## Review Article

# Dentures in Forensic Identification- A Review of Methods & Benefits

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**Abstract**

Forensic dentistry is one of the most innovative branches of dentistry which helps identify victims in mass disasters and in many medico legal investigations. This review article explain the role of a Prosthodontist in forensic odontology and reviews the strengths and weaknesses of various methods involved in labeling dentures. The dental literature was searched via, Science Direct, Ebsco Host and Medline/PubMed from 1979 to 2012 using various combinations of the following terms: Forensic identification, Denture Labeling, Denture Marking, Forensic Odontology, Palatine Rugae. All the available full text articles including reviews, case reports, original research were selected and abstracts were excluded. The article classifies the different methods also summarizes the importance denture labeling to ensure that students, dentists and dental technologists are exposed to denture marking methodologies to provide labeled denture which is simple, durable, inexpensive & esthetically pleasing.

**Key words:** Forensic identification, Denture Labeling, Denture Marking, Forensic Odontology, Palatine Rugae.

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## Introduction

Forensic odontology may have been born at the Battle of Nancy in 1477, when the body of Charles the Bold was identified by the absence of a lower tooth, [1] or in 1835, when a gold denture helped identify the burned body of the Countess of Salisbury.[2] In many instances, such as when victims are severely burned, traditional forensic techniques do not provide conclusive means of identification. Pathologic conditions noted in dental records, treatments, and prosthetic devices may survive fires when identifying markings and DNA may not. [3] Forensic dentistry relies on the ability to identify, collect, study and compare information from oral and facial structures.[4,5] Forensic odontology is an ancient branch of forensic science which has been also defined by Keiser Nielsen (1970) as 'that branch of odontology which is concerned with the proper evaluation, interpretation and presentation of dental findings in the interests of justice'.[6] It provides for victim

identification in many different scenarios involving many different types and number of victims like in the Asian tsunami of 2004 which involved over 200,000 dead and injured persons were dental records contributed to nearly 85% of the identifications.[7,8] Traditionally, overlays[5] have been used in many disaster situations, even before the 1980s and have given way to computerized matching software.[9,10,11]

**Rationale of forensic dentures**

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.[3] Information beyond the description of dentition can be used in the forensic odontology field, such as labeled dental prostheses which are critical in identification purposes after major mass disasters whether natural, accidental, or intentional like fire accidents, floods, tsunami, earthquakes, communal violence, plain crashes etc.[5,13,14] Denture labeling also avoid the confusion of mixing of dentures in geriatric institutions, mental institutions and in cases of hospitalized unconscious patients were dentures maintained by care takers.[14] Apart from that dental laboratories are also an area of concern were large number of prosthesis reaches for repair and are also fabricated.[5,14] Dentures labeling also can be useful to find out the correct mold and shade of teeth for the replacement of broken denture teeth by incorporating those details in the denture.[15] Hence the purposes of the denture marking thereby not only assist in return of lost denture, but also it facilitates the identification of edentulous persons who are either living or deceased.[14,17]

**Requirements for ideal markings**

The standard requirements for denture markers as outlined by the British Council on Prosthetic Services and Dental laboratory Relations are the following:[13,15] The strength of the prosthesis must not be jeopardized; It must be easy and inexpensive to apply; The identification system must be efficient; The marking must be visible and durable; The identification must withstand humidity and fire; The identification mark should be aesthetically acceptable; The identification mark should be biologically inert (when incorporated into the denture). [13,14]In addition, the marking should be permanent and resistant to everyday cleansing, and withstand the cleansing and disinfecting agents.[14] Radiopacity of the identification label should also be added to this list.[13]

**Classification for different types of denture labeling systems**

Over the years, 2 methods of denture marking have been proposed: the surface marking method and the inclusion method. [14] (Figure-1) In the inclusion method, the marks are enclosed in the denture. The mark should be placed in a part of the denture without affecting the resistance of the denture, it will not be visible when the patient wears them, and it will be relatively protected in case of a fire. Therefore, the posterior regions of the lingual flange and palate are recommended. The surface method is easy to apply and relatively inexpensive and simple, but they wear off very easily.[14]

**SURFACE METHODS**

**Scribing or engraving the denture**

This is the simplest way of marking dentures the two letters were engraved with a small round dental bur on the fitting surface of the maxillary complete denture, which resulted in countersunk letters. The first letter (K) is the initial letter of the name and the second letter (X) is the initial letter of the surname.[14] (Figure 2)

