SP-47

Role Of Prosthodontist In Forensic Odontology – A Review Article

Niranjana.R[1], Ganesh Ramesh[2], Sanjna Nayar[3], Sreedevi Kannan[5]

[1]MDS student, Department of Prosthodontics, Sree Balaji Dental College and Hospital, Bharath Institute of Higher Education and Research, Chennai, India.
[2]MDS, Professor, Department of Prosthodontics, Sree Balaji Dental College and Hospital, Bharath Institute of Higher Education and Research, Chennai, India.
[3]MDS, Professor and Head of the Department, Department of Prosthodontics, Sree Balaji Dental College and Hospital, Bharath Institute of Higher Education and Research, Chennai, India.
[4]MDS, Professor, Department of Prosthodontics, Sree Balaji Dental College and Hospital, Bharath Institute of Higher Education and Research, Chennai, India.

Abstract: Forensic odontology has recently become an integral part of forensic science. Any term associated with a court of jurisdiction is referred to as forensic. Forensic medicine is concerned with the application of concepts by practitioners of medical and paramedical sciences in the administration of justice. It includes various disciplines such as forensic toxicology, forensic engineering, forensic anthropology, and forensic odontology. Various odontological characteristics, such as DNA fingerprinting, bite mark identification, rugoscopy, and cheiloscopy, are used in forensic dentistry; however these markers are of little help in patients who are entirely edentulous. Due to infrequent follow-up of edentulous patients and a lack of record keeping by dental practitioners, dental records of edentulous patients are frequently limited. As a result, providing some type of permanent denture labeling or marking could be a solution to these issues. This paper presents a review of available literature emphasizing the fact that how a Prosthodontist can play an important role in identification of a deceased individual if trained to do so.

Key words: Forensic odontology, Prosthodontist, Forensic dentistry, edentulous patient.

INTRODUCTION

Forensic dentistry is primarily concerned with the cranio-facial structures. The teeth and their dental restorations, dental prosthesis, pattern of bone trabeculae, arrangement of air sinus, and overall oro-facial morphology present a wide number of choices and information[1]. According to "KeiserNielson," forensic odontology is the area of dentistry that deals with the proper management, analysis, and evaluation of dental evidence in the interest of the court system[2]. It includes various odontological parameters such as DNA fingerprinting, bite mark identifification, rugoscopy and cheiloscopy. The major function of this specialized field is the identification of unidentified bodies involved in any criminal case, natural disaster, or other catastrophic occurrence[3]. As a result, any dentist has a moral, social, and legal obligation to keep antemortem records of their patients in order to serve as a helpful identifying tool in the event of a tragedy or disaster[4]. The identification of shattered, burnt, or degraded bodies presents a considerable challenge in the investigation. The loss of finger prints, facial features, and, in certain circumstances, the lack or mutilation of body parts, is a fundamental constraint in identifying these non-viewable types of human remains[5]. Teeth are said to be the most durable structure in the human body. Teeth and the human dentition are distinctive and individualistic due to a variety of internal and external factors. All of these features combine to make the human dentition an excellent source of post-mortem data, particularly for non-visible human remains[6]. In addition to these existing odontological parameters, the prosthodontist can provide accurate and definitive identification markers by including various identification aids in the prostheses delivered to the patient and maintaining a database for the same, which can aid in positive identification of individuals by matching antemortem and postmortem data[4].

REASONS FOR IDENTIFICATION[7]

Identification of deceased individuals helps in various ways as

1. Criminal — in most cases, a criminal death enquiry cannot commence until the victim has been positively identified.
2. Marriage - People of various religious backgrounds are unable to remarry unless their previous partners have been proved dead.
3. Monetary (Financial) - Payment of pensions, life insurance, and other benefits is contingent on positive death confirmation.
4. Burial - Before being buried in a geographic location, many religions need a confirmed identification.
5. Social - It is the responsibility of society to protect human rights and dignity after death, which begins with the fundamental basis of identification.
6. Relieve (closure) - The identification of people who have been missing for a long time might bring a sense of relief to family members.

HISTORY [1, 9, 10, 11, 12, 13]:

There was historical evidence of persons being identified based on the evaluation of prosthodontic appliances:

- A young dentist named Paul Revere detected battle casualties by bridgework during the American Revolutionary War in 1775.
- A gold denture assisted in the identification of Countess of Salisbury's charred remains in 1835.
- Denture wearers made up 819 of the 3000 unidentifiable dead troops after Second World War. Unfortunately, only nine people who wore dentures were identified.

