CAD/CAM-GUIDED IMPLANT SURGERY AND FABRICATION OF AN IMMEDIATELY LOADED PROSTHESIS FOR A PARTIALLY EDENTULOUS PATIENT

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The treatment planning, placement, and restoration of dental implants for the partially edentulous patient can be challenging. Anatomical limitations can make implant location difficult to determine. The use of CT scans and surgical planning software to produce a CAD/CAM surgical template, as well as the use of a flapless surgical technique, can make implant placement more predictable, safer, and easier for patients. The article describes a computer-guided surgical technique for the partially edentulous patient, with a restoration fabricated prior to implant placement, for immediate loading. (J Prosthet Dent 2007; 97: 389-394)

The conventional treatment of the partially edentulous patient with dental implants involves a thorough diagnosis, treatment planning, a diagnostic waxing, and a surgical template for implant placement.[1,2] The position and number of implants placed are based upon radiographic diagnosis, anatomical landmarks, the quantity and quality of bone, tooth position, and biomechanics.[2,3] Using computer-assisted tomography (CT scan) can assist in determining bone quantity and quality,[4-6] but transferring the exact position of the planned implants to the patient can be difficult, imprecise, and require extensive laboratory procedures.[7]

Factors which support the immediate loading of dental implants in the restoration of the partially edentulous patient are reported in the literature. These factors include primary stability, splinting, reducing the mechanical load, creating a stable restoration to prevent implant removal or movement, and the use of a surgical template.[8,9] The technique presented was developed for the completely edentulous patient to place implants using 3-dimensional surgical planning software (Procera Planning Software; Nobel Biocare, Yorba Linda, Calif). The position of the planned implants is then transferred to the patient with a stereolithographic surgical template. This procedure may promote successful immediate loading for the partially edentulous patient, as it addresses the factors mentioned above.[5,10-12]

The procedure uses a flapless surgical technique and a working cast, which is created from the surgical template prior to implant placement. With this working cast a provisional or definitive restoration can be fabricated prior to implant placement. Using an immediately loaded restoration makes the transition for patients from a partially edentulous state to a dentate state easier. This article describes the use of a 3-dimensional (3-D) surgical planning software technique for the partially edentulous patient, and creation of a prefabricated provisional restoration for immediate loading.

TECHNIQUE

Presurgical procedure

1. Prepare mounted diagnostic casts with fully extended vestibular borders of the edentulous space. On those casts, complete a diagnostic waxing, or use acrylic resin artificial teeth, to identify the ideal tooth positions for replacement of missing teeth.

2. Duplicate the diagnostic tooth arrangement in acrylic resin (Jet Tooth Shade; Lang Dental Mfg Co, Wheeling, Ill). On the cast, block out the buccal and lingual undercuts of the teeth with wax (Truwax; Dentsply Intl, York, Pa) and coat the existing teeth with a separator (Rubber Sep; George Taub Products and Fusion, Jersey City, NJ). Add 3 to 4 mm of acrylic resin to the occlusal surface of the existing teeth, extending the acrylic resin into the lingual vestibule of the mandibular arch, or the palate in the maxilla. Do not cover the occlusal surface of the acrylic resin teeth, cover only the buccal and lingual surfaces to attach the teeth to the template (Fig. 1, A).

3. Make 3 verification windows (occlusal openings in the radiographic template to view the occlusal surface of the teeth through the template, confirming the seating of the radiographic and surgical template) with an acrylic bur (Laboratory Carbide Cutter H251FSQ; Brasseler USA, Savannah, Ga) around the arch of the

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1 A, Radiographic template with buccal and lingual vestibular border extensions. Buccal and lingual undercuts blocked out in wax; radiographic template covers occlusal surface of existing teeth. B, Verification window to access seat of radiographic template and radiopaque marker placed below gingival plane.

template (Fig. 1, B).

4. Make six to eight 1.5- to 2.0-mm-diameter holes in the vestibular borders of the radiographic template. Place the holes cervical to the gingival plane. Make the holes in the approximate positions of the central incisors, canines, premolars, and molars, and fill with gutta-percha (Gutta-percha; The Hygenic Corp, Akron, Ohio) (Fig. 1).

5. Make an interocclusal record with a rigid vinyl polysiloxane (Access Blue: Centrix Dental, Shelton, Conn) for the patient to hold the radiographic template in position during the CT scan and prevent movement. Make the record intraorally or on the mounted cast to the initial contact of the radiographic template.

