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Review Article

Evolution of dental markers in the field of forensic odontology- A review article

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Abstract

Forensic dentistry is one of the advanced and reliable branches of dentistry which helps to identify victims in mass disasters and in many medico legal investigations with the help of identification markers in the prosthesis. This review article explains the various denture markers which can be used in the field of forensic odontology and also describes about the strengths and weaknesses of various methods involved in this field. The dental literature was searched via, Science Direct, Ebsco Host and Medline/Pub Med from 1933 to 2013. This article also describes the various methods which are less expensive and can be easily used as an identification tool during the time of need.

Keywords: Forensic identification, Denture Marking, Forensic Odontology, Position of denture markers, Denture identification, Denture labeling system.

1. Introduction

As we are in new millennium, society is faced with new challenges in every conceivable area especially crimes and murders. Despite leaps in modern technology and medical breakthroughs that the last century has brought, crime still persists in all aspects of our lives and many times with challenging scenario for the investigators. Violent and heinous activities that ruin the lives of victims occur every day. The apprehension and subsequent prosecution of the perpetrator is necessary to maintain law and order. Through the specialty of forensic odontology, dentistry contributes a small but many times significant role in this process. By identifying the victims of crime and disaster through dental records, dentists work hand in hand those involved in crime investigation. Always parts of a bigger team, such personnel are dedicated to the same principles of all those involved in forensic casework: the rights of the dead and those who survive them. Prosthodontists over a course of time, also contributing in today's era of forensic science by incorporating various identifying elements in the prosthesis.

Forensic odontology may have been founded during the Battle of Nancy in 1477, when the body of Charles the Bold was identified by his missing lower tooth [1], or in 1835, when a gold denture helped to identify Countess of Salisbury whose body got burned. In many cases, such as when victims are burned severely, traditional forensic techniques fail to provide conclusive means of identification.

Pathologic findings noted in dental records, treatments, and prosthetic devices may resist fires when identifying markings and DNA may not. Forensic dentistry depends on the ability to identify, collect, study and compare information from oro-facial structures .According to Keiser Nielsen (1970) forensic odontology can be defined as 'that branch of odontology which is related to the proper evaluation, interpretation and presentation of dental findings in the interests of justice'. It helps for victim identification in many different situation involving many different types and number of victims like in the Asian tsunami of 2004 which killed over 200,000 and their dental records contributed to nearly 85% of the identifications. [2]

2. History of forensic odontology

It's almost two thousand years that odontology is used in forensic evidence. It started with the story of Lollia Paulina, a Roman empress as the 3rd wife of Emperor Caligula.

The first person in the United States to use odontology to identify human remains was Paul Revere.

He has friend called Dr. Joseph Warren, who died at the Battle of Bunker Hill on June 17th 1775 during the Siege of Boston. During warfare soldiers weren't given ceremonial burials instead of that were used to bury in mass graves. Same was done with Dr. Joseph Warren. On March 17th 1776 following the departure of the British from Boston, Paul went to the battle field in which his friend took his last breath. He was able to identify his friend because he had placed a false tooth in his mouth and recognized the specific wire he used to fasten it.

In North America the criminal case of Wayne Clifford Boden was a famous story, which was named as "The Vampire Rapist" due to the fact that he used to bite the breasts of his victim's. He was caught by the help of forensic odonotological evidence. Wayne Clifford Boden was a serial killer and rapist in Canada between 1969 and 1971 before his conviction on February 16th, 1972.

3. Requirements of denture identification[3-5]

Few proposed requirements for dentures construction are:

a. The strength of the prosthesis must not be affected.
b. It must be easy and cost effective
c. The identification system must have high level of accuracy.
d. The marking must be durable with good visibility
e. The identification must resist all conditions like humidity and fire.
f. The identification mark should not hamper esthetics.
g. The identification mark should be biologically inert specially when used inside prosthesis
h. The marking should be permanent and withstand to everyday cleansing and disinfecting agents

4. Position of the Denture Marker

Sites like posterior part of acrylic dentures and metal-based dentures outlast because of the tongue. The most common possible area where the markers can be placed is

a) Along the posterior lingual flange,
b) Under the teeth for the mandibular dentures
c) Posterior buccal surface to tuberosity region and
d) Palate area in a maxillary denture.

Sufficient thickness and polished surface of denture is preferred but if esthetics is concerned, intaglio surface is the site of choice.

5. Classification of different types of denture labeling systems:

It can be broadly classified as: the surface marking method and the inclusion method.

