Rehabilitations with immediate loading of one-piece implants stabilized with intraoral welding

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REHABILITATIONS WITH IMMEDIATE LOADING OF ONE-PIECE IMPLANTS STABILIZED WITH INTRAORAL WELDING

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The authors present an implant prosthesis procedure that uses screws on one-piece implants connected with a titanium pin at their abutment level and one supporter titanium bar in order to guarantee immediate stabilization. These can be implanted and fitted with customized temporary crowns in a single surgical procedure, restoring function and aesthetics and consenting recovery of the bone deficit with reduced healing times and limited patient discomfort. One-piece wide-diameter titanium screw implants with thread measurements of 2.1 and 2.6 mm (smaller diameter) up to diameter of 4.5 mm with one abutment of 2.0 and 2.5 mm respectively, were positioned and splinted by intraoral welding. One-piece titanium implants were used together with a pin (needle) titanium implant as supporting structure to achieve deep stabilization. The Scialom-like pin has a diameter of 1.2 mm and it is long enough to reach deep cortical bone that is "bicorticalism". The One-piece implant is tightly connected to the needle implant by means of Mondani intra-oral welding technique. In severely atrophic anterior maxilla, the use of this method allows the immediate loading of a fixed resin prosthesis soon after surgery. These implants yielded satisfactory functional and aesthetic outcome in bone-deficient upper anterior sectors, without invasive regenerative procedures. The low invasiveness of this approach also consents rapid healing, reduced biological burden and greater patient benefit.

International conferences have stated procedures and techniques for immediate loading based on scientific and clinical evidence and considering various edentulous anatomic forms, type of bone, length and structure of the implants used. Clinicians from the study group of Italian Immediate Loading School have a long and successful experience with immediate loading in implants connected together by intraoral welding. Intraoral welding can join and stabilize implants by the use of a titanium wire that is permanently connected to the implants or can connected in a single one-piece implant stabilized with one titanium pin (needle).

Welding procedure is performed intraorally before immediate loading. Stabilization and fixation of the implants allows immediate loading by means of provisional prosthesis occurring the same day of surgery. By inserting a prosthesis with adequate

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retention and stability on the same day as surgery, complaints and discomfort can be avoided or substantially reduced. The instantaneous stability that results from the splinting can reduce the risk of failure during the healing period.

The intraoral welding was presented in 1978 at the Congress of Implantology and Maxillofacial Surgery held in Ortisei (Bolzano, Italy), this "machine", invented by Pier Luigi Mondani sparked enormous interest. Initially, however, no one except the inventor dared to use an electric device that had to reach a melting point of 1678° C in order to welder the ends of metallic artifacts placed in the bone directly in the patient's mouth (1-7).

Mondani's technique was later employed at the Specialization School of Dentistry of the University of Modena, where it was tested and certified as safe, as it does not harm the tissues with which it comes in contact.

Mondani's intraoral welding is still an essential tool for professionals who exploit all implant techniques to rehabilitate most cases of edentulous ridges (1, 8-11).

MATERIALS AND METHODS

The "biocompatibility" of the welding, which occurs at 1678°C on the protruding and closely set portion of the needles placed in living tissue, is because 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 very similar to that of enamel.

While industrial welders melt titanium only in the presence of argon and in the absence of atmospheric oxygen, Mondani's small solder welds the titanium in the presence of air, blood, mouth saliva or even underwater. To summarize, spot welding involves three stages.

1) Current passes through the welding circuit at a voltage proportional to required energy, according to the formula E=V2xC/2, where E is energy, V is the voltage of the loaded capacitor, and C is the electrical value of the capacitor. The current flows through the needles, heating and welding them together;

2) The welding is aided and facilitated by the constant pressure exerted by the pliers on the surfaces to be welded;

3) The welding time (2-3 milliseconds) and the timing distribution of the two foregoing parameters create welding cycles that are repeated at each spot.

Mondani's intraoral solder also makes it possible to:

1) connect and splint the various tripodial (or quadripodial) abutments or the single needles of a whole arch using bars, forming a single block that is very resistant to the occlusal stress of temporary or definitive prostheses, which can be placed on it immediately;

2) splint other types of implants for both permanent and temporary stabilization during integrating osteogenesis;

3) remedy possible stress fractures of the needles or any other type of titanium implant (screws, blades, etc.) by welding a new abutment directly in the mouth;

4) increase the stability of different types of implants by soldering one or two balancing needles, thus distributing the load to the cortical bone (12).

Regarding the technical knowledge required to correctly perform intraoral soldering, the physical difference between fusion, soldering and syncrystallization has no practical consequence.

