Quadrant Rehabilitation With Implants and CAD/CAM Crowns

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Dental implants offer a predictable and efficient option for replacement of missing posterior teeth.[1] Implant selection, surgical technique, occlusion, and restorative materials are all important factors in treatment success.[2] When multiple teeth are missing in a quadrant, particular attention must be paid to restoration design and to the development of a stable occlusion to minimize premature occlusal contact, excursive interferences, and restorative material wear.[3,4]

CASE REPORT

This 45-year-old woman came into the office with no significant medical conditions. She was a nonsmoker and did not have any evidence of immunologic compromising conditions. Periodontal conditions were normal without signs of infection or other pathology. Four months earlier, tooth No. 31 was treated endodontically and temporized with glass ionomer cement (HY-bond [Shofu]). Tooth No. 28 was extracted after being deemed to have a nonrestorable root fracture (Figure 1). She had several failing composite restorations and a porcelain-fused-to-metal bridge opposing the teeth to be replaced (Figure 2).

The clinical exam and radiographs revealed about 14 to 18 mm of bone from the alveolar crest to the radiographic mandibular canal, and ample, healthy attached gingiva covering the edentulous portion of this ridge for proper implant healing and soft-tissue maintenance. Periodontal cleaning and examination was completed, and an appointment was made for the procedure.

Despite a lengthy dental history, the patient was enthusiastic and very receptive to the idea of replacing her missing teeth with 2 root-form implants and CAD/CAM all-porcelain restorations. The implants would be placed, 3 months allowed for integration, and then abutments placed and restorations fabricated.

IMPLANT PLACEMENT

Numerous implants are suitable for the replacement of missing posterior teeth. A few examples include Maestro (BioHorizons), Groovy (Nobel Biocare), and Screw-Vent (Zimmer Dental). Maestro implants are designed with a roughened surface (Resorbable Blast Texturing) that is reported to aid in osseointegration by increasing surface area, and they come mounted with an abutment that quickly is modified for direct porcelain fabrication.[5] This system also has implant choices of varying thread designs suited for varying bone quality and architecture found in different regions of the mouth.[6,7] In this case, a D2 thread design was used because of the porous cortical and coarse trabecular bone that is normally found in the posterior mandible.

Anesthesia, isolation, and a full-thickness flap were completed followed by sequential osteotomy formation with a series of drills using an electric handpiece, sterile water, and gentle force. A measuring tool was used to ensure that ideal placement resulted, with 2.0 to 3.0 mm of interproximal space between each of the implants, about 6.0 mm from the center of each implant. This was done to prevent gingival encroachment and to aid in cleansing ability.[8]

Two 12.0-mm (long) by 5.0-mm (diameter) D2 implants were placed into the osteotomy sites (Figure 3). The prosthetic abutments were then removed, cover screws placed, and the tissues reproximated over the implants with 4-0 chromic gut sutures. The patient returned in 1 week for a follow-up visit; healing was exceptional without patient complaints. The patient was then given an appointment to be seen 3 months later for a single-visit prosthesis fabrication.

RESTORATIVE PROCEDURES

Many restorative materials (both porcelain-to-metal and all-ceramic) are aesthetically pleasing and also have the strength to replace posterior teeth. All-ceramic restorations like Procera (Nobel Biocare), 3G OPC (Pentron Laboratory Technologies), VITA In-Ceram (Vident), and many others have proven to be suitable for this purpose, and the porcelain choice today often is determined by the clinicians' comfort and experience with the material.[9]

CEREC (CEREC 3D [Sirona]) CAD/CAM restorations have more than 20 years of restorative success (Chart 1). The porcelain blocks used have wear very similar to natural enamel.[10,11] An example of 2 porcelain choices for CEREC restorations are VITA Mark II (Vident) and ProCAD (Ivoclar Vivadent). Both have the ability to be stained and glazed and have proven to be cost effective, aesthetic, and

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Figure 1. Preoperative condition of the mandibular right quadrant 4 months after tooth No. 28 was extracted. Endodontics was completed on No. 31 and the composite and amalgam fillings present. Ample bone width exists for implant placement.

Figure 2. Compromised occlusion due to the broken molar with no other occlusal stops.