5.1 Surface making method:

It's a very simple method of denture labeling. In dentures the two numbers or letters can engraved with a small round dental bur on the fitting surface of the maxillary complete denture and on the posterior flanges of mandibular denture.[6] The numbers or letters might signify relative things to the person like age if numbers or first letter represents the first name and second letter represent the last name or surname of the individuals. For example, if it is written 23 then it might represent his or her age, date or year. (Figure 1)

Figure 1: Surface marking method

Advantages:

a.) This technique is easy to operate and incorporate in denture.
b.) It is economical.

Disadvantages:

a) It caused entrapment of food debris and might hamper the cleanliness of the denture.

Embossing letters as denture markers

Embossed letters are made by scratching or engraving on the model before processing the denture. Patient's initial letters were written on the buccal surface of the disto-buccal flange. Disto buccal flange is chosen as a site for embossing as it is quite thick and esthetically area as it will covered by the muscles of check. This technique can be also used in partial dentures, while preparing a refractory cast from a casting mould material as explained by Matsumura & Shimoe in 2002.[7] The procedure for this is to type the letter to be embossed with a label- marker and attach the trimmed tape to the appropriate position on the framework wax pattern and finish casting. The marked plate will be visible through tissue-colour acrylic resin.

Advantages:

a.) This technique is economical.

Disadvantages:

a.) This technique has been associated with malignancy due to continuous irritation of tissues

5.2 Inclusion methods

5.2.1 Metal identification bands

In Sweden, dentures have been marked with a stainless steel metal band incorporated into the acrylic and containing the personal identification details of the patient

and incorporated to denture post or prefabrication.[8] Metallic markers have been significantly found to be the most durable form of marker in cases of severe conflagration. The Swedish ID-Band (SDI AB, Sweden) has become the international standard. Studies have shown that ID-Band is not resistant to very high temperatures [9]. Olsson *et al* tested three different types of steel bands (Jasch, Remanit, IDband) exposed to three different temperature levels of 1100, 1200 and 1300°C but at 1100°C only the ID-band and the Jasch band were readable but none of them could resist at temperature of 1200 and 1300°C. Thomas *et al* tested 24 ID-Band, Ho-Band (stainless steel matrix) and Titanium foil at 700 and 900°C. The performance of ID-Band and Ho-Band showed similar results, meaning that Ho-Band could be used as a cheaper alternative.

5.2.2 Computer-printer denture microlabeling system

Berry *et al* suggested a post fabrication technique for identification of prosthetic devices [10]. A special bur, designed at Loma Linda University School of Dentistry (LLU Ident bur, Brassler USA, Savannah, Ga.), is used to prepare an apt preparation site in the denture base. Most often this is located in the flattest portion of the lingual flange of the mandibular denture and/or the palatal part of the maxillary denture. It is important that the identification not be placed in a site that would be esthetically unacceptable or removed during post insertion adjustments or routine relining procedures. The identification label bearing the patient's name, initials, driver's license, or social security number is computer generated which make it easy-to read font style of 4 or 5 point size. Additional information, such as the date and/or name of the concern dentist or laboratory fabricating the denture, can be included if kept brief. The label is laser printed on a small piece of white tissue paper mostly square or rectangular shaped (the kind that comes in a gift box) that has been taped by the leading edge (as it is placed in the computer's manual feed tray) in the centre of a full sheet of scrap paper (such as the printer's test sheet). The excess length is removed from the printed label and the width is reduced to less than 4 mm.