We believe that this brief overview of Mondani's intraoral welding can suffice to present it as a remarkable step forward in the evolution of implantology (13-16).

"Deep balancing" of the implant. Surgical protocol

To improve resistance to static and dynamic occlusal stress, one-step implants can also exploit the supporting structures that, joined together, are able to distribute stress across a broader surface.

A natural example can be found in the morphology of molar roots, which are designed to bear most of the static stress of mastication and deglutition. In addition to being in a region of compact bone, these teeth also distribute the load across areas that are broader than their occlusal surface (17).

Deep balancing of the implant is achieved by infixing a needle that diverges with respect to the axis of the main implant, which must reach and penetrate the cortical bone deeply and be soldered to the screw at the point where it emerges from the bone.

Titanium pin (Scialom) with diameters of 1.1, 1.2 and 1.3 mm are used as the supporting structures of screw implants, quick screws and especially MUM mini-implants, which are progenitor of all the small-diameter screws (Fig. 1). They must be placed so as to diverge in respect to the screw and must be pushed deeply until they touch and penetrate the cortical bone. They must then be soldered to the screw at the point where they emerge from the bone, using Mondani's intraoral welding: this is the only way that they can exert their stabilizing effect. In addition to increasing resistance to static and dynamic stress, deep balancing also exerts a counter clockwise action and provides great and immediate primary stability due to the cortical support. This prevents dangerous micromovements of more than 150 microns, as they are particularly harmful and can potentially inhibit osseointegration of the implants (18). Deep balancing is particularly useful for all single-tooth implants (including post-extractive ones and those placed in poorly mineralized bone) that will be loaded immediately. For example, we can cite post-extractive implants placed in shallow sockets, in which it is virtually impossible to achieve immediate primary stability. Thus, they cannot be loaded immediately without deep balancing (19-22).

Even when dealing with particularly thin ridges, when augment surgery is impossible or undesirable, MUM mini-implants (with a smaller diameter of 2.1 and 2.6 mm) are feasible. These implants are particularly effective because they are placed between the two close cortical walls (buccal and palatal or lingual) and as a rule, the deep cortical bone supports them. This represents the ideal bone for implants with very small core diameters, which can withstand static and dynamic masticatory stress foryears without undergoing stress fractures (12, 23, 24), as long as an adequate number is inserted and protocol is followed (25).

In all of these cases, deep balancing (i.e. stabilization by means of titanium needles) ensures increased resistance that can withstand the test of time. The front sector of the mandible is composed of very compact bone. The screws placed into this type of bone may sometimes be expelled due to necrosis, as the tissue is overly compressed by the screwing action and suffers reduced venous and lymphatic flow. In these cases, it is advisable to prepare osteotomies larger than the implant cores in order to avoid compression.

Deep balancing of screws inserted in tunnels wider than their core (to avoid ischemia of the walls)

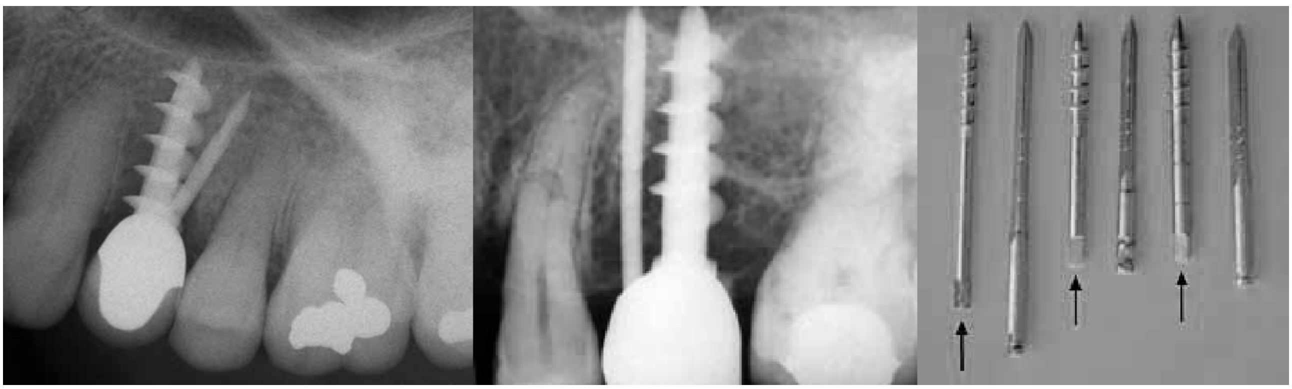

Fig. 1. ***Left***: *Exemple of deep balancing of a screw with a diverging needle replacing uppers premolars;* ***Right***: *Three MUM implants with different diameters (arrows) and the Pasqualini drills used for their placement.*

ensures the implant stability required to achieve osseointegration even with immediate loading. This assures:
- an antirotational function
- immediate loading
- primary stability
- greater resistance to static and dynamic stress.

