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Review Article

The decisive role of prosthodontics and its invaluable contribution to forensic odontology: A review

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ABSTRACT

Identification plays a significant role in delivering justice to any medicolegal investigations. Within the process of law enforcement, Forensic odontology has a vital role in identifying the victims. In some complicated cases when other means of investigation fails, identification by means of dentistry serves as prime source. In cases wherein the victims natural dentition was replaced by prosthesis, the role of prosthodontist in forensic odontology becomes crucial. Investigations can be done by tracing the labelling of dentures and other appliances. Thus it's attaining more popularity nowadays. This paper presents an overview of all the obtainable resources from the literatures demonstrating his fact on how the prosthodontist can contribute a major share in identification of an unidentified body.

1. Introduction

Forensic odontology mainly deals with utilising all the evident sources of dentition. The quality of dental documents maintained, is one of the essential factor in identification of the victims.[1] Forensic dentistry participates in the making of dental evidence with the main objective of contributing scientific and objective data as evidences in the legal proceeding.[2]

Dental structures being the most hardest and resilient structure of human body can survive longer than most other structures on exposure to post-mortem influences. The materials commonly used to restore teeth can highly withstand destruction caused by physical, chemical and biological annihilation.[2]

Forensic identification by utilising the information from prosthodontic appliances like denture marking, bar coding etc. are gaining great importance as they help in providing vital clues for patient identification.[3] Therefore, a prosthodontist's primary responsibility in forensic odontology is to have a thorough understanding of the various dental materials that are used, techniques for engraving records into prostheses, knowledge of rugae patterns, ability to make bite mark impressions, and ability to record and identify lip prints.

A prosthodontist can play an important role in identification of a deceased individual by implementing different methods and techniques to deliver services in an effective way.

2. History

Identification of corpse using dentition goes long back to 1775, the time of the US Revolutionary War, where Paul Revere, a young dentist, recognised war casualties with the help of their crown and bridgework.[2]

In the year 1885, the burned bodies of corpse of Countess of Salisbury was identified using a gold denture.

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Following world war II, out of 819 soldiers only 9 could be assessed using dentures as tagging and preservation of antemortem records were least in practice at that period.[2]

In 1849, the body of Dr. Parkman a professor at the Harvard University was burned out completely. He was later identified by Dr NC KEEP (who had previously made a removable denture for the victim) with the help of the charred fragment of a tooth fused to gold.[2]

The body of European tourists during tsunami was recognised with the help of prosthesis such as gold inlays, onlays, crowns, bridges and dental implants.

In 1977, Hitler and his wife's bodies were identified by means of the dental records of radiographs and prostheses.[2]

M. Raja Jayachandra Rathore of Canouj who died on the battle field in 1191 was also identified by his artificial anterior teeth, marking it probably as the first case of identification using dentition in India.[2]

The collapse of world trade centre on September 11, 2001, New York, U.S.A., caused the death of thousands of people, Deoxyribo Nucleic Acid (DNA) extracts from tooth brushes used by victims helped in the recognition of few of the deceased.[2]

3. Discussion

Identification with the guidance of dentistry, have three different applications:[2]

1. Comparative identification that enables to compare both the post mortem dental records and the antemortem records of an individual.
2. To ascertain the search of an individual when the antemortem records are unobtainable and there are no other relevant data which can be referred for the same.

3.1. Victims identification following mass casualty or catastrophes

There are numerous process and system employed for identification and prosthodontist can become part of this team and render their facilities in a better way, which include.

1. Comparative Dental Identification.
2. The Intelligent Dental Identification System.
3. Disaster Victim Identification process.
4. DNA Identification.
5. Photographic Superimposition.
6. Palatal Rugae in Identification.
7. Identification of Dental Implants.
8. Bite Marks Analysis.
9. Cheiloscopy:
10. Abuse.
11. Denture Labelling.