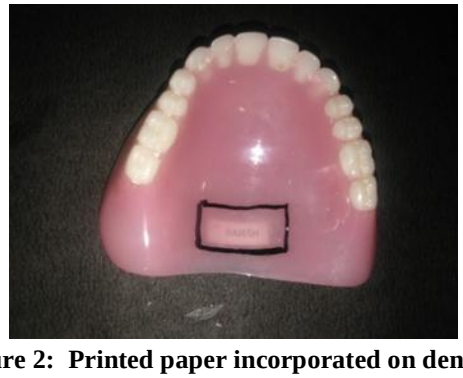

Figure 2: Printed paper incorporated on denture palate

Booi C. Ling suggested a computer-printer denture micro labeling [11]. Key a patient's personal identification information such as name, age, sex, national identification card number, and nationality into a computer using a character of 8-point font size. Check the information on the computer monitor for correctness. Print out this personal information using a bubble jet printer (Canon BJC-4200) or any plain paper printer Photocopy the printed information onto a photocopying grade transparency film (3M Transparency film PP 2500). Use the 50% reduction size, or maximum available reduction of the photocopying machine (Minolta EP 1080, Osaka, Japan). Chemically treat printed transparency film before incorporating into a denture (the monomer of the acrylic resin will smear the characters making it impossible for the label to be read) with 100% cyanoacrylic acid esters adhesive solution (Selleys Supa Glue, Selleys Chemical Company PTY Limited, Padstow, Australia). Add a drop of cyanoacrylic adhesive onto the transparency sheet near the label information. Spread it to cover the characters of the label. Let the label dry for 10 to 15 minutes, and then cut the label out to the appropriate size. Incorporate the label into the denture during the packing stage using the wax-spacer packing technique.

Alternatively, the label can be incorporated after the denture is processed by cutting a depression of approximately 1 mm deep, slightly wider than the size of the label. The label can then be coated with a thin layer of auto polymerized clear acrylic resin and placed in the depression. The denture is then trimmed and polished after the resin was cured.

5.2.3 Lead paper label and radiograph

Mona Sayed *et al* described using a lead foil paper found in the intra-oral x-ray film to type the patient's data with a manual ribbon typewriter. During the trial closure stage re-open the flask, incorporate the identification label. Alternatively, the label can be incorporated after the denture is processed by cutting a depression then be filled with light cured acrylic resin of the same colour. When a periapical radiograph is taken of the denture, the patient's details would appear clearly in it. (Figure 3)

Figure 3: Lead Paper labelling

Photograph

In this method, patient's photograph embedded in clear acrylic denture base as a marker is particularly useful in the countries with low literacy rate where a photograph is the easiest and convenient method of identification [12, 13]. However, thermal tests proved that the photographic marker and bar code were not resistant beyond 200–300°C. (Figure 4a and b)

Figure 4: Photographs embedded in denture

Advantages

a.) This method is particularly useful in the countries with low literacy rate where a photograph is the easiest method of identification

b.) This method is also useful in countries with diverse scripts.

5.2.4 Palatal rugae as identification

Crime branches with the assistance of dentist are able to identify the individuals based on the rugae pattern [14]. It has been found that rugae pattern vary among individuals but a similar among families.[15,16] When other methods might be difficult in identifying the victim, rugae patterns might be a useful marker.

5.2.5 Lenticular card method

In this technique a lenticular lens is used to produce desired images with an illusion of depth, morph, or the ability to change or move as the image is viewed from different angles.

Advantages

a.) Lenticular printing is a simple, cheap and quick method.

b.) This method can store a huge amount of information.

c.) The labels showed no sign of fading or deterioration.

d.) The lenticular card stores the concern patient's information in two or more images that can be viewed by changing the angle of view.

The possible disadvantages of this technique are that information can never be changed, and may not withstand a fire.

5.2.6 Denture bar coding:

A bar code is applicable to dentures having machine-readable code of a series of bars and spaces printed in defined ratios.[17] Bar codes are used in different fields of science to carry much information in the form of bar codes in a microchip. The sensor identifies the data and displays in the monitor of the system. This capability of the microchip in carrying any information is successfully used in the field of forensic odontology in the dentures to identify people and dentures. A monotonous technique described denture bar coding to printing a number code on paper, photographing the paper, making and transferring the negative replica to a piece of silk. An image of the bar code appeared on a prepared faience, by a machine that forced the paint through the silk, when heated to 860°C for 30 min in an industrial porcelain oven. 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. Barcoding is technique sensitive but it provides exact information.

Rajendran *et al*[18] in 2012 devised a innovative technique by incorporating mobile micro SD card as the microchip to carry information in the dentures. A memory card is an electronic data storage device designed for storing a large number of data files, such as audio, video clips, images, text documents of various formats. It is very small in size, erasable, re-recordable and it can retain data without any need of source of power or energy. There is enormous number of memory cards available in the market of variable sizes and storage capacities by different brand. A recess was made in the palatal in the maxillary denture's external surface on the palatal aspect with a carbide bur. The micro sd card was loaded with patient information and then nicely wrapped by a cellophane sheet avoiding thickness. It was placed on the recess and cured with self-cure auto polymerizing resin. (Figure 5)

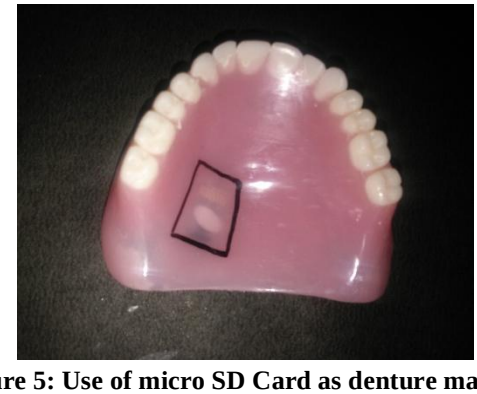

Figure 5: Use of micro SD Card as denture marker.

