Case Report

Laser micro-etching of metal prostheses for personal identification

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Abstract

Denture marking techniques play a vital role in establishing personal identification in suitable clinical and forensic situations. The denture marking techniques are categorized broadly into additive and ablative methods. Additive methods involve embedding or impregnation of markers for establishing personal identity. Ablative methods involve partial removal of the denture surface thereby providing a marking for identification. Engraving and etching methods are the commonly used ablative methods. Ablative methods can be of contact and noncontact subtypes. Laser micro-etching is a precise noncontact ablative denture marking technique that could be used for prostheses-guided personal identification.

Key words: Denture marking, lasers, micro-etching, personal identification

Introduction

Identification of the deceased is mandatory for social, religious, legal, and forensic purposes. Severe accidents, natural disasters, drowning and fire accidents, industrial, nuclear accidents, and war causes death and destruction at varying degrees, and clinicians are challenged with a daunting task of identifying the dead.[1-5]

Teeth and craniofacial structures constitute an important mode of personal identification, and a person can also be identified by the dental prostheses being worn, and several cases have been reported regarding personal identification utilizing dental prostheses.[6-8]

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Many techniques of denture labeling through impregnation and embossing have been reported in the literature. However, labeling of metal intraoral prostheses has been scarcely reported, and this report elaborates a denture marking technique for cast partial dentures using laser micro-etching.

Case Report

A 45-year-old female reported to the Department of Prosthodontics with the chief complaint of missing teeth in the mandibular arch [Figure 1] and expressed desire regarding the replacement of teeth and the possibility of marking the prostheses. Clinical and radiographic

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examination revealed no abnormal findings in relation to the teeth and supporting structures, and a cast partial denture was planned as the patient was not willing to undergo implant therapy. Informed consent was obtained from the patient and the following treatment was initiated.

Diagnostic impressions were made with irreversible hydrocolloid (Tulip-Cavex Holland BV, North Holland, Netherlands), and the casts were poured with type III dental stone (Orthokal-Kalabhai, Mumbai, India). The cast was surveyed using a William's surveyor (Saeshin Precision Ltd., Daegu, South Korea), and mouth preparation was done. Guiding planes were established and occlusal rests were prepared in mandibular right second premolar and second molar and cingulum rest prepared in mandibular left canine. An I-Bar retainer was planned on the lower left canine and circumferential clasps were provided on the mandibular right second premolar and second molar, respectively.

Once mouth preparation was completed [Figure 2], the final impression [Figure 3] was made with Addition silicone impression material (Elite HD+, Zhermack, Badia Polesine, Italy), and the models were poured with Type IV dental stone (Ultrarock – Kalabhai, Mumbai, India). A lingual bar design was chosen with lattice type denture base minor connectors and wax patterns were made (LiWa-Trimax, HongKong, China).

The framework was invested and casted with Co-Cr alloy (d. SIGN 30, Ivoclar Vivadent, Schaan, Liechtenstein), and the metal framework [Figure 4] obtained from the casting was finished and polished. The framework was carefully examined to select the site of denture marking and the cameo surface of the denture base minor connector was chosen as this area will be covered with acrylic resin and the engraving will be preserved permanently without any change from the intraoral environment and also insulated from microbial assault.

Figure 1: Kennedy's Class II modification 1 partially edentulous arch

Figure 2: Mouth preparation completed for cast partial denture

Figure 3: Final impression made with Addition silicone impression material

Figure 4: Cast partial denture framework in the cast

A numeric identification code was suggested by the patient (17489), and every digit was laser etched in the successive denture base minor connectors [Figures 5 and 6]. Framework was verified intraorally and jaw relation was recorded. Artificial teeth were arranged and processed and the prostheses inserted in the patient's mouth [Figure 7]. Oral hygiene instructions were given and the patient was followed regularly and the patient remained satisfactory and functional.

