Guided Immediate Implant Placement with Wound Closure by Computer-Aided Design/Computer-Assisted Manufacture Sealing Socket Abutment: Case Report

Gary Finelle, DMD[1]/Sang J. Lee, DMD, MMSc[2]

Digital technology has been widely used in the field of implant dentistry. From a surgical standpoint, computer-guided surgery can be utilized to enhance primary implant stability and to improve the precision of implant placement. From a prosthetic standpoint, computer-aided design/computer-assisted manufacture (CAD/CAM) technology has brought about various restorative options, including the fabrication of customized abutments through a virtual design based on computer-guided surgical planning. This case report describes a novel technique combining the use of a three-dimensional (3D) printed surgical template for the immediate placement of an implant, with CAD/CAM technology to optimize hard and soft tissue healing after bone grafting with the use of a socket sealing abutment. Int J Oral Maxillofac Implants 2017;32;e63–e67. doi: 10.11607/jomi.4770

Keywords: *bone graft, CAD/CAM healing abutment, computer-guided surgery, immediate placement, soft tissue healing*

Advances in three-dimensional (3D) imaging technology, including computed tomography (CT) scans combined with computer-aided technology, have revolutionized the field of implant dentistry.[1,2] Visualization of anatomical hard and soft tissue structures overlaid with a virtual prototype of the definitive prosthesis has allowed for computer-guided implant placement and has led to more predictable outcomes.[3] Recent studies investigating applications of computer-assisted technology to restorative and implant dentistry have demonstrated the clinical viability of this technology in improving the accuracy of implant placement.[4,5]

The advantages of computer-guided surgery[3] include *(1)* a noninvasive surgical approach, *(2)* prosthetically driven implant placement, *(3)* an increase in primary stability, *(4)* a minimization of the need for bone grafting, and *(5)* a minimization of treatment time and healing period. Anatomical information taken from a CT scan is transferred to digital 3D planning software, where the position and angulation of implants are virtually planned. This virtual planning serves as a platform to connect the surgical plan to the restorative plan, allowing for the presurgical preparation of a provisional or even a definitive prosthesis.

Immediate implant placement into an extraction socket reduces both the number of surgeries and the duration of treatment, benefitting both the patient and the surgeon. However, several issues exist with immediate placement in both the esthetic zone and the posterior regions that can limit the use of an immediate placement protocol. In the esthetic zone, the placement of an implant immediately after extraction can lead to esthetic compromises related to facial recession of the peri-implant mucosa.[6,7] It has been shown that facial recession can be caused by an unpredictable resorption of the buccal plate, which tends to be thinner in the maxillary anterior region.[8–10]

In the posterior region, buccal wall thickness is consistently thicker than in the anterior zone,[11,12] so esthetic compromises are not an issue. Rather, challenges lie in achieving primary implant stability with the limited hard tissue available. Although it has been shown that implant placement into an extraction socket of a molar can be a reliable treatment procedure, the bony architecture of the sockets often prevents the ideal placement of an implant. Some of the challenges to immediate placement in the posterior region include: *(1)* obtaining proper implant position, *(2)* achievement of primary stability, and *(3)* obtaining sufficient insertion torque. Furthermore, with an immediate placement protocol, the remaining bony defects are usually filled with bone substitute materials and covered with a collagen membrane. However, achieving primary closure

[1]Private Practice, Paris, France.
[2]Assistant Professor, Department of Restorative Dentistry and Biomaterials Science, Harvard School of Dental Medicine, Boston, Massachusetts, USA.

Correspondence to: Dr Gary Finelle, Dental7Paris, Private Practice, 59 Avenue de la Bourdonnais, 75007 Paris, France. Email: gary.finelle@dental7paris.com

Fig 1 Occlusal view of the area to be restored.