Advantages

a.) Denture bar coding can be used with crown and bridge restorations and can survive temperatures above 600°C, which can be compared during plane crashes.

b.) Denture bar coding gives exact information in every situation regardless of the extreme condition it might have faced in which fire or water also might have been involved.

c) Denture bar coding is easy to perform and not very expensive.

Disadvantages

a) bar coding needs costly equipment to read.

5.2.7 T bar method

A T-shaped clear PMMA resin bar is constructed by the help of base plate wax, which is cut processed and finished in clear PMMA.[19] A printed label (reduced in size, print-face inward) against the flat section of the bar is fixed for identification. Its surface is polished to produce a clear window displaying the ID label. The person name or other information is typed and the size of the name is reduced to half of the original size. A clear acrylic T shaped bar was cut slightly longer than the printed name. The name will be attached to the smooth surface of the T-bar and the opposite side will serve as a handle. A channel was cut on the external surface of the denture base to a depth of 1.5mm. Printed name was cut and left is facing on the working surface. Smooth surface of the T bar and the printed surface of name strip will be coated with a layer of light cured resin bonding agent. Wet surface of the T-bar was pressed on the wet printed side of the name strip. The wet surfaces allow the label to adhere to the T-bar and the paper is kept flat for proper contact, T bar along with the label was picked and another layer of bonding agent was placed on the back side of the label and the exposed edges of the T-bar. Assembly was cured and acrylic was flowed on the recessed area on the denture base and the name plate was seated. Resin was cured by light, trimmed and contoured along with the denture surface and polished. It also provides an exceptionally clear view of the embedded label.

5.2.8 Laser etching

Specially equipped and hi tech laboratories can provide a copper vapour laser (CVL) that can fetch a patient's identification into the metal surface of a partial denture easily, legibly and reduce the font size of the data by a CVL beam focused and delivered to the material surface by the dual axis scanner mounted with mirrors and a personal computer controls the movement of the scanner and the firing of the CVL. As the method requires specialized equipment it is very expensive and require experienced technicians to perform.

5.2.9 Radiofrequency identification tags (RFID)

In 1940 RFID technology was introduced, during World War II, and used to identify and locate aero planes belonging to the Royal Air Force. During the 1980's and 1990's, with the production of low cost tags due the advancing technology, the interest in RFID was renewed.[20-23] It forms part of a technology so called "automatic identification and data capture" and is used to recognize, locate and track people, animals and property. A serial number that identifies a person, animal, or object is incorporated in a microchip with an antenna attached to it. The antenna and chip together are called an RFID-tag or transponder. The antenna facilitates the chip to transmit the serial number, or any other required information to a reader. The reader converts the radio waves into digital information which was reflected back from the RFID-tag and then passed to a computer with applications to interpret it. There are 'passive' tags, so called because the power for reading the information on the chip is dependent on the information sent from the reader. 'Active' tags on the other hand, carry their own power supply enabling them to communicate between tag and reader, thus increasing the potential for detection of the signal.

Another feature of RFID-tags is to perform read/write function. There are 'read only' and 'read/writable' chips, to which new data can be transmitted. Tags come in various forms and dimensions, and can be adapted to specific applications as per as requirement. Every transponder has a fixed unique identification number, allowing individual tags to be identified within a group. Many of the physical properties of RFID-systems and their biological influence depend on the frequency used to transmit the data. Only low frequencies, 125 - 134 KHz, are advisable and mostly used. In three samples of complete upper dentures, small RFID-tag was incorporated. Their small size (8.5×2.2 mm) and ability to store the large amount of denture user data make them ideal to use in dentures. RFID system consisted of a data carrier, or tag, and an electronic operated reader that energizes the transponder by means of an electromagnetic field emitted through the reader's antenna. It then receives the coded signal returned by the transponder and converts it into readable data. No special training is required to set the tag in the denture of the patient. The chip remains intact and readable in extreme temperatures even below 0º temperature and after burning for 1 hour at 1500°C.Unfortunately, due to its high cost of manufacturing, RFIDs are not widely used and the setup might not available in most dental practises to read the information.

