Immediate definitive rehabilitation of the edentulous patient using an intraorally welded titanium framework: A 3-year prospective study

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Objective: The aim of this prospective study was to evaluate the concept of intraoral welding as a suitable technique for the placement of a final restoration in the edentulous patient on the same day as surgery. **Method and Materials:** Any patient with a completely edentulous arch who was considered eligible received a fixed restoration supported by an intraorally welded titanium bar. Definitive abutments were connected to the implants and then welded to a titanium bar using an intraoral welding unit. This framework was used to support the definitive acrylic restoration, which was fitted on the same day as implant placement. Restoration and implant success, mean marginal bone loss, pocket probing depth, and bleeding on probing were assessed over a 36-month follow-up period. **Results:** Twenty-six patients with an edentulous maxilla and 34 patients with an edentulous mandible, with a mean age of 57.1 years (SD = 17.9, n = 60), were consecutively treated with 324 immediately loaded implants. No fractures or radiographically detectable alteration of the welded framework was evident. A total of 321 (99.1%) implants osseointegrated and were clinically stable at the 6-month follow-up. At the 36-month follow-up, the accumulated mean marginal bone loss was, respectively, 0.967 mm (SD = 0.361) for the maxillary cases and 1.016 mm (SD = 0.413) for the mandibular cases. **Conclusions:** It is possible on the same day of surgery to successfully rehabilitate the edentulous patient with a fixed definitive prosthesis supported by an intraorally welded titanium framework.
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Key words: implant dentistry, osseointegration, prosthodontics

The increase of life expectancy in Western countries continuously brings new challenges to the dental practitioner, as there is an increase in the number of patients edentulous in one or both arches.[1] These patients often do not accept a rehabilitation with a removable prosthesis, for either functional or psychologic reasons. Rehabilitation with a provisional, immediately loaded, implant-supported restoration has already proved to be a viable option for the treatment of the edentulous maxilla[2–6] and the edentulous mandible[7–12] when good primary implant stability is obtained.[13]

Only a few studies have reported rehabilitation of a completely edentulous site with an immediately loaded final restoration. In 1999, Brånemark et al[14] proposed a clinical protocol with prefabricated components and surgical guides, elimination of the prosthetic impression procedure, and attachment of a definitive fixed prosthesis on the day of implant placement. The authors reported a 98% success rate for both the implants and prostheses in the rehabilitation of mandibular edentulism, and that definitive reconstruction can be carried out on the day of surgery. Using Brånemark et al's clinical protocol, van Steenberghe et al[15] observed a cumulative failure rate for implants and prostheses of 7.3% and 5.0%, respectively, after 1 year. The authors stated that marginal bone levels can be maintained around immediately loaded implants in the mandible in an average patient population for at least 1 year.

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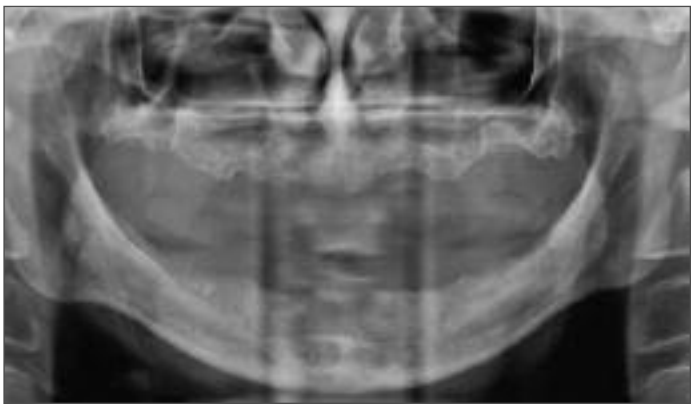

Fig 1 Panoramic radiograph before surgery.

In a case series published in 2005, Ibañez et al[16] successfully treated 12 edentulous maxillae with a definitive implant-supported restoration (either metal-acrylic or metal-ceramic) inserted 6 to 24 hours after surgery. In the same year, van Steenberghe et al[17] treated 27 patients with edentulous maxillae using a computed tomography scan–derived customized surgical template for flapless surgery and a prefabricated customized prosthetic superstructure. All patients received their final prosthetic restoration immediately after implant placement.

