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Restoring the Partially Edentulous Patient in the Aesthetic Zone

Computer-Guided Implant Surgery



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Implant placement has become a primary option in clinical dentistry, requiring proper diagnosis and case selection. Patients present with variable osseous anatomy at the proposed implant location, often making it difficult for the dentist to determine if sufficient bone is present in which to place an implant. Using 2-dimensional radiography (including panoramic, periapical, and bite-wing radiographs), which may not allow the dentist to adequately assess the form and density of bone at the recipient site, the dentist typically fabricates a surgical guide using a mounted cast and the radiographs. Several techniques for fabricating a surgical guide have been proposed, including the use of acrylic resin and vacuum-formed guides, among others.¹⁻⁶

The use of surgical guides aids in the correct placement of implants. The intent is to ensure proper implant placement so prosthodontic complications can be minimized. Recently, implant surgery has incorporated computer-guided technology that enables the dentist to evaluate fully the osseous morphol-

ogy with 3-dimensional views, and thus more accurately plan for implant placement. This method provides improved accuracy as a result of better diagnosis and a more accurate surgical guide,⁷⁻¹¹ and it is becoming the standard of care for predictable implant positioning.¹²⁻¹⁴ Specifically, a computed tomography (CT) scan is taken with a radiographic guide that mimics the position of the desired teeth. The addition of the computer software allows the clinician to simulate implant surgery prior to performing it on the patient. This computer software re-formats the CT scan and enables 3-dimensional simulations of the bone, its density, and amount, and its relationship to the radiographic guide. The software also enables the clinician to thoroughly

evaluate the patient's anatomy, and this information can then be used to design a blueprint of the anticipated surgical and prosthetic treatment plan. Once the most appropriate position for the implants is identified, the desired number, size, and position of the implants can be placed on the software. After this step the data is sent via the Internet to a milling center (Procera [Nobel Biocare]), which fabricates a stereolithography cast with the preplanned implant sites. From this cast a surgical template is fabricated to guide the surgeon in the precise positioning of each dental implant. Examples of such software include NobelGuide (Nobel Biocare), SurgiGuide (Materialise CSI), and Virtual Implant Placement Software (Implant Logic Systems).

With the increased demand for aesthetic restorations, patients desire the use of dental implants as well as the use of all-ceramic restorations, including ceramic abutments and all-ceramic crowns. The use of metal-free restorations provides an aesthetic result and excellent biocompatibility and material strength.¹⁵⁻¹⁸ These all-ceramic restorations may be fabricated using a large variety of systems, including Procera, IPS Empress 2 (Ivoclar Vivadent), and In-Ceram (VITA Zahnfabrik).

Computer-designed and computer-generated implant abutments have also changed the restorative protocols for implant dentistry. The Procera design software also offers the opportunity to develop computer-aided-design (3D CAD) implant abutments from zirconia. Through this portion of the software the user can custom design abutments and fixed restorations using all-ceramic materials that potentially offer greater aesthetic results than the more classic metal-ceramic restoration. Customized abutments from several materials may be fabricated with the 3D CAD technique in the following manner:

A screw with a graduated pin for determining the height of the abutments is placed into the implant replica embedded in the master cast to visualize and align the computer image with the master cast. The design software enables the alteration of the body of the abutment and its angle, height, width, and taper, as well as the gingival margin height and width, and the emergence angle of



Figure 1. Eight-unit metal-ceramic fixed partial denture.



Figure 2. The edentulous area.

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the implant. The completed abutment design is represented on the screen and transmitted electronically to the production facility, where it is milled. The implant abutment is delivered within 4 days of sending the order.¹⁹

The software enables the practitioner to fabricate individualized implant components with the desired height, width, and contour; these components are biocompatible and successfully mimic the appearance of natural teeth.²⁰⁻²²

This article describes the rationale and treatment of a partially edentulous patient using computer-guided surgery to place endosseous implants. The case includes immediate provisionalization of the implants and fabrication of all-ceramic custom abutments and all-ceramic restorations for the implants and adjacent natural teeth.