6. Conclusion

During natural calamities, accidents, fire burn causes extensive destruction of life and body, resulting in a chaos among people. Identification of lost life especially whose body is badly damaged is a matter of challenge among investigators and relatives. Many times even it is difficult to identify the body due to severe damage. But with years of research and knowledge, forensic odontology has given its persistent contribution towards such cases with excellent results. Not only this, incorporation of these elements has helped in old age homes and other patients in hospitals to keep the denture safe. All the various method enlisted in this review articles can be an aid to dentist in making a denture unique and subjective, providing a easy means for identification in the field of forensic odontology.

References

[1] Humble B. H. Identification by means of teeth. *Br Dent J* 1933: 54; 528.

[2] Harvey W. Identify by teeth and the markings of dentures. *Br Dent J* 1965:121; 334.

[3] MacEntee MI, Campbell T. Personal identification using dental prostheses. *J Prosthet Dent* 1979:41: 4; 377-380.

[4] Kruger-Monson, A.: Marking au plateproteser for identifikasjon. *Nor Tannlaegeforen Tid* 72:226, 1962.

[5] Turner CH, Fletcher AM, Ritchie GM. Denture marking and human identification. *Br Dent J* 1976; 141:114- 117.

[6] Michael G. Reeson; A simple and inexpensive inclusion technique for denture identification. *J Prosthet Dent* 2001; 86:441-2.

[7] Matsumura H, Shimoe S. Incorporation of a cast, embossed identification plate into a partial denture framework. *J Prosthet Dent* 2002; 88:215-7.

[8] Stevenson RB: Marking dentures for identification. *J Prosthet Dent*, 1987; 58(2): 255.

[9] Ch. Stavrianos, I. Stavrianou, P. Kafas; Denture identification system based on Swedish guidelines: A Forensic Aspect. *The Internet Journal of Forensic Science* 2008; 3(1).

[10] Berry FA, Logan GI, Plata R, Riegel R.A post fabrication technique for identification of prosthetic devices. *J Prosthet Dent*, 1995; 73(4): 341-343.

[11] Ling BC: Computer-printer denture microlabeling system. *J Prosthet Dent*, 1998; 79(3):363-364.

[12] Anehosur GV, Acharya AB, Nadiger RK. Usefulness of patient photograph as a marker for identifying denture-wearers in India. *Gerodontology* 2010; 27(4):272-7.

[13] Kamble VB, Desai RG, Arabbi KC, Dhopare SP. Use of photograph and memory card for identification of edentulous individual: An innovative technique. *Indian Journal of Dentistry* 2013; 4:72-6.

[14] Rajguru J, Somayaji NS, Babu NA, Masthan KMK, Khare P. Study of Palatal Rugae Pattern (Rugoscopy) in Chennai Population. *Indian J Forensic Odontol* 2012; 5: 3:93-96.

[15] Bali SK, Naqash TA, Abdullah S, Mir S, Nazir S, Yaqoob A. Denture Identification Methods: A Review. *International Journal of Health Sciences & Research* 2013;3(4):100-4

[16] Datta P, Sood S. The various methods and benefits of denture labeling. *J Forensic Dent Sci* 2010; 2(2):53-8.

[17] Agülolu S, Zortuk M, Beydemi K. Denture barcoding: A new horizon. *Br Dent J* 2009; 206:589-90.

[18] Venkateshwaran Rajendran, Suma Karthigeyan, Surendra Manoharan, Denture marker using a two dimensional bar code. *J Prosthet Dent* 2012; 107:207-208.

[19] Ryan LD, Keller JB, Rogers DE, Schaeffer L. Clear acrylic resin T-bar used in denture identification. *J Prosthet Dent* 1993; 70:189-90.

[20] Richmond R, Pretty IA. Contemporary methods of labeling dental prostheses-A review of the literature. *J Forensic Sci* 2006; 51:1120-6.

[21] Carlos Madrid, Tové Korsvold, Aline Rochat, Marcelo Abarca; Radio frequency identification (RFID) of dentures in long-term care facilities. *J Prosthet Dent* 2012; 107:199-202.

[22] Richmond R, Pretty IA. The use of radiofrequency identification tags for labeling dentures-scanning properties. *J Forensic Sci* 2009; 54:664-8.

[23] Millet C, Jeannin C. Incorporation of microchips to facilitate denture identification by radio frequency tagging. *J Prosthet Dent* 2004; 92(6): 588-590.