Klee de Vasconcellos et al[18] proposed the rehabilitation of the mandible with a definitive fixed prosthesis fabricated on a titanium bar attached to the implants on the day of implant placement. The overall implant and prosthetic survival rates were 100%. The authors concluded that an occlusally loaded complete-arch fixed prosthesis supported by four immediately placed implants does not appear to jeopardize osseointegration and represents a viable treatment option.

In 2006, Degidi et al[19] published a protocol for the immediate loading of multiple implants by welding a titanium bar to implant abutments directly in the oral cavity, so as to create a customized metal-reinforced provisional restoration. Recently, this clinical protocol was successfully evaluated and applied in a selected number of cases for the fabrication and placement of a definitive restoration in both the edentulous mandible[20] and maxilla.[21]

The aim of this prospective study was to evaluate the concept of intraoral welding in the edentulous patient over a longer period of time to better determine the long-term success of this approach.

METHOD AND MATERIALS

Patient selection and implant placement

Any patient 18 years or older with a completely edentulous arch (Fig 1) was considered eligible to be consecutively included in this prospective study. The condition of the opposing dentition was not considered to be a discriminatory factor. Patients were not eligible for this study if they met any of the following exclusion criteria: *(1)* active infection in the sites intended for implant placement; *(2)* systemic disease that could compromise osseointegration; *(3)* radiation therapy treatment in the craniofacial region within the previous 12 months; *(4)* smoking habit of more than 10 cigarettes per day; *(5)* pregnancy or lactation; *(6)* signs or symptoms of bruxism; *(7)* suitable quantity of bone for standard axial implant placement.

This study was designed and conducted in full accordance with the World Medical Association Declaration of Helsinki, as revised in 2002. All patients signed a specific written informed consent form. Each of them received 3.4-mm- or 3.8-mm-diameter parallel-screw, grit-blasted, and acid-etched implants with an internal hexagonal connection (XiVE Plus, Dentsply Friadent). All implants were placed in healed sites by one experienced surgeon (M.D.) in a private dental office in Bologna, Italy. During the implant placement procedure, the insertion torque and the implant stability quotient (ISQ) were registered by a surgical unit (Frios Unit E, W&H Dentalwerk) and a digital measurement probe (Osstell). Patients were dropped from the study if any of the implants did not achieve good primary stability, which was defined as *(1)* insertion torque < 25 Ncm and *(2)* ISQ < 60.

Preoperative analysis of anatomical features and choice of implant length were made using periapical and panoramic radiography

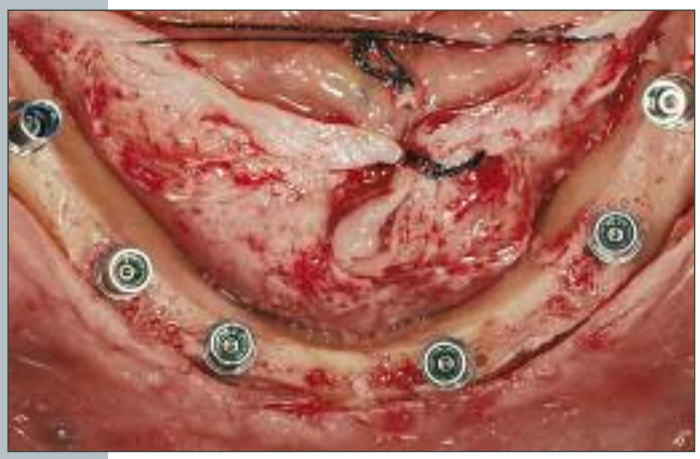

Fig 2 Occlusal view after implant insertion.

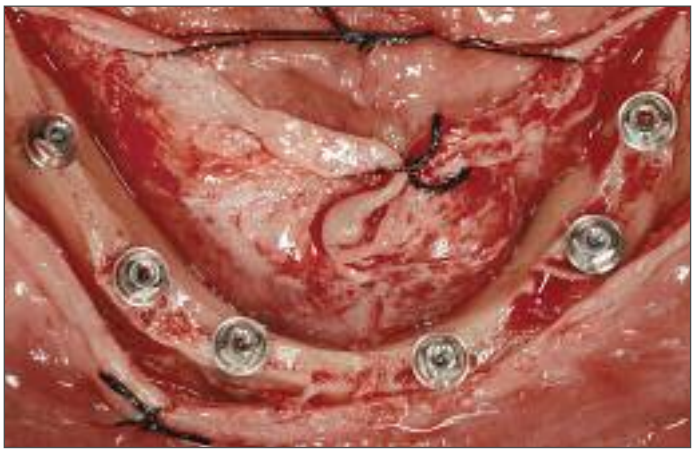

Fig 3 Occlusal view with MP abutment.

