Radiographic and surgical guide fabrication for implant-retained mandibular overdenture

Claudine Wulfman, DDS, MS,[a] Alain Hadida, MD, MS, PhD,[b] and Christophe Rignon-Bret, DDS, MS, PhD[c]
Paris Descartes University, Paris, France

A simple technique is presented to make a multipurpose duplicate of the patient's complete denture to plan and fabricate a mandibular implant-retained overdenture. This duplicate serves 3 different functions. It can be used as a radiographic guide, surgical template, and custom tray adapted to the patient's occlusion. Advantages of the technique described are twofold: it is cost effective and makes use of equipment and materials commonly found in dental practices. The use of a single guide allows the clinician to refer to the recorded prosthetic data at each step of implant treatment. (J Prosthet Dent 2010;103:53-57)

A complete denture, worn and validated by a patient, constitutes a reference for evaluating the implant treatment feasibility for mandibular implant-retained overdentures.[1] Clinical evaluation of prosthesis quality is essential for preoperative diagnosis and treatment planning.[2] The use of a complete denture duplicate as a radiographic guide or surgical template is described in the literature.[3,4] The duplicate denture provides advantages over using the patient's existing complete denture. First, the use of a duplicate removes the risk of altering or weakening the original denture when creating reference landmarks (drilling, grooves). Also, the original denture's esthetic appearance and surface texture are preserved when radiopaque materials, such as gutta-percha or zinc oxide cement, which serve to indicate ideal implant locations, are used.[5] Alternatively, a barium sulfate-based radiopaque duplicate enables visualization of the essential elements required for implant planning, directly from the radiographs.[6] Transforming the radiographic guide into a surgical template provides additional benefits, facilitating surgery. The duplicate's prosthetic volume can be modified to allow access for the contra-angle handpiece and improve operating site visibility during implant surgery. In situations of highly resorbed edentulous mandibular residual ridges, the radiographic guide is an essential tool, during the radiographic analysis, for selecting optimal implant sites in reduced bone volume, compatible with implant placement according to the prosthetic design.

Three-dimensional (3-D) diagnostic and treatment planning systems are available and can also assist clinicians in determining the best implant location and prosthetic planning.[7-9] Fixing the stereolithographic surgical template onto the bone ensures accurate implant placement.[10-11] However, the anchor pins used to fix this template may be difficult to place in an atrophic mandibular residual ridge. Moreover, the software and stereolithographic surgical template present substantial costs, and the use of each requires experience and computer skills.[12-13]

This article describes a simple procedure for making a multipurpose duplicate of the patient's complete denture to plan and fabricate a mandibular implant-retained overdenture. This duplicate is used, at first, as a radiographic guide to validate or modify the implant planning. As a radiographic guide, it allows for the visualization of the following information: planned implant axis, prosthetic volume, emergence site, available prosthetic space for the attachment components, and mucosal thickness. Analysis of the computerized images enables the clinician to select optimal implant sites and to confirm or modify the implant axis according to prosthetic and anatomic requirements. Secondly, the radiographic guide is then transformed into a surgical template. During surgery, this removable surgical template offers flexibility without compromising access to the implant sites. Once osseointegration of the implants is achieved, the template is finally converted into an occlusally adapted custom tray, which is a duplicate of the complete denture worn by the patient.

Advantages of the technique described include its cost effectiveness and the use of equipment and materials commonly found in dental offices. The use of a single guide allows the

[a]Assistant Professor, Department of Prosthetic Dentistry.
[b]Associate Professor, Department of Oral Surgery.
[c]Associate Professor, Department of Prosthetic Dentistry.

clinician to refer to recorded prosthetic data at each step of implant treatment.

