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INTRAORAL WELDING: A CONCEPT OF IMMEDIATE REHABILITATION OF EDENTULOUS ARCHES- A PRIMER

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Abstract:

Abstract: Complete maxillary or mandibular edentulism is considered to be the most challenging clinical condition to rehabilitate. A possible solution to provide stability and retention of the prosthesis in this condition,in a short time i.e on the day of implant surgery,is intraoral welding technique. This goal can be achieved by welding titanium bars on implant abutments directly inside the oral cavity, which decreases the risk of micromovements of implants with regard to surrounding bone and possibility of error or distortion due to prosthetic procedures.

Introduction

The increase in life expectancy continuously has brought new challenges to the dentistry, as number of edentulous patients are increasing in one or both arches.[1] These patients often do not accept a rehabilitation with a removable prosthesis, for either functional or psychologic reasons. The evolution of implant dentistry brought an increasing interest in immediate esthetic replacement of missing teeth. Placement of dental implants followed by immediate loading with a fixed, implant-supported prosthesis mimics the biomechanics of teeth within the alveolar bone. Biologic benefits for these patients are internal loading on the alveolus and preventing continued resorption of the jaw bone.[2]

More advanced protocols decrease the healing period, and in the case of immediate loading for a full-arch replacement, implants are exposed immediately to occlusal and muscular forces. The resultant changes in both the surgical and prosthetic protocols are remarkable and are a significant departure from the original two-stage protocol.[2] A time saving and successful decorum to rigidly splint multiple implants in a precise manner is the Intraoral Welding Technique.[3] Welding involves a metallurgical union process that relies on base metal fusion, i.e. the constituent metal of the structure, with or without the addition of filler metal, to form the soldered joint.[3] In intraoral welding, a titanium bar is welded to the implant abutments directly inside the oral cavity. It was introduced by Hruska and Mondani[3] in 1976. Further it has been widely documented by Degidi et al in 2006, who mentioned the creation of precise and passive prosthetic structure by assembling the framework directly inside the oral cavity.

Intraoral welding can join and support the implants by the use of a titanium wire or bar that is permanently connected to the implants. An electric current for milliseconds is used to fuse the titanium to the abutments. The welding procedure is performed intraorally before the immediate loading. Stabilization and fixation of the implants allows immediate loading and prosthesis insertion (provisional or definitive) to occur on the same day of the surgery. By inserting a prosthesis with adequate retention and stability the same day as the surgery, patient complaints and discomfort can be avoided or minimized. The immediate stability, which is a result of implant splinting can also reduce the risk of failure during the healing period. It can also eradicate the faults caused by inappropriate making of impressions.[4]

Intraoral Laser Welding

Intraoral welding can be performed either with a laser device - intraoral laser welding (ILW) or by electric resistance welding – intraoral welding (IOW). Electric resistance welding was introduced by Pier Luigi Mondani[5] in 1976 and then developed and perfected, and is based on the creation of an electric arc between two electrodes under an argon gas flux and it is called "syncrystallisation."[6] Syncrystallization is the term used to describe the union of two metallic surfaces through the sharing of atoms constituting the crystal lattice in the joint zone. Gordon[7] discussed the probability of welding metallic portions of dental prosthesis using laser technology in 1967. According to many authors,[8] laser technology is one of the best among all of three welding techniques, which can be used for different metals and it is the most effective method for delivering thermal energy to small areas as it permits the generation of a keyhole that effectively concentrates the energy input into one small area. Resistance to corrosion and mechanical strength of the welded joint can also

