

CAD/CAM TECHNOLOGIES IN THE SURGICAL AND PROSTHETIC TREATMENT OF THE EDENTULOUS PATIENT WITH BIOMYMETIC INDIVIDUALIZED APPROACH

A. POZZI*, M. GARGARI**, A. BARLATTANI***

* DDS PhD, Private Practice in Rome, Italy

** University of Rome Tor Vergata, Department of Odontostomatological Sciences

*** MD DDS, Chief and Director Dental Degree & Department of Dentistry, University of Rome Tor Vergata

SUMMARY

CAD/CAM technologies in the surgical and prosthetic treatment of the edentulous patient with biomimetic individualized approach

Background: The advent of modern endosseous implant design and improved surface technology has allowed the development of new restorative techniques that decrease patient's total treatment time. Utilizing the latest scanning, CAD/CAM and manufacturing technologies we are able to manufacture individualized dental restoration with high accuracy and a perfect precision of fit.

Materials and methods: This report describes the rehabilitation of a completely edentulous patient utilizing a CT-based implant planning with computer-assisted surgical design, simultaneous CAD/CAM fabrication of a surgical template, a flapless surgical placement of the implants, and a prefabricated fixed complete denture for an immediately loaded restoration according to Nobel Biocare's Teeth-in-an-Hour™ (Nobel Biocare Goteborg, Sweden) protocol.

This systematic approach to full mouth rehabilitation reduces the time necessary for an edentulous patient to go from severely atrophic alveolar support to implant retained prosthetic restoration. These aspects of minimally invasive and simplified surgery, along with reducing the treatment time and postsurgical discomfort, are beneficial to the patient, and allowing for rehabilitation with the same level of success as in flap surgery.

Conclusion: The Teeth-in-an-Hour protocol is a unique solution made possible by the Procera System. With the aid of the CT scans and a virtual planning software, a custom fabricated precision drill guide and a pre-manufactured prosthesis can be made before surgery. The execution of implant placement is performed with a flapless procedure that results in minimal surgical intervention. This results in a short and non-traumatic surgery with a minimum of postoperative complications, allowing the patient to leave the chair with a fixed prosthesis. Utilizing the latest scanning, CAD/CAM and manufacturing technologies the dental team is able to develop individualized zirconia full arch framework with high accuracy and precision of fit.

Key words: Nobel Guide, CAD/CAM technology, zirconia full arch framework.

RIASSUNTO

La tecnologia CAD/CAM nella riabilitazione implantoprotesica del paziente edentulo con un approccio biomimetico individualizzato

Background: l'introduzione di nuovi design implantari e di nuove superfici finalizzate al miglioramento delle capacità osteoinduttive e d'integrazione delle fixture ha stimolato i clinici a sviluppare nuove procedure restaurative che aumentino il comfort del paziente e riducano il tempo complessivo di trattamento. Utilizzando le ultime tecniche di scansione, in associazione con la tecnologia CAD-CAM, siamo in grado di produrre restauri protesici individualizzati con un alto grado di accuratezza e con una perfetta precisione, anche nei casi di riabilitazioni complete.

Materiali e metodi: questo articolo descrive un protocollo di trattamento per la riabilitazione implantare immediata delle arcate completamente edentule. Il protocollo Teeth-in-an-Hour (Procera System, Nobel Biocare) è una soluzione terapeutica unica, resa possibile da una piattaforma di produzione che mette a disposizione del team implantoprotesico, la tecnologia CAD/CAM nelle varie fasi di progettazione e realizzazione della riabilitazione su impianti. Il posizionamento dei pilastri implantari viene eseguito con una procedura chirurgica flapless mini-invasiva; questo approccio conservativo risulta in una chirurgia atraumatica, di breve durata rispetto alle procedure convenzionali e pertanto il dolore e le complicanze locali nell'immediato post-operatorio (sanguinamento e gonfiore) sono minime, con grande beneficio per il paziente, garantendo le stesse percentuali di successo della chirurgia a cielo aperto. Il team implantoprotesico utilizzando la tecnologia CAD-CAM è in grado di progettare e realizzare la riabilitazione implantoprotesica con un elevato grado di precisione e di accuratezza chirurgico-protesica. Utilizzando le ultime tecniche di scansione tattile-meccanica, l'elaborazione CAD/CAM e tecnologie di produzione e controllo di tipo industriale, è possibile ottenere restauri in ossido zirconio estesi a tutta l'arcata dentaria con un alto grado di accuratezza e precisione.

Conclusioni: questo nuovo protocollo attraverso la pianificazione computerizzata virtuale protesico-chirurgica dell'implantologia e la realizzazione di strutture CAD/CAM estremamente precise ed accurate, semplifica le procedure operative necessarie alla riabilitazione delle arcate completamente edentule, facilitando il passaggio da una protesi totale insufficiente e scomoda per il paziente con grave riassorbimento osseo ad una riabilitazione fissa definitiva in circa 4 mesi di trattamento.

Parole chiave: Nobel Guide, tecnologia CAD/CAM, strutture estese in zirconio.

