Introduction

Forensic odontology is the forensic science that is concerned with dental evidence. It is a relatively new science that utilizes the dentist’s knowledge to serve the judicial system. Human identification relies heavily on the quality of dental records. Forensic odontology, as a science, did not appear before 1897 when Dr. Oscar Amoedo wrote his doctoral thesis entitled “L’Art Dentaire en Medecine Legale” describing the utility of dentistry in forensic medicine with particular emphasis on identification. Dental identification plays a key role in natural and man-made disaster particularly aviation disaster. The most common role of the forensic dentist is the identification of deceased individuals. Dental structures are the hardest and most resilient tissues of the human body.

Abstract

Dental identification assumes a primary role in the identification of remains when postmortem changes, traumatic tissue injury, or lack of a fingerprint record invalidate the use of visual or fingerprint methods. The most common role of the forensic dentist is the identification of deceased individuals. Forensic identification based on assessment of prosthetic appliances is assuming greater significance, as labeling of dentures and other prosthetic appliance could provide vital clues for patient identification. Various recommendations have been made concerning the importance of denture identification. This paper presents a review of available literature highlighting the fact that how a prosthodontist can play a key role in identification of a deceased individual if trained to do so.

Key words: Dental implant, denture marking, forensic odontology, palatal rugoscopy, prosthodontics

History

There were historical evidences of identification of individuals based on assessment of prosthodontic
Dental Identification

A prosthodontist can employ various methods and techniques available in literature; few were enumerated below, and can play an important role in forensic identification. There are various process and system employed for identification and prosthodontist can become part of this team and render there services in a better way.

Comparative Dental Identification

The central dogma of dental identification is that postmortem dental remains can be compared with antemortem dental records to confirm identity. For dental identification to be successful, antemortem data need to be available. This relies heavily on dental professionals recording and keeping dental notes, radiographs, study models, clinical photographs, etc. Postmortem data are recovered characteristics from an unknown body.

The Intelligent Dental Identification System

Incorporates the design and development of dental records, dental database, and identification models. From the ability of data structure analysis, Intelligent Dental Identification System (IDIS) can integrate all important dental data necessary for identification purposes.

Disaster Victim Identification process

This consists of four main steps, that is, body tagging and bagging, finger printing, forensic pathology, and forensic dentistry. Forensic dentistry team was divided into two parts, that is, dental examination and dental radiology. Prosthodontist can play a key role in forensic dentistry team.

DNA Identification

Methods of human identification that are acknowledged as scientific are fingerprint, DNA, dental, and medical characteristics. Because of the resistant nature of dental tissues to environmental assaults, such as incineration, immersion, trauma, mutilation, and decomposition, teeth represent an excellent source of DNA material. When conventional dental identification methods fail, this biological material can provide the necessary link to prove identity. DNA identification is expensive, technically demanding, and logistically difficult to implement on large scale. In case of the tsunami in Thailand, it proved to be a relatively unimportant method of identification. DNA identification should not be considered as a first live method of identification, but rather should only be implemented when physical, fingerprint, and dental methods have been unsuccessful.

Photographic Superimposition

When examining whether a denture left at investigation scene belongs to an unknown set of skeletal remains is more troublesome. To demonstrate identity between a complete denture and a skull is difficult since the morphological characteristics of the denture base, including the arrangement of the artificial teeth, have to be compared with those of the surfaces of the jawbones, which cannot be observed from the outside. In cases like this, superimposition and X-ray computed tomography are effective for establishing proof of identity.

Palatal Rugae in Identification

Authors have described the use of palatal rugae patterns rendered on dental casts to compare with found remains. Positive identifications have resulted from this technique. The pattern of these rugae is considered unique to an individual and can be used as reliable method in postmortem cases. The anatomical position of the rugae inside the mouth surrounded by cheeks, lips, tongue, buccal pad of fat, teeth, and bone keeps them well-protected from trauma and high temperatures. Thus, they can be used reliably as a reference landmark during forensic identification. Palatal rugae have been equated with fingers and are unique to an individual. It can be of special interest in edentulous cases and also in certain conditions where finger prints cannot be taken, such as burnt bodies or where bodies have undergone severe decomposition. By the identification of the rugal pattern a prosthodontist may identify the bearer of upper denture.