6. Prescribe a CT scan of the arch with the edentulous space, using a double-scan technique.[19] Make the first scan of the patient with the radiographic template in place. Make the second scan of the radiographic template only.

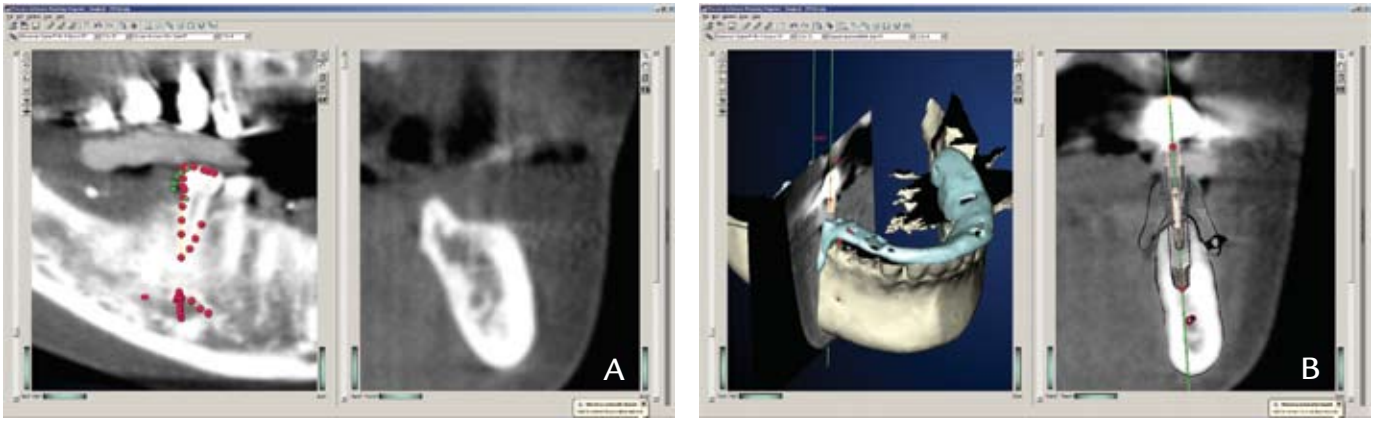
7. Download the CT data onto the computer. Convert the CT data in the surgical software (Procera Software CT scan file converter application; Nobel Biocare), superimposing the 2 sets of scans (one of the osseous tissues and the other of the radiographic template), to show the planned position of the teeth in relation to the bone. Using the 3-D implant planning software (Procera Planning Software; Nobel Biocare), evaluate the osseous tissues in relationship to the position of the teeth through the merging of independent data. From this information, evaluate and plan the positions and sizes of the dental implants[5, 10-12] (Fig. 2, A and B).

7. After the plan is complete, transfer the data to a milling center (Procera; Nobel Biocare) to fabricate the stereolithography surgical template via a CAD/CAM procedure, with the implant positioning sleeves (Guided Sleeves; Nobel Biocare) cemented in the surgical template.

8. Evaluate and adjust the surgical template to ensure proper seating on the cast and patient. Adjust the acrylic resin rings around each of the guide sleeves so that they do not interfere with the seating of the template.