The advent of modern endosseous implant design and improved surface technology has allowed the development of new restorative techniques that decrease a patient's total treatment time. Utilizing the latest scanning, CAD/CAM and manufacturing technologies we are able to manufacture individualized dental restoration with high accuracy and a perfect precision of fit. According to the original Branemark protocol the time period for the osseointegration of an implant, prior to restoration, in preparation for loading was between 3 and 6 months, depending on implant position and bone quality (Branemark, 1983; Gapski R., 2003). Changes in implant design and surface characteristics have led to the concept of early loading of implants, decreasing the unloaded time to less than 2 to 4 weeks. The success of immediate and early loading of implants has been well documented in multiple studies using the latest generation fixtures (Ogawa T., 2003; Zechner W., 2003). Rigid cross-arch stabilization has been shown to successfully allow the immediate loading of titanium implants in an edentulous ridge, allowing rapid sequence rehabilitation of the arch involved. With the combination of the new surface technology and cross-arch stabilization, immediate placement of an implant-supported fixed prosthesis following implant placement is now a predictable treatment option (Gapshi R., 2003; Tarnow D., 1997; Sadowsky S.J., 1997; Harris D., 2002; Chatzistavrou M., 2003).

There has been numerous treatment modalities described for the immediate loading of implants to achieve optimal prosthetic design during the rehabilitation of the edentulous ridge such as the conversion prosthesis (Balshi, 1985), retrofitting an existing complete denture, providing relief in the areas of the implants, by converting it into a provisional restoration using acrylic resin or acrylic resin metal-reinforced frameworks (Zitmaqn N.U., 1999). Laboratory fabricated transitional prosthesis can be processed following the placement of the implants by making a traditional impression of the fixtures. Another treatment is a laboratory-processed provisional utilizing a precast framework and processed complete den-

ture that is connected intraorally after implant placement (Rodrigues A.H., 2003).

Creating a provisional prosthesis after the surgical procedure can be difficult and time-consuming for both the patient and the clinician because of the extended time in the chair (Rodrigues A.H., 2003).

This report describes the rehabilitation of a completely edentulous patient utilizing a CT-based implant planning with computer-assisted surgical design, simultaneous CAD/CAM fabrication of a surgical template, a flapless surgical placement of the implants, and a prefabricated fixed complete denture for an immediately loaded restoration according to Nobel Biocare's Teeth-in-an-Hour™ (Nobel Biocare Goteborg, Sweden) protocol.

This systematic approach to full mouth rehabilitation reduces the time necessary for an edentulous patient to go from severely atrophic alveolar support to implant retained prosthetic restoration. These aspects of minimally invasive and simplified surgery, along with reducing the treatment time and postsurgical discomfort, are beneficial to the patient (Malo P., 2003). and allowing for rehabilitation with the same level of success as in flap surgery (Malo P., 2007).

Using surgical software (NobelGuide; Nobel Biocare AB) and a computerized tomography scan (CT scan), data can be transferred into a 3-dimensional (3-D) implant planning program to allow for accurate planning and placement of implants (Marchack, 2005). A surgical template and a fixed acrylic resin implant supported prosthesis are fabricated, ensuring precision of transfer from the virtual to the planned prosthesis, immediately after clinical implant placement through a flapless surgery, a prosthesis, manufactured prior to the implant surgery, was inserted.



Case report

A 60-year-old man presented with a mandibular complete denture (Fig. 1). The patient had been edentulous since he was 50 years old. Because of



Figure 1
Patient with a mandibular complete denture functionally inadequate.

over 10 years of removable complete denture use, the edentulous alveolar ridges have suffered severe resorption. The patient was never comfortable with the mandibular prosthesis and complained of ill-fitting mandibular prosthesis. The patient stated that he was interested in fixed prosthetic rehabilitation. The patient had a comprehensive examination by an oral surgeon and prosthodontist to establish his candidacy for implant therapy with immediate loading of the dental implants.

Patient selection is critical and may predicate success of the surgery (Sadowsky S.J., 1997; Zitzmann N.U., 1999) host factors, implant design, and occlusal loads may all impact osseointegration of the implants (Gapski R., 2003).

The patient was reevaluated to determine and confirm tooth position for aesthetics (Frush J., 1955), phonetics (Rothman, 1961), and appropriate vertical dimension (Swerdlow, 1965).

For radiographic guide preparation, the patients' previously worn prosthesis was used, when adequate, or a new complete transitional lower dentures was fabricated.

When a new removable prosthesis was fabricated, an impression was made with an elastomeric impression material (polyether, Impregum Penta, 3M Espe, Italy) to obtain the final casts. Maxillo-mandibular relation records, including the making of an interocclusal record and a trial insertion of the tooth arrangement, were accomplished.

Once the appropriate setup was achieved the mandibular arch rehabilitation started. If the fabricated transitional complete prosthesis is acceptable to the patient both functionally and aesthetically, the practitioner needs to confirm its stability or a reline would be required. It is imperative at this stage that both the patient and practitioner are satisfied prior to proceeding with the projected immediately loaded fixed prosthesis. This commits both the patient and practitioner to the final restoration; otherwise a new setup should be undertaken.

In this procedure, the transitional denture is duplicated into clear acrylic for use as a radiographic guide. As with all duplications, confirming the seat of the duplicate radiographic guide is imperative. The same denture can also be used as a radiographic guide but it is important that it's not reinforced with metal framework. Six buccal and 3 palatal holes, 1.5 mm wide and 1 mm deep, were made randomly at different levels in the removable prosthesis and were filled with a radio-opaque marker (guttapercha; Obtura Spartan, USA) (Fig. 2).

