicine is still in its early stages<sup>6</sup>. However, the availability of skilled forensic dentists is very few. It is possibly due to lack of sufficient knowledge. Neither the government nor do the people have a complete understanding of the importance of a forensic dental professional<sup>1</sup>.

Many national and international societies, such as the Indian Association of Forensic Odontology and the Indo Pacific Academy of Forensic Odontology, recently formed with headquarters in India, have been registered and working in India and are actively engaged in promoting this field<sup>12</sup>.

### **Future of Forensics**

- Forensic odontology in India is expected to become a separate discipline of dentistry in the near future, just as in the Western world. Quite often CAD-CAM systems are used in technology and can be used in the study of bite marks<sup>20</sup>.
- The Ballistics Analysis incorporates technology from ALIAS32, which is a relatively new addition to the forensic arena. It is mainly composed of an enhanced Apple MacPro computer and an interferometer that reforms variances as small as 2microns (about 1/50 of a human hair) and creates an online and offline model or digital clone<sup>20</sup>.
- While many researchers around the world are establishing reference groups for different ethnic backgrounds, Most of the work currently occurring in forensic dentistry reflects on enhancing the efficiency of age estimation, particularly around threshold ages (16–21 years) for children / adults<sup>21</sup>.
- Recently, forensic odontologists are scientifically advanced and skilled in digital bite marks and lip print analysis, and are involved in implementing various advanced technology to demonstrate the significance of stomatological structures such as tooth prints, rugae, and lip prints as biometric devices<sup>22</sup>.
- Several applications have been developed that facilitates the exact relationship between Ante-Mortem and Post-mortem records in the rotation of images, translation and scaling<sup>23</sup>.

### **Conclusion**

Forensic odontology enables the dentist to try and solve the medico-legal cases and uphold law and order in society. It is an emerging branch of dentistry with a diversity of evolutionary scope. Documentation and preservation of past history dental treatment, marking of dentures and implants if any with individual serial number helps in

identifying the individual in case of an emergency, dementia, unconsciousness, and missing persons or in identifying dead bodies in natural disasters. The modern era of dentistry with advanced imaging techniques, new material and methods involving dental care can definitely offer forensic odontologist valuable armamentarium in resolving many unresolved cases.

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