or computed tomography when available. Impressions of the maxilla and mandible were taken, and laboratory casts were made. The color shade and structure of the prosthetic teeth were determined, and appropriate highly wear-resistant commercial denture teeth (Vita Physiodens, Vita Zahnfabrik) were chosen. Teeth were premounted on a cast on a semiadjustable articulator and joined with acrylic resin according to the anatomical shape of the arch to be treated. This definitive acrylic cross-arch restoration was then hollowed out to create a space for housing the future titanium framework.

All patients were placed on antibiotic therapy the day before surgery (2 g amoxicillin per day). Local anesthesia (2% articaine/adrenaline 1:100,000) was administered at the time of surgery.

Surgery began with a midcrestal incision extending from the right to the left tuberosity in the maxilla and from the position of the right first molar to the left first molar in the mandible. In mandibular sites, the mental foraminae were located, flaps fully elevated, and the bone crest exposed. In the presence of a knife-edge ridge, a mild osteoplasty was performed under copious irrigation with sterile saline solution. Implants were placed with the widest possible anterior-posterior distribution using a surgical template. Four implant sites were placed in the intraforaminal area: The distal sites were at least 2 mm anterior to the mental nerve, and the mesial sites equally divided the remaining anterior space (Fig 2). In seven cases, sufficient bone was located in the retroforaminal region, and two additional implants were placed. No bone grafting material was employed.

Fig 4 Welding abutments in position.

The internal hexagonal connection of the implant was replaced by an abutment with an external circular and conic connection (MP, Dentsply Friadent) (Fig 3). This allowed us to compensate for any lack of parallelism between implants. These abutments were then connected to the implants with abutment screws tightened to 20 Ncm torque. A titanium cylinder (the so-called welding abutment) was then connected to each abutment with a long guide pin screw (Fig 4). A 2-mm-diameter bar

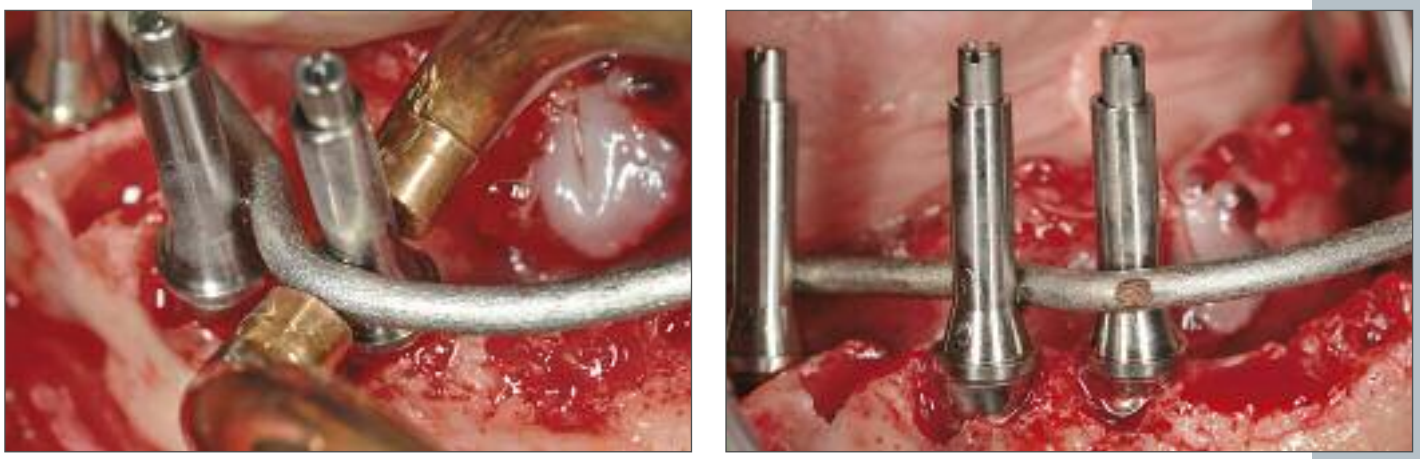

Fig 5 Welding procedure: preparation stage *(a)* and the welded joints *(b)*.