An interocclusal record was made as a radiographic index with a rigid vinyl polysiloxane (Zhermack SpA, Italy) at the patient's appropriate centric relation and occlusal vertical dimension. The patient was prescribed for a mandibular computed tomography (CT), using a dou-



Figure 2
Duplicate of transitional prosthesis used as radiographic guide with radio-opaque markers randomly positioned at different levels.

ble-scan technique (van Steenberghe D., 2002) which allowed views of different objects at different densities. The first scan was of the patient with the interim denture, which included the radiopaque markers and the interocclusal record. The second scan was of the denture only with the same orientation as in the mouth. The CT data was converted into a file format compatible with the planning program, having the two sets of scans superimposed upon each other. One scan was of the osseous tissues and the other of the complete denture, which showed the position of the planned denture teeth in relation to the bone. The reformatted data was returned to the surgical and restorative team to determine and plan for the implant positions. A 3-dimensional implant planning software program the Procera Software Planning program (Nobel Biocare AS), following the Procera Cad-Design procedure, allowed the clinicians to evaluate the osseous tissues in relation to the ideal prosthetic position of the denture teeth (Fig. 3). From this information, the

sizes and positions of the dental implants were digitally evaluated and virtually placed (Verstreken K., 1996) (Fig. 4). The surgical placement data was transferred to a milling center (Procera; Nobel Biocare) that fabricated and delivered the surgical template (Nobel Guide, Nobel Biocare, AB) (Fig. 5) to guide the surgeon as to the precise positions of each dental implant (Parel S.M., 1991).

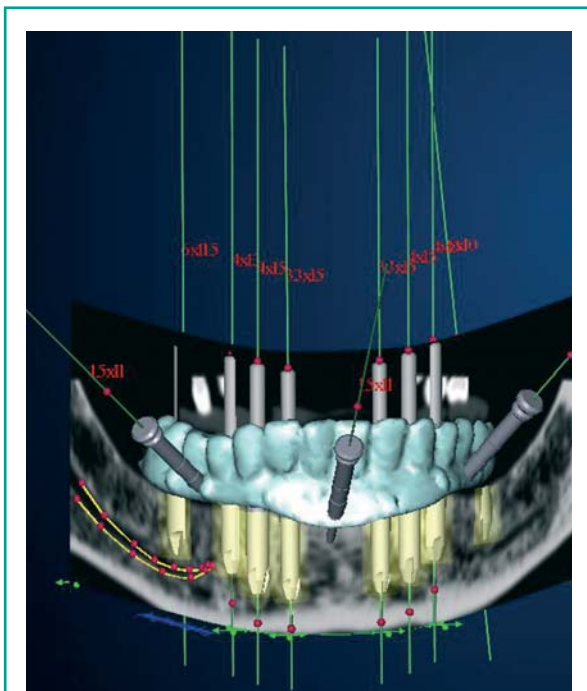


Figure 3
Procera Software Planning Program allows for prosthetic guided implant positioning.

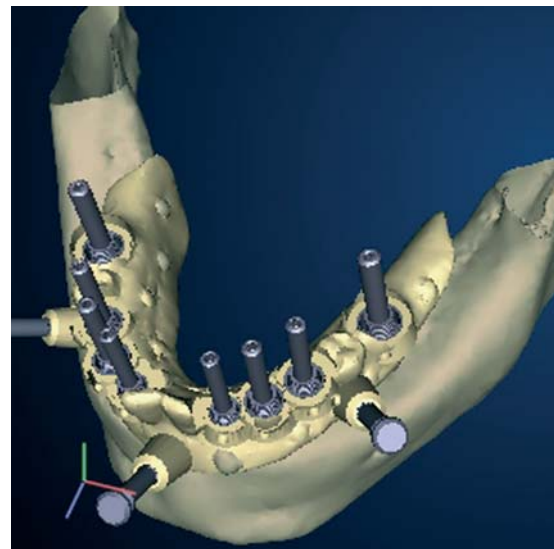


Figure 4
A 3-dimensional Procera Cad-design of surgical template after implant virtual positioning.



Figure 5
CAD/CAM manufactured surgical template.

Dental laboratory

The laboratory process consisted of fabricating a working cast connecting implant replica to the surgical stent and mounting the cast onto an articulator with the opposing cast using the original interocclusal record and radiographic guide. A new interocclusal record was made between the surgical template and the opposing arch on the articulator to facilitate positioning and to transfer the centric relation and occlusal vertical dimension information to the patient during surgery. Therefore an acrylic resin fixed complete denture reinforced with metal frame work to guarantee cross-arch stabilization of implants was fabricated.

Surgical procedure

The surgical template was oriented in the patient using a surgical index fitted to the opposing arch (Fig. 6) and stabilized with anchor pins (Nobel Biocare AB). After placement of the surgical template, flapless implant surgery was performed, following the manufacturer's instructions, using a drill protocol (NobelGuide; Nobel Biocare AB). The surgical procedure was performed according to the *Teeth-in-an-Hour concept* (Nobel Biocare AB). The flapless surgery was performed under local anesthetic (Rocci A., 2003). The surgical template was inserted and positioned with the centric relation interocclusal record. While the patient was closed into the interocclusal record, friction-fitted horizontal stabilization pins (Procera; Nobel Biocare) were used to help maintain the accurate position of the surgical template during the surgical procedure. The three horizontal stabilization pins were placed through the surgical template in a preplanned horizontal direction into the osseous tissues.