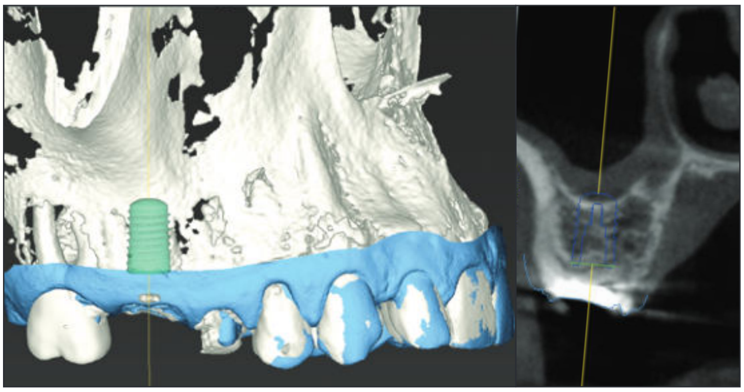

Fig 2 Virtual planning for implant placement and its cross-sectional view.

after guided bone regeneration of the area is difficult due to the lack of soft tissue and the size of the extraction socket. In addition, incomplete exclusion of soft tissue from the grafted area may compromise successful healing and osseointegration. Therefore, immediate implant placement in the posterior area is often not recommended, and delayed implant placement has been the standard protocol.[13]

Several studies have proposed the use of a healing abutment customized to the existing socket contours or a provisional restoration to facilitate healing following the immediate placement of an implant.[14,15] The use of a customized healing abutment provides the advantages of helping preserve the existing soft tissue architecture and reducing the risk of premature loading of the implant during healing. Despite its advantages, some clinicians may find the fabrication of a customized healing abutment difficult and time-consuming, as the contours must be estimated and built up incrementally with the provisional material. Also, working with acrylic or composite in a bleeding working field is not an easy task, and the inadvertent introduction of the temporary material into the socket could interfere with healing.

This case report presents a protocol combining computer-guided surgery to allow immediate implant placement in the posterior area, with a customized CAD/CAM socket sealing abutment (SSA) to optimize healing of the grafted area without the use of a collagen membrane and to avoid the challenges involved in a conventional technique. The goal is to enhance the efficiency of immediate implant placement in the posterior area and to simplify the sealing of the extraction socket following graft placement. The application of a CAD/CAM SSA also provides uninterrupted healing in the grafted site and develops an anatomically contoured emergence profile of the peri-implant soft tissue.

Case Report and Technique

A man 40 years of age presented with a nonrestorable maxillary right first molar. The treatment plan was to extract the nonrestorable tooth and restore with a single implant in addition to the restorations of neighboring teeth (Fig 1). The patient's medical history revealed no contraindications to dental implant therapy and restorative treatment.

3D Planning and Fabrication of CAD/CAM Customized Abutment

Following clinical and radiographic examination, a virtual diagnostic impression was taken with an intraoral digital scanner (Itero, Cadent), and a cone beam CT scan was administered (Promax 3D, Planmeca). The Standard Tessellation Language (STL) files from the intraoral digital scan were imported to computer-guided planning software and merged with the Digital Imaging and Communications in Medicine (DICOM) files from the CT imaging acquisition.

An implant for the maxillary first molar (Bone Level Implant 4.8 × 8 mm RC, Straumann) was virtually planned for immediate placement after a virtual extraction in the software. The ideal position of the implant was virtually planned based on the anatomical architecture and prosthetic considerations (Fig 2). The angulation and vertical position of the implant were determined to minimize off-axis loading of the implant and create a proper emergence profile. A 3D printed surgical template from a rapid prototyping machine (Objet Eden 350V, Stratasys) was designed and fabricated for the guided implant surgery (Fig 3). The emergence profile of the implant restoration was designed by duplicating the shape of the transmucosal area of the existing tooth via a virtual wax-up in CAD/CAM software (DWOS CAD software, Dental Wings) (Figs 4a and 4b). A CAD/CAM SSA was fabricated following the design of the emergence profile and the 3D virtual planning of the implant positioning. The core of SSA was fabricated through a subtractive milling technique (Villemin-Macodel, Milling Machine S08B) in resin polymethyl methacrylate (Straumann Polycon AE) and bonded to a titanium abutment (Variobase, Straumann) (Fig 4c).