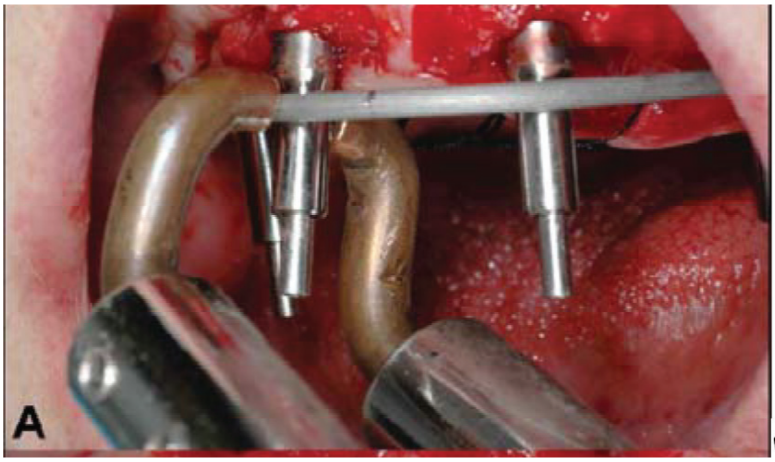

Fig 1

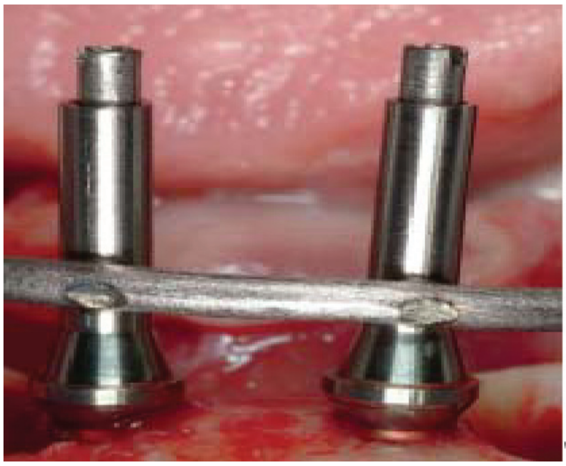
Fig 2


Fig 3

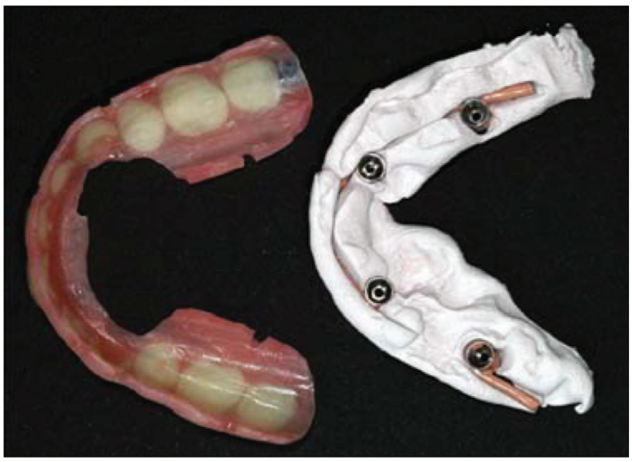
Fig 4

be improved with laser welding.[7] Shielding gases used in laser welding units shield the molten metal from oxidation but there are some limitations to welding such as porosity and cracks, which can be reduced by vaccum welding. Carlo Farnaini et al.(2014)[9] reported that peak power is the most significant parameter while determining the penetration depth which is equal to pulse energy per pulse duration. If the peak power is increased too much, the temperature of the alloy exceeds to the evaporation point, it will cause crater formation on surface of the materials.

The Intraoral Welder

Historically, the welding machine was officially introduced in the early 1970s, while the technical description of this invention was only published later in 1982.[10] In the seventies COMEPRE Company collaborated with Dr. Pier Luigi Mondani[10] to develop "Syncrial" the first intraoral welding machine allowing the welding by syncrystallization of scialom needles by spot welding points, of parts or of metallic implants also already firmly implanted in the bone tissue.[11] Initially, however, no one except the inventor dared to use an electrical device (Endoral welder) that had to reach a melting point of 1678° C in order to solder –inside the oral cavity - the ends of metallic artifacts placed in the bone. Later Mondani's technique was employed at the Specialization School of Dentistry of the University of Modena, where it was tested and certified as safe, and reported that it does not harm the tissues with which it comes into contact. The "biocompatibility" of the soldering, which occurs at 1678°C on the protruding and closely set portion of the needles placed in living tissue, is due to the fact that the electric current needs a working time of just 2–3 milliseconds. This micro-time, combined with the calculated pressure of the electrodes on the structures to be soldered, prevents the diffusion of the tremendous heat gradient beyond the welding point. Apart from being a bad conductor, titanium also has low thermal conductivity which is very similar to that of enamel.[12]

Nowadays Intraoral Welding devices are available in various companies such as Dentsply, ITS Italy, Swiss & Wegman etc. Recent Intraoral Welding devices are based on the resistance spot welding principle. They provide a stable and passively fitting framework for temporary or durable prostheses for immediate restorations – suitable for immediate or late loading on the same day of surgery.