The 1.5-mm twist drill was used to create retentive holes for the stabilization pins. The pins were positioned, securing the surgical template,



Figure 6
Surgical template oriented in the mouth using a surgical index fitted to the opposing arch and stabilized with anchor pins.

and the patient was allowed to open his mouth. The first osteotomy site was prepared, adjacent to the most anterior implant site, using the appropriate drilling guides and twist drills. The preplanned length and diameter of the implant was placed using the implant guide. After insertion of the implant (NobelSpeedy Groovy®, Nobel Biocare AB) with an oxidized surface (TiUnite; Nobel Biocare AS) a template abutment was inserted, which connected the surgical template to the placed implant, providing additional stability to the template. The next implant was inserted in the opposite side of the arch, also adjacent to the most anterior implant to guarantee the cross stabilization of the surgical guide. After the implant was placed, a second template abutment was inserted. The three horizontal stabilization pins, and the two template abutments, ensured the surgical template's stability and accurate position. The remaining implants were placed, using the same drilling guides and twist drills (Fig. 7). Furthermore, there is consensus on the importance of achieving adequate primary stability by placing implants at insertion torque values of 35 to 45 Ncm (Malo P., 2003). However, in more dense bone (classes D1 and 02, Lekholm and Zarb index), insertion torque should not exceed 50 Ncm to avoid bone overcompression and increase the risk of crestal bone loss. The minimally-invasive approach of Nobel Guide surgical procedure allowed no bleeding or pain performing surgery, and a healthy aspect of soft tissue after implant placement (Fig. 8).

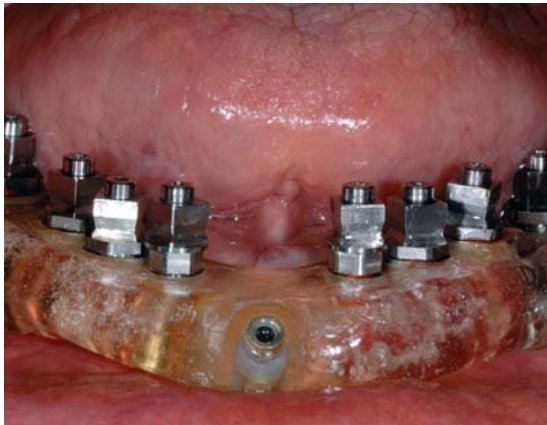


Figure 7
8 fixtures positioned and seated correctly on the sleeve of surgical template.

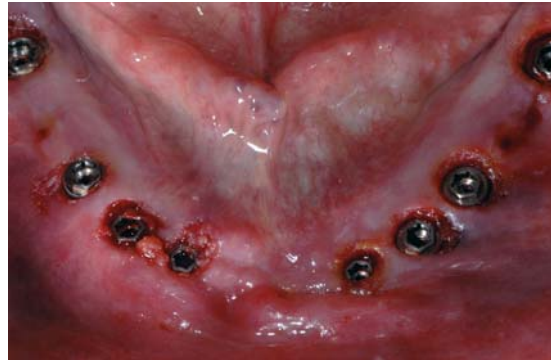


Figure 8
Minimally invasive guided surgery results in minimal postsurgical trauma of periimplant soft tissue.



Figure 9
The pre-fabricated temporary prosthesis framework passively fitted on implants.

Prosthetic procedure

After all implants were placed, the pre-fabricated temporary prosthesis framework was inserted (Fig. 9). Vertically adjustable abutments (Nobel Biocare AB) were used, which allowed for discrepancies in the z-axis. The adjustable abutment is an interlocking cylinder sleeve with two pieces that slide within one another. The sliding cylinders of the abutment allow for slight variations in the z-

axis position of the implant, allowing a passively fitting framework. Once the prosthesis was inserted, postoperative radiographs were made to confirm the fit of the prosthesis (Fig. 10a-b-c). The retaining screws were torqued at 35 Ncm into place, the occlusion was evaluated and adjusted to have simultaneous centric relation contact and a canine protected occlusal scheme (van Steenberghe D., 2002). In addition, provisional prostheses with narrow occlusal platforms, flat cusps, and light occlusal contacts to minimize the lateral forces are recommended (Rocci A., 2003) (Morton D., 2004) (Rangert B.R., 1997). The access holes were sealed with a cotton pellet and gutta-percha.

After surgery follow-up

Following the procedure, the patient was discharged home. The patients was enrolled in an implant maintenance program (Table I) and instructed to eat a soft diet for 2 months. To be classified as surviving, the implants were required to fulfill the following criteria: clinical stability, patient reported function without any discomfort, absence of suppuration, infection, or radiolucent areas around the implants at 10 days and 2-4 months, post-surgically.