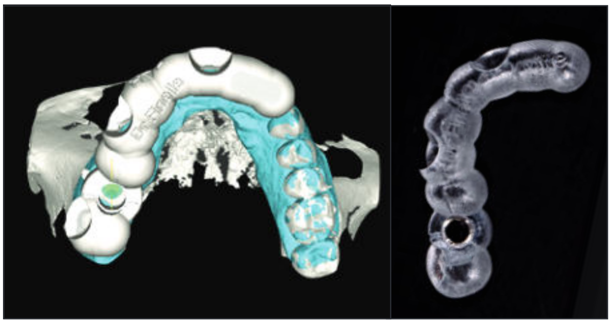

Fig 3 Virtual design of surgical template and 3D printed surgical template.

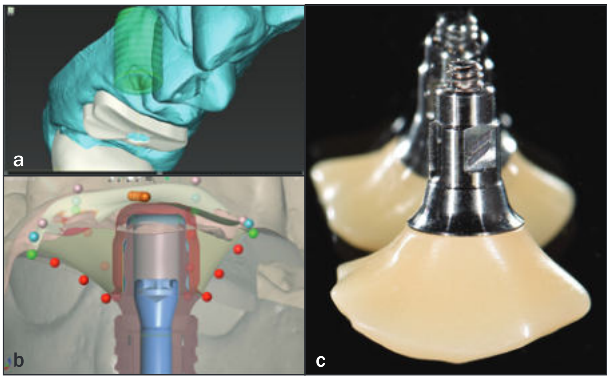

Fig 4 *(a)* Virtual implant placement in reference to the existing root. *(b)* Virtual design of transmucosal portion reproducing the shape of existing tooth emergence profile. *(c)* CAD/CAM customized healing abutment.

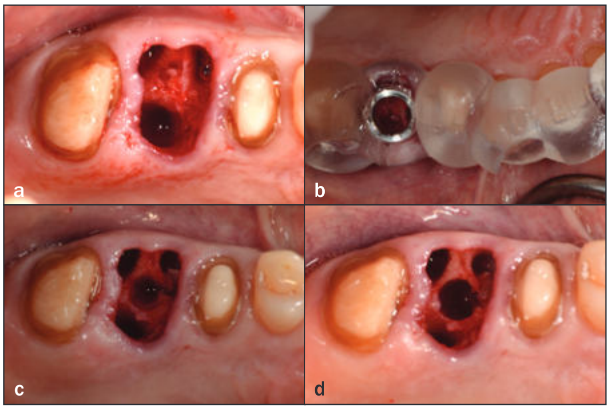

Fig 5 *(a)* Atraumatic extraction to preserve hard and soft tissue architecture. *(b)* Placement of 3D printed surgical template. *(c)* Occlusal view of intraseptal initial osteotomy. *(d)* Occlusal view of osteotomy in the septum.

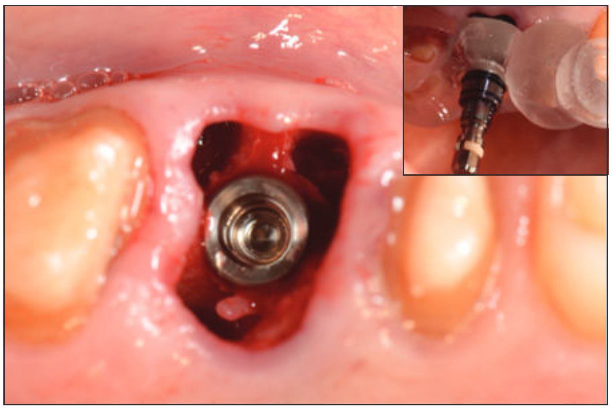

Fig 6 Guided implant placement through 3D printed surgical template.

Surgical Procedure

Local anesthesia with Lidocaine 2% with 1:100,000 epinephrine was administered to the patient. Atraumatic flapless tooth extraction was performed by sectioning the existing core and roots (Fig 5a) and separating the supracrestal gingival fibers with periotomes. The 3D printed surgical template was tried in. The fit, seat, and stability of the template were confirmed (Fig 5b). Following the manufacturer's protocol for computer-guided implant placement, the osteotomy was prepared in the middle of the septum as virtually planned in the planning phase (Figs 5c and 5d). An implant was placed in a guided fashion using the surgical template, and primary stability was successfully achieved (Fig 6). The insertion torque recorded during the placement was 33 N/cm. After removal of the surgical template, a cover screw was placed, and the remaining socket was grafted with a xenograft bone substitute (Bio-Oss 0.5 g small particles, Geistlich) (Fig 7). The CAD/CAM SSA was inserted to support the surrounding soft tissues and provide a barrier for the graft material without the use of a biologic membrane (Figs 8a and 8b).