The screw exploits deep balancing when it is used as a double substitute implant for multi-rooted teeth. Deep balancing can be obtained by soldering one or two diverging needles to the abutment, or by joining the abutments of two adjacent screws to form a single block. The figures of the case report exhaustively illustrate the surgical technique as well as the long-term outcomes of this implant method, which is specifically designed for immediate loading (26-28).

Clinical case report

Rehabilitation with immediately loaded implants in the completely edentulous upper maxilla of a 46-year-old male patient (1996). Bone loss in the front area is evident in both height and width. Implants were inserted according to the protocol of Italian Immediate Loading Implant School, with immediate placement of a temporary resin prosthesis that had the correct vertical height and was occlusally balanced. Due to the minimal bone thickness, implants with a smaller diameter were placed (MUM mini-implants) in the front sector; the thread diameter ranged from 2.1 to 2.6 mm. A bicorticalized needle was inserted besides the mini-implants for reinforcing purposes. It was placed in the bone with a slightly divergent axis with respect to the main implant, but parallel to the abutment emerging into the oral cavity (for prosthetic needs); it was then welded with Mondani's intraoral solder, thus achieving deep balancing. In addition, two implants placed in the right and left maxillary tubers, respectively, made it possible to bypass the large maxillary sinuses (29).

The exceptional stability of the implant permitted good healing of the soft tissues; the definitive gold-ceramic prosthesis was placed after 3 months. The panoramic X-ray (dated 1996) demonstrates the good

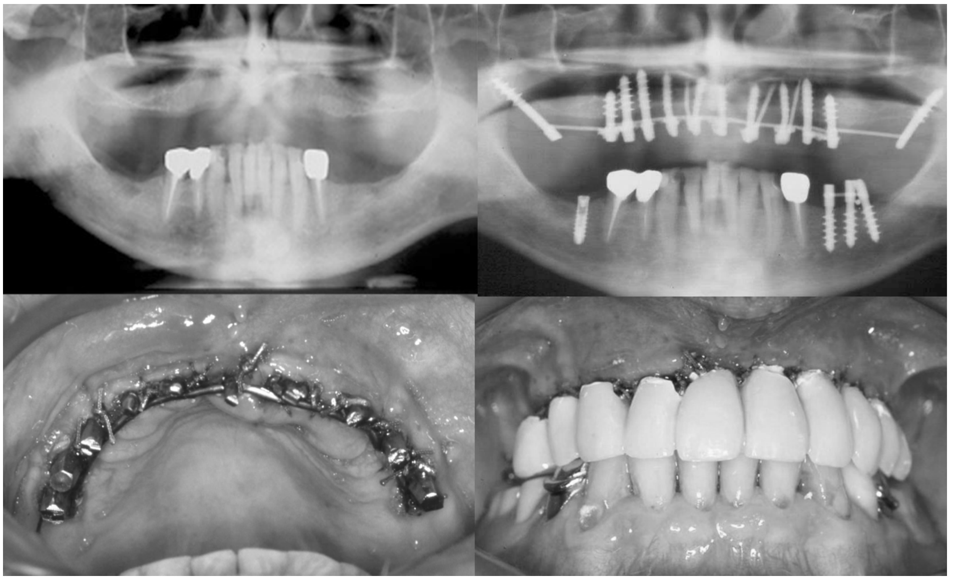

Fig. 2. *The number of implants placed in a single session should correspond as closely as possible to the number of missing teeth (Step 1 of the protocol). All implants must reach and penetrate the deep cortical bone to achieve the bicorticalization that determines primary stability (Step 2 of the protocol). Immediate splinting is performed with a titanium supporting bar with a diameter of 1.2 mm, set on the mucosa without any compression and welded to each implant by means of the intraoral solder (Step 3 of the protocol). The supporting bar must be placed so that the emerging pre-prosthetic abutments of the implants is free in the oral cavity. A resin provisional restoration is immediately applied during the same session. It has a correct height and is occlusally balanced, without interfering with static and dynamic equilibrium (Step 4 of the protocol).*