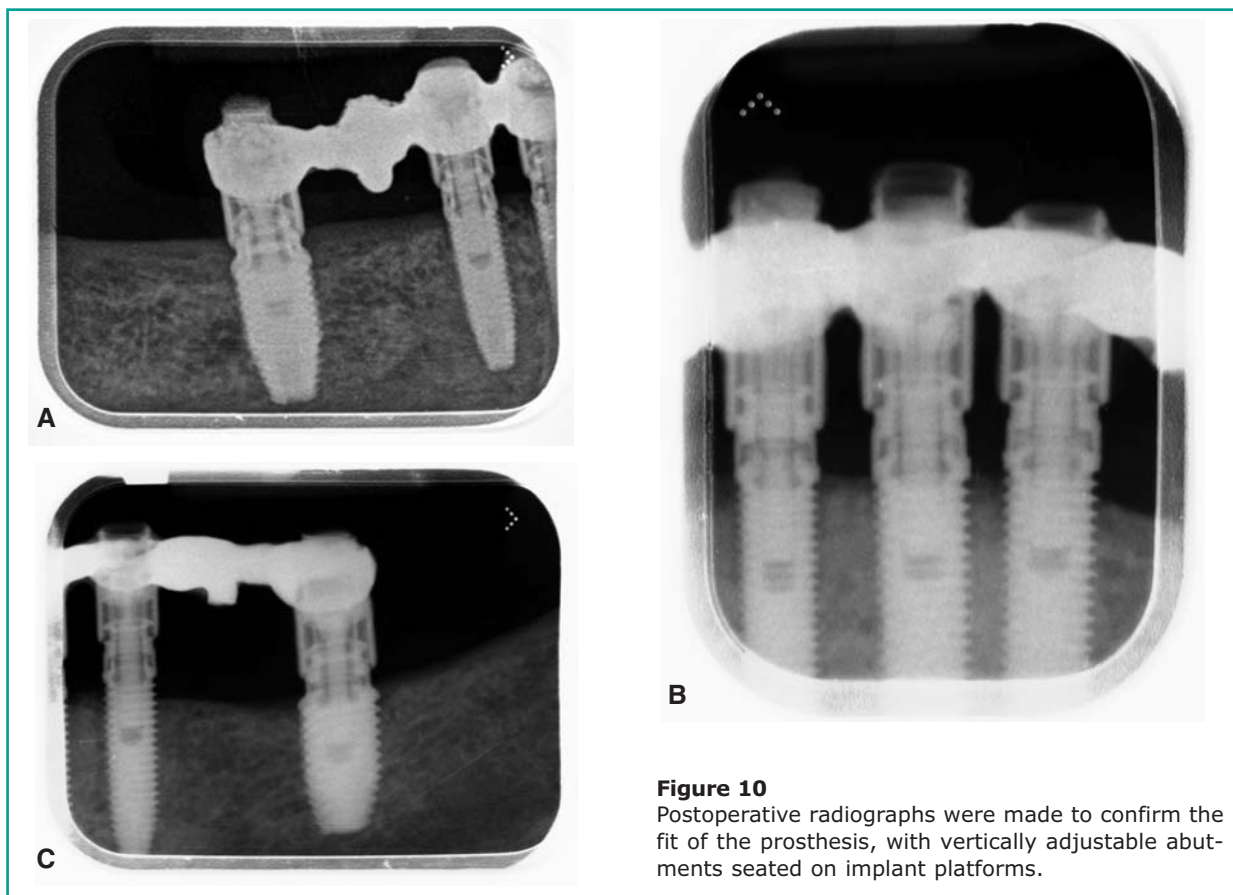


Figure 10
Postoperative radiographs were made to confirm the fit of the prosthesis, with vertically adjustable abutments seated on implant platforms.

Periapical radiographs were made at implant insertion and after 4 months. A conventional radiograph holder (Rinn RX Holder; Dentsply, Italy) was used, and its position was manually adjusted for an estimated orthogonal position of the film. The reference point for the reading was the implant platform (the horizontal interface between the implant and the abutment), and marginal bone remodeling was defined as the difference in marginal bone level relative to the bone level at time of surgery.

After 3 months, if the implants were judged stable (Fig. 11) a conventional protocol was followed to take an impression for manufacturing the definitive prosthesis. An impression using a reversible hydrocolloid was made for a study cast poured in a gypsum stone. This study cast was used to fabricate an open-top custom tray from a light-cured resin. At a subsequent appointment

impression copings (Nobel Biocare 29073) were torqued (15 Ncm) to the implant. If the impression copings seating could not be confirmed by visual inspection, a radiograph was taken to verify the seating prior to impression taking. A stone-impression is made using an impression plaster (Snow White Plaster 2, Kerr) to obtain rigid splinting of impression copings and accurate reproduction of the soft tissue anatomy for the fabrication of the master cast (Fig. 12). Laboratory analogs (Nobel Biocare 29108) were attached to the impression copings, and a soft tissue and stone master cast was fabricated. The esthetics and phonetics of the definitive prosthesis was dictated by the interim denture. The full bridge was produced using CAD/CAM technology following Procera Zirconia Implant Bridge protocol. The full bridge framework was modeled with a wax-up procedure using an acrylic

Table 1 - Postsurgical protocol.	
Day of surgery (Day 1)	Evaluation of occlusion; instructions to avoid prosthesis overload; explanation of treatment phases and maintenance procedures to the patient; oral hygiene procedures: administration of chlorhexidine mouthwash and application of chlorhexidine gel after surgery for 10 days; periapical radiographs
Day 10	Evaluation of occlusion; control of suppuration by finger pressure; instructions to avoid prosthesis overload; oral hygiene procedures.
Day 45	Panoramic radiographs; removal of prosthesis for cleaning and disinfecting; evaluation for fracture or loosening of prosthetic components; control of suppuration by finger pressure; instructions to avoid prosthesis overload; oral hygiene procedures.
Month 3	Evaluation of occlusion; evaluation for inflammation/infection; removal of prosthesis for cleaning and disinfecting; impression; periapical radiographs; oral hygiene procedures
Month 4	Definitive prosthesis placement; panoramic and periapical radiographs.
Maintenance Protocol	Periapical annual radiographs; oral hygiene procedures <i>every</i> 4-6 months without removal of prosthesis.

low shrinkage resin (Leocryl, Leone spa, Italy) (Fig. 13). The CAD design of the framework (Fig. 14) was obtained by tactile scan and related data was sent to the milling Center to produce definitive bridge from one blank of zirconia. Pro-cera Bridge Zirconia has a very high flexural strength and fracture toughness, these make zir-

conia very resistant to masticatory forces, still with maintained exact precision of fit (Sierraalta M., 2006) (Fig. 15, 16).

