

REVIEW ARTICLE

Role of Prosthodontics in Forensic Dentistry

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ABSTRACT:

For forensic identification, victims possessing all or most of their dentition have physical characteristics necessary for their identification, whereas those missing all of their teeth lack such information. Prosthodontist can play an important role in forensic identification and can employ various methods and techniques available in literature employed for identification. In the present review, we have summarized the role of prosthodontics in forensic dentistry.

Key Words: Extrapulmonary Tuberculosis, GeneXpert, Mycobacterium tuberculosis

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INTRODUCTION

Forensic dentistry by Keiser-Neilson in 1970 is defined as "that branch of forensic medicine which in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and display of the dental findings" by Keiser-Neilson in 1970.¹ The forensic dentistry is usually called on to identify victims of mass disasters or at any time when the features of the body are destroyed beyond recognition. The teeth and dental restorations resist fire, trauma and pathologic conditions noted in dental records, treatments, and prosthetic devices may survive fires when identifying markings and DNA may not.²

Forensic identification by using prosthodontic appliances such as by denture marking, bar coding is gaining greater significance by providing vital clues for patient identification.³

Forensic odontology has three major areas namely:

- The inspection and analysis of trauma to jaws, teeth, and oral structures.
- The inspection of marks to eliminate or identification of a suspect as the executioner. 8u
- The inspection of dental (involving all forms of dental restorations and prosthesis) from anonymous persons or bodies.1

Role of prosthodontics in forensic dentistry :-⁴

1. Sound knowledge of dental material
2. New ways of engraving records of the patient.
3. Impression making and models of bite mark.
4. Study of rugae pattern-Rugoscopy.
5. Lip print recording and identification.

HISTORY^{1,2,6}

There were historical evidences that prosthodontic appliances help in identification of individuals.¹ One of the oldest known examples of forensic dentistry was in 66A.D which involved Agrippina, the mother of Roman emperor Nero, who ordered the death of her rival Lollia Paulina, and demanded to see Lollia Paulina's head as proof of her death, but she wasn't sure that her rival was dead until she noticed Lollia Paulina's distinctive discoloured front teeth. During the US Revolutionary War in 1775, Paul Revere, a young dentist, identified his friend in war casualty by false teeth which he had placed in his mouth. In 1835, to identify the burnt body of Countess of Salisbury, gold dentures were helpful. In second world war some soldiers were identified by their dentures. Dr. George Parkman, a professor in Harvard university in November 1849, was killed by Dr. J W Webster and was identified by charred fragment of tooth

fused to gold in RPD. A badly mutilated body, in April 1968 was found on the railway line at Mt. Kuringai near Sydney was identified by upper acrylic denture bearing a name inscribed on it. Identification of European tourists in tsunami was done by gold inlay, crown, bridge work, and dental implants.

RATIONALE OF FORENSIC DENTURES²

For forensic identification, victims possessing all or most of their dentition have physical characteristics necessary for their identification, whereas those missing all of their teeth lack such information. Prosthodontist can play an important role in forensic identification and can employ various methods and techniques available in literature employed for identification

DENTURE MARKINGS

Dr. Robert H, brought in to focus the importance of denture identification. During forensic identification, its advantageous as unknown denture wearers can be identified with the help of “marked” dentures and can be easily returned to the owner, in the case of lost and found incidents. Denture markings should be:

- Inexpensive, easy, quick and efficient.
- Labelling should be visible and durable .
- Should not interfere with patient esthetics and strength of the dentures.
- Should be non-allergic
- Should be possible to retrieve from any sort of accidents.
- Resistant to acids or commonly using disinfectants and denture cleaning agents.