**Figure- 1:** Classification for denture labeling systems

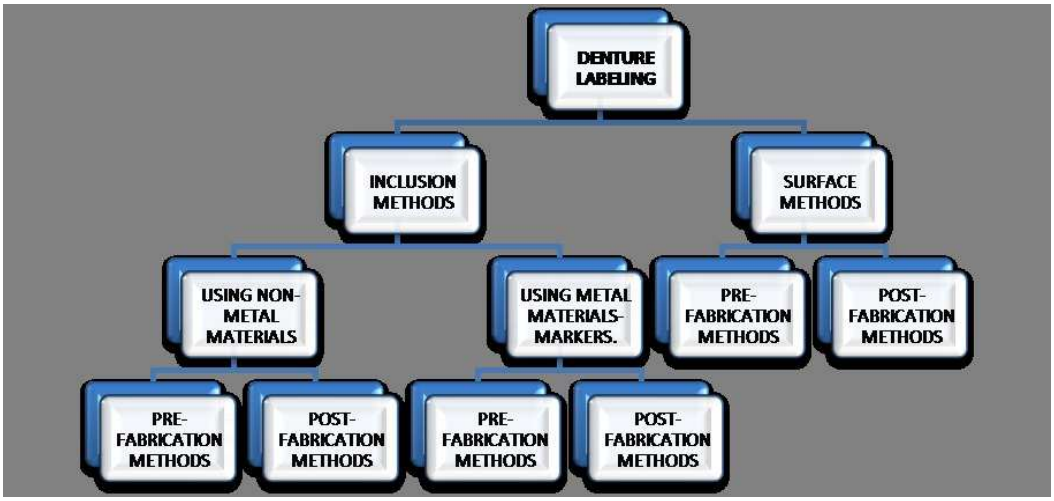


**Figure 2:** A removable complete maxillary denture. The initials of the owner are engraved

**Marking with embossed letters**

Embossed letters are made by scratching or engraving on the model before processing. His initial letters were written on the buccal surface of the disto-buccal flange. This technique can be also used in partial dentures, while preparing a refractory cast from a casting mold material as explained by Matsumura & Shimoe in 2002. Type the identification letters on embossing tape with a manual label-maker and attach the trimmed tape to the appropriate position on the framework wax pattern and finish casting. The marked plate which will be visible through tissue-colored acrylic denture base resin of the prosthesis.[10] (Fig. 3 A,B,C)

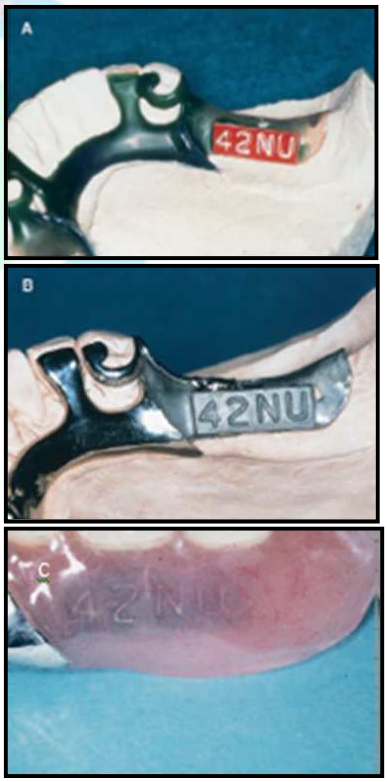


**Figure 3:** A, Piece of embossed plastic tape applied to wax pattern for partial denture framework. B, Cast framework of partial denture made from Ti-6Al-7Nb alloy. C, Marked plate is visible through tissue-colored acrylic denture base.

**Writing on the denture surface**

Stevenson in 1987 suggested the use of tape wrapped disposable blade to cut the patient's name or social security number in straight lines on buccal surface of the distobuccal flange & then rubbing lead pencil or ink pen over fine grooves to make them more evident. It would require frequent remarking, possibly every 3 to 4 weeks & would be the method of choice only for short-term hospitalized patients[19] whereas Heath et al (1988) mentioned a technique in which the roughened surface of a finished denture could be temporarily marked with a fiber-tip pen & these marks could be protected against abrasion with layers of sealant.[20] (Figure 4)

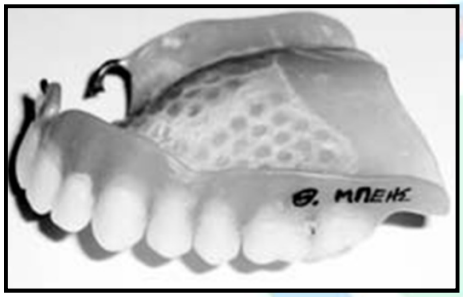

**Figure 4:** Patient's initial letter of the name and the surname is written in felt marker on the buccal surface of the disto-buccal flange.