The biocompatibility of zirconia improve soft tissue healing and guarantees a soft tissue seal around the neck of the implant (Fig. 17).

The zirconia framework was prepared for porce-



Figure 11
Periimplant soft tissue healing at 3 months after surgery and immediate loading.



Figure 12
Stone impression of the implants with an open top impression tray.



Figure 13
The full bridge framework was modeled with a wax-up procedure using an acrylic low shrinkage resin.



Figure 15
Procera Zirconia Implant Bridge made with CAD/CAM technology.

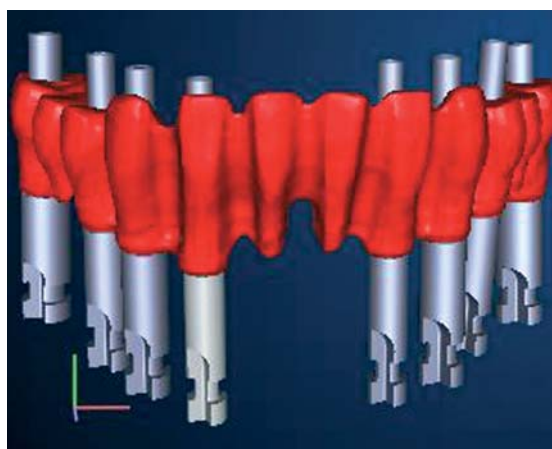


Figure 14
The CAD design of the framework obtained by tactile scan.



Figure 16
High precision and accuracy of fitting on implant platform of Zirconia implant Bridge.

lain application and the definitive prosthesis was seated in the mouth and torqued with special zirconia screws at 35 Ncm (Fig. 18a-b-c).

Discussion

The *Teeth-in-an-Hour* protocol is a unique solution made possible by the Procera System. With the aid of the CT scans and a virtual planning software, a custom fabricated precision drill



Figure 17
Full arch Zirconia framework try-in.



Figure 18
Completed Procera Zirconia Implant Bridge interocclusal lateral and frontal view: ideal implant positioning respecting volume emergence profile of definitive prosthesis.

guide and a pre-manufactured prosthesis can be made before surgery. During the clinical and digital planning stage most treatment decisions are made with regard to prosthesis design and implant placement. The execution of implant placement is performed with a flapless procedure that results in minimal surgical intervention. This results in a short and non-traumatic surgery with a minimum of postoperative complications, allowing the patient to leave the chair with a fixed prosthesis. The patient was elated with the short surgery time and remarked postoperatively at the uneventful short recovery with minimal discomfort. Flapless surgery means less chance of swelling, less pain, and faster initial healing times. Surgical complications can include planning and placement of the implants too deeply into the osseous tissues, making it difficult to seat the prosthesis. It is critical to ensure the osseous tissue is cleared around the placed implant, allowing the abutment to be completely seated.

This procedure may be contraindicated for patients with limited oral opening. The surgical armamentarium is longer than traditional drill kits and access may be difficult.

Utilizing the latest scanning, CAD/CAM and manufacturing technologies the dental team is able to develop individualized dental restoration with high accuracy and precision of fit (Fig. 19a-b-c). This new protocol simplifies the operative procedure of total arch reconstruction and allows transition from severe ridge resorption and failing conventional dentures to an implant fixed definitive prosthesis within 4 months (Fig. 20).

Acknowledgement

The authors wish to thank Mr. Alberto Bonaca, Dental technician, Perugia (Italy), for his precision and accuracy in performing all the laboratory phases of the treatment.