Denture markings are mainly classified as:²

Surface marking methods	Inclusion methods
Scribing or engraving method	ID-band
Embossing method	Lead Paper label
Writing on denture surface	T-bar
	Laser etching
	Electron microchips
	Radio-frequency identification (RFID)-tags
	Lenticular system
	Denture bar coding

SURFACE MARKING METHODS

i) **Scribing or Engraving method** – Personal identification details are printed on paper with a printer and placed into the designated space by creating approx. 1mm deep depression on the palatal aspect of denture base which is covered with an auto polymerizing acrylic resin and finished in usual manner or two letters of name preferably first letters of initials were engraved with a small round dental bur on the fitting surface of the

maxillary complete denture, which resulted in countersunk letters.

ii) Embossing method

This method involves marking the models during fabrication, so that denture carries the marked information. Embossed initial letters are made by scratching or engraving on the model before processing on the buccal surface of the disto-buccal flange. According to Matsumura & Shimoe in 2002, this technique can be also used in partial dentures, while preparing a refractory cast from a casting mold material.

iii) Writing on denture surface

Use of tape wrapped disposable blade to cut the patient’s name or social security number on buccal surface of the distobuccal flange and then rubbing lead pencil or ink pen over fine grooves to make them more evident was suggested by Stevenson in 1987. According to Heath et al (1988) the roughened surface of a finished denture could be temporarily marked with a fibre-tip pen & these marks could be protected against abrasion with layers of sealant.

INCLUSION METHOD²

ID band

Dentures can be marked with a stainless-steel metal band incorporated into the acrylic denture post or prefabrication containing the personal ID of the patient. The most commonly used fire-resistant material are titanium foil and HO Matrix band containing identifiable coding system of patient details.

Lead Paper label

Lead foil paper found in the intra-oral x-ray film to type the patient's data with any manual ribbon typewriter can be used. It can be incorporated in trial closure state or after the denture is processed by cutting a depression then, covered with light cured acrylic resin of same colour.

T-Bar

T-shaped clear PMMA resin bar is constructed in clear PMMA and identification printed label is made against the flat section of the bar by cutting the base plate wax and then flasking ,packing and curing. It is then surface polished to produce a clear window displaying the ID label.

Laser Etching³ Lasers have been used for engraving purposes such as the CO₂ lasers, fibre lasers, and diode lasers. Laser micro-etching is a very precise method which is not visible to naked eyes and required the help of a magnifying lens, loupes or microscope. Copper vapor laser (CVL) can etch a patient’s identification into the metal surface of a partial denture. This method requires specialized equipment which is very expensive and require experienced technicians to perform.

Electron microchips³

Patient information were first etched onto a chip (5x5x0.6 mm) which is then bonded with acrylic resin. The specialized equipment are used to transfer the patient details into the computer. Major disadvantage is that only the manufacturer can inscribe it, not the dentist.

Radio-Frequency Identification (RFID)-tags^{2,5}

Use of radio-frequency identification (RFID)- tags within dentures is a cosmetic, effective labelling method which permit rapid and reliable identification of the wearer. Its advantageous because of small size (8.5x2.2 mm) and the large amount of denture user data that can be stored in them.²

It consists of a data carrier, referred to as tag and a reader with an antenna. Tag consists of a microchip with patient's information. Reader reads the information contained in the tag. Firstly, programming of the tag by connecting to the computer is done then the programmed tag into the channel on the external posterior buccal surface of the denture is incorporated. Clear acrylic resin over the tag to recontour the denture is placed. RFIDs are not widely used due expensive technique of manufacture and data incorporation which may not be available in most dental setups.⁵

Lenticular System^{2,5}

In 2010, *Colvenkar* introduced Lenticular printing. This system uses a technology in which the lenticular lens is used to produce images with an illusion of depth, morphology or the ability to change or move as the image is viewed from different angles.²

Lenticular printing is a multistep process consisting of creating a lenticular image from at least two or more existing images, and combining it with a lenticular lens. Each image is sliced into strips, which are than interlaced with one or more of the other images. They are printed on the back of a synthetic paper and laminated on the lens.