Immediately after the surgery, postoperative periapical radiographs were taken to verify the proper positioning of the implant (Fig 9). At the 1-week follow-up, the patient reported an uneventful postoperative recovery, and clinical examination showed normal soft tissue healing with no signs of infection (Fig 10a). Upon retrieval of the SSA abutment at the 6-week follow-up, it was noted that the peri-implant soft tissue had maintained the emergence profile defined by the SSA (Fig 10b).

After 8 weeks of osseointegration, a digital impression (Itero, Cadent) was taken for the implant and the neighboring prepared teeth. A 3D printed working model was manufactured (Prodways, LS500D), and monolithic lithium disilicate crowns (IPS Emax press, Ivoclar) were fabricated through a pressing technique (Fig 11). The ideal emergence of the implant axis allowed for a screw-retained prosthesis. The implant crown was bonded onto a titanium base abutment (Variobase, Straumann) with resin cement (RelyX Unicem, 3M ESPE). After crown delivery at the proper insertion torque, the access hole was covered with restorative composite (Gænial A2, GC) (Figs 12a and 12b). A postoperative periapical

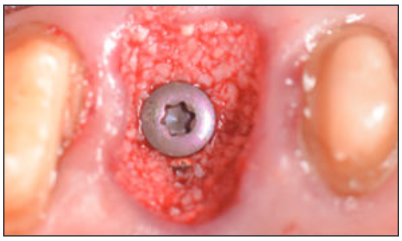

Fig 7 Guided bone regeneration around the implant and remaining socket.

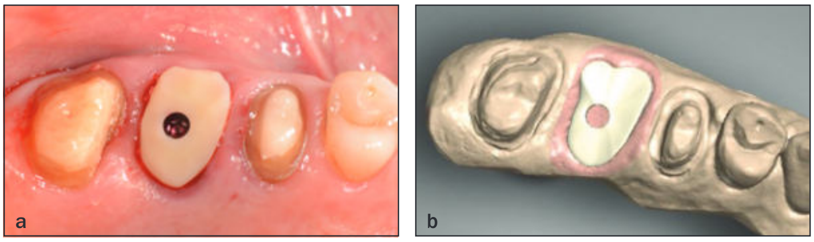

Fig 8 *(a)* Socket sealing abutment (SSA) as a mechanical barrier to seal the socket area and protect guided bone regeneration materials. *(b)* Virtual design of the SSA in the CAD software.

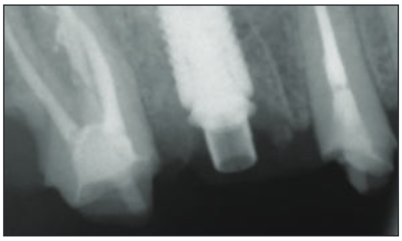

Fig 9 Postoperative radiograph immediately after the implant placement and SSA insertion.

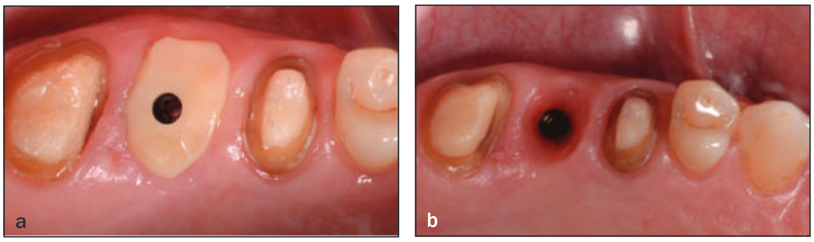

Fig 10 *(a)* One-week follow-up after implant placement and guided bone regeneration. *(b)* Emergence profile maintained through the SSA abutment at 6-week follow-up.