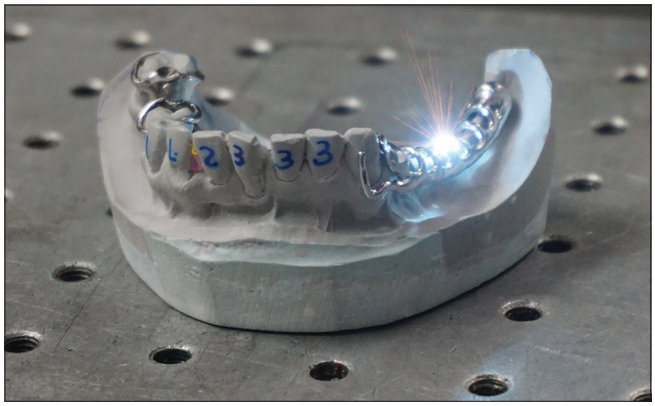

Figure 5: Laser micro-etching using diode laser

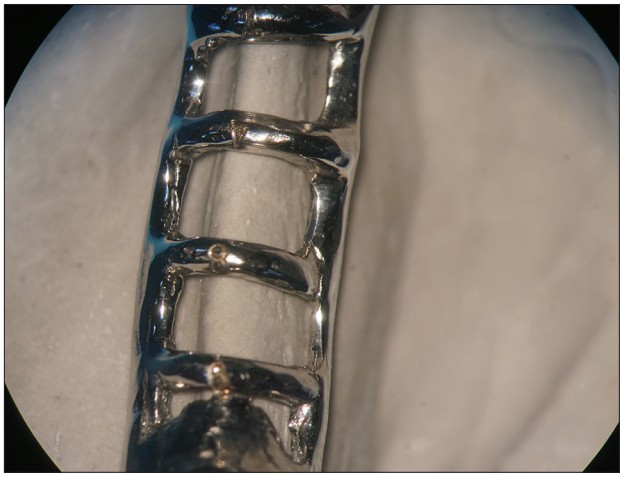

Figure 6: Etched surface under magnification revealing the digits

Figure 7: Insertion of Cast partial denture in patient's mouth

Discussion

Denture marking techniques can be an effective tool in personal and forensic identification of human subjects. The most commonly used denture marking techniques include impregnation, engraving, and embossing methods.[8-11] The major disadvantages with impregnation techniques include compromised esthetics due to incorporation of chips, barcodes, and other devices which also decreases the rigidity and strength of the prostheses. These techniques involve complicated lab procedures which may not be feasible under normal conditions. Engraving methods leave a rough and depressed surface prone to plaque accumulation, corrosion, and subsequent microbial damage to the metal and underlying tissues.

Raymond Richmond and Pretty[4] has proposed various requirements for an identity system and suggested that the techniques should be easy to perform, not weaken the prostheses, be cosmetically acceptable and allow for positive identification. Heath[7] used a spirit-based pen/pencil to label dentures and covered it with clear acrylic resin. Stevenson[8] described a technique wherein he used a scalpel for scribing a serial number and highlighting the scratch with graphite. Ling[12] used a white typing correction paper and this was incorporated into the cameo surface.

Lamb[13] used a pen-marked resin strip for denture marking. Luebke and Unsicker,[14] Chalian *et al*.,[5] and Ryan *et al*.[15] used T-shaped clear PMMA resin bars and embedded them into prostheses. Thomas[16] described the use of type-writers without ribbon on a metal band to print names and then embedding the metal bands into prostheses. Ling *et al*.[10] described the use of copper vapor lasers to mark a metallic label to incorporate into dentures. Rajan and Julian[17] used electronic chips of 5 mm × 5 mm × 0.6 mm containing patient's information and embedded them in acrylic resin. Millet and Jeannin[18] described a technique to incorporate radio-frequency identification device transponders into upper complete dentures.

Recent literature shows a need for standardizing the identification labels incorporated in prostheses and a foray into digital information storage. Baad *et al*.[19] have proposed a national identification number (permanent account number/Aadhar card number) on dental prostheses as universal personal identification code. Mahoorkar and Jain[20] have proposed the use of Aadhar card number for personal identification. Murugesh and Ganesh[21] has used lead foil labels to identify dentures.