**INCLUSION METHODS**

**Metal identification bands.**

Dentures have been marked in Sweden with a stainless steel metal band incorporated into the acrylic and containing the personal ID of the patient and incorporated to denture post or pre-fabrication. Metallic markers have been found to be the most durable form of marker in cases of severe conflagration. [21] 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 [22,23] like Olsson et al'[24] tested three different types of steel bands (Jasch, Remanit, ID-band) exposed to 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 at 1200 and 1300 ° C. Thomas et al [24] tested ID-Band, Ho-Band (stainless steel matrix) and Titanium foil at 700 and 900 ° C. The performance of ID-Band and Ho-Band was similar, meaning that Ho-Band could be used as a cheaper alternative.[25,26] (Figure 5)

**Figure 5:** Metal ID band placed posteriolaterally in maxillary denture

**Computer-printed denture microlabeling system**

Berry et al (1995) suggested a post-fabrication technique for identification of prosthetic devices. The identification label bearing the patient's details was computer generated and placed in slot in the denture followed by saturated clear resin polymer applier to seal it & cured in a pressure pot.[27]


**Figure 6:** Maxillary complete denture with printed label incorporated with packing of denture

Similarly Ling (1998) suggested a computer-printer denture microlabelling system in which Patient's details was computer printed & then photocopied onto a transparency sheet in 50% reduced size. After treating with cyanoacrylate acid esters adhesive solution the microlabel was then incorporated into the denture during the packing stage. [28,29] (Figure 6)

**Lead paper label and radiograph**

Mona Sayed et al (2009) explained using a lead foil paper found in the intra-oral x-ray film to type the patient's data with any 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 covered with light cured acrylic resin of the same color. When a periapical radiograph is taken of the denture, the patient's details would appear clearly in it.[30] (Figure 7)


**Figure 7:** Placement of lead foil label during trial closure and resultant x-ray view of denture

**Photograph**

The use of the patient's photograph embedded in clear acrylic denture base[31] as a marker is particularly useful in the countries with low literacy rate where a photograph is the easiest method of identification. However, thermal tests revealed that the photographic marker and bar code were not resistant beyond 200–300°C. [31]

**Denture Bar coding**

A bar code applicable to dentures consists of a machine readable code of a series of bars and spaces printed in defined ratios.[32] A tedious technique described denture bar coding to printing a number code on paper, photographing the paper, making and transferring the negative 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.[33] Barcoding is technique sensitive but it provides exact information.[17] (Figure 8)

**Figure 8:** Barcode strip placed within the processed maxillary denture

Rajendran et al in 2012 devised a comparatively simple 2-D bar-code technique with patient's details such as name, and social security number using a code generator. Print and laminate the 2-D

bar code label and incorporate the bar code in the denture with clear acrylic resin. To decode it hold a code decoder-enabled mobile camera and is translated into text on the mobile phone display easlily.[34] (Figure 9 A,B,C)

**Figure 9:** A, 2-D bar code incorporated into denture; B, Phone used to decode bar code; C, Information decoded

**T-Bar**

Ryan et al 1993 introduced a T-shaped clear PMMA resin bar which is constructed in clear PMMA and identification printed label (reduced in size, print-face inward) made against the flat section of the bar, apply bonding agent & cure it. Reduce the thickness of the block to to place in to the groove made in the denture. It is then surface polished to produce a clear window displaying the ID label. This procedure is easy, inexpensive and time-effective.[35] (Figure 10 A,B,)

**Laser etching**

Specially equipped laboratories can provide a copper vapor laser (CVL) that can etch 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 two 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.[17]

**Figure 10:** A, Schematic drawing of T-bar assembly seated in a denture base. B, Completed denture with identification inserted