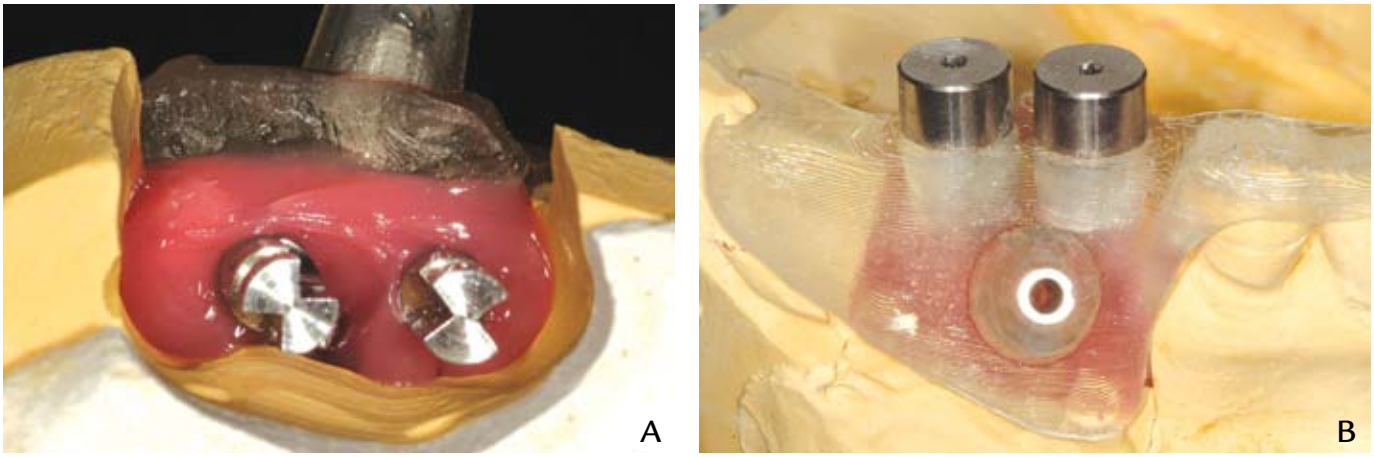
9. Place the adjusted surgical template onto the cast on which the radiographic template was fabricated. With a carbide bur (Laboratory Carbide Cutter H79FSQ; Brasseler USA), cut a space in the cast for the implant analogs. Position the implant analogs in the template with transfer copings (Guided Cylinder with Pin Unigrip; Nobel Biocare) to provide the exact positions of the implants, in the x-, y-, and z-axes (this transfer does not locate any orientation of the implant external hex or lobes of an internally connected implant) (Fig. 3). Place a soft tissue replica (Gi-Mask; Coltene/Whaledent, Cuyahoga Falls, Ohio) into the template and around the implant analogs. Add ADA type II dental stone (Denstone; Heraeus Kulzer, South Bend, Ind) to the cast and implant analogs, to connect the analogs to the cast (Fig. 4).

10. Fabricate a provisional restoration or definitive restoration on the cast, if an immediate load procedure is planned. For the patient presented, a splinted acrylic resin (Jet Tooth Shade Acrylic Resin; Lang Dental Mfg Co) provisional restoration was fabricated using nonengaging copings (Snappy Abutment temporary copings; Nobel Biocare). Place the selected abutments (Snappy Abutments; Nobel Biocare) onto the working cast. Place the nonengaging copings onto the abutments. Using a vacuform matrix (0.020", Clear, Tem-



2 A, Software allows for multiple views for implant planning. B, Planned mesial implant position and surrounding anatomical landmarks.

3 Seated CAD/CAM surgical template on modified cast with guided screw and guided cylinder assembly (left) with guided anchor pin (right) to transfer implant position onto working cast.



4 A, Placement of soft tissue replica, sealing any voids before stone is poured into modified space. B, Completed working cast.

porary Splint Material; Buffalo Dental, Syosset, NY) made of the original diagnostic waxing, place acrylic resin into the vacuum-formed matrix, filling the void from the matrix to the provisional copings.

11. Make an interocclusal record with a rigid vinyl polysiloxane (Access Blue; Centrix Dental), between the surgical template and the opposing arch on the patient or on the mounted cast (Fig. 5).

Surgical procedure

1. After the local anesthetic is given, place the surgical template intraorally. Confirm seating of the template through the verification windows. Have the patient occlude into the interocclusal record, which was made in the laboratory between the surgical template and the opposing arch.

2. Place the friction fitted horizontal stabilization pins (NobelGuide Anchor Pins; Nobel Biocare) to hold the surgical template with a 1.5-mm twist drill to the planned length. Once seated, have the patient open to expose the surgical sites of the guide.

3. For each implant site, prepare the site first using a start drill (NobelGuide Start Drill; Nobel Biocare), which is a soft tissue punch and counter-sink drill. Using the surgical template, guide the start drill in the correct x-, y-, and z-axes. Next, place a 2-mm drill guide into the surgical template. Use the 2-mm drill through the guide, to control the x- and y-axes, to the planned implant depth (Fig. 6). Use the appropriate size drills to expand the osteotomy site for the planned implant diameter and length. Complete the osteotomy site and place the implant with an implant mount (NobelGuide Surgical Implant Mount; Nobel Biocare) to control the x-axis, y-axis, and z-axis of the implant position, replicating the planned position in the surgical planning software.[11,12]