(Bio-Micron s.a.s., Limbiate) made of commercially pure grade 2 titanium was welded to the first distal abutment on the left using an intraoral welding unit (Aptiva NS1100, EnneServizi). The bar was then shaped with a pair of How straight utility pliers (Unitek, 3M ESPE) to bend the bar passively to contact the abutment adjacent to the one that had previously been welded. The process was repeated for all remaining abutments.

Intraoral welding

The modern intraoral welding protocol is a refinement of the technique reported by Mondani and Mondani[22] and Hruska[23] (Figs 5 and 6). The welding process is subdivided into three stages: preparation, welding, and cooling.

Preparation stage. The 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 any surface oxidation. The copper electrodes at the extremity of the pincers are gently put in contact with the parts to be welded, and firm pressure is then applied. It is crucial to have complete contact between the curved bar and the welding abutment during the entire process. Firm and constant pressure must be 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 whole process.

Welding stage. An electrical charge from a previously unloaded capacitor is transferred to the copper electrodes of the welding pincers. Electrical current supplied to the electrodes instantly raises the temperature of the two titanium components to fusion point. Welding is performed without the use of filler metal and takes 2 to 5 milliseconds to carry out.

Cooling stage. Thanks to the different thermal conductivity of the titanium parts (19 watts per kelvin per meter) and copper electrodes (386 watts per kelvin per meter), the process is performed without producing any discomfort to the patient or damage to the surrounding tissue, as no perceptible heat is transmitted to the peri-implant area. The copper electrodes dissipate all the heat that is generated. During this stage, the titanium crystallizes, and, therefore, the bar and the abutment must be kept under firm pressure.

Completion of restoration

The framework created by welding the titanium bar to the implant abutments was removed, and the passivity of the whole structure was

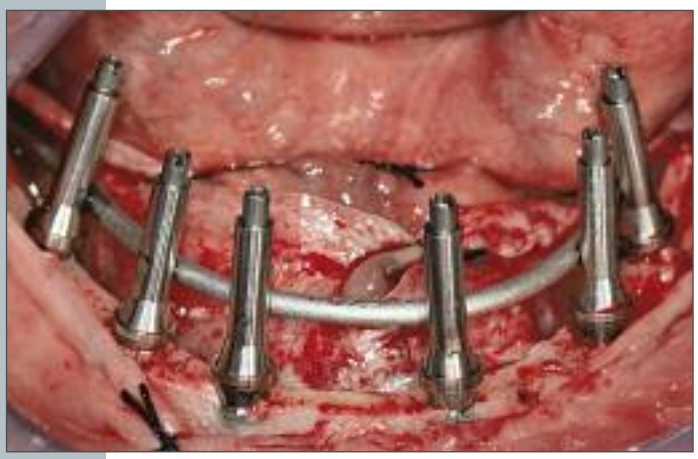

Fig 6 Intraorally welded framework.

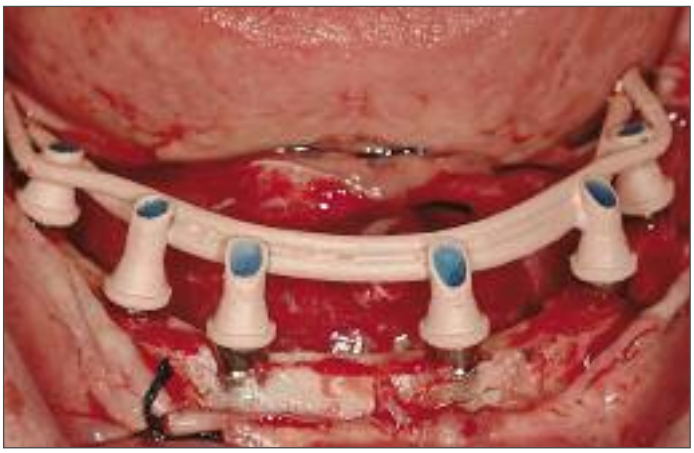

Fig 7 Opaqued framework.

checked with the Sheffield 1 screw test. The framework was then abraded with airborne particles (Modulars 3, Silfradent) and opaqued (OVS 2 Opaker, Dentsply Trubyte) to avoid metal light reflection through the acrylic resin (Fig 7). The soft tissue was positioned around the abutments and sutured into place. The opaqued framework was repositioned in the oral cavity, and the hollowed acrylic resin restoration was relined over the titanium framework with a small quantity of cold-cured acrylic resin. The correct vertical length was checked and established using facial reference marks recorded before surgery. The restoration was then removed from the oral cavity and completely filled with heated pressure-processed acrylic resin. The restoration was trimmed, polished, and screw retained the same day by fastening the screws with 20 Ncm torque (Figs 8 and 9). Screw holes were closed with light-cured composite resin. Patients were instructed to eat a soft diet for 4 weeks after surgery. Oral hygiene instructions were provided.

