

Case Report

Replacement of a Single Missing Tooth With an Implant-Supported Patient-Specific Restoration

by Victor A. Martel, DMD

Treatment of a single hopeless tooth is a routine challenge in dentistry. Causes for this condition commonly include traumatic injury, advanced caries and/or periodontal disease, and failed endodontic procedures. When adequate bone exists at a hopeless tooth site, the current standard of care is surgical extraction of the tooth, followed by placement of a dental implant and eventual restoration with a single crown. This article reviews the evolution of this treatment modality and its alternatives. A case report describing restoration of a hopeless maxillary first molar site using state-of-the-art techniques for preserving both hard and soft tissue is also presented.

The first and most obvious of the choices that patients with a hopeless tooth must confront is surgical extraction followed by no further treatment. Any patient inquiring about this option must be educated about its repercussions, which typically include loss of masticatory function and underlying bone, shifting of adjacent and opposing teeth, and occlusal imbalance. Occlusal imbalance, in turn, can lead to signs of instability, such as wear, chipping, migration, muscle pain, and temporomandibular disorders.

The use of a removable partial denture or a resin-bonded prosthesis (eg, Maryland bridge) are also options for replacing a missing tooth. However, the bulkiness of the acrylic and metal and unsightliness of the clasps necessary to stabilize the former make it unacceptable to many patients, while success rates for the latter have varied widely, from only 53% in 11 months to 90% in 11 years.¹⁻⁵ For these reasons, preparation and fabrication of a three-unit fixed partial denture (FPD) was considered for many years to be the treatment of choice for single-tooth replacement.

The most significant drawback of this procedure is the need to prepare two additional teeth to serve as abutments. Once prepared, the abutment teeth are vulnerable to decay and endodontic trauma, necessitating root canal treatment. Endodontic therapy, placement of a post and core, and crown lengthening all may be necessary when the restoration is performed. Alternatively, failure of the initial FPD may make one of the abutment teeth hopeless, requiring the extension of the FPD to greater lengths involving additional abutment teeth, with an increased risk of future complications.

Depending on the patient's age, the choice of replacing a single tooth with an FPD may lead to many more problems and expenses than the patient ever imagined. A 2004 analysis in *Dental Economics* examining the impact of replacing a single tooth with a FPD vs a single implant determined that after 30 years the cumulative patient fees for maintaining an FPD are approximately 61% greater than those for a single implant.⁶ However, this study did not include the treatment cost of any biologic complications of the FPD. The economic benefits of placing a single implant instead of fabricating an FPD affect the dentist as well, with net production rate for a single-implant restoration ranging from 19%

to 43% higher than that for an FPD.⁶

More than 25 years have passed since Adell et al described the successful use of multiple osseointegrated implants to support fixed-partial prostheses in the edentulous jaw.⁷ Experience with this methodology led to its application to partially edentulous cases. By the 1980s clinicians had begun using implants to replace individual missing teeth. The topic was introduced in 1986,⁸ and since then has been studied extensively. One 5-year multicenter study showed a 96.6% success rate in the maxilla and a 100% success rate in the mandible.⁹ A 10-year prospective study involving 99 patients who received single-tooth implants found a survival rate of 97.4%, with minimal prosthetic complications and an extremely low complication rate for teeth adjacent to the single-tooth implants.¹⁰

The following case illustrates the restoration of a maxillary first molar extraction site with an implant-supported crown, using a simple technique for using computer-aided design and computer-aided manufacturing (CAD-CAM) technology to fabricate a patient-specific restoration.

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During the new patient comprehensive examination of a 72-year-old female, the complete radiographic series revealed a large radiolucency (Figure 1 [View Figure](#)) on the distal aspect of the maxillary right first molar. An open distal contact between the second and first molars had created a long-standing food trap, and the bitewing view indicated the presence of extensive caries under a gold onlay restoration. The patient stated that she had no history of pain. Pulpal exposure with necrotic pulp tissue was diagnosed, and the prognosis of the tooth was deemed hopeless because of the extent of decay and the compromise to long-term structural integrity.