Denture Labeling and its Important in Forensic Dentistry

Marking dentures has been well documented as a useful aid in the identification of the following: Victims of
fatal disasters, misplaced dentures in hospitals, nursing homes, and institutions, as well as patients who suffer from unconsciousness or psychiatric problems such as traumatic or senile loss of memory.[28-32] More often denture may be found close to the scene where body is found and chances of identification of edentulous person wearing denture are less difficult in comparison to those in a dentate patient. Hence denture labeling is very important.[33,34] In Australia, the Nursing Home Standards require that dentures of residents be “discreetly labeled” and marking of all dentures is recommended by the Australian Dental Association.[35] Denture marking is regulated by law only in Sweden and Iceland.[36] In US, denture marking is mandatory but in New York dentures are marked only if patient requires it. Although no legislation has been approved pertaining to this matter, it is a social and an ethical obligation on the part of the practicing dental surgeon to do so. There have been a number of requests from individuals and dental organizations over the years to insist that dental prostheses are labeled with the patient’s name or a unique number.[32] Unlabeled dentures have been recovered from patients and then fitted to casts retained by the treating dentist or laboratory, and this has been an accepted method of identification.[37]

In the recent Highland Towers Condominium disaster at Ulu Kelang, Selangor there were five edentulous victims wearing dentures. The forensic investigating odontologist did not find any of their dentures having any form of identifying markings, thereby frustrating the dental victim identification team from making any conclusive identification.[38] The authors in a study propose that the denture should be labeled and include the country code prefixed before the identity card number. In countries where no identity cards are issued to their citizens, then the driving license number, social security number or the income tax file number is the recommended identifying number to be employed.[39] It has been observed in numerous incinerated bodies the lower lingual posterior, and the upper palatal posterior portions of the dentures are usually spared. These sites become the choice of areas for the marking.[36,40,41] Denture marking should also not be restricted to acrylic dentures only but also be extended to those made from cobalt-chromium. Cobalt-chromium appliances resist melting even in some cases of incinerated remains. Identifying markings can also be incorporated in orthodontic appliances, maxillo-facial reconstructive prostheses, crowns, and bridges.[38]

A survey undertaken to determine the extent of the practice of denture marking in South Australia, the methods in use, and the attitudes of dentists, dental technicians, and institutions to it. The results indicated that 24.5% of all practitioners providing removable prostheses to their patients include an identifying label as part of the service on some occasions. This included 19.9% of general dental practitioners, 25% of specialist prosthodontists, 57.1% of practitioners with training in forensic odontology, and 43.5% of clinical dental technicians. No practitioner labeled dentures routinely. Reasons cited for not labeling dentures included cost, lack of awareness of standards, and recommendations and a belief that it was of little importance.[35]

Denture labeling was evaluated in an Indian sample. The results are in contrast to European studies wherein the majority of patients agreed to denture marking, indicating patient background (e.g., education level) may affect perception to denture marking.[42]

### Methods of Denture Labeling

Regulatory bodies have recommended that all prostheses be marked with an identification system[40] and several techniques have been described to identify dentures.[43-54] Few methods enumerated for marking of dentures are presented in [Table 1].

### Identification of Dental Implants

Nonvisual identification of victims utilizes DNA, fingerprint, and dental comparison as primary scientific identifiers. In incidents where a victim has been incinerated, there may be loss of fingerprint detail and denaturing of DNA. Although extremely durable, tooth loss will also occur with extreme temperatures and the characteristics of recovered dental implants, if any, may be the only physical identifying data available.[55] The physical properties of high corrosion resistance, high structural strength, and high melting point, suggest the retention of intact implants following most physical assaults.[60]

Berketa et al.,[61] did a study to determine what changes occur following cremation to bone-supported dental implants placed within mandibles of sheep. A selection of dental implants was photographed and radiographed. They were then surgically placed in sheep mandibles and the entire sheep heads cremated in a commercial cremator. Following retrieval and reirradiating of the implants, image subtraction evaluation of the radiographs was recorded. Photography within the retrieved implants revealed the batch number within the Straumann™ implant was still visible, which could significantly add weight to the identification of deceased persons.