CLINICAL REPORT

A 56-year-old male reported to the University of Michigan Department of Prosthodontics with a chief complaint of discomfort in the

maxillary arch associated with movement of a 8-unit metal-ceramic fixed partial denture (Figure 1). In addition, he expressed displeasure with both the aesthetics of the restoration and roughness due to fracture of the incisal porcelain on the left central incisor. The 8-unit fixed partial denture extended from the right second premolar to the left cuspid; the teeth replaced with pontics were the right cuspid, right lateral incisor, and the right and left central incisors. **[Author: in photo, fracture seems to appear on the RIGHT central incisor. Please clarify.]**

The patient was presented with 3 treatment options: (1) a removable partial denture to replace the edentulous area and all-ceramic restorations to replace the restorations on the remaining teeth involved in the fixed partial denture, (2) an 8-unit all-ceramic fixed partial denture, or (3) placement of 3 endosseous implants to replace the 4 missing maxillary teeth, and all-ceramic restorations to replace the restorations on the abutment teeth in the anterior fixed partial denture.

The patient chose the third option. During further evaluation it was decided that an all-ceramic restoration was required for the maxillary left first premolar due to extensive attrition and fracture of the lingual cusp.

The patient's medical history was noncontributory except for a history of a cardiac pacemaker that was recently replaced. Consultation with the patient's cardiologist resulted in antibiotic prophylactic coverage (amoxicillin, 2 grams at 1 hour before procedure) for each appointment, but the patient's history would not contraindicate dental care, including elective surgery (ACC/AHA Guidelines for the Management of Patients With Valvular Heart Disease).

PRESURGICAL PROCEDURES

(1) The 8-unit maxillary fixed partial denture was sectioned to expose the edentulous area (Figure 2), and a provisional removable partial denture with no clasps was fabricated.

This transitional prosthesis helped to assess tooth position and aesthetics.

(2) Nine holes 2 mm in diameter were placed into the provisional removable partial denture and filled with gutta-percha (Ultradent Products) to serve as radiopaque markers. At this point the patient was referred for a CT scan using a double-scan technique.²³ The first CT scan was made with the provisional removable partial denture in place in the mouth; the second CT scan was made of only the provisional removable partial denture outside of the patient's mouth. Both scans, consisting of up to 200 individual projections, are necessary to form the eventual 3-D images of the bone and prosthesis. At this point the data from the CT scan was introduced into the Procera NobelGuide software. The planning software allowed evaluation of the osseous tissue and other important anatomical structures in relation to the position of the denture teeth present in the provisional partial denture.

(3) The NobelGuide software is sophisticated and requires several days of training to operate, therefore only the highlights of the planning process will be described here. The software allows the clinician to coordinate the radiographic views from the CT scan and the implant surgery plan.

(4) Based upon the available bone and the patient's desire for no additional grafting procedures, 3 implants were planned for placement into the anterior maxilla; Replace Select (Nobel Biocare) implants (3.3 x 13 mm) were planned in the positions of the maxillary right lateral incisor and left central incisor, and a 4.0 x 13-mm implant was planned in the area of the maxillary right cuspid. In addition, the plan required 1 anchored pin to stabilize the surgical guide during the implant surgery procedure (Figures 3 and 4).

(5) The surgical plan was sent via the Internet to a milling facility (Procera) for fabrication of the surgical guide that would accommodate the drill sizes for the implants.

(6) When the surgical guide was received, it was sent to the dental laboratory in conjunction with the opposing cast and jaw relation records. The laboratory poured a master cast made from the surgical guide and articulated it with the opposing cast to fabricate the provisional restorations. The surgical guide contains all the information necessary for the fabrication of the master cast, including the position, size, and angulations of the implants, making it possible to fabricate the abutments and the provisional fixed restorations.