TECHNIQUE

Fabrication and use of the radiographic guide

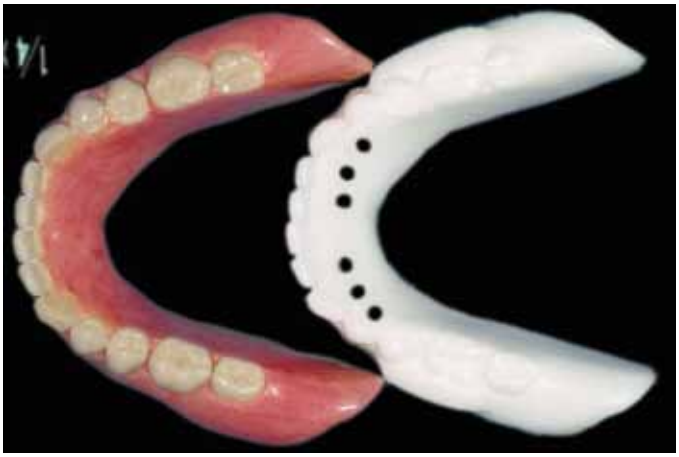
1. Ensure that the existing complete denture is adequate by evaluating it according to the method developed by Sato et al.[2]

2. Duplicate the mandibular complete denture using a box or duplicating flask (Dento-Box; Hager Worldwide, Inc, Odessa, Fla).[3] Fill half of the box with vinyl polysiloxane (Express Penta H Putty; 3M ESPE, Seefeld, Germany) and place the denture in the impression material. After complete polymerization of the impression material (Express Penta H Putty; 3M ESPE), lubricate the denture-silicone surface with a separating agent (Vaseline; Unilever, Greenwich, Conn) before filling the second half of the box with the same impression material (Fig. 1). Remove the denture from the box. Use the impression as a mold for the radiographic guide. Mix barium sulfate powder (10% to 15% in weight) (barium sulfate; Unither, Paris, France) with acrylic resin powder before incorporating the monomer (Formatray; Kerr Corp, Orange, Calif). Pack the mixture in the mold and close the box until the acrylic resin polymerization is complete. Remove the mold from the plastic box, separate the 2 halves of the mold, and retrieve the duplicate denture. Remove acrylic resin sprues. Finish and polish the duplicate denture.

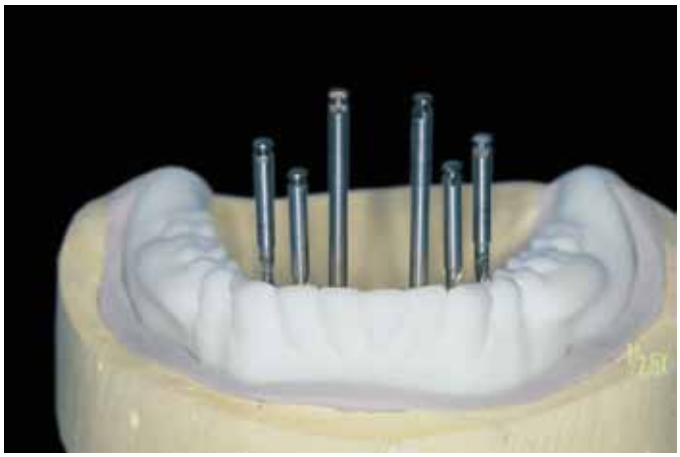
3. Index the desired emergence implant sites in the positions of the lateral incisors, canines, and first premolar areas on the intaglio surface of the duplicate prosthesis to create a guide (Fig. 2). Then index these sites on the denture polished surface, lingual to the location of the teeth. Select symmetrical sites for implant positions.

4. Drill 6 grooves with a 2-mm twist drill (Twist Drill, 2 mm, 25008; Nobel Biocare AB, Göteborg, Sweden), parallel to each other and perpendicular to the occlusal plane to optimize implant stress distribution (Fig. 3).[14-17]

1 Intaglio surface of complete mandibular denture placed in left half of box, while impression of polished surface impression is in right half.