A treatment plan was developed, calling for extraction of the molar and immediate placement of a dental implant. After a brief initial healing period, an Encode® Healing Abutment (BIOMET 3i™, Palm Beach Gardens, FL) would be connected to the implant. The Encode Complete Restorative System (BIOMET 3i) eliminates the need to seat an impression coping for an implant-level impression. Instead, an impression is made of the Encode Healing Abutment. In addition to simplifying the overall restorative process and reducing chairtime, this approach spares the soft tissue from unnecessary trauma, potentially better preserving soft-tissue levels and minimizing bone remodeling. A patient-specific definitive abutment fabricated by means of CAD/CAM technology would then support a porcelain-fused-to-metal (PFM) crown.

The patient provided informed consent, and local anesthesia was administered on the day of surgery. Surgical extraction of the hopeless tooth was performed by tri-sectioning the individual roots while preserving the furcational bone. The socket was carefully debrided of granulomatous tissue. To provide better osseous support for an 11.5-mm implant, a decision was made to perform a 2-mm sinus lift, using a synthetic bone graft material. Then, an osteotomy was created following the implant manufacturer's recommendations, and an internally connected NanoTite™ Tapered PREVAIL® Implant (BIOMET 3i) was placed. After implant placement, autogenous bone was positioned in the cervical area of the expanded platform of the implant. A low-profile healing abutment was placed

(Figure 2 [View Figure](#)), and a collagen membrane was packed circumferentially around the site and secured with sutures.

The patient returned to the surgeon 8 weeks later for removal of the low-profile healing cap and placement of an Encode Healing Abutment into the internal interface of the implant. The height of the Encode Healing Abutment was selected to allow it to be at least 1-mm supragingival circumferentially, following soft-tissue maturation. After placement into the internal interface of the implant, the abutment was hand tightened (Figure 3 [View Figure](#)). A periapical verification radiograph was taken, and the patient was given oral hygiene instructions. Twelve weeks after implant placement, torque testing confirmed osseointegration. Healthy soft-tissue maturation had occurred around the Encode Healing Abutment.

At the first restorative appointment, clinical and radiographic examinations of the healing abutment confirmed that it was still fully seated and the screw tight. A direct full-arch impression was made by applying light body polyvinylsiloxane (PVS) impression material with a syringe around the healing abutment, followed by placement of heavy-body impression material in a closed stock tray. The impression tray was seated and the impression material allowed to set, according to the manufacturer's instructions. The impression was then examined for verification that the entire occlusal surface of the Encode Healing Abutment was recorded (Figure 4 [View Figure](#)). This is essential because codes embedded on the occlusal surface of the Encode Healing Abutment communicate the implant depth, hex orientation, platform diameter, and interface (either internal or externally hexed) to a computer during scanning.

A PVS impression was also made of the opposing arch and sent to the commercial laboratory, along with the maxillary impression, an occlusal registration, and a shade selection. In the laboratory, the impression of the arch was poured using a low-expansion die stone for fabrication of a master cast. The casts were mounted on the recommended articulator, using the occlusal record. An Encode Complete Work Order was then sent along with both casts to the BIOMET 3i PSR department for fabrication of the definitive Encode Abutment.

After the master casts were scanned, the definitive abutment was designed virtually (Figure 5 [View Figure](#)). With the same data, an implant analog was placed into the cast with a computer-driven robotic arm (Figure 6 [View Figure](#)). Using this Robocast™ Technology (BIOMET 3i) allows the definitive Encode Abutment to be placed on the master cast for fabrication of the definitive restoration by the laboratory.

The definitive abutment was milled from a solid blank of titanium in a computer numerical controlled (CNC) process and placed in the master cast (Figure 7 [View Figure](#)), which was then returned to the laboratory for fabrication of the PFM crown (Figure 8 [View Figure](#)).

At the insertion appointment, the Encode Healing Abutment was replaced by the definitive abutment (Figure 9 [View Figure](#)). An audible and tactile click ensured complete seating. The abutment was then secured with a Gold-Tite® Abutment Screw (BIOMET 3i) placed through the access opening. After a verification radiograph confirmed complete seating, the abutment screw was tightened to 20 ncm of torque with a restorative torque indicator.

