

Evaluation of the efficacy of titanium plates as denture markers under various heat sources and pressure - An *in vitro* study

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Abstract

Introduction: Denture Markers are used as one of the main identifying aid in mass disasters. Dental description of missing person in mass disasters plays a vital role in forensic research. Difficulties arise when the teeth are missing. In such situation the prosthodontic identification (ID) of replaced teeth becomes the priority. Till recently, there was no development of denture marker that could withstand massive fire accidents. **Aim:** To determine the use of titanium chips with identity code engraved on it as denture markers that could withstand high temperature and pressure. **Materials and Methods:** Wax patterns were fabricated with identity code moulded on a rubber stamp. It was invested and casted with titanium. Titanium chips were inserted into the polymethylmethacrylate (PMMA) block and subjected to various heat treatments. **Results:** There was no loss of identity when subjected to 1,500°C overnight but only residues left under pressure of 200 kg/cm³. **Conclusion:** The literature recommends the metallic denture markers in order to withstand the post mortem assaults. Titanium denture markers could be a preferred option as it can withstand high temperatures under pressure also.


Key words: Denture markers, forensic odontology, personal identification, titanium

Introduction

'Everyone has a right to recognition everywhere as a person'.^[1] Following major disasters such as earthquakes, fires, or floods; a definitive and early identification (ID) of the dead and injured becomes of the utmost importance. Often this ID must be accomplished via some form of forensic dentistry.^[2] Determination of the various individual physical and genetic characteristics of the human dentition has proved to be very efficient in aiding

the task of ID.^[3,4] Edentulous subjects, on the other hand, have lost all or most of the key features that have proven valuable in such cases, hence the process of ID is made much more difficult unless the victims wear ID marked dentures.^[3] ID of badly mutilated bodies, or bodies burned beyond all recognition, can usually be made if labeled dentures are present. The dentures generally remain undamaged owing to the protection afforded them by the soft tissues of the oral cavity.^[5] An ideal denture marking should fulfill all of the following criteria.^[6,7]

- 1) The mark carried by the denture must be capable of yielding positive ID.
- 2) The technique must be easy and quick to carry out and cheap to introduce.
- 3) It should, ideally, be fire resistant, and if it is not, it must be placed palatally or lingually in the molar region, so that the tongue can protect it.
- 4) The marking method should not affect the durability of the denture base material.
- 5) It should be cosmetically acceptable to the patient, and as unobtrusive as

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possible. Over the years, various denture marking systems have been reported in the literature and have been divided broadly into “surface marking” and “inclusion methods”.^[8] The inclusion technique involves the use of papers, metal bands, radio frequency ID (RFID) tags, barcoded silicone and ceramic chips.^[9] Lose was the first to use the inclusion technique, he used “onion skin paper” on the fitting surface of the denture.^[5] The purpose of this study was to evaluate a denture marking system that is inert, biocompatible, and withstand temperatures of massive fire disasters.

Materials and Methods

This study was carried out using titanium chips with identity code engraved on it.

Fabrication of the mould

To make the titanium chips, a rubber stamp [Figure 1] was made with numbers moulded on it. A putty impression of the rubber mould was made and inlay wax melted and poured into it. The wax patterns were invested and casted in titanium (Hangzhou Kaile Dental Material Manufacturer Ltd., China) [Figure 2]. The titanium chips were then trimmed finished and polished [Figure 3].

Incorporation of titanium chips into acrylic

A rectangular wax pattern of 15 × 10 × 5 mm and a thickness

of 0.5 mm was made, flaked, dewaxed, and packed with a layer of clear heat polymerized denture base resin; and the titanium chip was placed in between and again packed with a layer of clear acrylic resin [Figure 4]. The acrylicized chip was about 1 mm thick.

Evaluation of the sample

A total number of 40 samples were made and divided into four groups ($n = 10$) [Table 1].

First a radiovisiography (RVG) was taken before subjecting the sample to temperature [Figure 5]. Then it was subjected to high temperatures.

