THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL REPORT

Computer-guided implant removal: A clinical report

George Deeb, DDS, MD,[a] Leonard Koerich, DDS,[b] Daniel Whitley III, DDS,[c] and Sompop Bencharit, DDS, MS, PhD[d]

ABSTRACT

Occasionally, osseointegrated dental implants must be removed because of complications such as malpositioning or screw fracture. This is most often accomplished with a surgical handpiece and trephine. However, a flap is often required to access and visualize the implants. This paper presents a treatment in which computer planning and a 3-dimensional-printed, customized fabricated, surgical guide was used to assist in implant removal. This technique simplified the procedure, allowed conservative removal of peri-implant bone, and permitted subsequent immediate implant replacement. (J Prosthet Dent 2018;■:■-■)

Contemporary dental implants have a long-term survival rate of over 90%,[1] during which most late complications are related to implant abutments and prostheses.[2] Occasionally, however, osseointegrated dental implants require removal because of malpositioning, stripped abutment screw threads, or fractured screws.

Removal of osseointegrated implants can be difficult. The most common methods are reverse torque and trephination.[3] Reverse torque can be effective when thick bone surrounds the implant.[3] However, reverse torque can be unpredictable, and thin bone around implants may be accidentally removed with the implant, leaving anterior implants with little or no facial bone.[3] Trephination provides a more controlled removal of an implant.[3] However, reflection of a flap, and sometimes removal of the cervical peri-implant bone, is necessary to visualize the position and angulation of the implant and to position the trephine drill properly.

Computer-aided planning and computer-guided surgery have been used to improve the accuracy of dental implant placement.[4] More recently, the use of a high precision and cost-effective 3-dimensional (3D) printer allows fabrication of implant surgical guides in the office.[5] In this report, a treatment protocol and clinical application of such a surgical guide was used to assist in the removal of a dental implant and its immediate replacement.

CLINICAL REPORT

A 59-year-old white man presented to the Virginia Commonwealth School of Dentistry Implant clinic after sustaining midfacial trauma resulting in fracture of his maxillary implant-supported fixed partial dentures (FPDs): maxillary right canine to maxillary right central incisor and maxillary left canine to maxillary left central incisor. The FPD and computer-aided designed and computer-aided manufactured (CAD-CAM) abutments of the maxillary left canine to maxillary left central incisor implants were dislodged. However, the abutment screws were intact, and the prefabricated abutments of implants in the positions of maxillary right canine and maxillary right central incisor were fractured, and parts of the screws were wedged inside the implants. Attempts to retrieve the screw fragments were unsuccessful. Therefore, the decision was made to remove implants in the positions of maxillary right canine and maxillary right central incisor by

[a]Associate Professor, Department of Oral and Maxillofacial Surgery, School of Dentistry, Virginia Commonwealth University, Richmond, Va.
[b]Former predoctoral student, School of Dentistry, Virginia Commonwealth University, Richmond, Va.
[c]Private practice, Jacksonville, N.C.
[d]Associate Professor, Department of General Practice, School of Dentistry, and Director of Digital Dentistry Technologies, Department of Biomedical Engineering, School of Engineering, Virginia Commonwealth University, Richmond, Va.