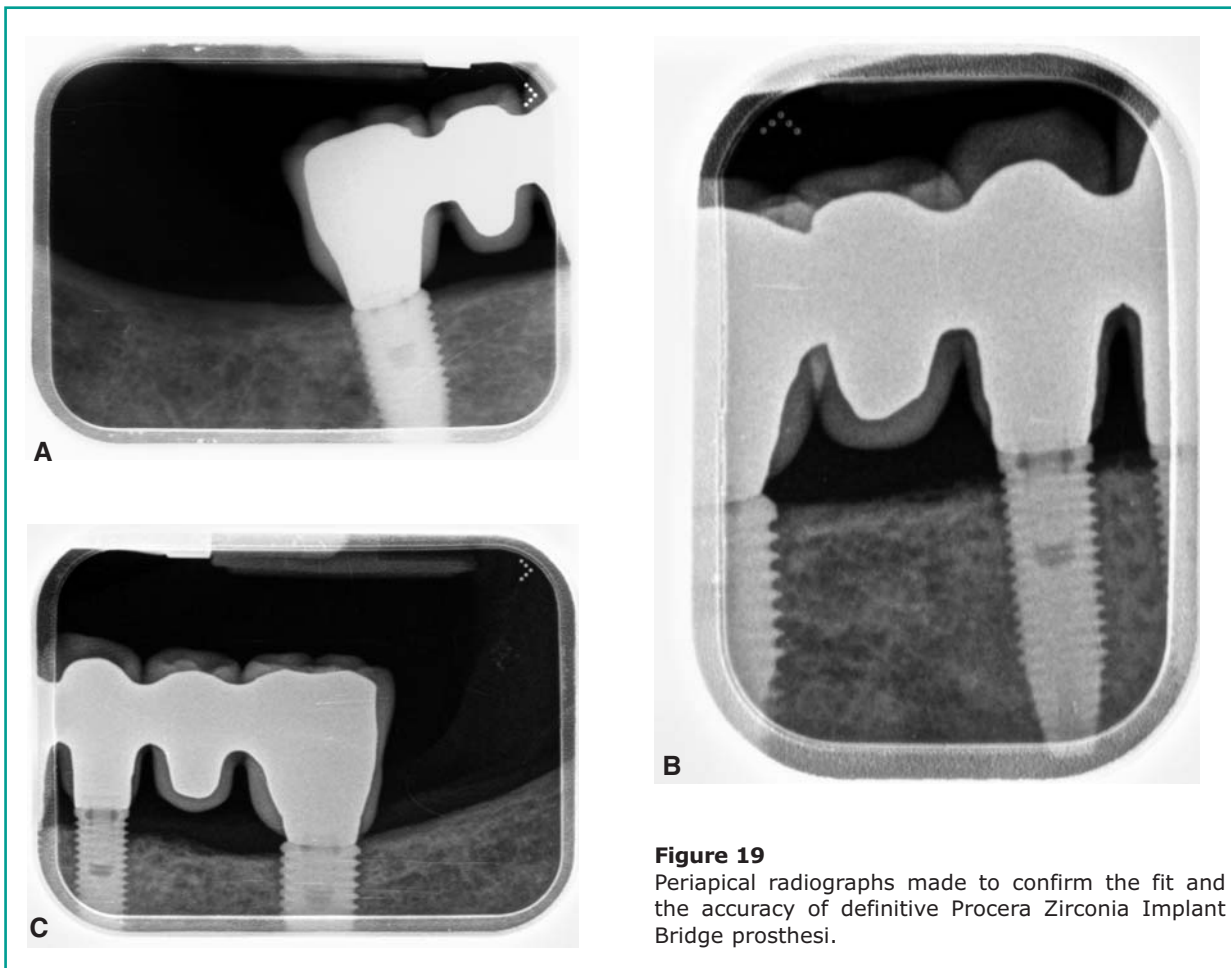


Figure 19
Periapical radiographs made to confirm the fit and the accuracy of definitive Procera Zirconia Implant Bridge prosthesis.

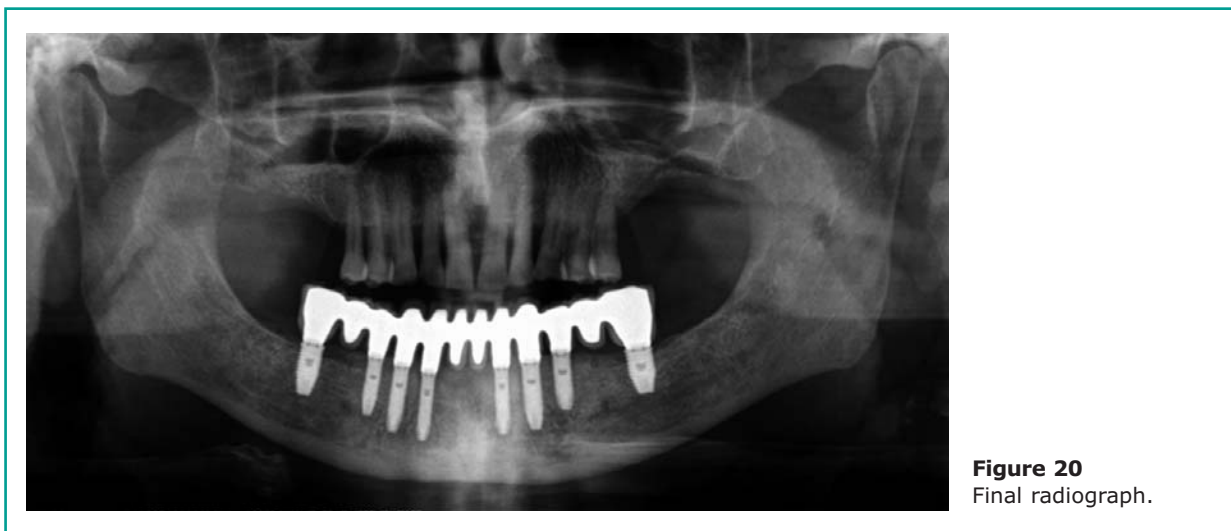


Figure 20
Final radiograph.