- Dr. J W Webster assassinated Dr. Goerge Parkman, a Harvard University professor, in November 1849. Dr. N C Keep, who had made a removable partial denture for Dr. Parkman, had utilised a burned fragment of a tooth fused to gold to identify the body.
- A horribly mangled body discovered on the railway line at Mt. Kuringai in Sydney in April 1968 was recognised by an upper acrylic denture with a name engraved on it.
- Gold inlays, crowns, bridgework, and dental implants are used to identify European tourists who died in the tsunami.
- In 1977, the bodies of Adolf Hitler and his wife were identified using dental records, with the help of radiography and prosthesis.
- Many others, such as M. Raja Jayachandra Rathore of Canouj, who died in combat in 1191, were identified by his artificial front teeth. This was most likely India's first case of dentition-based identification.

DENTAL IDENTIFICATION [14, 15]:

A Prosthodontist can play a critical part in forensic identification by utilising numerous procedures and techniques available in the literature. For identification, many processes and techniques are used, and a Prosthodontist can become a member of this team and provide these services more effectively.

The role of Prosthodontist in Forensic odontology is:

- a thorough understanding of dental materials
- the ability to engrave records into prostheses
- the study of rugae patterns
- bite mark impressions
- lip print recording and identification

CENTRAL DOGMA OF DENTAL IDENTIFICATION [8]:

There are two main steps to dental identification:

- First, to demonstrate a high degree of certainty, comparison identification between the remains of a deceased and a person represented by antemortem (before death) is done. In most cases, the body or circumstantial evidence provides information that aids in the identification of the deceased person.
- Second, in circumstances when there are no antemortem records and no other clues to the person's identification, the forensic dentist creates a postmortem (after death) dental profile that suggests features of the person and aids in the search for antemortem materials.

INTELLIGENT DENTAL IDENTIFICATION SYSTEM [16]:

- Design and development of dental records, dental databases, and identification models are all included.
- From the ability to analyse data structure, Intelligent Dental Identifying System (IDIS) can incorporate all important dental data for identification purposes.

DNA IDENTIFICATION [17, 18, 19]:

- Each person's DNA pattern is distinct. Teeth are a valuable source of DNA material due to their resistance to external stress such as incineration, immersion, mutilation, and decomposition.
- When traditional dental identification methods fail, this DNA biological material can offer the necessary link to prove a victim's identity. This technique of identification should always be used as a supplementary method.
- Teeth, bone tissue, hair bulb, biopsy sample, saliva, blood, and other bodily tissues are the biological components that can be used to isolate DNA and perform laboratory testing for human identification.

PHOTOGRAPHIC SUPERIMPOSITION [20]:

- It is more difficult to determine whether a denture left at the crime scene belongs to an unknown set of skeletal remains.
- It is difficult to prove the identity of a complete denture and a skull since the morphological properties of the denture base, including the artificial teeth arrangement, must be compared to those of the surfaces of jawbones which cannot be observed from the outside.
- In such situations, Superimposition and X-ray computed tomography are efficient in providing proof of identity.

RUGOSCOPY [21, 22]:

- Palatoscopy is the study of the palate in general, and Rugoscopy is the study of the patterns of the grooves and ridges (rugae) of the palate in order to detect particular patterns.
- The palatal rugae were first described by Winslow in 1753 which are uneven, asymetrical mucous membrane ridges that stretch laterally from the incisive papillae located in the anterior half of the mid palatine raphe.
- The arrangement of these rugae is considered unique to each individual which retains its shape throughout life and can be utilised as a reliable strategy in postmortem circumstances.
- The rugae are highly protected from trauma and high temperatures since they are anatomically surrounded by cheeks, lips, tongue, buccal pad of fat, teeth, and alveolar bone.
- They can be utilised as a reliable reference landmark during forensic identification when antemortem data has been stored beforehand.
- Palatal rugae are an ideal forensic identifying parameter because of their uniqueness, post mortem resilience, overall stability, and low cost of use.
- A prosthodontist can identify the bearer of an upper denture by identifying the rugal pattern, and some judgments are frequently made using ante-mortem impressions taken for study models or prosthodontic consideration.