Results

Since there was no mathematical measurement, statistical analysis was not possible. The results showed that, in Group I,

Table 1: Sample distribution and heat treatment

Group ($n=10$)	Heat treatment
I	At 1,500°C overnight in an electric furnace
II	In an induction casting machine with maximum temperature of 1,500°C
III	Directly under oxyacetylene flame without pressure at about 1,500°C
IV	Directly under oxyacetylene flame with pressure of 200 kg/cm ³ at about 1,500°C



Figure 1: Rubber stamp with identity code

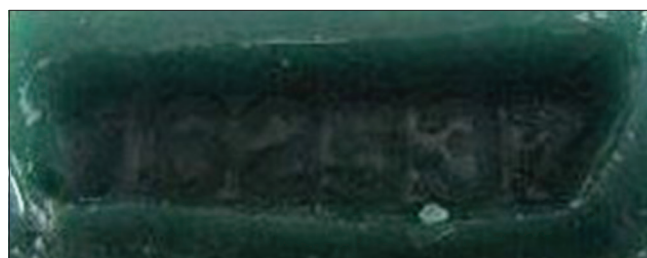


Figure 2: Wax pattern



Figure 3: Titanium plates with identity code



Figure 4: Titanium plates inserted in denture base resin



Figure 5: Radiovisiography prior to heat treatment



Figure 6: Radiovisiography after heat treatment

at 1,500°C overnight in an electrical furnace, there was no loss of identity code. In Groups II and III also there was no loss of marking after heat treatment. Group IV showed significant loss of identity under oxyacetylene flame with maximum temperature of 1,500°C and pressure of about 200 kg/cm³. There was only residue left. The observation of Groups I, II, and III was confirmed with RVG which showed that there was no loss of identity. But, under pressure there was only residue present [Figure 6]. Results are tabulated.

Discussion

Haines^[10] reported that among 380 air disaster victims, there were 97 dentures and only seven were marked. In another report by the same author^[11] citing the Rijeka air disaster, five edentulous victims remained unidentified owing to an absence of markings on their dentures. The author also stated that while dentistry contributed to ID in 58% of the victims, this would have increased to 85% had all of the victims' dentures been identifiable. Such cases present cogent evidence in support of the argument for the need for some form of denture ID mark, not only for humanitarian and legal purposes but also to minimize the cost of ID.^[12,13] There are those that would argue that some of the methods of denture ID may prove too expensive to be commercially viable, however, it could also be argued that the expenditure incurred in placing denture ID markers is extremely low compared with the cost of replacing a lost denture or the loss of quality of life associated with being dentureless.^[14] Though there are advanced techniques like laser etching, the equipments required for such procedures are not easily available in the dental setup. Hence, insertion of casted metal chips would be an effective alternative. The engraving of universal identity code rather than name would provide the accurate details of the individual without confusion.

Titanium is called the "space age metal";^[15] it has a low density and is a strong, lustrous, corrosion resistant (including seawater, aquaregia, and chlorine) transition metal with a

silver color. The two most useful properties of the metal form are corrosion resistance and the highest strength-to-weight ratio of any metal.^[16] In its unalloyed condition, titanium is as strong as some steels, but 45% lighter. The relatively high melting point (more than 1,650°C or 3,000°F)^[17] makes it useful as a refractory metal. It is paramagnetic and has fairly low electrical and thermal conductivity.

Kamath and Kamath^[18] used a method of engraving on porcelain fixed partial dentures on the lingual side of the crowns and high lightened it with stains. In the recent years, digital imaging is used as a major decisive identifier. Forensic dentists form their opinions on the basis of direct superimposition of questioned (Q, a bite mark or postmortem X-ray) and a known sample (K, a suspect's teeth or antemortem dental X-ray). Hence, photographic accuracy and dimensional control of images are very important, demanding rigorous attention to scale dimensions and the detection of photographic distortion. Dental comparison techniques used are similar to the physical comparison of Q and K evidence in fingerprint, ballistics, and tool mark studies.^[19] Other dental appliances, such as removable orthodontic braces have also been used for ID purposes. Whittaker describes a case where a removable orthodontic appliance was used to identify a victim of a house fire.^[20] Authors have also described the use of palatal rugae patterns rendered on dental casts to compare with found remains. Positive IDs have resulted from this technique.^[21] Julian and Rajan have incorporated microchips into the denture.^[22] Most recently, Colvenker has used the lenticular card as the ID method into the dentures.^[23] Till recently there was no definitive ID system established for massive fire disasters. Titanium chips with unique ID number will give all the information of the individual and is the only method of ID that could withstand high temperatures in fire accidents. In all the massive fire accidents reported overtime, there was a drop in pressure rather than pressure build-up. This is the most cost effective method of ID compared to the other recent techniques.

Conclusion

The temperature of a process plant fire and the tunnel fire^[24] does not exceed beyond 1,000°C.

Jet flames can give rise to temperatures more than 1,000°C, but not above 1,500°C. Hence, titanium, an element with high melting temperature could be an ideal method of denture marking with no biological hazard.

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