Colvenkar[22,23] has used Micro-SD cards and lenticular cards with digital information incorporated in lingual flange of lower dentures. Agüloglu,[24] Nalawade *et al*.[25] has used barcode technology to mark dentures for identification. Nuzzolese

et al.[26] has used radiofrequency identification tag in dentures to facilitate recognition and to aid in human identification.

Laser marking is a technique utilizing the use of lasers in a variety of methods viz., chemical alteration, charring, foaming, melting, and ablation to produce markings on an object for identification purposes. One subset of laser marking is laser engraving which uses laser beams to engrave markings onto an object. Different types of Lasers have been used for engraving purposes such as the CO_2 lasers, fiber lasers, and diode lasers.

Diode lasers are mostly frequently used since they have a wide range of uses that include barcode readers, fiber-optic communications, CD/DVD/Blu-ray disc reading and recording, laser printing, and scanning. Commonly used Diode lasers are ones with Nd: Yag crystals which are optically pumped through laser diodes and emit light in the wavelength of 1064 nm in either a continuous or pulsed fashion. These are used in laser engraving machines and are controlled by a computer which determines the intensity and direction of the beam, speed of movement, and beam spread. The controller traces patterns with the beam on to the surface being engraved.

There are three types of laser engraving machines: The first kind is the X-Y table in which the laser beam can move in an X-Y direction. The second type is a cylinder table in which the laser beam traverses like a helix, and the third type employs a stationary worktable and two movable mirrors which move the laser beam in varying patterns. The point where the laser touches the surface should be on the focal plane of the laser's optical system. The dimension of the focal point is small usually ranging in fractions of millimeters. Only the area inside this focal point is significantly affected when the laser beam passes over the surface. The energy delivered by the laser heats the surface upon which it is directed under its focal point and vaporizes the focused point.

Flat table engraving has been employed in this instance for this technique wherein the laser beam was controlled to penetrate a fixed depth thereby avoiding unnecessary weakening of the prosthesis. The laser engraving machine used to mark the cast metal framework was the Kite Laser Machine (DongGuan Kite Laser Technology Ltd., China) which utilizes a movable work table and galvanizing mirrors which direct the beam on to the work surface. The engraving unit was controlled by a computer with the EasyLaser software (Damalini AB, Sweden). The characters to be engraved into the framework were entered in the software input page and the laser unit engraved the characters on the surface upon activation. One drawback of this unit was that the engraving cannot be performed over steeply curved surfaces. The unit had a red pilot beam which served to orient the object to be engraved into position. Once the object was in place, the unit was activated and the laser beam was focused on the object. The collimated beam generated intense heat at the point of contact and 'spot vaporization' occurred to a controlled depth of 0.5 mm. The parameters followed for engraving the metal framework were 15 mA, 60 V and a frequency of 5 Hz. The laser wavelength used in this technique was 1064 nm with a power of 60 W. A 5 Hz frequency was used with a marking speed of 7000 mm/s and marking depth was 0.5 mm with a precision of up to 0.003 mm

Laser micro-etching is a precise method where the etching is not visible to ocular vision and can be visualized only with the help of a magnifying lens, loupes or microscope, thus providing good aesthetics. This technique is simple, cost effective, and reduces laboratory time involved in other denture marking techniques. Since the etching is performed in the cameo surface of the denture base minor connector it will be covered by the acrylic resin. Therefore, the minor connector under the denture base material was selected for etching as the engraving will be covered and preserved by the acrylic superstructure. However, other areas of the framework can also be used for laser micro-etching but they are vulnerable to plaque accumulation and can compromise hygiene and mechanical properties of the metallic framework. Limitations of this technique include requirement of adequate thickness of metal surfaces for etching. Another limitation involved in laser etching is the availability of the laser engraving unit. Nevertheless this technique can be used in all metallic prostheses where denture labeling is attempted and it can be a reliable tool for personal identification dependent on prostheses.

Conclusion

Laser micro-etching is a precise, cost effective, and promising denture labeling technique for metallic prostheses and can provide a permanent mode of personal identification.

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