A NEW METHOD OF MARKING DENTURES USING MICROCHIPS

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ABSTRACT

Over the years various methods of denture marking have been reported in the literature. They include surface marking and inclusion techniques using metallic or non-metallic materials, microchips and microlabels. The microchips are preferred because of their small size and aesthetic acceptability. They are not however widely used due to the high cost of manufacture and data incorporation. This article details the procedures involved in inscribing a microchip using the photochemical etching process used in the electronics industry. The resulting microchip was cosmetically appealing, cost effective and was able to satisfy all the forensic requirements for a suitable denture marker.
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Keywords: Denture marking, Microchips, Photochemical etching

INTRODUCTION

A person must be identified in the event of death or loss of memory. Dental identification plays a major role in this process as the teeth and restorations often outlast all other body tissues after death.[1,2] When the teeth are lost however this becomes impossible and it is important that any prosthesis such an edentulous individual may be wearing be marked.

Over the years various denture marking systems have been reported in the literature and have been broadly divided into surface marking and inclusion methods. The surface marking methods include engraving the casts, scribing the denture or writing on the denture surface[3,4,5] while the inclusion methods involve incorporation of metallic or non-metallic labels or microchips into dentures.[6,7,12-14] Microchips may be electronic memory chips or simply vehicles for imprinting miniaturized letters and digits. The advantages of using chips for denture marking are that they are small, they are cosmetically acceptable and more easily inserted. The 'Swiss identification system'*uses small metal, plastic or ceramic discs for denture marking.[8]

Gold microchips embossed with intelligence data were used by the U.S. Armed Forces[9] while the 'MIN-I-DENT'** identification strip is made of plastic.[10] A metal denture marking microchip has also been described by Cotter *et al.*[11]

In spite of its advanced technology, the microchip has not been popular because of its unavailability and high cost. An attempt was therefore made to develop a denture marking chip with a view to overcoming some of the previous difficulties, which was simple, inexpensive and effective.

MATERIALS AND METHODS

The chip[†] used was a modification of an already existing technique of computer chip manufacture. In this case instead of circuit diagrams used in making computer chips, patient data information were fed into the computer for printing on paper.

The chip consists of a base laminate on which the required data is incorporated using a photochemical etching process. The base laminate is composed of high quality woven E-glass sandwiched between

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** *Super Tooth Products, Minnesota, USA*

† *Zeta Microsystems, Chennai, India*

epoxy resin with copper cladding which is designated in industry as FR-4 and is used in the manufacture of printed circuit boards in the electronics industry.

The data were incorporated on the base layer in a series of steps:

1. The required data were printed by high quality laser printer on paper.
2. A photographic reduction was then carried out to the required size (0.5mm) and the reduced pattern photographed.
3. The 0.6 mm copper cladded FR-4 sheet was coated with a photosensitive polymer film by lamination and the pattern on the photographic film transferred to the photopolymer by UV exposure. It was then developed and hardened.
4. The surface containing the pattern was now subjected to tin electroplating after which the polymer layer was removed.
5. The surface was then etched with ferric chloride solution and the areas not covered by tin etched off .
6. The surface was cleaned leaving the inscription clearly visible as copper patterns coated with tin. The chip was then ready for incorporation into a recess created in the acrylic of the dentures (Figs.1 and 2).

FORENSIC TESTS ON THE CHIP

Forty six heat processed acrylic resin blocks (3x2x1cm) were prepared. A chip was placed into a 5mm depression cut into each block and covered with a mixture of clear autopolymerizing acrylic resin.[††] The blocks were polymerized in a pressure pot for 15 minutes at 25psi and 40°C.

Each chip was clearly visible through the clear acrylic resin after polishing and 30 samples were used for testing, with one sample kept exclusively for reference. The reference/control sample was used for visual and radiographic comparison of extent of visibility of data on the samples before and after the forensic tests.

The specimens were prepared differently for tensile testing. Fifteen heat processed acrylic resin blocks (3x2x1cm) were prepared. A depression of 5mm was made in a side of a resin block allowing for a 4cm chip to be partly buried and partly to protrude after.

Autopolymerizing acrylic resin was flowed into the depression and the chip placed in the depression and covered with resin. The blocks were polymerized in a pressure pot for 15 minutes at 25psi and 40°C.

