DENTAL TECHNIQUE

CAD-CAM titanium preparation template for the socket-shield technique

Li Chen, DDS, PhD,a Zhen Yang, DDS,b Xiaoqiang Liu, DDS, PhD,c Wei-Shao Lin, DDS,d and Jianguo Tan, DDS, PhDe

ABSTRACT

The socket-shield technique can be challenging and time-consuming. This article presents a digital approach to fabricating a computer-aided design and computer-aided manufacturing (CAD-CAM) titanium preparation template for the socket-shield technique. Preoperative cone beam computed tomography (CBCT) was used to map the remaining root, and the desired shape of the buccal fragment of the root was determined as the socket shield. A CAD-CAM titanium preparation template was fabricated to facilitate root sectioning and the preparation procedure for forming an adequate socket shield. (J Prosthet Dent 2020;123:786-90)

TECHNIQUE

1. Obtain preoperative diagnostic data from the patient, including digital photographs, an intraoral scan in the standard tesselation language (STL) file format, and the cone beam computed tomography (CBCT) imaging in the Data Imaging and Communications in Medicine (DICOM) file format (Fig. 1).
2. Import the DICOM and STL files into a 3D dental CAD software program (Segma Dental CAD; Segma). Complete a virtual diagnostic waxing and isolate the root from the surrounding anatomic structure (Fig. 2).

3. For immediate implant placement, determine the appropriate implant position based on the virtual diagnostic waxing and design the surgical template for the implant placement. Based on the planned implant position, determine the appropriate contour and thickness of the socket shield (Fig. 3).

4. Use the contour and boundaries of the socket shield to plan for the locations of the proximal and lingual guide planes. Design the proximal and lingual guide planes for the CAD-CAM preparation template in the CAD software program (Segma Dental CAD) and provide space between the desired contour of the socket shield and guide planes to account for the dimension of the tungsten carbide instrument needed during socket-shield preparation (Fig. 4). Based on the determined position of the proximal and lingual guide planes, design the CAD-CAM preparation template (Fig. 5). Incorporate seating verification windows in the design of the preparation template.

5. Subtract the segmented root from the diagnostic intraoral scan and export the new diagnostic cast and segmented root in STL format. Print the new diagnostic cast and segmented root by using a 3D printer (Perfactory Desktop Digital Dental Printer; EnvisionTEC) in photopolymerizing resin (E-Denstone Peach; EnvisionTEC) and fabricate the CAD-CAM preparation template by using a 5-axis mill (5X-200; Arum Europe GmbH) and titanium disk (Segma). Assemble the diagnostic cast and segmented root and position the preparation template on the diagnostic cast.

6. Select a tungsten carbide rotary instrument (Bone cutter H162SXL.314.014; Komet Dental) of sufficient length and mark depth indicators on the
instrument to guide the preparation depth during
the surgery (Fig. 6).
7. Proceed with the planned surgery and use the
CAD-CAM titanium preparation template and
tungsten carbide rotary instrument to section and
prepare the buccal root fragment, forming an
appropriate socket shield. Ensure the tungsten car-
bide rotary instrument contacts with and is parallel
to the proximal and lingual guide planes in the
preparation template (Fig. 7).
8. Upon completion of the socket-shield preparation,
place the dental implant following the guidance of
the surgical template (Fig. 8).

DISCUSSION
This technique report presents a digital process for
fabricating a CAD-CAM titanium preparation template
for the socket-shield technique. In a retrospective study

Figure 4. Design process of proximal and lingual guide planes for preparation template. A, Teal color indicates shape of remaining root, and black line indicates desired shape of socket shield. Pink color indicates contour of guide planes. Between black line and pink guide planes, space for tungsten carbide rotary instrument. B, Frontal view of socket shield and path of insertion for guide planes.

Figure 5. A, Incisal view of computer-aided design and computer-aided manufacturing socket-shield preparation template. Seating verification windows incorporated in template design. B, Frontal view of preparation template.

Figure 6. Printed diagnostic cast and segmented root. Mark depth indicators (blue lines) on tungsten carbide rotary instrument to guide preparation depth during surgery. One depth indicator represents location of upper margin of guide plane. Other depth indicator represents lower margin of guide plane.
of 128 case series, the authors found that the most common complication resulted from improper socket-shield preparation, leading to exposure (perforation) of the socket shield. When using the socket-shield technique without a preparation template, clinicians have to stop frequently to check the preparation depth and angulation and to verify the complete separation of the root while avoiding the penetration of the surrounding bone and adjacent teeth. After separation and extraction of the palatal root fragment, the buccal root fragment has to be prepared to the desired thickness and shape to form an appropriate socket shield. Using a CAD-CAM preparation template, the thickness and shape of the socket shield can be determined during preoperative planning, and the orientation and extension of the tungsten carbide rotary instrument can be properly guided by the preparation template during surgery. Seating verification windows are also incorporated in the template design, and clinicians should inspect the proper fit of the preparation template on the printed diagnostic cast and intraorally to ensure the accurate seating of the template and execution of the surgical plan. Another benefit of the present technique is using the concept of prosthetically driven surgical planning approach. With the use of a CAD-CAM preparation template, desired definitive prosthesis design (through diagnostic virtual waxing) can be planned in conjunction with the surgical planning of the socket shield.

Titanium was used to mill the preparation template, but cobalt-chromium (Co-Cr) alloy could be an alternative material. Furthermore, 3D metal printing technologies could also be considered for fabricating the desired preparation template. Although photopolymerizing resin is a convenient material for the fabrication of the surgical template by using a desktop stereolithography (SLA) 3D printer, it may not be suitable for the SS preparation template described in this report. Proximal and lingual guide planes on the SS preparation template are important to guide the tungsten carbide rotary instrument to section and prepare the buccal root fragment, but the photopolymerizing resin may not withstand the cutting force from the tungsten carbide instrument. Wear of a photopolymerizing resin surgical template can deform guide planes, leading to inaccurate execution of the surgical plan.

Accurate and complete isolation of the remaining tooth or root in the CAD software program is essential in planning the socket shield, which requires high-resolution CBCT imaging with minimal artifact. Metal prostheses in the remaining tooth or root should be removed before the CBCT imaging to decrease artifact. If artifact cannot be eliminated and the complete isolation of the remaining tooth or root cannot be achieved from the DICOM files, the proposed technique is not applicable. In addition, a custom dental CAD software program (Segma Dental CAD; Segma) was used to design the preparation template. The development of new software programs would facilitate this technique.
SUMMARY

Root separation and preparation is challenging and time-consuming when using the socket-shield technique. The described CAD-CAM titanium preparation template can guide clinicians performing the technique and possibly improve surgical efficiency and safety through careful prosthetically driven surgical planning.

REFERENCES


Corresponding author:
Dr Wei-Shao Lin
Department of Prosthodontics
Indiana University School of Dentistry
1121 W. Michigan Street, Office: DS-S406
Indianapolis, IN 46202-5186
Email: weislin@iu.edu

https://doi.org/10.1016/j.prosdent.2019.06.009