3.2. Comparative dental identification

The core tenet of dental identification is that post-mortem dental remains and antemortem dental records can be compared to verify the identity. For dental identification to be accurate, antemortem data needs to be obtainable. This depends clearly on dental professionals recording and maintenance of dental notes, radiographs, study models, clinical photographs, etc. Post mortem data's are obtained from the recovered characteristics from an unidentified corpse.[2,3]

3.3. The intelligent dental identification system (IDIS)

IDIS mainly includes the development and configuration of dental records, database and identification models. It will be utilitarian in assisting the general dental practitioners regardless of their knowledge in forensic odontology to contribute in identification of both living and post-mortem subjects. It will drastically decrease the amount of time required for identification and also stores digital images of dentition with various processing features.[3,4]

3.4. Disaster victim identification process

Body tagging and bagging, forensic pathology, finger printing and forensic dentistry are the four major steps. Forensic dentistry team was categorized into two. The Dental examination team and the dental radiology team. Prosthodontist can join the team and lead the investigation.[3]

3.5. DNA identification

Fingerprint, DNA, dental, and medical characteristics are the scientifically acknowledged methods of human identification. The recent advances in DNA profiling have made DNA evidence to be more widely acknowledged in courts. This in turn has revolutionized the aspect of forensic odontology. DNA that is in charge for all the activities in the cells, yields important information's both in the healthy and deceased individuals.[3] When other means of classical identifications become impractical following mass calamities or fire explosions, teeth provide a rich source of DNA as they have a high chemical and physical resistance.

However, identification using DNA is exorbitant and practically difficult to execute on a wider scale. It should be taken into account only when other prime methods fail.

3.6. Photographic superimposition

While evaluating the denture at the investigation site its hectic to rule out whether the real owner of the denture is among the unidentified sets of skeletal remains. superimposition and X-ray computed tomography are effective in establishing evidence of identity in cases wherein the denture morphology including artificial teeth arrangement has to be differentiated with external surface

of jawbones.[3]

3.7. Palatal rugae in identification

Authors have stated the use of palatal rugae patterns rendered on the dental casts in order to match with the remains found. This method has provided positive results. The anatomy of rugae inside the mouth is surrounded by lips, tongue, cheek, buccal pad of fat, teeth, and bone which shields it from trauma and high temperatures. Thus, rugae can be used as reliable landmark for studies during a forensic identification.

Like fingers, palatal rugae's are distinctive from person to person. Hence in edentulous cases it can play a great role. Prosthodontist maybe able to identify the real owner of the maxillary denture by spotting and recognising patterns in rugae.

Thomas along with Van Wyk, compared the rugae to the pattern on the victim's old denture and identified a severely burnt victim, this proves that rugae is stable in adult life. Thus, palatal rugae exhibits all the features required for identification i.e., uniqueness, resistance to postmortem, and stability. The study of palatal rugae in order to justify a person's identity is known as palatoscopy /palatal rugoscopy.[3,5,6]

3.8. Identification of dental implants

Although teeth are extremely resistant, extreme temperatures may lead to loss of its structures and in such cases only the characteristics of recovered dental implants, if any, can serve as the only existing physical identifying source accessible. The physical properties such as high resistance to corrosion, high structural strength, and high melting point explains the retention of intact implants.[3,7]

3.9. Implant recognition software (IRS)

It's a software tool which is beneficial in the field of forensic dentistry. The facial bones and dental structures are sometimes the only prime source for the identification of victims after a mass disaster or murder. If the victim has a dental implant, the forensic dentist could easily access the system, the location and size of implant used and this in turn could be a crucial lead in identification of victim. This software program serves a great help especially to dentists with limited knowledge in this field.[7]

3.10. Bite marks analysis

Bite marks are the registration of the teeth on the skin of an individual by the humans or animals. Identification of a bitemark can be an evidence linking a particular suspect to the crime. Contusions are the most commonly seen type of bite marks.[1]

Bite marks can serve as two or three dimensional proof. However, a three-dimensional duplication of the teeth mark is required for the clarification. Prosthodontists can easily aid in the fabrication of accurate reproduction of the mark. Methods used for bite mark study includes the following:

1. Making of impression from bitten substances with dental stone and then copying it from dental study casts.
2. Digital photography method.
3. Photocopier generated overlays
4. Computer-assisted overlay production method.

According to the studies it's shown that computer-generated overlays provide the most definite and reproducible exemplars.