2 Duplicate of conventional denture from radiopaque resin, perforated anteriorly in relation to potential implant sites.

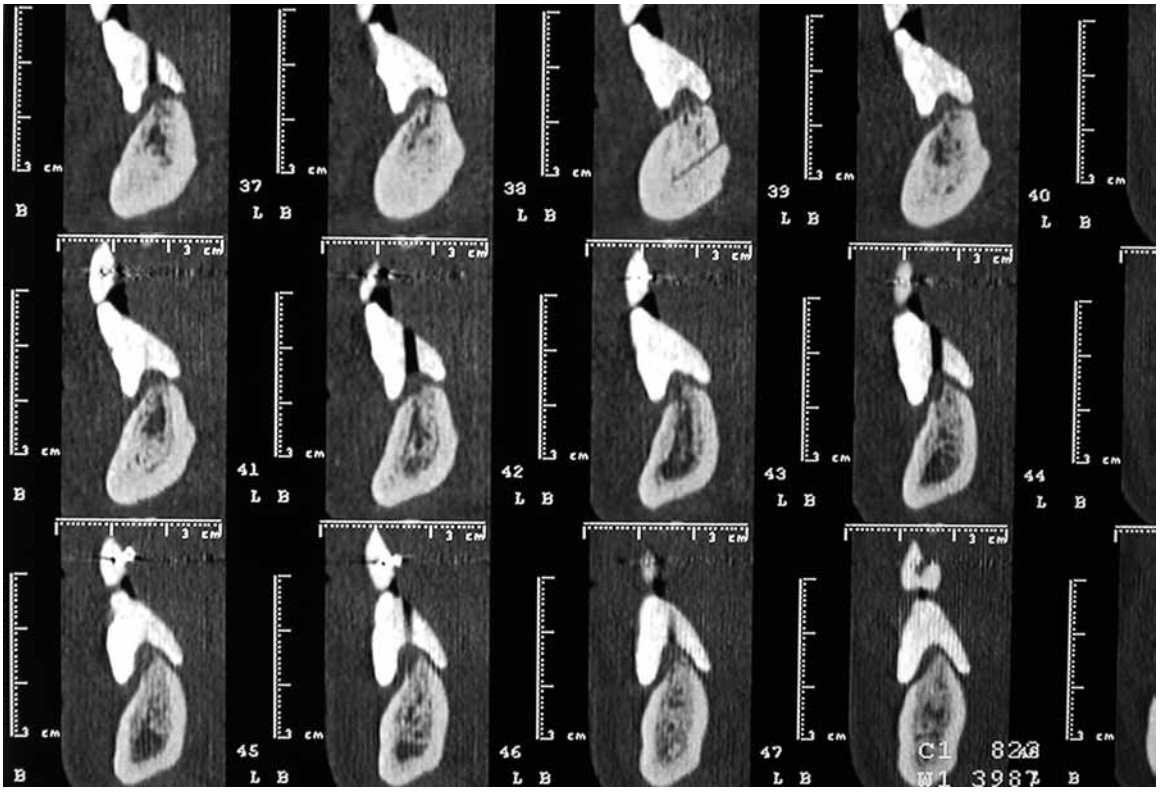


3 Two-mm twist drills parallel to each other.

5. Add autopolymerizing acrylic resin (Pattern Resin; GC America, Alsip, Ill) on the occlusal surface of the duplicate prosthesis to create an accurate record of the occlusion and to ensure correct placement of the radiographic guide. Have the patient occlude on the radiographic guide during the radiographic exam, to maintain it firmly on the mucosa of the denture-bearing area, as it is a mucosa-borne guide (Fig. 4).

6. Select optimal implant sites

4 Interocclusal registration made using autopolymerizing acrylic resin.



5 Prosthetic information appears on CT-scan images: prosthetic volume, bone volume, potential implant axis, and mucosal thickness.

from the radiographic images, and confirm or modify the implant axes, considering anatomic requirements (Fig. 5).

Fabrication and use of the surgical template

7. Drill the guide according to the planned implant position and orientation with a 3-mm twist drill (Twist Drill, 3 mm, 25013; Nobel Biocare AB). Incorporate steel tubes (215 610 002; Weber Métaux et Platiques, Ivry sur Seine, France) with an internal diameter of 2.1 mm in the selected positions (Fig. 6) to serve as drilling guides for the 2-mm twist drill during surgery.