References

1. Adell R, LU. A 15 year study of osseointegrated implants in the treatment of edentulous jaw. *Int J Oral Surg* 1981; (10): 387-416.
2. Balshi T. The Biotes conversion prosthesis: a provisional fixed prosthesis supported by osseointegrated titanium fixtures for restoration of edentulous jaw. *Quintessence Int* 1985; 16: 667-677.
3. Branemark P. Osseointegration and its experimental background. *J Prosthet Dent* 1983; 50: 339-410.
4. Campelo LD, C.J. Flapless implant surgery: a 10-year-clinical retrospective analysis. *Int J Oral Maxillofac Impl* 2002;(17): 271-276.
5. Chatzistavrou M, F.D. Immediate loading of dental implants in partially edentulous patients: a clinical report. *J Prosthodont* 2003; 12: 26-29.
6. Frush J, F.R. Introduction to dentogenic restoration. *J Prosthet Dent* 1955; 5: 586-95.
7. Gapski R, W.H. Critical review of immediate implant loading. *Clin Oral Implants Res* 2003; 14: 512-527.
8. Gapski R, W.H. Critical review of immediate implant loading. *Clin Oral Implants Res* 2003; 14: 512-527.
9. Glauser R, L.A. Immediate occlusal loading of Branemark MkIV TiUnite implants placed predominantly in soft bone: 1-year results of a prospective, clinical study. *Clin Impl Dent ReI Res* 2003; (1): 47-56.
10. Harris D, B.D. EAO guidelines of the use of diagnostic imaging in implant dentistry. A consensus workshop organized by the European Association for Osseointegration in Trinity College Dublin. *Clin Oral Implant Res* 2002; (3): 566-570.
11. Jemt T, B.T. Precision of CNC-milled titanium Framework for implant treatment in the edentulous jaw. *Int J Prosthodont* 1999; 209-15.
12. Jemt T. Three-dimensional distortion of gold alloy castings and welded titanium frameworks. Measurements of the precision of fit between completed implant prosthesis and the master cast in routine edentulous situations. *J Oral Rehabil* 1995; 22: 557-64.
13. Malo P, F. B. Immediate and early function of Branemark System implants placed in the esthetic zone: a 1-year prospective clinical multicenter study. *Clin Implant Dent Relat Res* 2003; 5 (1): 37-46.
14. Malo P, N.M. The use of computer-guide flap less implant surgery and four implants placed in immediate function to support a fixed denture: preliminary results after a mean follow-up period of thirteen months. *J Prosthet Dent* 2007; 97: 526-534.
15. Marchack C. An immediately loaded CAD/CAM-guided definitive prosthesis: A clinical report. *J Prosthet Dent* 2005; 93: 8-12.
16. Marchack C. What can we offer patients with today's advancements dental materials? *J Calif Dent Assoc* 2003; 31: 339-40.
17. Marx RE, S.T. Severely resorbed mandible: predictable reconstruction with soft tissue matrix expansion (tent pole) grafts. *J Oral Maxillofac Surg* 2002; 60: 877-878.
18. Morton D, J.R. Immediate restoration and loading of dental implants: clinical considerations and protocols. *Int J Oral Maxillofac Implants* 2004; (19), Suppl:103-108.
19. Ogawa T., N.I. Different bone integration profiles of turned and acid-etched implants associated with modulated expression of extracellular matrix genes. *Int J Oral Maxillofac Implants* 2003; 18: 200-210.
20. Parel SM, F.J. The use and fabrication of a self-retaining surgical guide for controlled implant placement: a technical note. *Int J Oral Maxillofac Implants* 1991; 6: 207-210.
21. Rangert BR., S. R. Load factor control for implants in the posterior partially edentulous segment. *Int J Oral Maxillofac Implants* 1997; (12): 360-370.
22. Rocci A., M.M. Immediate loading in the maxilla using flapless surgery, implants placed in predetermined positions, and prefabricated provisional restorations. A retrospective 3-year clinical study. *Clin Implant. Dent Relat Res* 2003; (5): 29-36.
23. Rodrigues AH, M. S. Laboratory processed acrylic resin provisional restoration with cast metal substructure for immediately loaded implants. *J Prosthet Dent* 2003; 90: 600-4. .
24. Rothman R. Phonetic considerations in denture prosthesis. *J Prostet Dent* 1961; (11): 214-23.
25. Sadowsky SJ. The implant supported prosthesis for the edentulous arch: design considerations. *J Prosthet Dent* 1997; 8: 28-33.
26. Sierralta M, R.M. Load to fracture of Procera Zirconia Bridges. *J Dental Res* 2006; special issue A.
27. Swerdlow, H. Vertical dimension literature review. *J Prosthet Dent* 1965; (15): 241-7.
28. Tarnow D, E.S. Immediate loading of threaded implants at stage I surgery in edentulous arches: ten consecutive case reports with 1-5 year follow-up. *Int J Oral Maxillofac Implants* 1997; 12: 319-324.
29. van Steenberghe D, N.I. A custom template and definitive prosthesis allowing immediate implant loading in the maxilla: a clinical report. *Int J Oral Maxillofac Implants* 2002; 17: 663-670.
30. Verstreken K, V.C. Computer assisted planning of oral implant surgery. A three-dimensional approach. *Int J Oral Maxillofac Implants* 1996;11: 806-810.

31. Zechner W, T.S. Osseous healing characteristics of three implant types. Clin Oral Implants Res 2003; 14: 150-157.
32. Zitzmann NU, M.C. Treatment plan for restoring the

Edentulous maxilla with implant supported restorations; removable overdentures versus fixed partial denture design. J Prosthet Dent 1999; 82 (1): 188-196.

Correspondence:

Dott. Alessandro Pozzi

Viale Liegi 44

00198 Rome

E-mail: info@studioalessandropozzi.com

Website: www.studioalessandropozzi.com