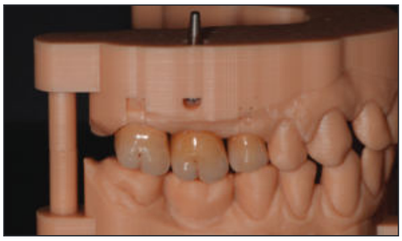

Fig 11 3D printed model and definitive restorations.

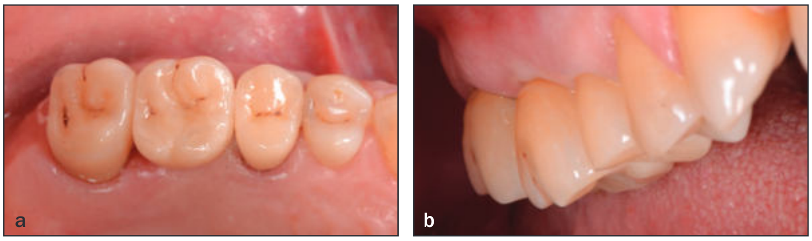

Fig 12 *(a)* Occlusal view of the definitive restorations. (b) Buccal view upon the delivery.

Fig 13 Postoperative radiograph.

radiograph was taken to verify the seating and marginal integrity after insertion (Fig 13).

DISCUSSION

The present protocol is proposed to overcome the major challenges encountered when undertaking immediate implant placement in the posterior region. Immediate implant placement in posterior extraction sites presents a challenge due to the hard and soft tissue architecture after extraction. The extraction socket configuration in the posterior areas often compromises the achievement of primary stability and hinders primary wound closure following placement of bone graft material. Through the use of computer-guided surgery, primary stability can be successfully obtained in the septum following tooth extraction. The existing roots can be virtually eliminated, and the implant placement is virtually planned with ideal engagement of the implant in the septum. The accuracy of the system provides a precise osteotomy preparation and guides the implant placement as virtually planned.

Immediate implant placement often requires guided bone regeneration with a membrane, which complicates the surgical procedure. The success of the bone graft depends on the isolation of the grafted area from the intraoral environment and prevention of soft tissue growth into the grafted site. Releasing incisions with coronally positioned flaps are often required to achieve primary closure of grafted extraction sites. This interrupts the soft tissue architecture and lengthens the healing period. The proposed protocol simplifies the procedure of bone grafting following immediate implant placement and suggests the use of an SSA. This serves as a mechanical barrier to isolate the grafted area, stabilize the clot and contain the graft material, and seal the socket from foreign contaminants, while minimizing the risk of premature loading of the implant during healing. By preparing an SSA fabricated by CAD/CAM technology that follows the transmucosal contours of the natural tooth, the grafted area can be sealed and separated from the growth of soft tissue without the use of a membrane and releasing incisions.

A few case reports have demonstrated the use of immediate provisionalization after immediate implant placement to assist in the maintenance of peri-implant soft tissue architecture.[7,14] A socket preservation technique at the time of flapless extraction and implant placement in combination with a provisional restoration resulted in minimal changes to the ridge contours. A recent study[15] described the use of a prefabricated polymethyl methacrylate shell to fabricate a customized healing abutment. A prefabricated shell approximating the anatomy of the cervical root area of the removed tooth is modified and incrementally built up to support the subgingival contours. In the current protocol, the subgingival contours were virtually designed by duplicating the anatomical contours of the existing tooth, rather than approximating the subgingival contour by conventional laboratory techniques. The application of CAD/CAM technology to reproduce the precise contours of the cervical root area eliminates conventional laboratory procedures and provides a predictable seal around the soft tissue.

The CAD/CAM socket sealing abutment also serves to maintain soft tissue contours during osseointegration and healing of the peri-implant soft tissues. These preserved soft tissue contours are then captured by a digital impression to create the ideal contours for the definitive crown for better esthetics and hygiene.