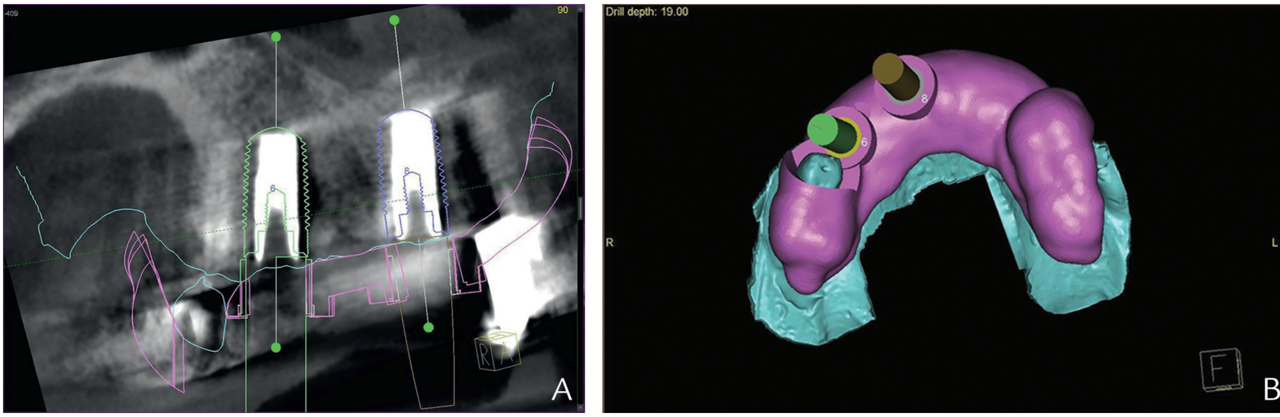

Figure 1. Planning implant removal guided surgery. A, Larger implants were used to represent size of trephine drill (CBCT scan). B, Posterior implant-supported prostheses used to support implant removal guide (3-dimensional design based on CBCT scan).

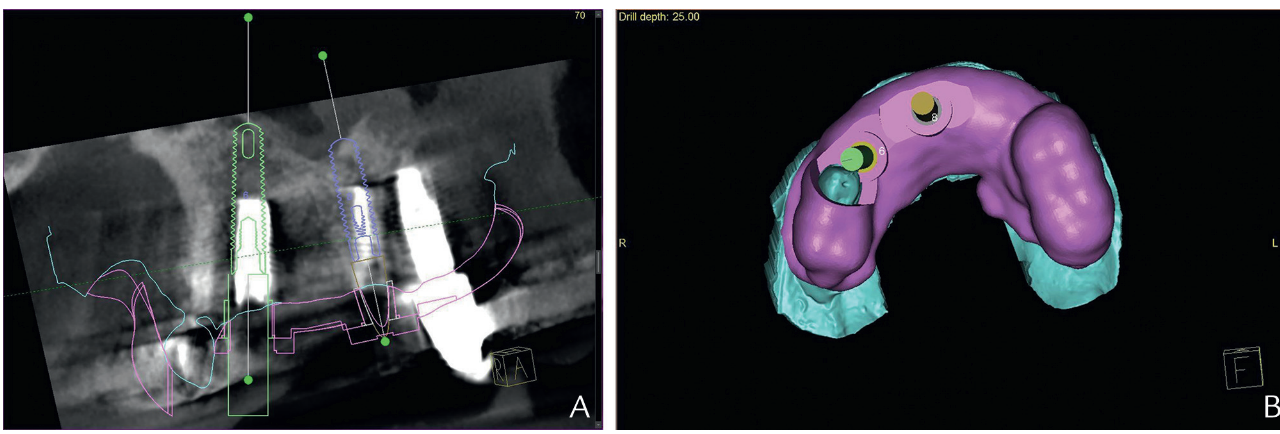

Figure 2. Planning implant placement guide. A, Two longer and smaller diameter replacement implants planned (CBCT scan). B, Implants planned to be placed slightly palatal to original sites to facilitate grafting and facial bone regeneration (3-dimensional design based on CBCT scan).

using a 3D-printed surgical guide and to replace them with implants in a more apical position.

Digital Imaging and Communications in Medicine (DICOM) data from cone beam computed tomography (CBCT) scans and standard tessellation language (STL) digital cast file were loaded into imaging software (360 ips; 360 imaging). An implant removal guide was made by using the existing maxillary right canine and maxillary right central incisor implants as a guide to positioning the trephine drill. Two 6×11.5-mm implants (Trabecular Metal; Zimmer Biomet) were used to mimic the external diameter of the trephine drill, approximately 5.5 mm (Fig. 1).

The treatment plan was to immediately replace the removed implants with 2 3.7×13-mm Zimmer trabecular metal implants (Zimmer Biomet) (Fig. 2). Because of limited facial bone on the existing maxillary right central incisor implant,[6] with approximately half of the implant exposed with no facial bone, the plan was to place the new implants slightly more palatal to the existing implant sites and to use longer porous tantalum trabecular metal-enhanced implants to facilitate bone grafting.[6] Implants

Figure 3. Printed implant removal guide and trephine drill. Note amber color of guide after ultraviolet polymerization.

were also planned to be placed more apically to allow appropriate prosthetic design.