Observations

The following observations were made:

- Restoration success, defined as absence of fractures in both the acrylic resin superstructure and the welding joints, even if one or more implants supporting the restoration has been removed.
- Implant survival,[24] defined as absence of implant mobility, peri-implant radiolucency, swelling, or pain in the surgical site at time of follow-up examinations.
- Implant success,[24] defined as implant survival plus marginal bone loss less than 1 mm after 1 year of load and no more than 0.2 mm of loss between each follow-up after the first year of function.
- Changes in marginal peri-implant bone level, defined as modification of the distance between the implant platform plane and the highest coronal point of the supporting bone, assessed using periapical radiographs taken with a customized positioning jig. Each periapical radiograph was digitized with a scanner (Epson Expression 1680 Pro, Epson Italia) and analyzed with measurement software (Meazure 2.0 build 158, C Thing Software) employing the Jaffin et al[25] protocol, using platform height and implant length as double cross-references.
- Level of marginal gingival health assessed at the 6-month follow-up with mesial and distal probing depth measurements taken using a pressure of 0.15 N and frequency of bleeding on probing.

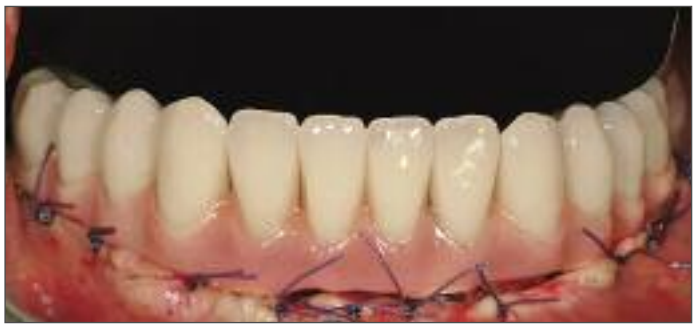

Fig 8 Trimmed and polished final restoration.

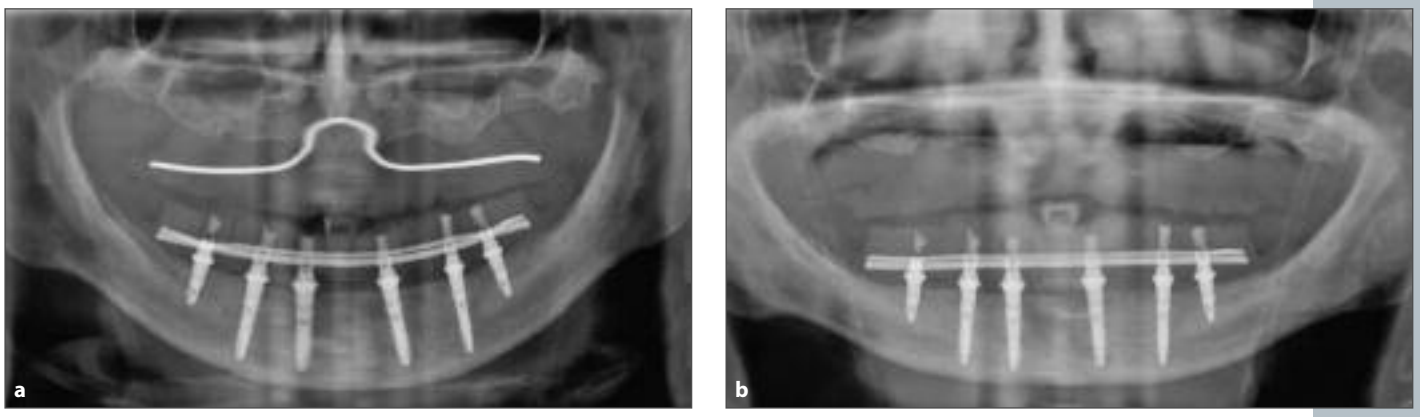

Fig 9 Panoramic radiograph after surgery *(a)* and 3 years after surgery *(b)*.