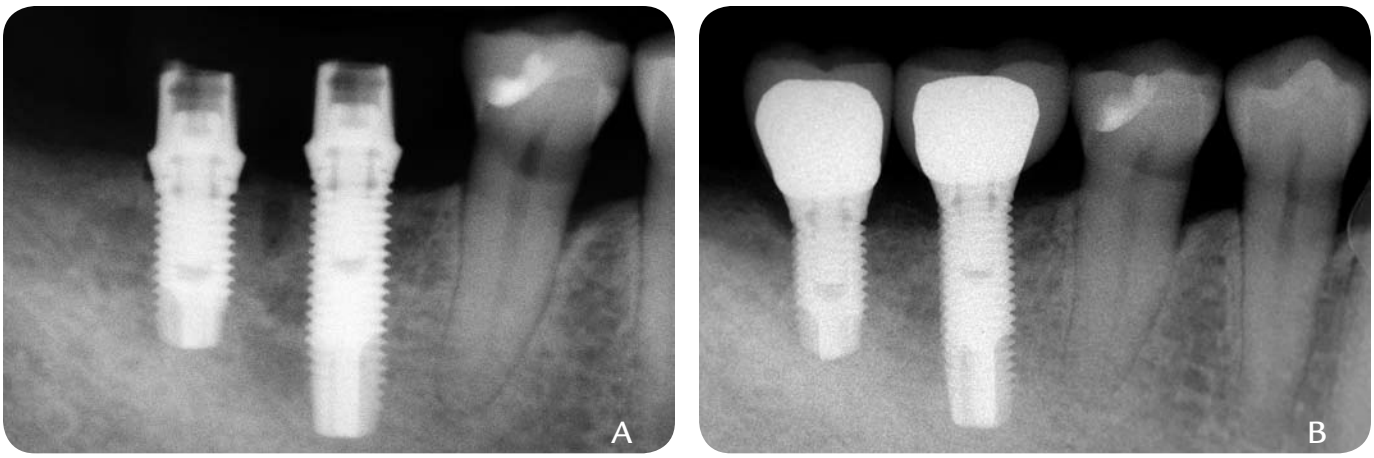
4. After the implants are placed, attach the abutments (Snappy Abutments) and cement the restoration (Figs. 7 and 8). Use a definitive cement (Ketac-Cem Aplicap; 3M ESPE, St. Paul, Minn) to prevent loosening of the restoration. Line the restoration with the cement. Do not overfill the restoration with cement. Ensure all excess cement is removed around the abutment and implant. Adjust the provisional restoration out of occlusion, to prevent implant overload and micromovements.

5. Evaluate the patient postsurgically for lateral contacts and healing. Examine the patient for lateral interferences and healing at 1-, 2-, and 4-week intervals, and 3 months follow-

5 Surgical template in place.

6 Twist drill (2 mm) used through drill guides, to transfer x- and y-axis of osteotomy site.

7 Splinted provisional restoration, seated on abutments and cemented with glass ionomer cement.



8 A, Postoperative periapical radiograph made after implant surgery. B, Postoperative radiograph made after implant crown cementation.

ing surgery. After implant integration is determined, fabricate the definitive restorations.

DISCUSSION

The advantages of this procedure, for the completely edentulous arch, include (1) shorter surgery times, (2) shorter treatment times, (3) less invasive, flapless surgery and, therefore, less chance of swelling, less pain, and faster initial healing times, (4) placement of a prefabricated definitive or provisional prosthesis, and (5) use of the fixed prosthesis immediately.[12] For the partially edentulous patient, primary stability can be determined preliminarily in the planning software using Houndsfield units, which quantify bone density. The restoration can be fabricated prior to implant placement; therefore, the restorative procedure is easier for the patient and the clinician. The prosthesis can be created using a technique which reduces load to the implants, promotes implant stability, and at the same time is designed to prevent removal during the healing period. The CAD/CAM surgical template used can easily transfer the planned positions from the software to the patient with the use of the surgical instrumentation and protocol. Because of the design of the surgical instrumentation, the osteotomy site preparation is more precise and, therefore, there is a greater possibility of having a more stable implant.

The one disadvantage with any immediate load procedure is the possible loss of an implant, especially in patients who may have bruxism. A limitation of this procedure, particularly for the partially edentulous patient, is interarch space for the surgical instrumentation. Surgical drills have an added 10 mm in length, and, therefore, may be difficult to place in patients with minimal opening or those needing implant placement in the second molar position.

After implant placement, the implant should be evaluated for stability by either the insertion torque value or other means for evaluating implant stability. If the implant is not stable, a nonloaded or 2-stage approach to implant healing can be used. This technique for implant placement allows for all methods of implant healing, from a loaded or nonloaded approach.

SUMMARY

A new technique using a dual CT scan and surgical planning software to produce a CAD/CAM surgical template that transfers the position of the planned implants to the patient is described. From the surgical template a working cast is created to fabricate a restoration prior to implant placement.

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