Intraoral Welding Technique

After the implant site selection, implant are placed with widely possible antero posterior distribution using surgical template. Angulated abutments are connected to the implants immediately after the implant placement. First, a so-called welding abutment, a titanium cylinder, is connected to each abutment with a long pin screw. A 2.0-mm-diameter bar made of grade 2 commercially pure titanium is welded to the most distal abutment on the left using an intraoral welding unit. The bar is then adjusted with orthodontic utility pliers to passively contact all the abutments. The whole welding process is divided into three parts: Preparation, Welding, and Cooling stage.[13] In the Preparation stage, two electrodes of the welding pincers are placed on either side of the bar and the abutment, both of which must be clean and free of surface oxidation. The copper electrodes at the extremities of the pincers are gently put into contact with the parts to be welded and firm pressure is then applied (Fig1). It is important to maintain complete contact between the curved bar and the welding abutment during the entire process. Firm and constant pressure must be constantly applied to ensure a perfect joint between the parts to be welded. The presence of water or saliva does not compromise the quality of the welded joint. The surgical team and the patient must wear protective goggles during the entire process."

In the Welding stage, An electrical charge from a previously unloaded capacitor is transferred to the copper electrodes of the welding pincers. Electrical current which is supplied to the electrodes instantly raises the temperature of the two titanium components to fusion point (Fig 2). The process takes only 2 to 5 ms to carry out and brings the core of the titanium parts to a temperature of nearly 1,660°C. A barely perceptible clicking sound can be heard during this phase. This procedure is performed without the use of any additional filler metal.

In the cooling stage, the titanium crystallizes. To avoid crystallization of titanium, the bar and the abutment must be kept under firm pressure and if all of the instructions are followed properly, a solid joint is formed. The only way the process can fail is if there is inaccurate positioning of the titanium components or if insufficient pressure is applied during the welding and cooling stages. If either of these occur, the joint obtained is very unstable and fragile. After the welding, the prosthetic framework is removed (fig 3) and its passivity is checked with the Sheffield 1-screw test. The welding abutments of the framework are screwed to analogs of the angulated definitive abutments and are inserted in cast model. Framework is finally refined to fit the prosthesis (fig 4).

Modified Protocol

If more rigid structure is required or if titanium bars are used with thin diameters, an additional bar can be welded onto welded abutments, following the exactly same procedure as for the first bar removing the structure after each welding to check for passive fit of the prosthesis.[14]

Bars can be welded in various ways

a. two parallel bars, one sitting above the another

b. bars forming rail

c. bars are placed horizontally

Discussion

Advantage of intraoral welding procedure is to create a very precise rigid framework quickly and directly inside the oral cavity, when immediate functional loading is planned.[15] Rigid framework splinting obtained by this technique, can limit the micromovements in immediate loading protocols and is indicated in partial and full-arch prosthesis, which reduces the mechanical stresses exerted on each single implant and assure an optimal distribution of occlusal load and decreasing the lateral forces on healing implant. With this technique, time-costly laboratory steps can be avoided, such as the creation of a customized impression tray, while a passive fit of the framework is easily obtained.[16] When implants are splinted together, partial and full arch immediate restorations can be performed under low insertion torque. This reduces the micromovements of weaker implants and hence in turn increases the osseointegration.[17] No major limitations have been reported to this technique.

"Unfortunately, there are more limits to syncrystallisation and electric resistance welding, as these are not effective on every kind of metal and alloy, and these cannot be used on patients with pacemaker. Among the techniques,laser technology found to be the most efficient method for delivering thermal energy to small areas. It is one of the best fusion welding techniques for different metals.[18] This depends on the ability to focus the light beam in a focal point. The best advantage is that the weld process can usually be performed exactly where it is required, that is, at the level of an implant abutment.[19] Moreover, the procedure can be carried out directly on the master cast, thereby eliminating the risk of inaccuracies and distortions due to the duplication of the model and the heat source, being a concentrated high-power light beam, and minimizing the distortion problems in the prosthetic pieces.[20]

The clinical use of the intraoral welding technique to immediate load the implants surgically inserted

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with computer assisted surgery reported to be a good treatment approach nowadays, which allows the creation of an immediate and passive provisional restoration that could limit complications reported in the past and reduce the intraoperative time with respect to the traditional technique of intraoral welding.[21]

Conclusion

Titanium bars welded intraorally on prostheses is now a widely proven technology and allows the stabilization of fixed prostheses in edentulous ridges that otherwise could not be rehabilitated. The welded joint structure reported excellent microstructural quality, with only minor porosity detected at 50,000× magnification. Welded joint between abutment and titanium bar after subjected to functional loading showed no fracture or radiographically detectable alteration, improving the quality of the results,reducing the operative time, and giving greater comfort to the patient.[22]

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