SURGICAL PROCEDURE

The surgery was performed under local anesthetic and by means of a flapless technique. Replace Select implants (3.3 x 13 mm) were placed in the position of the maxillary right lateral incisor and left central incisor, and a 4.0 x 13-mm implant was placed in the area of the maxillary right cuspid. The surgical guide was placed in the patient's mouth, and a stabilization pin (designed on the computer software to secure the surgical guide in place) was inserted after creating a hole with a 1.2-mm drill (Figure 5). The first osteotomy site was prepared for the right most distal implant using the appropriate drilling guides and twist drills. The implant was placed using the implant guide. After insertion of the implant, a template abutment was placed (Nobel Biocare) connecting the implant to the surgical guide, providing additional stability for the guide. The same procedure was performed for the left most distal implant. The third implant was placed using the same drilling sequence and guides. After all the implants were placed, the custom abutments were torqued to 35 NC, and the temporary restorations were placed. **[Author: Do you mean 35 Ncm?]**

RESTORATIVE PHASE OF TREATMENT

(1) The right second and first premolars, left lateral incisor, left cuspid, and left first premolar were prepared for full-coverage all-ceramic fixed restorations with a moderate

chamfer margin (Figure 6). Retraction cord "00" (Ultradent Products) impregnated with hemostatic solution (Hemodent [Premier]) was used for gingival retraction.

(2) Impression copings were placed and verified radiographically for seating onto the implants. A single impression was made to record the implants and the natural tooth preparations (Extrude low consistency [Kerr]).

(3) Prior to pouring the master cast, a soft-tissue moulage (Gingitech [Ivoclar Vivadent]) was developed by applying the soft-tissue material onto the tissue surface of the impression with an approximate thickness of 2 mm. This would aid the technician in achieving proper profile emergence of the crowns and verifying the fit of abutments on the implants.

(4) Three custom zirconia abutments were fabricated using the 3-D CAD technique previously described. The definitive restorations consisted of 6 Procera all-ceramic zirconia crowns and a 3-unit zirconia fixed partial denture. Each of the fixed units were veneered with NobelRondo (NobelBiocare) veneering porcelain. Zirconia was the material of choice because of its flexural strength^{18,24} and fracture toughness.^{18,25}

(5) At the delivery appointment the provisional abutments were removed and the ceramic custom abutments were placed and secured with screws tightened to 35 Ncm torque. The access openings were filled with wax, and the all-ceramic crowns were placed onto the abutments to verify marginal integrity, occlusal relationships, and aesthetics. The all-ceramic restorations were cemented onto the implant abutments using provisional cement for use with dental implant restorations (Premier).

(6) The restorations for the natural dentition (right first and second premolar, left lateral incisor, left cuspid, and left first premolar) were prepared

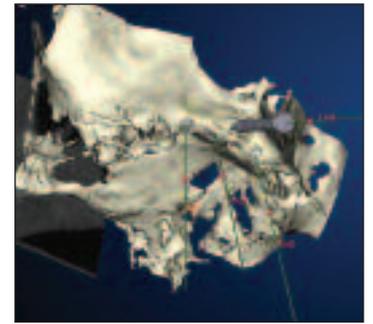


Figure 3. Pictured above is 3-D software after planning the placement of all implants and the anchored pin.

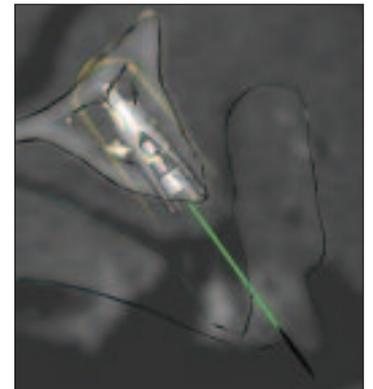


Figure 4. Close-up view of the implant planned for the right lateral incisor. The cast was then poured using a type V gypsum material (Die-Keen [Heraeus Kulzer]).