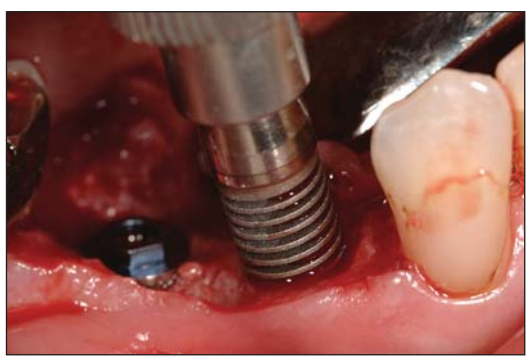

Figure 3. Osteotomies performed; placement of second implant into the second osteotomy site.

Figure 4. 10 months after implant placement. The first goal was to provide a definitive occlusal stop on the molar.

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suitable for porcelain crowns on natural teeth or implant abutments.[12] VITA Mark II has proven to have durability and long-term success with a mean survival rate reported at a greater than 97% success rate for nearly 5 years; this is comparable to other all-ceramic materials.[9,13] Wear rates for this porcelain is similar to natural enamel which may minimize the abrasion from opposing teeth.[14]

The fit to the implant abutment is excellent, and their design, fabrication, and finish are simple and efficient with practitioner experience.[15] These porcelains polish well and can also be glazed to reduce the chances of plaque accumulation and implant failure from bacterial pathogens.[16,17] Staining adds the benefits of a smoother surface and the ability to customize color of the monochromatic porcelain block. It also provides the least abrasive opposing surface and helps to hide abutment metal show-through.[18,19] Glazing also produces the least abrasive surface for the opposing dentition and directly influences the strength of the CAD/CAM porcelain material[20] (Chart 2).

The patient returned to the office 10 months after implant placement to begin restorative treatment. The first priority was to establish a posterior, vertical occlusal stop in order to stabilize occlusion and to allow for efficient implant crown construction (Figure 4).[21,22]

Chart 1. Advantages of CAD/CAM CEREC Implant Crowns.

1. Efficient design and fabrication.
2. Reduced implant component inventory.
3. No need for temporary fabrication or problems.
4. Never heat buildup on abutments from temporary fabrication.
5. Excellent adaptation of porcelain to abutment.
6. Tissue contact surfaces can be glazed.
7. Adjacent tooth contacts ideally controlled.
8. Wear similar to natural teeth.

Chart 2. Hiding Metal Abutments Under All-Porcelain Restorations.

1. Place abutment bevel toward the facial for added porcelain thickness.
2. Porcelain chosen with sufficient visual opacity.
3. Ample reduction of abutment preps.
4. Stain porcelain.
5. Use opaque luting cement.

ENDO CROWN (TOOTH NO. 31) AS THE POSTERIOR OCCLUSAL STOP

Decay was excavated from tooth No. 31, and then a caries indicator (Sable Seek [Ultradent Products]) was used several times to ensure complete decay extirpation. An all-ceramic crown preparation was then finalized using a tapered diamond and an end-cutting diamond to flatten, smooth, and define the margins. As with all porcelain restorations, care is taken to ensure there are no sharp corners that may impart stress points within the final porcelain restoration. Ample porcelain thickness is ensured by a 2.0- to 3.0-mm occlusal clearance in all excursive movements and 1.5- to 2.0-mm buccal and lingual reduction. The preparation was designed to create maximum resistance and retention form by having porcelain fill the pulp chamber, extending about 3.0 mm into the pulp canals, thus increasing the surface bonding area (Figure 5).

The tooth was then isolated, a glycerin-based dusting adhesive applied (VITA CEREC Liquid [Vident]), a titanium dioxide reflective medium blown onto the tooth, and an image acquired by the CEREC 3D acquisition unit. From this image the restoration was designed in the Dental Database mode using a library of tooth shapes and sizes, which is refined and customized by the dentist. After about 5 minutes of design manipulation and 15 minutes of milling, the restoration was completed and the VITA porcelain was tried in the mouth (Figure 6). The occlusion and contours were adjusted with a finish diamond on a high-speed handpiece with copious water and left in a roughened, nonpolished state while verifying even contact with the contralateral side (Figure 7).

DESIGN, MILLING, AND CUSTOMIZATION OF THE IMPLANT CROWNS

The implant cover screws were removed and the implant abutments placed while the crown for the endodontically treated tooth No. 31 was being milled. After probing to ensure noninvasion of biologic tissue widths, a diode laser (Odyssey [Ivoclar Vivadent]) was used to recontour gingiva around the abutment to ensure a complete camera view while acquiring an image.[23] Abutment recontouring was done with a high-speed diamond with copious water to provide 2.0 to 3.0 mm of occlusal clearance in all excursive movements and 1.5 to 2.0 mm of buccal and lingual room for porcelain fabrication (Figures 8 and 9).