BITE MARK ANALYSIS [23, 24]:

- Bite mark identification is a science that can be used to connect a suspect to a crime.
- The mark created by human or animal teeth in the skin of alive humans, cadavers, or unanimated items with somewhat softer consistency is referred to as a bite.
- Bite marks are impressions left on food, skin, or other materials left at a crime scene, depending on the incident or circumstances. They may be found on the victim of an assault.
- Aside from identifying the agent, bite mark analysis in a forensic investigation can reveal the type of violence and the time between the development of the bite mark and the inspection.
- Bite mark interpretation necessitates a three-dimensional reconstruction.
- Prosthodontists are knowledgeable with the qualities of various impression materials used in various scenarios, and so can assist in the creation of an accurate duplicate.
- Bite marks have the following physical characteristics:

1. The distance between the cuspids.
2. Alignment of the teeth
3. Teeth width, thickness, and spacing
4. Teeth that are missing
5. Wear patterns.
6. Dental history, including fillings, crowns, and any restorations

SEX DETERMINATION THROUGH PULPAL TISSUE [24]:

- The sex determination from pulpal tissue is based on the presence or absence of X-chromosome

PROSTHESIS LABELLING [9, 25]:

Currently, two methods of denture marking are suggested in the literature:

1. Surface marking methods
2. Inclusion methods

SURFACE MARKING METHODS:

- This procedure involves writing a small piece of data or a code number on the denture; it does not physically alter the denture and preserves its structural integrity.
- As the prosthesis is used often and routinely, the written data or code fades with time, which is a major disadvantage of this technology.
- Surface marking on a denture can be accomplished in two ways:

a) scribing or engraving
b) embossing.

SCRIBING OR ENGRAVING:

- A small round bur is used to engrave short data or a code on the tissue fitting surface of maxillary dentures and the lingual aspect of the tissue fitting surface of mandibular dentures.
- To protect the structural integrity of the denture, the trough created by the bur should be as small as possible, and the patient should be informed on how to clean the dentures and maintain dental hygiene.

EMBOSSING

- A small bur is used to etch a short code or data into the master cast in this technique. The engraving on the maxilla is done on the palatal area, whereas the engraving on the mandible is done on the lingual aspect of the alveolar ridge.
- Following that, the usual stages of denture fabrication are followed, and the engraving is transferred as an elevation onto the intaglio surface of the denture.
- This practise is strongly prohibited since it irritates the underlying tissues and leads to the development of denture sores.

INCLUSION METHODS

- In this method, the short data or code is incorporated into the denture and it becomes the structural component of the denture. The structural integrity of the denture will be compromised if the inclusion is not done correctly and it will be unable to fulfil its core purpose which is the prosthetic rehabilitation.
- The following are the most prominent methods of inclusion:

1. ID bands
2. Paper strips
3. T bar
4. Laser etching
5. Electron microchips
6. Radio Frequency Identification (RFID) tags
7. Lenticular system
8. Denture bar coding
9. Photographs

1. **ID BANDS:**
- This process is used after the acrylic has completed its curing cycle but before the polishing and finishing steps.
- On a titanium foil or a Ho Matrix Band, a bar code or short data is inscribed. The denture is then etched with a shallow trough to accept the engraved metal band. The engraved band is firmly set in the trough, which is then filled and cured with clear acrylic. The conventional finishing stages are then carried out to prepare the denture for delivery.

2. **PAPER STRIPS:**
- In this procedure, the patient's information is typed on a piece of "Onion skin paper" and placed on the denture fitting surface, between the ridge and the middle of the palate. After that, it's covered in clear or pink acrylic before being sealed in the denture flask and cured, polished, and completed according to routine protocol.

3. **T BAR:**
- A "T" shaped clear acrylic polymethyl methacrylate resin bar with the patient's information or a short code is created. The denture base is created with a trough in the shape of the T-bar. After that, the T-bar is inserted into the trough, and clear acrylic is utilised to secure the structure to the denture base.

4. **LASER ETCHING:**
- This method is predominantly used for cast partial dentures; a copper vapour laser is utilized to etch the patient's specific details on to the metal. For a better view of the laser etched region, the piece carrying the short code or data can be overlay with clear acrylic.

5. **ELECTRON MICROCHIPS:**
- In this method, the patient's information or a code is etched onto a chip by the manufacturer. After that, the chip is inserted in acrylic resin. The chip's radiopaque property permits tissue-colored material to be placed over it. The chip can withstand temperatures of up to 600 degrees Celsius and is chemically resistant.
- The only disadvantage of this technology is the high initial cost, and the initial etching of features can only be done during the electron microchip manufacturing process.