Figure 5. Surgical guide in place; note sleeve in buccal phalange that will accommodate a stabilizing pin for the surgical guide.



Figure 6. Tooth preparation with moderate chamfer.



Figures 7 and 8. Final restorations.

teeth and evaluated for marginal integrity, occlusal relationships, and aesthetics.

(7) The tooth preparations
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Restoring the Partially...

continued from page

were cleaned with ultrafine pumice (Whip Mix) and treated with chlorhexidine (Zila Pharmaceuticals), and the internal surface of the crowns were cleansed with acetone. A thin coat of resin-modified glass ionomer cement (FujiCEM [GC America]) was placed onto the internal surface of the all-ceramic crowns, which were seated with finger pressure (Figures 7 and 8).

The patient was recalled at 1 week and at 1 month; no occlusal adjustments were needed after the cementation appointment.

DISCUSSION

Computer-guided implant placement has many advantages over conventional implant surgery methods, especially in demanding situations. The use of the computer software allows for enhanced accuracy and predictability. The accuracy of this method also allows the advantage of immediate provisionalization; due to knowledge of the size, positions, and angulations of the implants, the laboratory may be able to fabricate abutments and provisional restorations that are ready for delivery at the time of surgery.

Indications for guided surgery include complex anatomical concerns; poor bone density, height, or width; and proximity to other teeth or roots. By using the guided surgery technique the clinician has improved control of these variables, and if the diagnosis, treatment planning, and surgical procedures are appropriate, has the assurance that the implants will be placed in the correct position.

CONCLUSIONS

The use of guided surgery and computer planning software is the most accurate method for placing endosseous implants to date, permitting the clinician to achieve optimal implant positioning when considering all anatomical limitations.

The placement of endosseous implants in edentulous areas has proven to be an excellent alternative for

replacing single or multiple teeth, while the use of ceramic abutments and all-ceramic restorations helps achieve long-term success and excellent aesthetic results. ♦

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Continuing Education

Test No. 91.x



To submit Continuing Education answers, use the answer sheet on page xx. On the answer sheet, identify the article (this one is Test 91.x), place an X in the box corresponding to the answer you believe is correct, detach the answer sheet from the magazine, and mail to Dentistry Today Department of Continuing Education.

The following 8 questions were derived from the article *Restoring the Partially Edentulous Patient in the Aesthetic Zone: Computer-Guided Implant Surgery* by Bill Abbo, DDS, MS, and Michael E. Razzoog, DDS, MS, MPH, on pages # through #.

Learning Objectives

After reading this article, the individual will learn:

- the advantages of computer-guided implant placement, and
- presurgical, surgical, and restorative procedures for computer-guided placement of implants.

- The access holes of implant abutments should be filled using ____.**
 - cotton pellets
 - wax
 - resin
 - They should not be filled.
- Which of the following is NOT an implant planning software system?**
 - NobelGuide
 - SurgiGuide
 - SurgiCare
 - Virtual Implant Placement Software
- The design software enables the alteration of abutments; which of the following CANNOT be modified?**
 - height
 - width
 - taper
 - It is possible to modify all of the above.
- With the surgical guide made from the NobelGuide software the clinician can determine the ____.**
 - position of the implants
 - angulations of the implants
 - size of the implants
 - all of the above
- Zirconia is a restorative material of choice due to its ____.**
 - biocompatibility
 - flexural strength
 - fracture toughness
 - all of the above
- Impression copings should be verified radiographically to determine ____.**
 - seating on the implants
 - proper angulations
 - seating of the fixed restoration
 - none of the above
- Custom abutments should be secured with screws tightened to ____.**
 - 32 Ncm
 - 45 Ncm
 - 35 Ncm
 - 42 Ncm
- The template abutment is used ____.**
 - to provide additional stability for the surgical guide
 - as a guide for the drilling sequence
 - to provide a stable bite registration
 - none of the above