Bite marks should contain the following[1,8]

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

3.10.1. Cheiloscopy

The external surface of lips have many elevations and depressions forming a characteristic pattern, these patterns are called lip prints. The examination of lip prints is known as cheiloscopy. Like fingerprints, the lip prints are unique and distinguishable and thus helps in personal identification. In 1932, Edmond Locard, a French Criminologist, was the first to use lip prints in the identification of victim. The two ways to get a lip print are as follows

1. Direct method.
2. Indirect method.

One common problem faced during the cheiloscopic studies is that of smudging or spoiling of lip prints leading to unidentifiable marks.[1,9,10]

3.10.2. Abuse

A dentist should always be in alert and should be able to differentiate any unusual oral injuries, especially in cases of head or body injuries of child, aged patients or injuries caused by domestic violence's. Fractured teeth, laceration of the labial or lingual frenum, missing or displaced teeth, fractures of the maxilla and mandible , and bruised or scarred lips are some of the common visible injuries in head and neck regions in case of abused victims. In case of senile patients, abuse is commonly seen in physical and psychological forms, mostly among those in nursing home.

Prosthodontists can help in identification of an abused patients as they usually deal with elderly age groups. The careful examination, recording of case history and

psychological analysis of the patients maybe useful. In order to identify these abused patients, prosthodontists should check for the following signs: battle's sign (bruises found behind the ear) bald spots (alopecia caused by trauma), injuries in skull, abnormal bleeding within the delicate blood vessels of retina, bruises around the eye, any fascial fractures, lacerations, fractured tooth, avulsed or discoloured teeth in absence of valid reasons. [1]

3.11. Denture labelling

Denture labelling has a long history of being a very effective method for identifying victims. It has been observed that the mandibular lingual posterior and the maxillary palatal posterior portions of the dentures are generally spared even in cases where victims bodies are completely burned. Hence, these regions has been prioritized for denture markings.

The denture marking is considered essential for the following reasons:

1. In cases such as amnesia or senility, loss of memory, psychiatric cases, homicide, suicide, victims of fire, explosion, floods, earthquake, plane crash, or war, It serves to identify the unknown denture wearer.
2. In cases of lost and found, the denture can be easily returned to the rightful owner.
3. A rapid and accurate method other than finger printing is important for the identification of an individual.
4. In the laboratory, the dental technicians can easily identify a denture, particularly at the deflasking stage, if it is marked/labelled.
5. To ensure precise delivery of dentures to the respective patient.

The various methods of marking the denture are: [1–5,9,11,12]

3.11.1. Surface modification technique

It involves writing, scribing on the polished or tissue surface of the denture post fabrication with a water proof marker or embossing initials of the patient on the master cast. However, these methods are not permanent and may lead to food and debris accumulation making the surface prone to oral infections

3.11.2. Inclusion technique

This technique involves the placement of metallic, non metallic labels or microchips during the denture processing stage. Patient's name or identification number is incorporated in the denture permanently. This technique might be time consuming and requires skill.

3.11.2.1. Surface Marking. Candidates name or other information's are first labelled using laser printer. The label is then placed on the selected depression of minimum 1mm made on the palatal surface of the denture. Auto polymerizing acrylic resin is then used to cover the depressions made. Followed by trimming and finishing. [1]

3.11.2.2. Paper strips. This is an economical technique wherein a scribed paper strip is incorporated between the slopes of the alveolar ridge and the center of the palate. The paper strip is then covered using acrylic resin prior to the final closure for acrylisation of the denture. [2,13]

3.11.2.3. Band. Stainless steel bands or fire resilient materials like titanium foil, matrix bands containing the information of the denture wearer can be used to tag the dentures. [1,2,9,13]

3.11.2.4. Denture micro labelling system. In this system, a transparency film is used to record patients name and other informations. Before introducing this label into the denture, it is chemically treated with 100%of cyanoacrylic acid. A thin coat of auto polymerising clear acrylic resin can be applied on top of them after the incorporation of label onto the denture.