The CEREC restoration was placed on tooth No. 31, and a "pull" impression was taken with a polyvinyl

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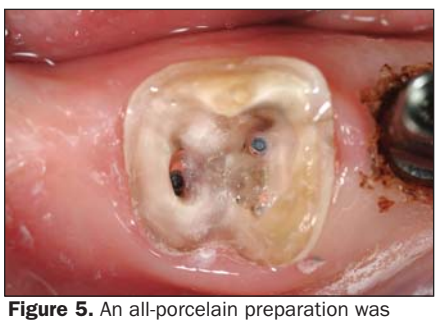

Figure 5. An all-porcelain preparation was done on the molar for the fabrication of a CEREC restoration, thus providing a definitive occlusion before the implant crowns were designed.

Figure 6. After milling, the porcelain is tried in and the occlusion adjusted.

Figure 7. All excursive movements are checked to ensure the lack of interferences or prematurities.

Figure 8. The titanium alloy Maestro abutments are screwed securely into place. The abutments have an antirotational bevel that can be placed on the facial aspect, thus providing additional porcelain thickness to help hide abutment show-through.

Figure 9. Laser-tissue recontouring around the distal abutment was followed by a polyvinyl siloxane impression.

Figure 10. The pull impression was poured and mounted on a simple, hinged articulator so that the CAD/CAM porcelain can be designed, stained, and glazed, and occlusion checked with little patient waiting. The CEREC porcelain on the model provided an occlusal stop, helping to ensure proper occlusion.

Figure 11. Triad material was used for a mock-up and the bite recorded with the articulator. This was scanned into the computer so that the occlusion was incorporated into the CEREC restorations with minimal occlusal adjustments.

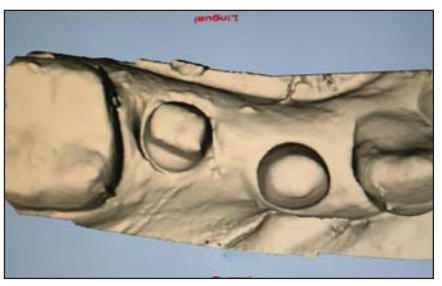

Figure 12. After removing the partially-cured Triad material from the model, the abutments were powdered and the entire quadrant was scanned by the CEREC acquisition unit. The restorations were designed individually on the virtual model.

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siloxane (Splash! [Discus Dental]) in a prefabricated, quadrant bite tray (Exacta Tray [Exacta Dental]). This was then poured in stone and mounted on a simple (plastic), hinged articulator. Slight smoothing and recontouring of the stone mimicking the gingival was done to allow for a smooth surface with slight pressure on the tissues.

The CEREC machine is most adept at imaging abutments directly without impressions taken or models made, however when multiple units are made along with staining and glazing, it is often more time efficient to verify contacts, contours, and occlusion from a model (Figure 10). The patient was allowed to relax in the office for about 90 minutes.

To accurately incorporate a functional mock-up occlusion into the restorations, the CEREC Correlation mode was used.

Since there was no preoperative anatomy to copy here, a light-cured resin (Triad [DENTSPLY]) was used to develop the anatomy. The model was then lubricated with the Triad model-release agent, the temporary resin material placed on the model, the articulator closed, and excess material carved away with a lab knife. It was then light-cured with an incomplete curing time of 20 seconds to ensure complete removal later.

In this design mode the preoperative occlusal table, as well as some facial and lingual contours, was scanned into the computer and put into the restoration by the computer (Figure 11). Design time was lessened because there were no occlusal contours or heights to manipulate with the computer. Intraoral fitting time is less because gross occlusal adjusting is seldom needed.

The mock-up was then powdered with titanium dioxide and the entire quadrant scanned into the acquisition unit with 3 images (Figure 12). This allows the design of the first implant crown to be milled and virtually seated in the computer so the second one can be designed without re-scanning or waiting. The computer used the porcelain of tooth No. 31 and the tooth mesial to the implant abutments for reference points to align the mocked-up occlusion (Figure 13).