Fig. 3. ***Left***: *Correct positioning of the supporting bar and abutments before cementation of the definitive prosthesis and definitive gold-porcelain prosthesis that respects oral physiology, without compressing the soft tissues (1996);* ***Right***: *X-ray of the finished case. Reparative osteogenesis is complete (90 days). These data are particularly interesting because they demonstrate that immediate loading on very stable implants (as per protocol) not only fails to cause bone resorption. Note the spaces between the crowns. Good oral hygiene can be maintained even when there is a titanium supporting bar.*

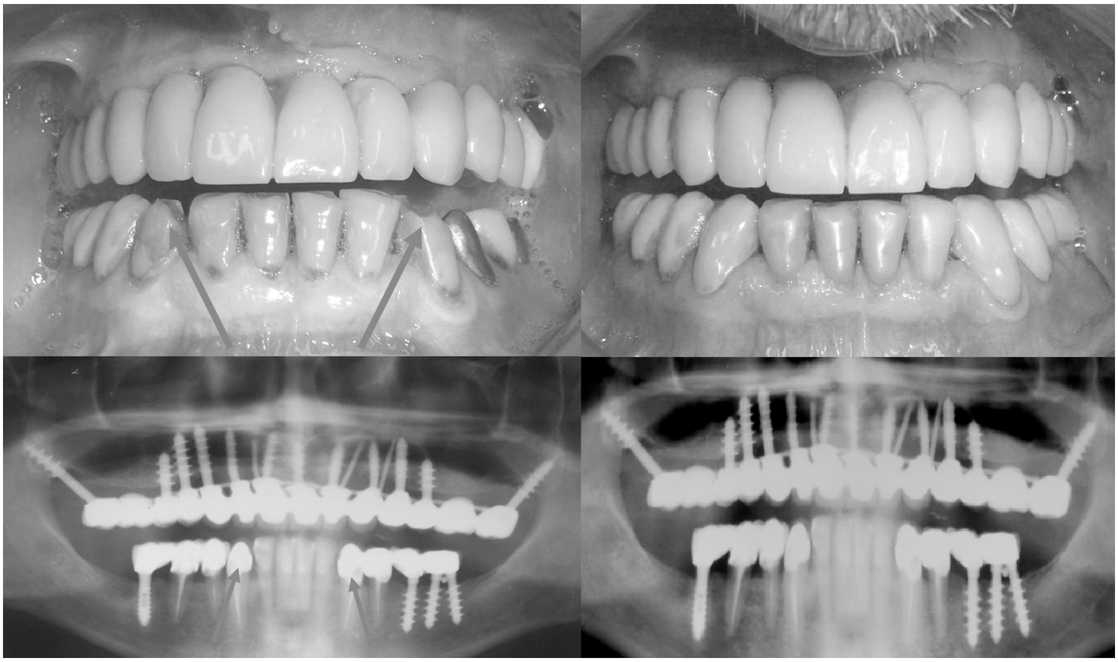

Fig. 4. ***Left***: *Follow up to 11 years (2007) note the partial destruction of the lower canines. Orthopantomography (2007) shows the prosthetic reconstruction to allow proper canine disclusion;* ***Right***: *Follow-up (2014) also shows two new crowns on the lower canines and the OPT taken 18 years later (2014) shows the good condition of the bone around all of the implants.*

status of the bone tissue, with no signs of resorption cones around the implant (Fig. 2). Fig. 3 shows the palatal image of the supporting bar. The prosthetic crowns rest on the bar without covering it. These conditions clearly facilitate correct oral hygiene. The picture taken at the eighteen-year follow-up (2014) also shows two new crowns on the lower canines (arrows). The OPG X-ray, also taken 18 years later, confirms healthy bone conditions with no signs of lesions (Fig. 4).

Scrupulous periodic checks of the occlusion and of oral hygiene conditions are imperative in such cases (30-38).

CONCLUSIONS

Colleagues that employ the intraoral solder should apply deep balancing to screw implants in cases similar to those presented here and in many other clinical situations. This makes it feasible to treat cases that would be possible to solve only with invasive surgery (39, 40). The definitive prosthesis can be placed in furcation areas, with optimal and enduring aesthetic results.

This contradicts the mistaken conviction that in implantology bi- and/or tri-furcations are harmful for the periodontium (see the cases described here) (23, 41-43).

Deep balancing immediately stabilizes the implants by means of strong mechanical osseointegration that allows immediate cementation of the temporary prosthesis, also favoring enduring biological osseointegration, with all the benefits that ensue.

Among the advantages of intraoral welding are immediate stabilization of the implants, immediate provisionalization, reduced risk of failure during the healing period, elimination of errors caused by unsatisfactory impression-making and a potential reduction in patient complaints and discomfort (12, 24, 44, 45).

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