6. **RADIO FREQUENCY IDENTIFICATION (RFID) TAGS:**
- An RFID system consists of a data carrier, also known as a transponder, and an electronic hand-held reader that uses an electro-magnetic field to energise the transponder. This hand-held reader can both write and read data to the tag.
- The large quantity of data that may be stored on the transponder is a major benefit of this approach. The RFID tags are also small (8.5 mm 2.2 mm) and can resist temperatures up to 1500 degrees Celsius.
- The main drawbacks are its high cost and lack of availability in most dental labs or dental offices.

7. **LENTICULAR SYSTEM:**
- In this method, a lenticular lens is used to create an image of the patient's face or any code. The images are printed on the back side of the synthetic paper and lenticular technology is used to laminate them on the lens.
- The main advantages of this technology are that it is simple, inexpensive, rapid, and weather resistant.

8. **DENTURE BAR CODING:**
- A bar code is a machine-readable code made up of a series of bars and spaces that are printed in predetermined ratios. The code is first printed on paper, and then photographed, and finally a negative is created. The negative is then transferred to silk. An industrial porcelain oven is used for this, which is heated to 860o C for 30 minutes. The coding from the negative is forced to transfer to the silk. This silk component can then be inserted into the denture and sealed with acrylic resin later.

9. **PHOTOGRAPHS:**
- This is a relatively new denture marking technique in which the patient's personal photograph is proposed to be incorporated into the transparent acrylic denture foundation.
- This strategy is effective in countries with a low literacy rate, when the simplest way of identifying is a photograph.

IDENTIFICATION OF DENTAL IMPLANTS [27, 28]:
- DNA, fingerprints, and dental comparisons are the most common scientific identifiers. In circumstances where the victim's fingerprint detail has been lost and the DNA has been denaturized due to cremation. Tooth loss will occur as a result of such extreme temperatures. Then, if any dental implants are found, they may be the sole evidence that can be used to identify the victim.
- Implants have a strong corrosion resistance, structural strength, and melting point, all of which contribute to keep implants intact after most physical assaults.
- Even when the implant was subjected to high heat exposure in a furnace, Berketa J et al. discovered that the batch number was still intact. The batch number was laser etched within the chamber of their implant and exposed to extreme heat in the experiment. When the abutment was removed, the result was an entire batch number that could be identified.

ABUSE [29, 30]:

- A dentist should be well aware of child, elderly or spousal abuse when any odd oral injuries, especially in cases of head or body injuries.
- Fragmented teeth, laceration of the labial or lingual frenum, missing or displaced teeth, maxillary and mandibular fractures, and bruised or scarred lips are all typical injuries in the face and mouth as a result of abuse. Abuse of the elderly is most widespread in both physical and psychological forms, especially in old age homes.
- Prosthodontists can aid to detect mistreated patients to a greater extent by carefully recording a complete case history and understanding their psyche, as they frequently deal with older patients.
- Prosthodontists should look for bruises behind the ear (battle's sign), traumatic alopecia (bald spots), any type of skull injury, retinal haemorrhage, blackened eye, any fracture in the face, lacerations, fractured tooth, avulsed or discoloured teeth in the absence of any reason to identify such patients.

CONCLUSION:

The use of forensic dentistry in the identification of a victim is no longer a novel idea. The oral cavity is a rich and noninvasive source of DNA that can be used to identify people and provide information for legal proceedings. However, dental practitioners must be encouraged to keep dental records and use distinctive markers in prosthetics, as well as maintain a database that can be accessed on demand. More research should be done to better identify population-based features in high-risk locations in order to further investigate this fascinating field of forensic sciences.

REFERENCES:

1. Gosavi S, Gosavi S. Forensic odontology: A prosthodontic view. J Forensic Dent Sci 2012;4:38-41.
2. Keiser-Nielsen S (1968) Forensic odontology. International dental journal. 18:668.
3. Pramod JB, Marya A, Sharma V (2012) Role of forensic odontologist in post mortem person identification. Dental research journal 9: 522.
4. Singh K, Prakash P, Bahri R, Bhandari SK. Prosthodontic markers: Identifification tools in forensic medicine. IP Ann Prosthodont Restor Dent 2020;6(2):120-123.
5. Berketa JW, James H, Lake AW (2012) Forensic odontology involvement in disaster victim identification. Forensic science, medicine, and pathology 8: 148- 56.
6. Berketa JW (2014) Maximizing postmortem oral-facial data to assist identification following severe incineration. Forensic science, medicine, and pathology 10: 208-216.
7. Weedn V W. Postmortem identifications of remains. Clin Lab Med 1998; 18: 115-137.
8. Jacob RF, Shalla CL. Postmortem identification of the edentulous deceased denture tissue surface anatomy. J forensic Sci 1987; 32; 698-702.
9. Mishra SK, Mahajan H, Sakorikar R, Jain A. Role of prosthodontist in forensic odontology. A literature review. J Forensic Dent Sci 2014;6:154-9.
10. MacEntee MI, Campbell T. Personal identification using dental prostheses. J Prosthet Dent 1979; 41:377-80.
11. LauG, TanWF, TanPH. After the Indian ocean tsunami: Singapore's contribution to the international disaster victim identification effect in Thailand. Ann Acad Med Singapore 2005; 34:341-51.
12. Bagi BS. Role of forensic odontology in medicine. J Indian Dent Assoc 1977;49:359-63.
13. Sansare K. Forensic odontology, historical perspective. Indian J Dent Res 1995;6:55–7.
14. Dhakshaini MR, Satpathy A. Contribution of a Prosthodontist in the Field of Forensic Odontology. Int J Prosthodont Restor Dent 2014;4(2):56-59.
15. Barua, D. R., Changmai, A., & Gaurav, A. (2018). Role of a prosthodontist in forensic dentistry-a step towards evolution. Journal of Clinical and Diagnostic Research, 12(9), ZE01–ZE03. https://doi.org/10.7860/JCDR/2018/35881.11988
16. Chomdej T, Pankowa W, Choychumroon S. Intelligent Dental Identification System (IDIS) in forensic medicine. Forensic Sci Int 2006;158:27-38.
17. Schwartz TR, Schwartz EA, Mieszerski L, McNally L, Kobilinsky L. Characterization of deoxyribonucleic acid (DNA) obtained from teeth subjected to various environmental conditions. J Forensic Sci 1991;36:979-90
18. Hirsch C, Brondolo T, Butcher B. Report to HE Dr. Surachai,Minister of Public Health, Thailand, and Dr. William Aldis, WHO representative to Thailand World Health Organization. Assessment of victim identification operations: Thailand tsunami disaster. New York: City of New York office of Chief Medical Examiner; 2005. p. 11
19. Saxena S, Sharma P, Gupta N. Experimental studies of forensic odontology to aid in the identification process. J Forensic Dent Sci 2010 Jul-Dec;2(2):69-76.
20. Minaguchi K, Hanaoka Y, Kiriyama T, Yamamoto K, Kuroyanagi K. Personal identification of a skull by a complete denture-application of superimposition and X-ray computed tomography analysis. Nihon Hoigaku Zasshi 1994;48:282-8.
21. Goswami, R., Garg, R., & Jolly, R. (2014). Role of Prosthodontics in Forensic Odontology. November 2011.
22. Sharma R., Anand D., Choudhary A., Shetty K. Role of prosthodontist in forensic sciences – A review article. Ann Prosthodont Restor Dent 2018;4(3):68-71.
23. Stimpson P.G, Mertz C.A. Forensic Dentistry. CRC Press, Boca Raton, Florida 1997

24. Bowers, C. Michael. "Forensic Dental Evidence: An Investigator's Handbook." Elsevier Academic Press, 2004.
25. Kareker N, Aras M, Chitre V (2014) A review on denture marking systems: a mark in forensic dentistry. The Journal of Indian Prosthodontic Society 14: 4-13.
26. Bathala LR, Rachuri NK, Rayapati SR, Kondaka S (2016) Prosthodontics an "arsenal" in forensic dentistry. Journal of forensic dental sciences 8:173.
27. Berketa J, James H, Marino V. Dental implant changes following incineration.Forensic Sci Int. 2011; 207:50-54.
28. Berketa J, James H, Marino V. Survival of batch numbers within dental implants following incineration as an aid to identification. J Forensic Odontostomatol. 2010;28:01-04
29. Luntz L. History of forensic dentistry. Dent Clin North Am. 1977;21(1):07-17.
30. Matoo KA Kumar S, Khan A. Prevelance of elder abuse among completely edentulous patients seeking complete denture prosthesis – a survey. J Indian Aca. Geriatrics. 2009; 5:177-80.