Fig.1: *Denture-marking microchip with inscription. Dimensions 5mm x 5mm x 0.6mm*

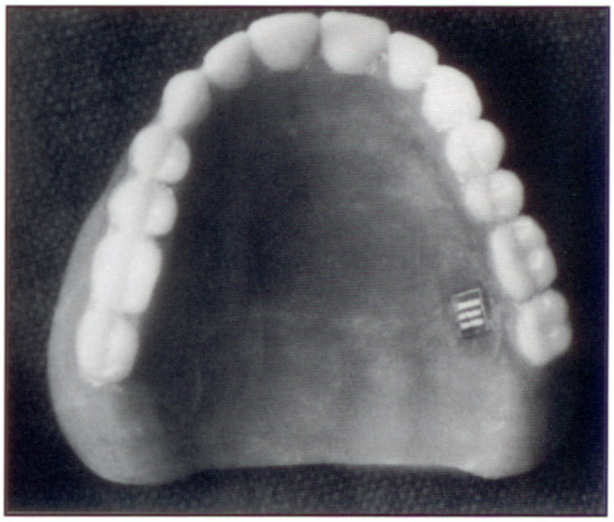

Fig.2: *Microchip incorporated in the posterior palatal region of maxillary denture*

[††] *Stellon, DPI, India*

1. Heat resistance

Fifteen specimens were placed in a porcelain crucible individually in a muffle furnace. The temperature was gradually raised to 1000^{0}C and changes observed visually, noted and tabulated. The temperature at which the markings were unreadable was recorded as the maximum heat resistance (Fig. 3) .

2. Acid resistance

A further 15 specimens were immersed in 99.98% sulphuric acid kept in separate glass beakers and the markings observed every week for 10 weeks. The point at which the markings were visually unreadable due to the opacification of the clear acrylic resin surface was recorded as the maximum acid resistance (Fig.3).

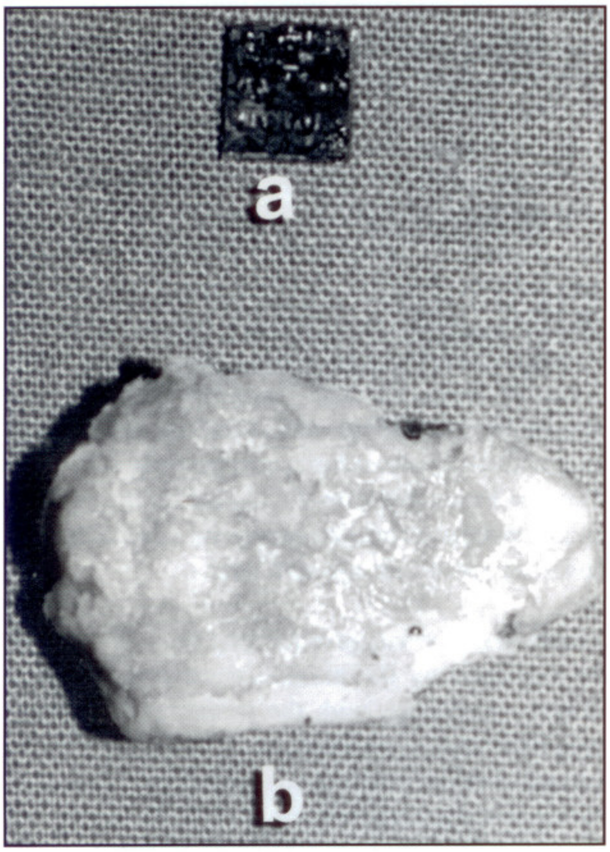

Fig. 3: *Microchip embedded in acrylic resin blocks (a) after heating at 600^{0}C, (b) after immersion in sulphuric acid at eight weeks*

3. Radiography

Radiographs of 15 samples were taken on periapical dental film*** at 70Kv for 0.5 seconds with a conventional dental X-ray machine#. Radiographs were also taken of the visually unreadable 30 samples subjected to heat and acid tests. The ability to read clearly the data on the radiographs was noted (Fig. 4).