This case report introduces a unique approach for immediate implant placement in the posterior zone and simplifies the concurrent guided bone regeneration procedure by combined applications of computer-guided implant placement and CAD/CAM technology. The utilization of computer-guided surgery combined with CAD/CAM technology facilitated immediate implant placement in the posterior area and provided a predictable outcome while reducing the length of treatment, number of surgeries, postoperative discomfort, morbidity related to open-flap technique, and cost of the treatment.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to Dr Antoine Popelut for his contribution in this study and Jerome Vaysse (HTD), Christophe Sireix (Sireix Lab), and Asselin Bonichon (LNT) for their laboratory support. The authors reported no conflicts of interest related to this study.

REFERENCES

1. Verstreken K, Van Cleynenbreugel J, Marchal G, Naert I, Suetens P, van Steenberghe D. Computer-assisted planning of oral implant surgery: A three-dimensional approach. Int J Oral Maxillofac Implants 1996;11:806–810.
2. Schwarz MS, Rothman SL, Rhodes ML, Chafetz N. Computed tomography: Part I. Preoperative assessment of the mandible for endosseous implant surgery. Int J Oral Maxillofac Implants 1987;2:137–141.
3. van Steenberghe D, Naert I, Andersson M, Brajnovic I, Van Cleynenbreugel J, Suetens P. A custom template and definitive prosthesis allowing immediate implant loading in the maxilla: A clinical report. Int J Oral Maxillofac Implants 2002;17:663–670.
4. Valente F, Schiroli G, Sbrenna A. Accuracy of computer-aided oral implant surgery: A clinical and radiographic study. Int J Oral Maxillofac Implants 2009;24:234–242.
5. Ozan O, Turkyilmaz I, Ersoy AE, McGlumphy EA, Rosenstiel SF. Clinical accuracy of 3 different types of computed tomography-derived stereolithographic surgical guides in implant placement. J Oral Maxillofac Surg 2009;67:394–401.
6. Evans CD, Chen ST. Esthetic outcomes of immediate implant placements. Clin Oral Implants Res 2008;19:73–80.
7. Kan JY, Roe P, Rungcharassaeng K, et al. Classification of sagittal root position in relation to the anterior maxillary osseous housing for immediate implant placement: A cone beam computed tomography study. Int J Oral Maxillofac Implants 2011;26:873–876.
8. Araújo MG, Sukekava F, Wennström JL, Lindhe J. Ridge alterations following implant placement in fresh extraction sockets: An experimental study in the dog. J Clin Periodontol 2005;32:645–652.
9. Hämmerle CH, Araújo MG, Simion M. Osteology Consensus Group 2011. Evidence-based knowledge on the biology and treatment of extraction sockets. Clin Oral Implants Res 2012;23(suppl):s80–s82.
10. Benic GI, Mokti M, Chen CJ, Weber HP, Hämmerle CH, Gallucci GO. Dimensions of buccal bone and mucosa at immediately placed implants after 7 years: A clinical and cone beam computed tomography study. Clin Oral Implants Res 2012;23:560–566.
11. Braut V, Bornstein MM, Belser U, Buser D. Thickness of the anterior maxillary facial bone wall-a retrospective radiographic study using cone beam computed tomography. Int J Periodontics Restorative Dent 2011;31:125–131.
12. Braut V, Bornstein MM, Lauber R, Buser D. Bone dimensions in the posterior mandible: A retrospective radiographic study using cone beam computed tomography. Part 1—analysis of dentate sites. Int J Periodontics Restorative Dent 2012;32:175–184.
13. Chen ST, Beagle J, Jensen SS, Chiapasco M, Darby I. Consensus statements and recommended clinical procedures regarding surgical techniques. Int J Oral Maxillofac Implants 2009;24(suppl):s272–s278.
14. Tarnow DP, Chu SJ, Salama MA, et al. Flapless postextraction socket implant placement in the esthetic zone: Part 1. The effect of bone grafting and/or provisional restoration on facial-palatal ridge dimensional change-a retrospective cohort study. Int J Periodontics Restorative Dent 2014;34:323–331.
15. Chu SJ, Hochman MN, Tan-Chu JH, Mieleszko AJ, Tarnow DP. A novel prosthetic device and method for guided tissue preservation of immediate postextraction socket implants. Int J Periodontics Restorative Dent 2014;34(suppl):s9–s17.