During designing, the margins were drawn 2.0 to 3.0 mm away from the abutment and onto the gingiva (Figure 14). This "overdrawing" of the margin allows the porcelain to be milled precisely to the tissue. However, it will be relieved, rounded, and contoured after fabrication. Because of mesial drifting of No. 31 and the placement of the implant, the author chose to make a bicuspid in the area of tooth No. 28 and a small molar in the position of teeth Nos. 29 to 30 (Figure 15). The occlusal tables were narrowed buccolingually (slightly) to reduce the chances of any parafunctional or excursive occlusal contacts (Figure 16). The occlusion was then checked and adjusted to have very light contact on the implant crowns (Figure 17).

The CEREC restorations were then stained and glazed in a single bake over a 20-minute period and then bench-cooled for about 5 minutes (Figure 18). During this time, direct composite restorations were placed on several other teeth utilizing a microhybrid composite (Esthet-X Micro [DENTSPLY Caulk]).

DELIVERY AND FOLLOW-UP

All 3 CEREC restorations were tried in place and the occlusion was checked (Figure 19). Since the CEREC correlation mode was used, there was very little adjustment made to the occlusion. Slight adjustments were made to the opposing-arch porcelain with a bullet-shaped finishing bur to relieve an occlusal prematurity and then polished with porcelain polishing points (Dialite [Brasseler USA]) and a diamond polishing paste (Brasseler USA).

Tooth No. 31 was isolated and the preparation was scrubbed with alcohol using a microbrush. The porcelain was etched with hydrofluoric acid for 2 minutes and then silanated. The restoration was then placed with a self-adhesive, dual-cured resin cement (RelyX Unicem [3M ESPE]). Excess cement was removed and the restoration was cured for 20 seconds from 3 sides with a halogen light.

The implant abutment porcelain was then tried in the mouth, sandblasted (Microetcher [Danville Engineering]), silanated, and cemented with an opaque, resin luting agent (Insure Pink Opaque [Cosmedent]) to help prevent show-through of the abutment metal. No preparation of the abutments was done.

The patient was then seen at one week and one month. Hygiene care was reviewed at each of these appointments. Since the quadrant was restored with individual teeth, flossing and brushing are to be done with conventional methods and reinforced with the use of interdental brushes and flossing aids.

CONCLUSION

Many implant systems, porcelain materials, and restorative techniques can provide serviceable restorations when posterior teeth are missing. These systems provide quality, dependability, and efficient rehabilitation of edentulous areas. The one-year follow-up with this patient showed great patient acceptance of the implants and restorative materials. A recare exam at 22 months continued to show good function, wear, and tissue acceptance. A very good long-term prognosis for the restorations can be expected (Figure 20).✦

References

1. Lowe RA. Predictable fixed prosthodontics: technique is the key to success. *Compend Contin Educ Dent.* 2002;23(suppl 1):4-12.
2. Jackson BJ. Occlusal principles and clinical applications for endosseous implants [published correction appears in *J Oral Implantol.* 2003;29(6):314]. *J Oral Implantol.* 2003;29(5):230-234.
3. Gittelson G. Occlusion, bruxism, and dental implants: diagnosis and treatment for success. *Dent Implantol Update.* 2005;16:17-24.
4. Saba S. Occlusal stability in implant prosthodontics – clinical factors to consider before implant placement. *J Can Dent Assoc.* 2001;67:522-526.
5. Misch CE. Non-functional immediate teeth in partially edentulous patients: a pilot study of 10 consecutive cases using the Maestro Dental Implant System. *Compend Contin Educ Dent.* 1998;19(spec issue):25-36.
6. Strong JT, Misch CE, Bidez MW, et al.

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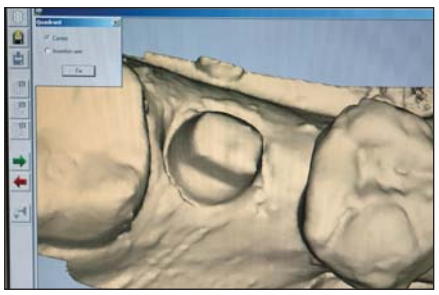

Figure 13. The posterior implant CEREC restoration was designed while the first implant porcelain was being milled. The computer shows a "virtual seating" of the anterior implant porcelain while it was being fabricated. A "virtual seating" of the completed restorations on the molar and anterior implant is done by the computer so that the distal implant crown can be fabricated.

