Contribution of prosthodontics in forensic sciences- A review.

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Abstract

Purpose- This article aims to highlight the various prosthodontic applications and their contributions in the field of forensic dental sciences.

Data Sources- PubMed, ResearchGate, Google scholar, and Google

Study selection- The database identified many publications during this electronic search. Titles and abstracts of the found publications were studied. A total of thirty-nine publications were judged to be relevant by the title and abstract. Their full text was read and analysed. All these articles had the most appropriate data, thus were included for this review article and conclusion was established.

Data extraction- After extracting the intended data from the results of each study done. They were carefully segregated and complied in a self-designed format. The overall data was analysed to conclude the review and establish the results.

Results- Appreciation of the forensic field gives the dental practitioner another reason to maintain legible and legally acceptable record and assist legal authorities in the identification of victims and suspects. Role of the forensic odontologists is to recognize the abuse, reassure the victim about confidentiality and report to the proper agency.

Conclusion- The prosthodontist must understand about the implications of forensic odontology. The knowledge about the forensics helps him/her to assist the legal authorities for identification of victims and suspects. Though this is not a recent concept but still more studies should be performed to explore this field of forensic odontology.

Key words: Bite mark analysis, Cheiloscopy, Forensic odontology, Rugoscopy.

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Introduction

Keiser Nielsen has explained forensic odontology as "that branch of odontology which is concerned with the proper evaluation, interpretation, presentation of dental findings in the interests of justice".[1,2] The teeth are the hardest structures of our body.[3] Teeth (exposed to postmortem etc.) damaged teeth can survive for longer duration as compared to other body tissues as they can be restored by materials that are resistant to biological, chemical as well as physical destruction.[4]

History

In 1775, revolutionary war was going in U.S. During that time, Paul Revere, a dentist identified the casualties during the war by assessing the crown and bridgework.[3] Later in 1885, with the help of gold denture, the burnt body of Countess of Salisbury was identified.

After the Second World War, dentures were used to identify 9 out of 819 soldiers.[5] Dr. N.C.Keep was able to identify body of Dr. Parkman, whose tooth charred fragment was fused to gold. Dr. Parkman was a professor at Harvard University. In 1968, near railway line of Sydney, a mutilated body was

identified by the maxillary denture, which had a name inscribed on it. During tsunami, European tourists were identified by the help of gold inlays, onlays, crowns, bridges, dental implants.[6] In 1977, dental radiographs and prosthesis were used to identify the bodies of Hitler and his wife.[7] Many such identifications were made by artificial teeth. In 1911, M. Raja Jayachandra Rathore died in the battlefield. He was the first case in India where artificial anterior teeth was used.[8]

On September 11, 2001, in New York, U.S., a disaster took place. Some of the victims who lost their lives were identified from the DNA extracts from toothbrushes.[8] Forensic odontologists identified 80% of Tsunami victims in southeast Asia in December 2004.[9]

Prosthodontic applications:

I. Denture marking methods:

There are 2 types – methods for marking the surface of denture and inclusion methods

A) Methods for marking the surface of denture:

1) Scribing or engraving on the denture: It is simple way of marking dentures. Round bur is used to engrave the two letters (initial and first letter of the patient) on the surface of the maxillary complete denture.[10]

2) Marking with embossed letters: Scratching or engraving is done on the dental models for making embossed letters on the final denture. In the case of removable partial dentures, letters are embossed on a wax framework followed by casting of the dentures. The embossed letters are visible through the acrylic denture base in a cast partial denture.[11]

3) Writing on denture surface: The patients' initials are written on the denture with the help of fiber tip pen. The buccal surface of distobuccal flange is usually selected for writing. Layers of sealant are used to protect the marks against abrasion.[12]

4) Denture bar coding system: In this system, a bar code, which is a placed on the denture. This bar code can be read by the machine. The coding can be printed in defined ratios. It is concealed by the help of cyanoacrylate resin.[13]

B) Inclusion methods:

1) Paper strips / Onion skin paper method: This method is done at the time of trial closure during processing of denture. Jeffrey explains how onion skin paper with carbon inscription can be applied to the denture base. Once denture processing is done, that paper is peeled from the denture and code is seen on denture.[13]

2) Metal identification bands: Stainless steel metal bands are used to incorporate the personal ID of a patient in the acrylic dentures.[14]

3) Computer printed denture microlabelling system: Computer generates an identification label containing all patients' details. Once the denture fabrication is complete, that identification label is placed in the slot. It is then sealed with saturated clear acrylic resin and cured in a pressure pot.[15]

4) Marking with photograph: Patient photograph can be used as a marker by embedding in the clear acrylic resin. It is the easiest method for identification in countries with poor literacy rate.[16]

5) Laser etching technique: Metallic surface of cast partial or complete denture is etched with patient details. A copper vapor laser is used in this laser etching technique.[17]

6) Denture bar coding: 2D bar code with patients' details was devised by Rajendran et al. The bar code is labelled and incorporated in denture. For decoding the bar code, a code decode enabled mobile camera is required and finally translation of patient information into text on mobile phone is displayed.[18]

7) Lenticular system: Colvenkar introduced this simple, cheap and quick system in 2010. This system is a multistep procedure in which lenticular image and then combined with lenticular lens. These images are printed and laminated on lens.[19]

8) Radiofrequency identification tags: A person is identified with a serial number. Microchip is used to store that identification. This microchip has an attached antenna, which is used to transmit that serial number. Once the reader has that serial number, it converts it to digital form. This digital information is analysed by the computer.[20]
9) Data matrix code incorporation: Ceramic discs of 4mm diameter and 0.5mm thickness is laser engraved with matrix codes. During denture fabrication, at the time of packing and flasking these discs are incorporated into denture fabricating material.[21]
10) Memory card incorporation: Memory card is used to store the patient information. The memory card is wrapped with a cellphone sheet and placed on the palatal side of the denture. After placing the card it is covered with self-cure resin.[22]

II. Palatal Rugoscopy:

The study of the palate is called palatoscopy. The study of the grooves and ridges of the palate is called rugoscopy. Caklas and Shetty et al reported about rugae and Winslow described them. In the fields of genetics, prosthodontics, forensic odontology, comparative anatomy, antropology, orthodontics rugoscopy has been used widely.[23,24] Palatal rugae are about three to seven ridges radiating out tangentially from the incisive papilla. Venegas et al analysed the number, size, shape, position of the palatal rugae.[25] The rugae pattern are unique, specific to racial groups so they are considered as reliable method for the postmortem cases.[26] Rugoscopy is of special interest in burnt, decomposed bodies as we edentulous cases. Thomas and Kotz concluded that rugae patterns are genetically determined. The rugoscopy can be used to differentiate population as well as identification of individual.[27] As the patterns of palatal rugae is unique as well as due to added advantage of low utilization cost, overall stability, it is considered as an ideal forensic identification parameter.[28]

III. Cheiloscopy:

In this methos of investigation, lip patterns are used for identification of individual. These lip patterns are formed on the outer side of lip. Edmond locard in 1932 suggested using these lip patterns for investigations and criminal/ individual identifications. Lip prints were renamed by Suzuki and Tsuchihashi as ‘figura linearum labiorum rubrorum’. Synder mentioned in his book about that lip patterns of each individual are different, similar to individual fingerprint. [29]

IV. Bite Marks:

These are the marks made by human or animal teeth in the skin of dead body, objects (food) of comparatively soft consistency or any living individual. Violence cases, time interval of crime production and examination can be assessed by this bite mark analysis. A three- dimensional reproduction is required for analysis of bite marks. Prosthodontists by the help impression and impression materials, can replicate the bite marks.[30] The replica can help to assess distance between the 2 cuspids, crowns, fillings, anatomical aspects of tooth, malalignment like spacing, etc.[31]