The guides were planned and printed on site by using a 3D printer as described previously.[5] Briefly, the STL files of the surgical implant removal and implant placement guides were loaded into the Preform program

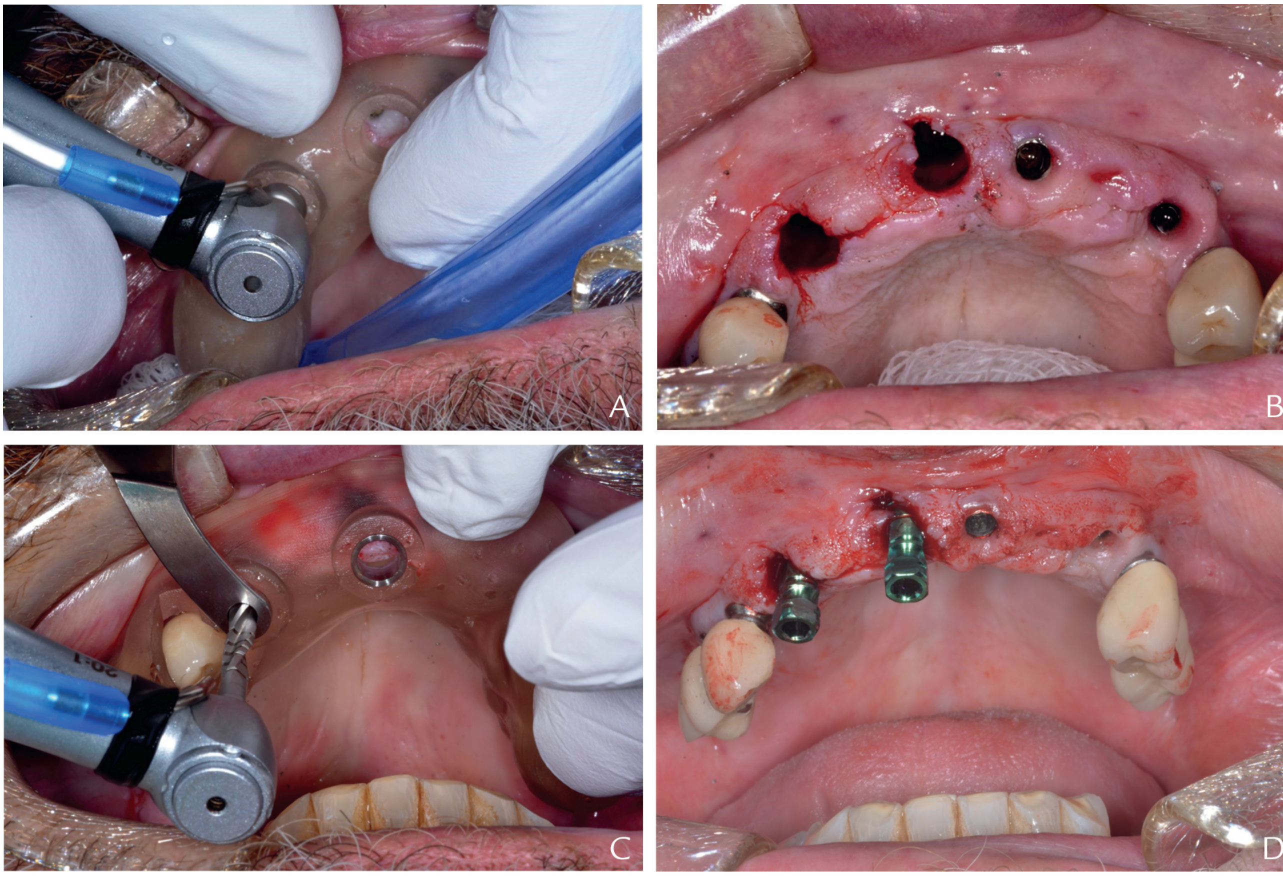

Figure 4. A, Implant removal guide used to direct trephination. B, Sites after implant removal. C, Implant replacement guide used to direct implant drills. D, Implant replacement.