The PFM restoration was tried in and evaluated for fit, esthetics, and harmony of occlusion (Figure 10 [View Figure](#)). Once approved, an additional verification radiograph was taken to ensure complete seating of the crown. After confirmation, the screw-access opening in the abutment was blocked out with a cotton pellet and Fermit-N (Ivoclar Vivadent Inc., Amherst, NY). The restoration was then cemented with Premier Implant Cement™ (Premier Dental Products, Plymouth Meeting, PA). The excess cement was removed, the occlusion was rechecked, and a postrestorative periapical verification radiograph was taken. The patient was given oral hygiene instructions. At the 6-month re-care appointment, excellent soft-tissue adaptation was confirmed and a periapical radiograph revealed acceptable bone-height levels (Figure 11 [View Figure](#)).

Discussion

Since the introduction of CAD/CAM technology to dentistry in the 1980s, a number of innovations based upon this knowledge have developed. The Encode Complete Restorative System used in the case report is one example. The process of restoring a single implant with this system mirrors that of conventional dentistry from the perspective of ease of use: the restorative dentist needs to make only a simple impression of the healing abutment. The definitive abutment is customized to the patient, providing optimal peri-implant gingival support.^{11,12} The computerized milling process creates an abutment that requires no manipulation after machining and fits more precisely than was previously achievable with cast custom abutments.¹³

In anterior sites where achieving an ideal emergence profile is even more important, definitive Encode Abutments may also be fabricated in nitride-coated titanium (its gold color imparts a warm hue through thin gingival issues) or in zirconia for all-ceramic restorations.

Because of the surgeon's intraoperative decision to augment the maxillary bone by means of a sinus lift, he chose to place a low-profile healing abutment initially to eliminate any chance of the implant being loaded during eating. However, Encode Abutments normally may be placed during implant placement, further reducing postsurgical trauma to the soft tissue.

The implant used in this case also represents a state-of-the-art approach to preservation of hard and soft tissue. Crestal bone remodeling to the first implant thread has been assumed to be a natural consequence of implant placement;^{14,15} however, increased understanding of the biomechanical sequelae has led to a reconsideration of that belief.¹⁶⁻¹⁸ Inflammatory reactions in the peri-implant soft tissues resulting from bacterial contamination at the implant/abutment junction (IAJ) on standard implant designs¹⁹ have been implicated²⁰ as a cause of bone remodeling. Modifying the IAJ by using an abutment smaller in diameter than the implant platform shifts the perimeter of the IAJ inward toward the implant's central axis. This is known as platform switching. With the PREVAIL Implant, platform switching is intrinsic. One theory is that such "medialized" designs also shift the inflammatory cell infiltrate inward, limiting crestal bone loss.¹⁸ Clinicians placing platform-switched implants have reported significant reductions in peri-implant bone loss.^{16,21}

While such diminutions have the greatest consequences in the esthetic zone, the implant placement in posterior sites, as in the present case, helps prevent crestal bone remodeling, thus decreasing the potential for gingival recession and lateral food impaction.

Conclusion

Although patients have various options for replacing a missing tooth, treatment with a dental implant has become the new standard of care. The latest advancements in implant technology make this as easy to accomplish as conventional dental procedures, while reducing treatment time and patient discomfort and delivering superior esthetic results.

Acknowledgment

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References

1. Priest GF. Failure rates of restorations for single-tooth replacement. *Int J Prosthodont*. 1996;9(1):38-45.
2. Samama Y. Fixed bonded prosthodontics: a 10-year follow-up report. Part II. Clinical assessment. *Int J Periodontics Restorative Dent*. 1996;16(1):53-59.
3. Hansson O, Bergström B. A longitudinal study of resin-bonded prostheses. *J Prosthet Dent*. 1996;76(2):132-139.
4. Boening KW. Clinical performance of resin-bonded fixed partial dentures. *J Prosthet Dent*. 1996;76(1):39-44.
5. Pröbster B, Henrich GM. Eleven-year follow-up study of resin-bonded fixed partial dentures. *Int J Prosthodont*. 1997;10: 259-268.
6. Priest G, Priest J. The economics of dental implants for single missing teeth. *Dent Econ*. 2004;8:130-138.
7. Adell R, Lekholm U, Rockler B, et al. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg*. 1981;10(6): 387-416.
8. Jemt T. Modified single and short-span restorations supported by osseointegrated fixtures in the partially edentulous jaw. *J Prosthet Dent*. 1986;55(2):243-247.
9. Lekholm U, Jemt T. Principles for single tooth replacement. In: Albrektsson T, Zarb GA, eds. *The Brånemark Osseointegrated Implant*. Chicago, IL: Quintessence; 1989:117-126.
10. Henry PJ, Laney WR, Jemt T, et al. Osseointegrated implants for single-tooth replacement: 5-year multicenter study. *Int J Oral Maxillofac Implants*. 1996;11(4):450-455.
11. Papazian S, Morgano SM. A laboratory procedure to facilitate the development of an emergence profile with a custom implant abutment. *J Prosthet Dent*. 1998;79(2):232-234.

