The replacement of a failing tooth with a dental implant in the esthetic zone is challenging. One of the proposed protocols is the immediate placement of a narrow-diameter implant. The platform switching concept has also been described as beneficial for the outcomes of such patients. In addition, implant placement using a palatal approach associated with buccal gap grafting with particulate bone substitutes and a subsequent connective tissue graft lead to predictable long-term success.

One of the acceptable alternatives for patients with adequate marginal bone height and width for implant placement is the socket-shield technique in which the failing tooth is intentionally partially extracted leaving the buccal remnant of the root adhered to the buccal plate of the socket. The technique can be associated with the immediate placement of an interim implant-supported prosthesis. Furthermore, this technique can be digitally guided by using a computer-aided design and computer-aided manufactured (CAD-CAM) preparation guide.

In spite of these successful reports, the association of the socket-shield technique with the placement of an immediate interim crown risks detachment of the root fragment from the buccal plate. Detachment occurs because of undesirable mechanical stimulation by the intermediate prosthetic abutment on the root fragment; this could be prevented with a digitally designed custom abutment based on the natural emergence profile as segmented from the tooth to be extracted. (J Prosthet Dent 2021;:–:

**TECHNIQUE**

1. Make a cone beam computed tomography (CBCT) scan (OP300; Instrumentarium) with image
acquisition parameters of 200 μm voxel, 90 kVp, 8 mA, exposure time of 12.5 seconds, slice thickness of 0.5 mm, and field of view of Ø61×78 mm. Place a lip retractor during the CBCT scan to facilitate the alignment of CBCT and intraoral scans. In addition, scan both maxillary and mandibular arches, as well as of the occlusal relationship with an intraoral scanner (TRIOS 4; 3Shape A/S).

2. Import the CBCT Digital Imaging and Communications in Medicine (DICOM) and intraoral scanner standard tessellation language (STL) files into an implant planning software program (NemoStudio; Nemotec SL).

3. Open the DICOM files in the implant planning software program and segment the failing tooth 3-dimensionally (3D) by manually outlining its area in all cross-sectional images containing the tooth. Using the same procedure, 3D segment the buccal fragment shape from the root to be intentionally left in the socket. Based on these segments, virtually wax the implant-supported crown and define the position of the respective implant in the bone (Fig. 1). If possible, the implant should be positioned at least 2 mm away from the buccal root fragment.

4. Based on the natural coronal emergence profile obtained from the root segmentation, use a CAD software program (DentalCAD; exocad GmbH) to digitally design a custom abutment to be cemented onto a prefabricated intermediate abutment (TiBase; Neodent). Use the same CAD software program to plan the platform position of the TiBase abutment to be coronal to the socket shield (Fig. 2). If necessary, adjust the shape of the custom abutment to ensure a buccal gap of 2 mm from the abutment to the buccal root fragment. Digitally design the surgical guide by choosing the shape and height of the drilling sleeves by using the same implant planning software program (NemoStudio; Nemotec SL).

5. Fabricate the interim implant crown with polymethylmethacrylate resin (Trilux Multilayer; RuthiBras) with a milling machine (Ceramill Motion 2; Amann Girrbach AG). Fabricate the surgical guide with light-polymerizing resin (priZma 3D Bio Guide; Makertech Labs) by using a digital light processing 3D printer (Hunter; FlashForge) with the following parameters: 1-mm offset, 0 harden, 20 density, constant direction, and offset end type. Mill the custom abutment with the same milling parameters.
machine but with zirconia (Zolid Fx Multilayer; Amann Girrbach AG).

6. Carefully remove any remaining intraradicular post to prevent root fracture. Perform partial extraction therapy by using a dedicated drilling kit (PET Kit; MegaGen). Introduce the first drill of the kit longitudinally into the root canal, taking into consideration the total root length as measured on the preoperative CBCT image (Fig. 3).