8. Remove the buccal and lingual flanges in the anterior portion of the surgical template to allow use of surgical instrumentation and maintain visibility of the surgical site. Modify the acrylic resin at the occlusal level so as to avoid contact between the contra-angle head and the surgical template during drilling (Fig. 7). Disinfect the surgical template for 30 minutes in a chlorhexidine solution (Eludril; Pierre Fabre Medicament, Castres, France).

9. Raise the mucoperiosteal flaps to expose the bone. Place the surgical template on the denture-bearing area and maintain firmly by applying digital pressure on the first molar area. Use the template to guide the 2-mm twist drill through the cortical bone for each implant site. Remove the surgical guide and place a direction indicator (Branemark System Direction Indicator 28976; Nobel Biocare

6 Tubes with 2.1-mm internal diameter in selected implant site.

7 Surgical template with modifications of acrylic resin base and incisal surfaces.

8 Buccal and lingual flanges of duplicate denture restored with autopolymerizing acrylic resin to allow use as custom tray.

AB) in one of the drilled sites. Use this indicator as a reference to direct the drilling on a parallel axis to the opposite site. Follow the drilling sequence according to the implant system recommendations provided.

Fabrication of the custom tray

10. Add autopolymerizing acrylic resin (Unifast Trad; GC America, Inc) to the intaglio surface of the complete denture, across from implant sites, to recreate the initial intaglio surface of the duplicate denture and flanges using the previously fabricated mold. Allow the acrylic resin to polymerize. Remove the restored duplicate denture from the mold. Remove acrylic resin sprues. Finish and polish (Fig. 8).

11. Following implant osseointegration, use the prosthesis duplicate as an occlusally adapted custom tray during the impression phase for the implant-retained overdenture.

SUMMARY

There are numerous advantages to this complete denture duplicate. It is easy to fabricate from materials commonly available in dental offices. As a radiographic guide for highly resorbed mandibles, it allows selection of optimal implant sites while meeting prosthetic and anatomical requirements. As a surgical guide, it allows implant alignment along planned prosthetic axes during implant surgery and ensures good visual access for the surgeon. The guide can be converted into an occlusally adapted custom tray to make a complete mandibular implant-retained overdenture, as it benefits from the fact that the original denture has been worn and integrated by the patient. This procedure requires firmly maintaining the radiographic guide and surgical template on the mucosa of the denture-bearing area during the radiographic exam and surgery, as it is a mucosa-borne guide. The described protocol is particularly useful for highly resorbed mandibles.

REFERENCES

1. Cooper LF, Scurria MS, Lang LA, Guckes AD, Moriarty JD, Felton DA. Treatment of edentulism using Astra Tech implants and ball abutments to retain mandibular overdentures. Int J Oral Maxillofac Implants 1999;14:646-53.
2. Sato Y, Tsuga K, Akagawa Y, Tenma H. A method for quantifying complete denture quality. J Prosthet Dent 1998;80:52-7.
3. Oh WS, Saglik B. A simple method to duplicate a denture for an implant surgical guide. J Prosthet Dent 2008;99:326-7.
4. Sukotjo C, Radics A. Use of vinyl polysiloxane for the fabrication of implant surgical guide. J Prosthet Dent 2004;92:596-7.