Advantage of this technique is, it is simple, quick, durable and waterproof and also does not interfere with the oral function, because of its small size. Disadvantage of this technique is that the information can never been changed and may not withstand a fire.⁵

Denture Bar Coding^{3,5}

Automatic identification using barcodes incorporated into dentures has been developed. Barcode systems can contain large amounts of data. The barcode was then read with a reader, and incorporated on to the denture, sealed with acrylic resin and could be used for crowns also. In 2012, *Rajendran et al*, devised a simple 2-D bar-code technique with patient's details using a code generator. 2-D bar code label is printed and laminated and bar code is incorporated in the denture with clear acrylic resin.

Photographs²

In countries with low literacy rate where a photograph is the easiest method of identification. Patient's photograph embedded in clear acrylic denture base as

a marker is useful. However, thermal tests revealed that the photographic marker and bar code were not resistant beyond 200–300°C.

OTHERS

Cheiloscopy^{3,4}

The external surface of lips has many elevations and depressions forming a characteristic pattern of lip called lip prints, examination of which is cheiloscopy. French Criminologist, *Edmond Locard* in, 1932 first utilized lip prints for identification of victim. Lip prints can be used to confirm the presence or absence of a person in any scene of a crime and can be involved in the identification of the definite person.

There are two methods to obtain lip print:

- Direct method
- Indirect method

Palatal Rugoscopy^{2,3,4}

Palatal rugae comprise of irregular and asymmetric ridges of the mucous membrane extending laterally from incisive papilla and anterior part of median palatal raphae, study of which is known as palatal rugoscopy. The rugae pattern is found to be unique to an individual and therefore, can be used as reliable method in victim identification and usually protected from trauma due to their position in the head also insulated from heat by the tongue and buccal fat pads. It is mainly useful in edentulous cases and in conditions where other methods for identifications are less reliable as in burnt cases or where bodies have undergone severe decomposition.

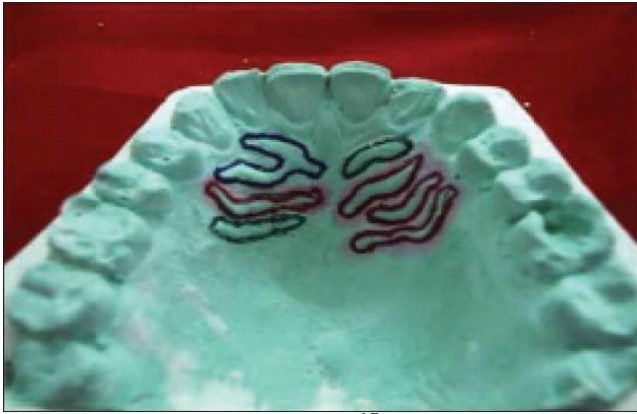
Thomas and Kotz concluded that different patterns of rugae are genetically determined, and so can be rather used in population differentiation than individual identification. *Lysell* measured rugae in a straight line from medial to lateral and categorized as Primary (>5mm), Secondary (3-5mm), Fragmentary (2-3mm). (Rugae <2mm is not taken in to consideration).

Whereas *Thomas & Kotze* have further detailed various patterns of primary rugae – branched, unified, cross linked, annular & papillary.

To study pattern of rugae, first impression of maxillary arch is taken which is the poured with dental stone. By the identifying of the rugal pattern, prosthodontist may help to find out upper denture wearer and some judgments are usually made by using ante-mortem impressions made for study models or prosthodontic consideration.

The advantages of palatal rugae include---

1. Uniqueness
2. Post mortem resistance
3. Overall stability
4. Low utilization cost



Bite Marks Analysis:^{6,7}

Bite marks are the marks left by the teeth of human or animal in the skin of a person. The science of identification of bite mark identification can be used to link a suspect to a crime. Depending upon the crime or circumstances bite mark impressions are left on food, skin or other items left at a scene. The interpretation of bite marks involves a three-dimensional reproduction.

Prosthodontists are well versed with the properties of different impression materials applied in different situations and hence can aid in the construction of an accurate replica.