7. Use the second drill to section the root vertically in a mesiodistal direction, creating a buccal and a palatal root fragment.

8. After careful removal of the palatal root fragment, abrade the buccal root fragment by using the third

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**Figure 2.** Root shield (blue) and abutment profile (gold concave abutment profile) in cross-sectional CBCT image; distance between coronal aspect of socket shield and platform of custom abutment (2.2 mm) measured in checkered image. CBCT, cone beam computed tomography.

**Figure 3.** Partial extraction therapy drilling (PET Kit, MegaGen); lance drill (drill nº1 of PET Kit).

**Figure 4.** C-shaped labial root fragment.
and fourth drills. This should be performed without damaging the mesial and distal extensions of the buccal root fragment, which should be left attached to the buccal plate of the socket and have a C-shape (Fig. 4).

9. Vertically reduce the cervical portion of the buccal root fragment to the alveolar bone crest level (Fig. 5) by using the fifth and sixth drills. This step will ensure an adequate fit of the custom abutment.

10. Use the surgical guide and an image-guided drilling kit (Neodent Guided Surgery kit; Neodent) to perform implant placement (Cone Morse Ø3.5 × 16 mm; Neodent) (Fig. 6).

11. Evaluate the TiBase abutment intraorally. Unscrew it to cement the custom abutment to the TiBase abutment extraorally with a resin luting agent (RelyX Unicem; 3M ESPE) (Fig. 7).

12. Place the interim implant restoration (Fig. 8). If necessary, adjust the centric and excursive occlusal contacts.

**DISCUSSION**

The socket-shield technique has been reported to maintain the alveolar bone structure, providing satisfactory esthetics in patients receiving immediate implants. Nevertheless, a consensus regarding methods for assessing the outcomes of socket-shield surgeries is lacking. The present technique is consistent with a previous study that suggested the usefulness of a digital workflow to perform the socket-shield technique followed by an implant-supported restoration. The authors are unaware of a previous technique report describing a fully digital workflow to perform the socket-shield technique associated with the immediate placement of an implant in the anterior maxilla and a CAD-CAM custom abutment designed based on the natural coronal emergence profile of the tooth to be extracted.

Fully digital workflows using custom abutments and implant-supported interim restorations are useful to improve predictability for anterior immediate implants. With the described technique, the risk of trauma and mobilization of the buccal root fragment by the
implant-supported crown should be minimized by the design of the CAD-CAM customized abutment. This design followed the natural coronal emergence profile of the failing tooth to maintain the support of the peri-implant suprabony soft tissue while still ensuring a buccal gap of 2 mm between the implant and the buccal root fragment to allow for soft-tissue ingrowth and closure.12

The present technique also uses a CAD-CAM custom abutment designed to be cemented on the TiBase abutment, as described previously.10 One of the advantages of this technique is that the TiBase has different options of transmucosal height. Therefore, in situations where the implant needs to be placed deeper than planned to achieve a satisfactory torque, the resulting difference in height can be compensated for by an increased transmucosal height to avoid altering the final height of the implant-supported crown.

Limitations of the present technique include that it is mostly applicable to situations with adequate marginal bone height and buccolingual width at the immediate implant site. Therefore, the commonly found loss of the buccal plate of the socket should be considered a contraindication for the socket-shield technique.16 Furthermore, the present root segmentation technique may also be hindered by the presence of CBCT artifacts related to scattered radiation caused by metal objects.17 Future long-term prospective clinical studies are needed to assess long-term success rates with the digital workflow presented.

SUMMARY

The socket-shield technique can be performed with satisfactory predictability by using drilling kits dedicated to partial extraction therapy in a digital workflow for image-guided immediate implant placement with CAD-CAM surgical guides. The CBCT and intraoral scans can also be used to fabricate a CAD-CAM custom abutment to be digitally designed based on the natural coronal emergence profile of the failing tooth to be replaced.

REFERENCES


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