5. Wat PY, Pow EH, Chau FS, Leung KC. A surgical guide for dental implant placement in an edentulous jaw. J Prosthet Dent 2008;100:323-5.
6. Basten CH, Kois JC. The use of barium sulfate for implant templates. J Prosthet Dent 1996;76:451-4.
7. Malo P, de Araujo Nobre M, Lopes A. The use of computer-guided flapless 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(6 Suppl):S26-34.
8. Sanna AM, Molly L, van Steenberghe D. Immediately loaded CAD-CAM manufactured fixed complete dentures using flapless implant placement procedures: a cohort study of consecutive patients. J Prosthet Dent 2007;97:331-9.
9. van Steenberghe D, Glauser R, Blombäck U, Andersson M, Schutyser F, Pettersson A, 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:S111-20.
10. Van Steenberghe D, Malevez C, Van Leynenbreugel J, Bou Serhal C, Dhoore E, Schutyser F, et al. Accuracy of drilling guides for transfer from three-dimensional CT-based planning to placement of zygoma implants in human cadavers. Clin Oral Implants Res 2003;14:131-6.
11. Vrielinck L, Politis C, Schepers S, Pauwels M, Naert I. Image-based planning and clinical validation of zygoma and pterygoid implant placement in patients with severe bone atrophy using customized drill guides. Preliminary results from a prospective clinical follow-up study. Int J Oral Maxillofac Surg 2003;32:7-14.
12. Azari A, Nikzad S. Computer-assisted implantology: historical background and potential outcomes--a review. Int J Med Robot 2008;4:95-104.
13. Widmann G, Bale RJ. Accuracy in computer-aided implant surgery--a review. Int J Oral Maxillofac Implants 2006;21:305-13.
14. Chun HJ, Park DN, Han CH, Heo SJ, Heo MS, Koak JY. Stress distributions in maxillary bone surrounding overdenture implants with different overdenture attachments. J Oral Rehabil 2005;32:193-205.
15. Meijer HJ, Starmans FJ, Steen WH, Bosman F. A three-dimensional, finite-element analysis of bone around dental implants in an edentulous human mandible. Arch Oral Biol 1993;38:491-6.
16. Frederick DR, Caputo AA. Effects of overdenture retention designs and implant orientations on load transfer characteristics. J Prosthet Dent 1996;76:624-32.
17. Renouard F, Rangert B. Risk factors in implant dentistry: simplified clinical analysis for predictable treatment. 2nd ed. Chicago: Quintessence; 2008. p. 33-54.

Corresponding author:
Dr Claudine Wulfman
15 rue du sergent Baauchat
75012 Paris
FRANCE
Fax: +00 33 1 42 87 38 89
E-mail: claudine.wulfman@parisdescartes.fr

Noteworthy Abstracts of the Current Literature

Self-adhesive resin cement versus zinc phosphate luting material: A prospective clinical trial begun 2003

Behr M, Rosentritt M, Wimmer J, Lang R, Kolbeck C, Bürgers R, Handel G.
Dent Mater 2009;25:601-4. Epub 2008 Dec 18.

Objectives: The literature demonstrates that conventional luting of metal-based restorations using zinc phosphate cements is clinically successful over 20 years. This study compared the clinical outcomes of metal-based fixed partial dentures luted conventionally with zinc phosphate and self-adhesive resin cement.

Methods: Forty-nine patients (mean age 54 ± 13 years) received 49 metal-based fixed partial dentures randomly luted using zinc phosphate (Richter & Hoffmann, Berlin, Germany) or self-adhesive resin cement (RelyX Unicem Aplicap, 3M ESPE, Germany) at the University Medical Center Regensburg. The core build-up material was highly viscous glass ionomer; the finishing line was in dentin. The study included 42 posterior, 5 anterior crowns and two onlays. Forty-seven restorations were made of precious alloys, 2 of non-precious alloys. The restorations were clinically examined every year. The clinical performance was checked for plaque (0-5; PI, Quigley-Hein), bleeding (0-4; PBI; Mühlemann) and attachment scores. The examination included pulp vitality and percussion tests.

Statistics: Means of scores, standard deviation, cumulative survival and complication rates were calculated using life tables.

Results: The mean observation time was 3.16 ± 0.6 years (min: 2.0; max: 4.5 years). During that time no restoration was lost, no recementation became necessary. One endodontic treatment was performed in the self-adhesive composite group after 2.9 years. At study end bleeding (1.44 RelyX Unicem vs. 1.25 zinc phosphate) and plaque (1.64 RelyX Unicem vs. 1.0 zinc phosphate) scores showed no statistically significant difference.

Significance: The self-adhesive resin cement performed clinically as well and can be used as easily as zinc phosphate cement to retain metal-based restorations over a 38-month observation period.

Reprinted with permission of the Academy of Dental Materials.