V. **Dental Implants**

Identification of data can be done by the help of dental implants. DNA identification, fingerprint, tooth specifications and replacements are primary scientific identifiers. However, in some situations denaturing of DNA and fingerprint details can be lost. So, in these cases the identifiers

are tooth replacements i.e. implants. Implants are made of titanium. Titanium is corrosion resistant along with high melting point and good structural strength. Due to these physical properties, these titanium implants become resistant to most of the physical assaults.[32] Berketa et al after placing implants in sheep mandibles, cremated the heads of the sheep in the creamator.[33] Laser etching of the batch number was done in the chamber of the Straumann TM implants. On the retrieval of implants, identification was done easily as batch number was visible even after the cremation of heads. So the companies were asked to manufacture implants with individual serial numbers for identification of the deceased.[34]

VI. Panoramic Radiography:

Radiography is helpful to assess eruption stage and hence can determine the age of an individual. Sign of ageing is secondary dentin deposition, which is seen by the decrease in size of the pulpal cavity.[35]

Studies Done for Estimation of Age and Sex Determination

- Sex determination using mean values of mandibular Canines-
  In cases of natural calamities, canines were found to be unaffected. Boaz et al specified the values of left mandibular canines. Buccolingually and mesiodistally the mean values were less in males than females.
- Cementum annulations for age estimation-
  These are used reliably for age estimation.
  Age of individual (predictable) = n+t where n=X\Y and t = age at which tooth erupts.
  X= total cementum width from dentinocemental junction to surface of cementum.
  Y= cemental width between 2 incremental lines.

- Enamel rod patterns-
  These tooth patterns are unique for each individual. These patterns are laid down by the ameloblasts. These are called tooth prints as they become similar to other methods of identification like lip prints, rugae. These patterns can be duplicated by the help of rubber base impressions, techniques like Acetate peel technique.[35]

Discussion:

Dental identification plays a significant role in forensic investigation. Dental database has become an essential part of forensics as there is lack of comprehensive fingerprint database. Dental database includes investigations based on tooth fillings, alignment, restorations, missing, carious as well as presence of prosthesis such as complete or removable dentures etc. Documentation of these investigations can be done in an efficient way. These investigations play a significant role **i**n case of disaster (natural, manmade and in particular aviation disaster).

The role of a prosthodontist in the field of dental forensics can be explained based on teeth and prosthesis present in a victim.[36] In the case of a dentulous victim, the prosthodontist can identify the victim by examining the all the teeth present, missing teeth, carious teeth, restorative teeth, partial dentures and dental implants. In the case of the edentulous victim with a denture-marked prosthesis, it is very easy to identify the victim with the denture marking (in cases of accidents and disasters). Even though various denture marking methods are available, the latest inclusion methods like the incorporation of microchips, memory card, or

a matrix code stand tall among all others. If the prosthesis is unmarked, the clinician can identify it by pouring casts from the prosthesis. Palatal rugoscopy can be done with the available casts to identify the victim. A resin prosthesis of the oral cavity (kept at room temperature for over two hundred days) can be used for DNA extraction, analysis and hence victim identification. In cases of victims (edentulous and without any prosthesis), prosthodontist can use palatal rugoscopy and cheiloscopy along with traditional methods of identification of such type of edentulous victim.[37]

CAD-CAM with 3D digitizing systems are the recent advancement that helps a prosthodontist in the field of dental forensics. This system scans an object to construct a 3D image. This scanning in CAD CAM overcomes the disadvantages of traditional impression making and impression materials.[38] 3D digitizing system are the revolutionization in the field of forensics. These 3D systems include scanning by lasers, structured light scanners, photogrammetry etc. These 3D technologies help in the quick and accurate collection of data with minimal degradation so they can be presented in court without any bias. A new system is a hybrid product which is a combination of 2D and 3D technology. This new system is advanced in comparison of 3D system. Ex: Bullet Trax-3D and Brass Trax-3D systems. The Ballistics Analysis introduces ALIAS32. This technology works by creating a mathematical model or digital clone.[39]

Conclusion:

Each dentist should understand about the forensic implications in the field of dentistry. This understanding about the forensic sciences by a dental practitioner, helps him/her to assist the legal authorities for identification of victims and suspects. Though this is not a recent concept but still more studies should be performed to explore this field of forensic odontology.

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