- Biologic and technical complications, which are elaborated in the results.
- Periapical radiographs were taken at T0: after surgery and fitting of the immediate final restoration; T1: final restoration follow-up after 6 months of full occlusal loading; T2: final restoration follow-up after 1 year of full occlusal loading; T3: final restoration follow-up after 2 years of full occlusal loading; T4: final restoration follow-up after 3 years of full occlusal loading (Fig 9).

RESULTS

Sixty patients in good medical health were consecutively included in this study between January 2006 and December 2006. The mean age of the patients at the time of the surgery was 57.1 years (SD = 17.9). Each of them received a fixed restoration that was attached to dental implants placed in either an edentulous maxilla or edentulous mandible. Average insertion torque and ISQ values are listed in Table 1. A total of 321 of 324 (99.1%) implants osseointegrated and appeared to be clinically stable at the 6-month follow-up. The radiographic evaluations and the probing depth measurements are summarized in Tables 2 and 3. Similar early biologic complications were recorded in three patients who reported swelling, discomfort, and pain in the surgical site, respectively, 4, 5, and 8 weeks after surgery. The restorations were carefully removed, and mobility of one implant was observed. The mobile implant was classified as failure and removed. The restoration was adapted with light-cured composite resin, polished, and screw-retained the same day. The patient with the mobile implant underwent an antimicrobial cycle consisting of 500 mg Beta-lactam antibiotic (amoxicillin, Pfizer) twice daily for 5 days. Biologic complications are summarized in Table 4.

Table 1 Mean insertion torque and ISQ values

	Maxilla	Mandible
Torque (Ncm)	31.9 (SD 6.2)	38.7 (SD 10.2)
ISQ (T0, surgery)	70.4 (SD 4.9)	71.1 (SD 6.3)
ISQ (T1, 6 mo)	74.1 (SD 8.3)	77.5 (SD 8.9)

Table 2 Mean measurements of bone loss pattern (mm)

Follow-up range	Mean	SD	Median
Maxillary cases			
T0 to T1	0.437	0.179	0.41
T1 to T2	0.176	0.108	0.15
T2 to T3	0.159	0.172	0.13
T3 to T4	0.195	0.183	0.18
T0 to T4	0.967	0.361	0.93
Mandible cases			
T0 to T1	0.607	0.138	0.51
T1 to T2	0.202	0.192	0.19
T2 to T3	0.094	0.114	0.09
T3 to T4	0.113	0.102	0.15
T0 to T4	1.016	0.413	0.98

Table 3 Mean measurements (mm) of pocket probing depth (PPD) and bleeding on probing (BOP) frequency

	Mean PPD	Median PPD	BOP
Maxillary cases	1.719 (SD 0.283)	1.63	17.3%
Mandibular cases	1.617 (SD 0.244)	1.59	16.7%

Table 4 Adverse events

Gender	Age at surgery (y)	Failed implant (width/length)	Surgical site (FDI)	Reason for failure	Time of failure
Male	56	3.4/13 mm	First molar (26)	Mobile implant—failed to integrate	4 weeks after surgery
Female	61	3.8/13 mm	Canine (33)	Mobile implant—failed to integrate	5 weeks after surgery
Female	51	3.4/11 mm	Lateral incisor (12)	Mobile implant—failed to integrate	7 weeks after surgery

This study achieved a 96.67% prosthetic success rate at the 36-month follow-up. Two patients (3.3%) reported small fractures of the acrylic resin superstructure, respectively, 9 and 17 months after surgery. The prostheses were repaired with light-cured composite resin, polished, and screw-retained the same day.

DISCUSSION

The interesting assessment already published[19–21] regarding the immediate rehabilitation of the edentulous patient using the intraoral welding approach has been confirmed after a longer follow-up period by the results of the present study. Hruska et al[26] analyzed the long-term success rate of 436 implants immobilized with an intraoral welding machine. In this study, the intraoral welding technique was used only as a means of rigidly attaching the provisional splint, as the titanium wire was cut 3 months after surgery, the abutments were replaced, and a new definitive gold and porcelain restoration was placed. After a 5-year follow-up, only three (0.7%) implants failed. One failed after 1 year of loading because its neck fractured, and two failed between the second and the third year after surgery due to peri-implantitis.

A major concern in the development of the intraoral welding protocol was the endurance of the welded joint. The structure of the welded joint was analyzed in a previous study,[19] which reported excellent microstructural quality, with only minor porosity detected at 50,000× magnification. In this study, 116 welded joints between the abutment and the titanium bar were analyzed at every follow-up, and no fracture or radiographically detectable alteration of the welded substructure was evident after 12 months of functional loading.