**Lenticular system**

Lenticular printing introduced by Colvenkar in 2010 is a simple, cheap and quick method in which a lenticular lens is used to produce images with an illusion of depth, morph, or the ability to change or move as the image is viewed from different angles. Lenticular technology allows images to be printed on the back of a synthetic paper and laminated on the lens. It does not require special glass or device to read the data, like computer or handheld reader. The possible disadvantages of this technique are that information can never be changed, and may not withstand a fire.[36] (Figure 11)


**Figure 11:** Maxillary complete denture with lenticular card having patient details

**Radiofrequency identification tags (RFID)**

The inclusion of radio-frequency identification (RFID)- tags within dentures is a cosmetic, effective labeling method

permitting rapid and reliable identification of the wearer. They are preferred because of their small size (8.5×2.2 mm) and the large amount of denture user data that can be stored in them. RFID system consisted of a data carrier, or tag, and an electronic handheld reader that energizes the transponder by means of an electromagnetic field emitted via 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. The chip remains intact and readable in sub-zero temperature as well as after burning for 1 hr at 1500°C.Unfortunately, RFIDs are not widely used due to the high cost of manufacture and data incorporation and may not be available in most dental set-ups.[37-40](Figure 12)

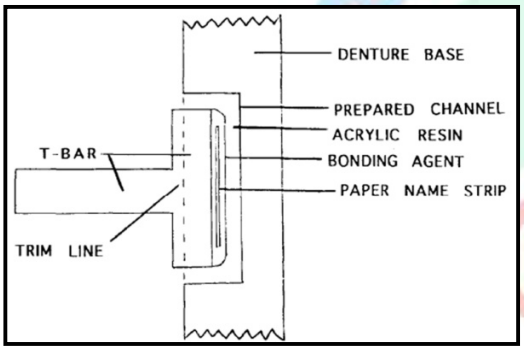


**Figure 12:** A, Read/write RFID tag, hand-held reader, and maxillary denture; B, Verification of data transmission between tag and reader

## OTHERS

### Palatine Rugae pattern of denture

According to English et al (1988) study, palatal rugae patterns are sufficiently characteristic to discriminate between individuals.[41] Its characteristic did not change as a result of growth & remain stable from the time of development until mucosa is degenerated by death. Sharma, et al (2009) study showed that palatal rugae and lip prints are unique to an individual and can be identified by palatoscopy methods like Intraoral inspection, Study of models, Calcorrugoscopy or overlay print, Stereoscopy, sterophotogrammetry.[42,43] 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). Wheras Thomas & Kotze have further detailed various patterns of primary rugae – branched, unified, cross linked, annular & papillary.[42, 44]

## Discussion

In large scale disasters, associated with fire, the damage caused by heat could make medico-legal identification of human remains difficult. Therefore, the role of forensic odontology can be crucial. As teeth, restorations and dental prostheses are quite resistant to high temperatures, they could be used as aids in the identification process.[45]

Denture marking or labeling is not a new concept in either prosthetic or forensic odontology, and forensic odontologists have proposed its routine international practice for many years. Over the years, 2 methods of denture e marking have been proposed: the surface marking method and the inclusion method. The inclusion method can be divided in 2 categories: a) inclusion method using non-metal materials and b) inclusion method using metal materials-markers. The surface method is easy to apply and relatively inexpensive. Skilled personnel are not necessary, but they wear off very easily and should be reapplied.[14]

The inclusion method is permanent and provides a more predictable result, but it could weaken the structure and create porosity. It is more expensive and is usually made by trained personnel in dental laboratories, or it can be done in a

dental office with relatively basic lab equipment.[20,46]

Since there is no international consensus regarding the marking materials, the need for new more persistent materials is obvious. There are many proposals about the use of microchips and radio-frequency identification (RFID)- tags for marking dentures. They have small size; they could include a lot of information (full name of the patient, sex, country of origin, ID number, etc). The data can be detected with the aid of a reading device. Their disadvantage is the high cost of manufacture and data incorporation. At the same time they arise a number of ethical dilemmas.[47,48]

**Conclusions**

The major reasons for not marking dentures are cost, lack of awareness of the various methods and a belief that it is of little importance. Needless to say, that the value of labeling dentures is immense when a positive identity of an individual is required. This has been stressed by forensic odontologists worldwide. Hence, dental education is required to ensure that both student dentists and student dental technologists and dentists are exposed to denture marking methodologies for providing esthetically suitable and efficient denture marking system that is also inexpensive, simple and permanent.

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