Bite marks should include following characteristics:

1. Distance from cuspid to cuspid.
2. Tooth alignment.
3. Teeth width, thickness and spacing.
4. Wear patterns
5. Missing teeth.
6. Dental history including fillings, crowns, etc.

Kouble and Craig compared direct methods and indirect methods of bite mark analysis:⁷

1) Direct method:

In this method, the model of suspects' teeth is compared to a life size photograph of the actual bite mark. Direct comparison is made between dental models, photographs or finger print powder lift models. "Fingerprint powder lift" technique (involving dusting the bitten skin with fingerprint powder and using fingerprint tape to transfer the bite marks onto a sheet of acetate) is used.

2) Indirect methods:

This method involves the use of transparent overlays to record a suspect's biting edges. These overlays are made by free-hand tracing the occlusal surfaces of a dental model onto an acetate sheet.

Use of transparent overlays is considered subjective because the tracing can be easily manipulated. On the other hand, photocopier-generated overlays is considered to be the best method in matching the correct bite mark to the correct set of models without the use of computer imaging.



Identification of Dental Implants:³

Cases where there is denaturing of DNA and loss of fingerprint detail due to incineration of the victim, in such extreme temperatures tooth loss will also occur with extreme temperatures. Then the recovered dental implants, if any, may be the only evidence which will identify the victim.

Implants have high structural strength, high corrosion resistance, and high melting point which will help in the retention of intact implants following most physical assaults. *Berketa J et al* carried an experiment, in which the batch number was laser etched within the chamber of their implant and was exposed to intense heat and found that the batch number was still intact even after the implant was subjected to intense heat exposure in a furnace.

Abuse:^{1,3}

Dentist should be aware of child, elderly or spousal abuse when confronted with unusual oral injuries, especially in cases of persons with accompanying head or body injuries. Injuries due to exploit can exhibit in the oral-facial region includes traumatized teeth, lacerated labial or lingual frenum, fractured maxilla or mandible, missing or displaced teeth, and scarred lips¹⁰

Prosthodontists can help to identify abused patients by recording a detailed case history carefully and understanding their psychology as they usually deal with elderly patients. Prosthodontist should look for bruised behind ear (battle's sign), traumatic alopecia (bald spots), any kind of skull injury, retinal haemorrhage, blackened eye, any fracture in the face, lacerations, fractured tooth, avulsed or discoloured teeth in absence of any reason.

CONCLUSION^{1, 5, 6}

Forensic dentistry plays a major role in identification of those individuals who are not identified visually or by other means¹ Each practitioner has a responsibility to understand the forensic implications associated with the practice of his or her profession.⁶ The importance of forensic dentistry has increased awareness about identification of victims during recent tragedies and past and present situations

Denture marking or labelling is not a new concept in either prosthetic or forensic dentistry and its routine

practice has been urged by forensic dentists internationally for many years.⁵ During an identification process, dental records are used to give patients with optimal dental service and beneficial to legal authorities. Therefore, all the form of dental treatments should be documented and kept suitably. A dentist's work in the forensic field should give the reason to maintain legible and legally acceptable records and also to assist legal authorities in the identification of victims and suspects.³



Fig.1 SURFACE MARKING



Fig.2 ENGRAVED/SCRIBING METHOD



Fig. 3 RFID TAGS



Fig.3 EMBOSSED METHOD



Fig.4 ID BAND



Fig.5 DENTURE BAR CODE

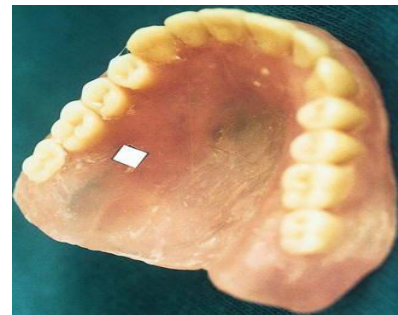


Fig.6 ELECTRON MICROCHIP



Fig.7 PHOTOGRAPH LABELLING

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