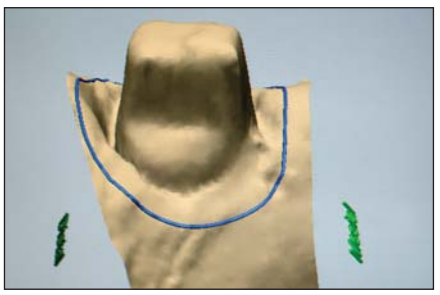

Figure 14. The design was done in Correlation mode. The margins of the restoration were drawn about 3 mm away from the abutment onto the virtual gingiva. The porcelain in these areas will be rounded, smoothed and glazed so there is no positive gingival impingement by the porcelain.

Figure 15. Immediately after milling the restorations, they were seated on the model and the bite was adjusted.

Figure 16. The occlusal anatomy was refined and the occlusal tables were slightly narrowed buccolingually to reduce chances of interferences.

Figure 17. The endo crown on the molar was in solid occlusion, and excursive movements were checked to verify light occlusal contact.

Figure 18. Staining and glazing was done in a single bake and bench-cooled in a total time of about 25 minutes. One week after insertion shows good aesthetics and healthy response to gingival tissues.

Figure 19. The occlusion was rechecked several times with articulating paper and areas of porcelain adjustment were polished.

Figure 20. After 22 months, the function and aesthetics are excellent and the long-term prognosis is very good.

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Functional surface area: thread-form parameter optimization for implant body design. *Compend Contin Educ Dent.* 1998;19(spec issue):4-9.
7. *BioHorizons Maestro Surgical Manual*. Birmingham, AL: BioHorizons; 2002:1-2.
8. Misch CE. *Contemporary Implant Dentistry.* St Louis, MO: Mosby; 1993.
9. Martin N, Jedynakiewicz NM. Clinical performance of CEREC ceramic inlays: a systematic review. *Dent Mater.* 1999;15:54-61.
10. Krejci I, Lutz F, Reimer M. Wear of CAD/CAM ceramic inlays: restorations, opposing cusps, and luting cements. *Quintessence Int.* 1994; 25:199-207.
11. Giordano R. Materials for chairside CAD/CAM-produced restorations. *J Am Dent Assoc.* 2006;137(suppl): 14S-21S.
12. CEREC Symposium 2001. *Compend Contin Educ Dent.* 2001; 22(suppl):
13. Reiss B, Walther W. Clinical long-term results and 10-year Kaplan-Meier analysis of Cerec restorations. *Int J Comput Dent.* 2000;3:9-23.
14. Abozenda B, Pober R, Giordano R. In-vitro wear of restorative dental materials. *J Dent Res.* 2002;81(spec issue):1-4.
15. Fritzsche G. Treatment of a single-tooth gap with a Cerec 3D crown on an implant: a case report. *Int J Comput Dent.* 2004;7:199-206.
16. Castellani D, Bechelli C, Tiscione E, et al. In vivo plaque formation on cast ceramic (Dicor) and conventional ceramic. *Int J Prosthodont.* 1996;9:459-465.
17. Kawai K, Urano M, Ebisu S. Effect of surface roughness of porcelain on adhesion of bacteria and their synthesizing glucans. *J Prosthet Dent.* 2000;83:664-667.
18. Al-Wahadni AM, Martin DM. An in vitro investigation into the wear effects of glazed, unglazed and refinished dental porcelain on an opposing material. *J Oral Rehabil.* 1999;26:538-546.
19. Sarac D, Sarac YS, Yuzbasioglu E, et al. The effects of porcelain polishing systems on the color and surface texture of feldspathic porcelain. *J Prosthet Dent.* 2006;96:122-128.
20. de Jager N, Feilzer AJ, Davidson CL. The influence of surface roughness on porcelain strength. *Dent Mater.* 2000;16;381-388.
21. Ky KE. Principles of occlusion in implant dentistry. Interview. *Dent Implantol Update.* 2006;17:33-38.
22. Kim Y, Oh TJ, Misch CE, et al. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin Oral Implants Res.* 2005;16:26-35.
23. Lanning SK, Waldrop TC, Gunsolley JC, et al. Surgical crown lengthening: evaluation of the biological width. *J Periodontol.* 2003; 74:468-474.

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Disclosure: Dr. Griffin has no financial interest in any way with the products, materials, or suppliers used in this article.