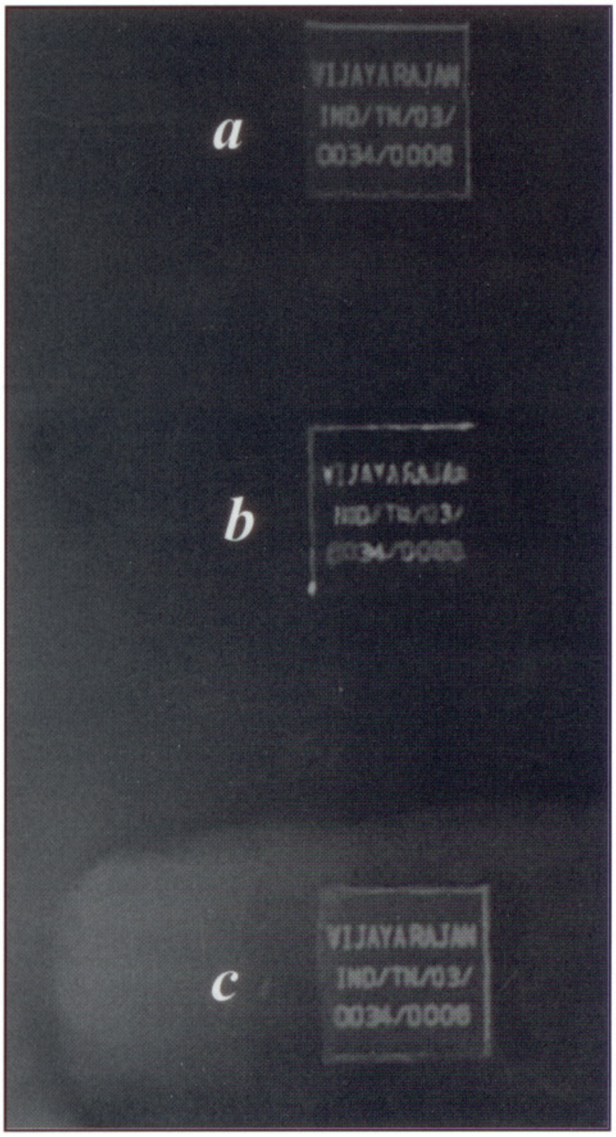

Fig. 4: *Microchips radiographed on dental film and by conventional dental X-ray machine (a) Microchip under normal conditions, (b) Microchip after heating at 600^{0}C, (c) Microchip after immersion in sulphuric acid at eight weeks*

*** *Kodak EktaSpeed,Eastman Kodak Company ,USA*

Satelec, Italy

4. Tensile bond strength

The fifteen specimens made for tensile testing were mounted in the jaws of a Universal testing device## (Fig. 5) and pulled to breaking point. The values were noted and also the point of failure, whether at the chip/acrylic bond interface or within the chip itself.

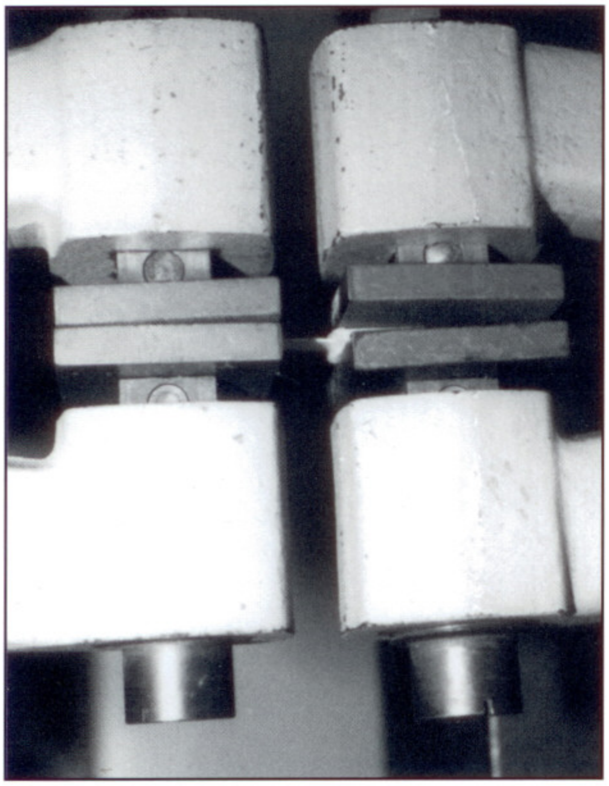

Fig. 5: Tensile bond strength testing in a universal testing machine

Tests	n	Mean values
Heat resistance (°C)	15	600±25.24
Acid resistance (weeks)	15	8
Tensile bond strength (kg/m_2)	15	15.07±0.45

Table 1: Mean heat resistance, mean acid resistance and mean tensile bond strength of the chip

RESULTS

1. **Maximum heat and acid resistance and tensile bond strength.**
   Table 1 shows the mean maximum heat resistance (^{O}C) and acid resistance (wks), and the mean maximum tensile bond strength. All the specimens failed at the chip/acrylic resin bond interface.

2. **Radiography**
   The data were clearly visible on all the samples because of the radiopacity of the markings. The data were also clearly visible on the radiographs taken on the visually unreadable samples subjected to heat and acid tests.

DISCUSSION

The study conducted to evaluate the resistance of the chip showed that it was able to withstand a temperature of up to $600^{0}C$, had excellent acid resistance, was radiopaque and bonded with acrylic resin. Because of this specific bonding characteristic as both the chip and dentures are made of resin, there is no weakening of the denture as would be expected with the metallic markers. The chip could also store a lot of personal information in a small area and was cosmetically pleasing. The data inscribed could be read radiographically or directly with naked eye or with a magnifying glass and no special devices are necessary to read the chip. The data were also clearly visible on the radiographs taken on the visually unreadable samples subjected to heat and acid tests. This can be attributed to the copper-tin inscriptions on the epoxy resin base rendering the data radiopaque and resistant to heat and acid tests.

The main disadvantage of the chip is that it can only be inscribed by the manufacturer and not by a dentist. However, with the proliferation of chip manufacturers, availability ought not to be a problem and dentists simply need to specify their requirements to a company of their choice. Presently, the cost of manufacture of 100 chips is about Rs250 (US$5), making the marking procedure inexpensive. Although initial results appear encouraging further long term clinical studies are needed to demonstrate the success of the technique.

Instron, Massachusetts, USA

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