Recently, Komiyama et al[27] evaluated the outcome of immediately loaded implants installed in edentulous jaws following computer-assisted virtual treatment planning combined with flapless surgery. The authors reported higher occurrences of surgical and technical complications compared to conventional protocols, since these complications occurred in 42% of treated cases. Misfit of prosthetic superstructure appeared in 5 of 31 cases, resulting in disconnection of the prosthesis in two patients where implants were left for unloaded healing. Implant losses resulted in the removal of the superstructure in three patients, who then received removable dentures. Extensive adjustments of occlusion were made in 10% of the immediately connected restorations. Radiographic bone defects developed in three patients after drilling, which appeared, in two cases, after guide anchor-pin drilling in the maxilla and, in another case, in a severely resorbed mandible.

Yong and Moy[28] evaluated the surgical and prosthetic complications of CAD/CAM-guided surgical implant placement (Nobel Guide, Nobel Biocare). The authors reported an overall implant failure rate of 9%, bony interference that prevented complete seating of the prostheses, and fractures of the carbon fiber framework prosthesis.

The intraoral welding procedure allowed the direct creation of a precise and completely passive framework, without the need of any correction with luting agents[29] or additional components, such as those often necessary for CAD/CAM frameworks.[17] It also proved to be time and cost effective, as it employs only a simple titanium bar, commercially available denture teeth, and standard titanium abutments. In the maxillary cases, the bone resorption pattern was similar to that reported by Ibañez et al[16] and slightly lower than that observed by van Steenberghe et al.[17] The prostheses were removed only once, at the 6-month follow-up, to verify osseointegration, thus probably reducing possible damage to the peri-implant tissue and diminishing the risks of recession and bone resorption.[30]

CONCLUSIONS

The goal of an immediate loading protocol is to reduce the number of surgical procedures and to shorten the time frame between surgery and restoration placement without compromising the implant success rate. Within its limitations, this study has confirmed that it is possible to successfully rehabilitate the edentulous patient on the same day as implant placement with a definitive fixed restoration supported by an intraorally welded titanium framework without jeopardizing osseointegration.

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REFERENCES

1. Douglass CW, Shih A, Ostry L. Will there be a need for complete dentures in the United States in 2020? J Prosthet Dent 2002;87:5–8.
2. Salama H, Rose LF, Salama M, Betts NJ. Immediate loading of bilaterally splinted titanium root-form implants in fixed prosthodontics—A technique reexamined: Two case reports. Int J Periodontics Restorative Dent 1995;15:344–361.
3. Tarnow DP, Emtiaz S, Classi A. Immediate loading of threaded implants at stage 1 surgery in edentulous arches: Ten consecutive case reports with 1- to 5-year data. Int J Oral Maxillofac Implants 1997;12:319–324.
4. Grunder U. Immediate functional loading of immediate implants in edentulous arches: Two-year results. Int J Periodontics Restorative Dent 2001;21:545–551.
5. Olsson M, Urde G, Andersen J, Sennerby L. Early loading of maxillary fixed cross-arch dental prostheses supported by six or eight oxidized titanium implants: Results after 1 year of loading, case series. Clin Implant Dent Relat Res 2003;5:81–87.
6. Misch CE, Degidi M. Five-year prospective study of immediate/early loading of fixed prostheses in completely edentulous jaws with a bone quality–based implant system. Clin Implant Dent Relat Res 2003;5:17–28.