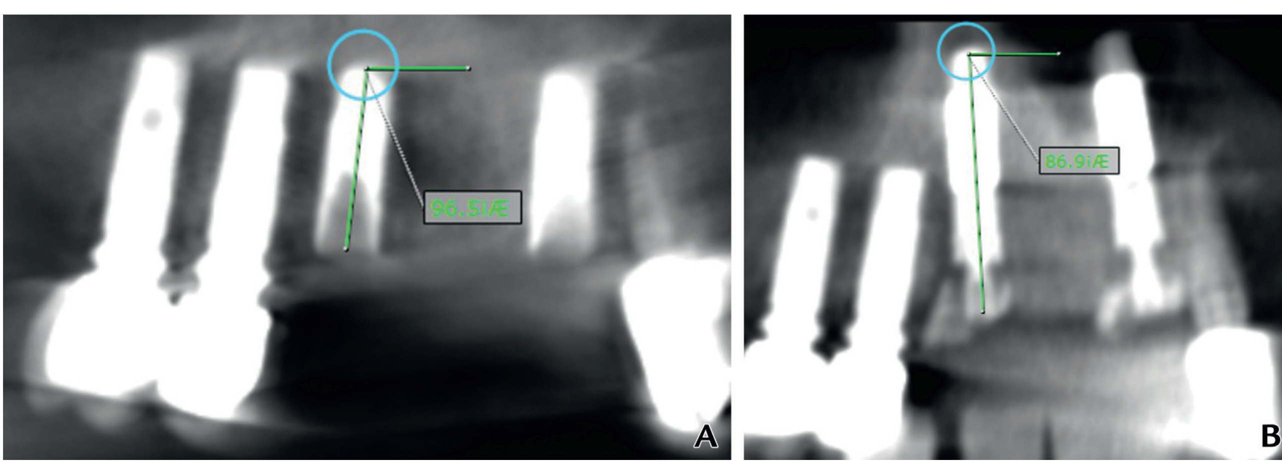

Figure 5. Superimposition of preoperative and postoperative cone beam computed tomography scans (frontal view). A, Preoperative positions of implants in positions of maxillary right canine and maxillary right central incisor (CBCT scan). B, Postoperative positions of maxillary right canine and maxillary right central incisor implants. Note corrected angulation in mesiodistal direction (CBCT scan).

(Formlabs Inc). They were printed (Form 2; Formlabs Inc) in biocompatible resin (Dental SG resin; Formlabs Inc). The printed resin was rinsed twice with 92% isopropyl alcohol, completely polymerized (LC-3D PrintBox; NextDent BV) (Fig. 3), and autoclaved.

After local anesthesia was administered, the surgical guide was seated. The trephine was introduced through the guide (Fig. 4A) and was used to make an osteotomy around the fractured implants, which were subsequently removed easily (Fig. 4B). The new osteotomy sites were

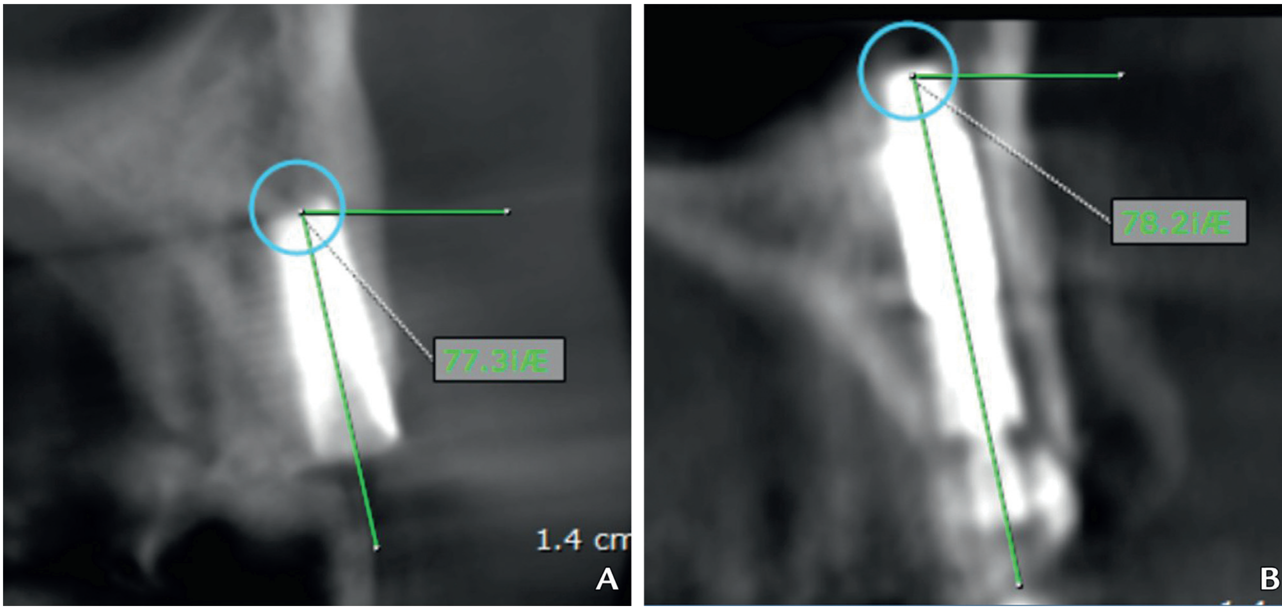

Figure 6. Superimposition of preoperative and postoperative cone beam computed tomography scans (sagittal view). A, Preoperative faciopalatal view of maxillary right canine implant. B, Postoperative view of maxillary right canine implant. Note that implant placed slightly palatal but with almost same angulation.