12. Touati B. Biologically driven prosthetic options in implant dentistry. *Pract Proced Aesthet Dent*. 2004;16(7):517-520.
13. Byrne D, Houston F, Cleary R, et al. The fit of cast and premachined implant abutments. *J Prosthet Dent*. 1998;80(2):184-192.
14. Albrektsson T, Zarb G, Worthington P, et al. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants*. 1986;1(1):11-25.
15. Davarpanah M, Martinez H, Etienne D, et al. A prospective multicenter evaluation of 1,538 3i implants: 1 to 5-year data. *Int J Oral Maxillofac Implants*. 2002;17(6): 820-828.
16. Feldman S, Boitel N, Weng D, et al. Five year survival distributions of short length (10mm or less) machine-surfaced and Osseotite® implants. *Clin Implant Dent Relat Res*. 2004;16(1):16-23.
17. Sullivan D, Vincenzi G, Feldman S. Early loading of Osseotite implants 2 months after placement in the maxilla and mandible: a 5-year report. *Int J Oral Maxillofac Implants*. 2005;20(6):905-912.
18. Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. *Int J Periodontics Restorative Dent*. 2006;26(1):9-17.
19. Berglundh T, Lindhe J, Marinello CP, et al. Soft tissue reactions to de novo plaque formation at implants and teeth. An experimental study in the dog. *Clin Oral Implant Res*. 1992;3:1-8.
20. Ericsson I, Persson LG, Berglundh T, et al. Different types of inflammatory reactions in peri-implant soft tissues. *J Clin Periodontol*. 1995;22(3):255-261.
21. Calvo Guirado JL, Saez Yuguero MR, Pardo Zamora G, et al. Immediate provisionalization on a new implant design for esthetic restoration and preserving crestal bone. *Implant Dent*. 2007;16(2):155-164.

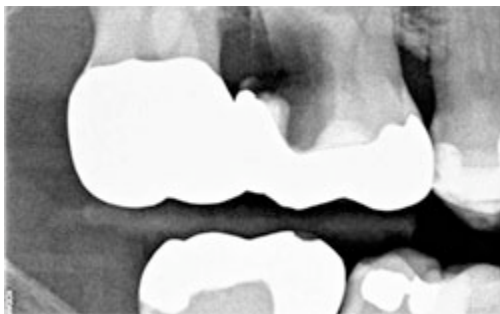


FIGURE 1 Initial radiograph of the large radiolucency at the site of the maxillary first molar.



FIGURE 2 Radiograph of the site after implant placement and low-profile healing abutment.



FIGURE 3 The Encode Healing Abutment in place after hand tightening.



FIGURE 4 Impression of the occlusal surface of the Encode Healing Abutment. Codes embedded on this surface record the implant depth, hex orientation, platform diameter, and interface type.

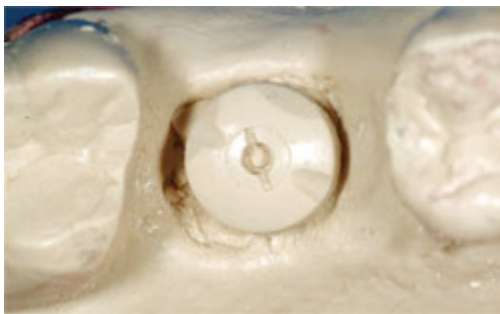


FIGURE 5 The definitive Encode Abutment is designed virtually after scanning of the model containing the Encode Healing Abutment.



FIGURE 6 The implant analog in position, after placement by a computer-driven robotic arm.



FIGURE 7 The definitive abutment in the master cast.



FIGURE 8 The PFM crown in the cast.



FIGURE 9 Occlusal view of the definitive Encode Abutment after placement in the mouth.

FIGURE 10 The PFM crown in place.



FIGURE 11 Six-month periapical radiograph revealing good bone height around the platform-switched implant.

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