7. De Bruyn H, Van de Velde T, Collaert B. Immediate functional loading of TiOblast dental implants in full-arch edentulous mandibles: A 3-year prospective study. Clin Oral Implants Res 2008;19:717–723.
8. Tealdo T, Bevilacqua M, Pera F, et al. Immediate function with fixed implant-supported maxillary dentures: A 12-month pilot study. J Prosthet Dent 2008;99:351–360.
9. Capelli M, Zuffetti F, Del Fabbro M, Testori T. Immediate rehabilitation of the completely edentulous jaw with fixed prostheses supported by either upright or tilted implants: A multicenter clinical study. Int J Oral Maxillofac Implants 2007;22: 639–644.
10. Maló P, Nobre Mde A, Petersson U, Wigren S. A pilot study of complete edentulous rehabilitation with immediate function using a new implant design: Case series. Clin Implant Dent Relat Res 2006;8: 223–232.
11. Aalam AA, Nowzari H, Krivitsky A. Functional restoration of implants on the day of surgical placement in the fully edentulous mandible: A case series. Clin Implant Dent Relat Res 2005;7:10–16.
12. Friberg B, Henningsson C, Jemt T. Rehabilitation of edentulous mandibles by means of turned Branemark System implants after one-stage surgery: A 1-year retrospective study of 152 patients. Clin Implant Dent Relat Res 2005;7:1–9.
13. Ostman PO, Hellman M, Sennerby L. Direct implant loading in the edentulous maxilla using a bone density–adapted surgical protocol and primary implant stability criteria for inclusion. Clin Implant Dent Relat Res 2005;7(suppl):S60–69.
14. Branemark P-I, Engstrand P, Ohrnell LO, et al. Branemark Novum: A new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. Clin Implant Dent Relat Res 1999;1:2–16.
15. van Steenberghe D, Molly L, Jacobs R, Vandekerckhove B, Quirynen M, Naert I. The immediate rehabilitation by means of a ready-made final fixed prosthesis in the edentulous mandible: A 1-year follow-up study on 50 consecutive patients. Clin Oral Implants Res 2004;15:360–365.
16. Ibañez JC, Tahhan MJ, Zamar JA, et al. Immediate occlusal loading of double acid-etched surface titanium implants in 41 consecutive full-arch cases in the mandible and maxilla: 6- to 74-month results. J Periodontol 2005;76:1972–1981.
17. van Steenberghe D, Glauser R, Blombäck U, et al. A computed tomographic scan–derived customized surgical template and fixed prosthesis for flapless surgery and immediate loading of implants in fully edentulous maxillae: A prospective multicenter study. Clin Implant Dent Relat Res 2005;7(suppl): S111–120.
18. Klee de Vasconcellos D, Bottino MA, Saad PA, Faloppa FF. A new device in immediately loaded implant treatment in the edentulous mandible. Int J Oral Maxillofac Implants 2006;21:615–622.
19. Degidi M, Gehrke P, Spanel A, Piattelli A. Syncrystallization: A technique for temporization of immediately loaded implants with metal-reinforced acrylic resin restorations. Clin Implant Dent Relat Res 2006;8:123–134.
20. Degidi M, Nardi D, Piattelli A. Immediate rehabilitation of the edentulous mandible with a definitive prosthesis supported by an intraorally welded titanium bar. Int J Oral Maxillofac Implants 2009;24: 342–347.
21. Degidi M, Nardi D, Piattelli A. Immediate loading of the edentulous maxilla with a final restoration supported by an intraoral welded titanium bar: A case series of 20 consecutive cases. J Periodontol 2008 ;79:2207–2213.
22. Mondani PL, Mondani PM. The Pierliugi Mondani intraoral electric solder. Principles of development and explanation of the solder using syncrystallization. Riv Odontostomatol Implantoprotesi 1982; 4:28–32.
23. Hruska AR. Intraoral welding of pure titanium. Quintessence Int 1987;18:683–688.
24. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.
25. Jaffin RA, Kolesar M, Kumar A, Ishikawa S, Fiorellini J. The radiographic bone loss pattern adjacent to immediately placed, immediately loaded implants. Int J Oral Maxillofac Implants 2007;22:187–194.
26. Hruska A, Borelli P, Bordanaro AC, Marzaduri E, Hruska KL. Immediate loading implants: A clinical report of 1301 implants. J Oral Implantol 2002; 28:200–209.
27. Komiyama A, Klinge B, Hultin M. Treatment outcome of immediately loaded implants installed in edentulous jaws following computer-assisted virtual treatment planning and flapless surgery. Clin Oral Implants Res 2008;19:677–685.
28. Yong LT, Moy PK. Complications of computer-aided-design/computer-aided-machining-guided (NobelGuide) surgical implant placement: An evaluation of early clinical results. Clin Implant Dent Relat Res 2008;10:123–127.
29. Longoni S, Sartori M, Ariello F, et al. Passive definitive fit of bar-supported implant overdentures. Implant Dent 2006;15:129–134.
30. Abrahamsson I, Berglundh T, Sekino S, Lindhe J. Tissue reactions to abutment shift: An experimental study in dogs. Clin Implant Dent Relat Res 2003;5: 82–88.