then prepared using the implant replacement guide (Fig. 4C), and 2 3.7×16-mm Zimmer trabecular metal implants (Zimmer Biomet) were placed (Fig. 4D). The implants had good primary stability (approximately 50 Ncm). Because of the thin bone, the facial aspect of the maxillary right central incisor implant was grafted with Puros particulate allograft (Zimmer Biomet) and a Bio-mend membrane (Zimmer Biomet).

After implant placement, we made a postoperative CBCT scan and superimposed the preoperative and postoperative scans by using a small field of view as previously described.[7] The implant in the position of the maxillary right canine had an angulation similar to the previous implant but was located more apically and approximately 1 mm more palatally (Figs. 5, 6).

DISCUSSION

Removal of osseointegrated implants can be difficult. Imprecise removal of implants can result in an unpredictably large bony defect. Implant failures caused by mechanical problems, as with this patient, are rare, and therefore, limited information is currently available. Computer-aided planning and fabrication of a 3D-printed surgical guide can be used to plan the position of the trephine drill precisely without the need for developing a flap for exposure of the site. This guided trephination protocol presents a safer and more straightforward surgical protocol than an unguided open flap approach. It is possible that the technique can also be applied to a treatment with an open flap protocol as well as where bone or soft tissue augmentation is needed before implant placement. Using guided trephination to remove an unrestorable implant, clinicians should note the availability of appropriate hard tissue and keratinized soft tissue, and augmentation may be considered on an individual patient basis. Maintenance and preservation of tissue and subsequent site development should always be considered at the planning stage as well as during the surgery.

A limitation of the technique is that radiographic scatter from existing restorations and implants can mask the exact location and positioning of the implant. This can be avoided by using a scan appliance to merge the preoperative records more exactly. However, at the time the described treatment plan was developed, the CBCT image had already been made. After we discussing the risks and benefits with the patient and following the As Low As Reasonably Achievable (ALARA) principles, a second preoperative CBCT scan was not made, and a limited field of view was used to superimpose the scans.[7] This method allowed precise measurement of the preoperative and postoperative implant position.[8] The technique also minimized the patient's exposure to radiation without sacrificing the precision of the CBCT scan superimposition.

CONCLUSIONS

Computer-aided planning and trephination using guided surgery with a computer-generated 3D-printed guide can be used for precise implant removal. The method eliminated the need for surgical exposure of the site and limited damage to the adjacent bone and allowed immediate implant replacement.

REFERENCES

1. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11-25.
2. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. J Prosthet Dent 2003;90:121-32.
3. Froum S, Yamanaka T, Cho SC, Kelly R. St James S, Elian N. Techniques to remove a failed integrated implant. Compend Contin Educ Dent 2011;32:22-6, 28-30.
4. Deeb GR, Allen RK, Hall VP, Whitley D III, Laskin DM, Bencharit S. How accurate are implant surgical guides produced with desktop stereolithographic 3-dimentional printers? J Oral Maxillofac Surg 2017;S0278-2391:31019-4.
5. Whitley D, Bencharit S. Digital implantology with desktop 3D printing. Somerville, MA: Formlabs White Paper; 2015. p. 1-15.
6. Bencharit S, Byrd WC, Hosseini B. Immediate placement of a porous-tantalum, trabecular metal-enhanced titanium dental implant with demineralized bone matrix into a socket with deficient buccal bone: a clinical report. J Prosthet Dent 2015;113:262-9.
7. Koerich L, Burns D, Weissheimer A, Claus JD. Three-dimensional maxillary and mandibular regional superimposition using cone beam computed tomography: a validation study. Int J Oral Maxillofac Surg 2016;45:662-9.
8. Edelmann AR, Hosseini B, Byrd WC, Preisser JS, Tyndall DA, Nguyen T, et al. Exploring effectiveness of computer-aided planning in implant positioning for a single immediate implant placement. J Oral Implantol 2016;42:233-9.

Corresponding author:
Dr Sompop Bencharit
Virginia Commonwealth University
520 North 12th St
Richmond, VA 23284
Email: sbencharit@vcu.edu