Berketa et al.[60] did a study to ascertain if the batch number was still identifiable following intense heat exposure in a furnace. The information regarding batch number was laser etched within the chamber of their implant. The result indicated that there was an intact identifiable batch number on removal of the abutment.
Table 1: Methods of denture labeling

| Method                        | Procedure                                                                 | Advantage/disadvantage                                                                 |
|-------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Engraving                     | A label-maker is used to prepare an embossed plastic pattern, which in turn is used to insert a marked metal plate in to a denture framework. The use of small tape makes it possible to include more than 6 letters on one lingual flange. | The technique is simple and facilitates incorporation of a stable and fireproof label in the denture base material |
| Scribing/disking              | Personal identification details were input into a computer where using an image editing software program the letters were reversed and printed on paper. Then, methyl methacrylate monomer was applied on the area of the specimen plate where the mark would be located. The paper with the mark was pressed on the specimen plate and the binder resin that adhered to the paper melted in the methyl methacrylate monomer on the denture surface. In this manner, identification details borne by the toner on the paper were transcribed to the surface of the denture. | The advantages of this method are large numbers of letters could be included in the personal identification label without space constraint; and mechanical strength of denture would not be adversely affected |
| Inclusion                     | Computer-printer denture microlabeling system                              | Advantages of this method are it is easy to use, cost-effective, the background of the label is clear and only the black images of the characters of the label can be clearly seen. It has minimal esthetic impact on the patient. Disadvantage is it cannot withstand fire |
| Placement of metallic, nonmetallic labels or microchips upon which the name and service number is inscribed on to the denture. Various methods of inclusion are present in literature | A micro label procedure uses a transparency film with name and other information of the patient incorporated onto it. Chemically treat printed transparency film with 100% cyanoacrylic acid esters adhesive solution before incorporating into a denture. Incorporate the label into the denture during the packing stage. The label can then be coated with a thin layer of autopolymerized clear acrylic resin. | Advantages of this method are it uses equipment readily available in any dental laboratory, not a time consuming process and easy to use. This technique can be used for both complete and removable partial dentures. Disadvantage of this technique arise when relining becomes necessary |
| Lenticular card                | It is 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. 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 then interlaced with one or more of the other images. These are printed on the back of a synthetic paper and laminated on the lens. | Advantage of this technique is, it is durable and waterproof. It also does not interfere with the oral function, because of its small size. The disadvantage of this technique is that the information can never be changed. The procedure can be used only after the denture is processed, as covering the lens surface with acrylic resin during denture processing will not allow the information to be seen clearly. It may not withstand a fire |
| Bar coding                    | Automatic identification using barcodes incorporated into dentures has been developed. Barcode systems can contain large amounts of data. However, the scanning of barcodes may be difficult due to the opacity of the acrylic resin, and for this reason the use of clear acrylic resin is recommended with this system. | The advantages of this method are large numbers of data can be stored. Disadvantage of this method is the curvature of the denture may cause distortion of the barcode, making it unreadable. Also, barcode technology may present practical obstacles for denture prostheses |
| Incorporation of microchips   | Radio Frequency Identification (RFID) is a method of identifying by using radio waves. 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. First, program the tag by connecting to the computer then incorporate the programmed tag into the channel on the external posterior buccal surface of the denture. Place clear acrylic resin over the tag to recountour the denture. | Advantages are it is esthetically acceptable, it does not interfere with oral function and its data can be modified at any time. Disadvantages are the tag is not fireproof and it is an expensive technique |
As the implants are machine made, they lack the individualization required for their use as identifiers of the deceased. If the companies constructing implants place individual serial numbers rather than batch numbers on these implants then the potential exists for a new approach to be established for the identification of the deceased.[60]

Conclusion

The unique nature of our dental anatomy and the placement of custom restorations ensure accuracy when the techniques are correctly employed. Forensic dentistry plays a major role in identification of those individuals who are not identified visually or by other means. Denture marking or labeling 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. The supervising authority on the health sector should make denture marking mandatory and as a prosthodontists, we request our colleagues, other dental specialist, and general dental practitioners that it is the professional and ethical duty of ours to do so.

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