3.11.2.5. T- Bar. A T shaped clear Poly methyl methacrylate(PMMA) resin bar is fabricated by trimming the base plate wax which is then acrylized using either clear or pink Poly methyl methacrylate. A printed identification is fixed into the flat surface of the bar. It is then highly polished to produce a clear window showing the crucial data's of the denture wearer. [2,9,13]

3.11.2.6. Lenticular card. Lenticular printing is a complex process in which multiple steps are involved. In this process, every single image is made into strips and then interlaced with other images. Its then printed on the other side of synthetic papers and laminated on the lens. However, it has few drawbacks

1. It cannot resist fire.
2. Corrections cannot be made on the written information. [1–3,9,11,13]

3.11.2.7. RFID tags. Radio Frequency Identification (RFID) is a cosmetic labelling method used for tracking and identification with the help of using radio waves. The microchip in the tag stores all the informations regarding the patients, all this details is read by the reader. Programming of the tag is done by connecting it to the computer and then this programmed tag is added into the channel located in the posterior buccal surface of the denture. The denture is then recontoured by placing clear acrylic over the tag. The main drawback apart from it being an expensive technique is that, the tag is not resistant to fire. [2,9,13]

3.11.2.8. Bar coding. This technique is similar to the bar coding of other products.

Fire proof bar code systems are introduced into the denture. Bar codes can store enormous amount of datas.

The opacity of the acrylic resin may pose a problem with the scanning of the barcodes. Therefore, its recommended to use clear acrylic resin. [1,3,9,11,13–15]

3.11.2.9. Photograph inclusion method. The patient's photo, which is implanted in a clear acrylic denture base, is used in this procedure. Using a micro-tip graphite pencil, the patient's name, age, and location are inscribed on the reverse of the image. The marker is especially helpful in areas where there is a poor literacy rate because identification by photo is the simplest. [2,9,13]

3.11.2.10. Incorporation of memory card. This is an electronic storage device that stores a wide range of information's. It's not big in size, it's re-recordable and the data entered can be retained without the use of power. All the crucial information's for identification of the patient along with photos are first stored in the memory card, the card is neatly covered with a cellophane sheet and is then kept on the external region of the palatal aspect of the denture. A layer of auto polymerizing acrylic resin is then added to cover them. [14,15]

3.12. Denture marking using aadhar number

Patient's unique identification number printed in their Aadhaar card issued by Unique Identification Authority of India (UIDAI) is used as denture markers. The laminated label is positioned in 1 mm depth recess, created on the palatal surface of the complete denture. To properly adapt the label on the finished surface of denture, one drop of cyanoacrylate adhesive is placed in the prepared slot. Fill the recess with clear auto polymerizing resin before trimming and polishing in a conventional manner. [16]

3.13. Sites for location of the denture marker

The cameo or polished regions of the denture is usually the preferred site and if aesthetics is given more preference, then the intaglio or impression surface is used. However, if the denture is marked on intaglio surface it might get covered when relining is done. Hence the most appropriate sites for the tagging of dentures includes: [17]

1. Posterior region of the buccal surface of upper denture.
2. Lingual flange of lower denture.

The above sites are chosen due to the following reasons:

1. Readers accessibility
2. Resin has sufficient thickness to integrate without any technical complications.
3. Aesthetics of the denture is maintained.

Some other suggested sites include:

1. The palatal surface or the buccal tuberosity areas
2. The lingual surface of anterior and posterior regions are used in case of fixed prosthesis like crowns, to carve the initials or reference number.
3. Occlusal surface of the posteriors are the least preferred site for marking due the chance of losing the details during the correction of occlusion.

In Fixed partial denture, once the opaque layer of porcelain is processed, dentin porcelain is applied and initials or letters can be marked with the brush at this step stains can then be applied to this initials. The enamel porcelain is applied next and it's further shaped using a soft brush, Thus the initials are maintained. One major disadvantage is that only the initials can be carved due to lack of space in the crown and bridge, and the lingual surfaces of anterior and posteriors are the most preferred sites for carving. [18]

4. Conclusion

Forensic dentistry holds a significant role in identification of unrecognised individual in cases where other methods such fingerprint analysis fails. Forensic dentistry deals with analysing of dental proofs and proper examination and representation of all dental findings in the name of law. The Prosthodontists plays a crucial role in forensic dentistry as they deal with fabrication of various prosthesis which can serve as an important identification material. The critical requirement of any medico-legal investigation is Identification and error in this step may lead to wrong identity which may pose a huge problem in delivering justice.

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6. Conflict of Interest

None.

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