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DENTAL TECHNIQUE

Combination of cone beam computed tomography and CAD-CAM techniques for maintaining natural emergence profile in immediate extraction and/or implant placement and restoration of a central incisor: A dental technique

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ABSTRACT

For immediate extraction and implant placement, preservation of the natural emergence profile is essential to optimize esthetics. In the technique presented, the Digital Imaging and Communications in Medicine (DICOM) and standard tessellation language (STL) data were merged to simulate the tooth before surgery and to design the interim restoration. The existing tooth and gingival architecture were replicated. (J Prosthet Dent 2019;122:193-7)

An optimal esthetic outcome for an implant-supported restoration is essential, particularly in the anterior sector. An immediate extraction, implant placement, and immediate restoration protocol can minimize tissue loss,[1,2] and radiological techniques including cone beam computed tomography (CBCT) can correctly indicate immediate placement treatment. An analysis of residual bone volumes has been facilitated by advances in 3D imaging, which allows more precise implant planning.[3] Correct placement can be achieved by guided surgery techniques[4] and should be combined with prosthetic techniques, including the interim restoration, to preserve the existing periodontal architecture and provide an optimal esthetic result.[5,6] Reproduction of the cervical and radicular anatomy of the original tooth makes it possible to maintain the level and the architecture of the gingival tissues before extraction.[7-9]

The purpose of this article was to describe a technique for the creation of an interim tooth that mimics the natural crown contours and emergence profile before the surgical phase. At the same time, the protocol described for making the definitive prosthesis eliminates the need to make a new impression after the bone and gingiva have healed. Both these techniques use computer-aided design and computer-aided manufacturing (CAD-CAM) technology.

The technique illustrated was used to treat a 32-year-old man who was referred to the author's clinic (R.N.) with a nonrestorable maxillary central incisor with an apical third root fracture (Fig. 1).

TECHNIQUE

1. Make diagnostic impressions. For this patient, conventional impressions were made, although a digital scan may also be made (Fig. 2). Concurrently, make a CBCT scan (5G XL; NewTom). Also make photographs to provide information for the dental laboratory technician.
2. Plan the implant location using an implant planning software program (Simplant; Dentsply Sirona) (Fig. 3). Digitize the diagnostic cast using a laboratory CT scanner (S600 ARTI; Zirkonzahn) to obtain a virtual cast as a standard tessellation language (STL) file.
3. Modify the STL file with virtual waxing to obtain a cast with the position of the future tooth (the slight displacement of the tooth caused by the trauma was corrected). Also scan a cast without the relevant tooth.
4. Index these casts from the Digital Imaging and Communications in Medicine (DICOM) data so

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Figure 1. Pretreatment situation. A, Discolored fractured right maxillary central incisor. B, Cone beam computed tomography image.

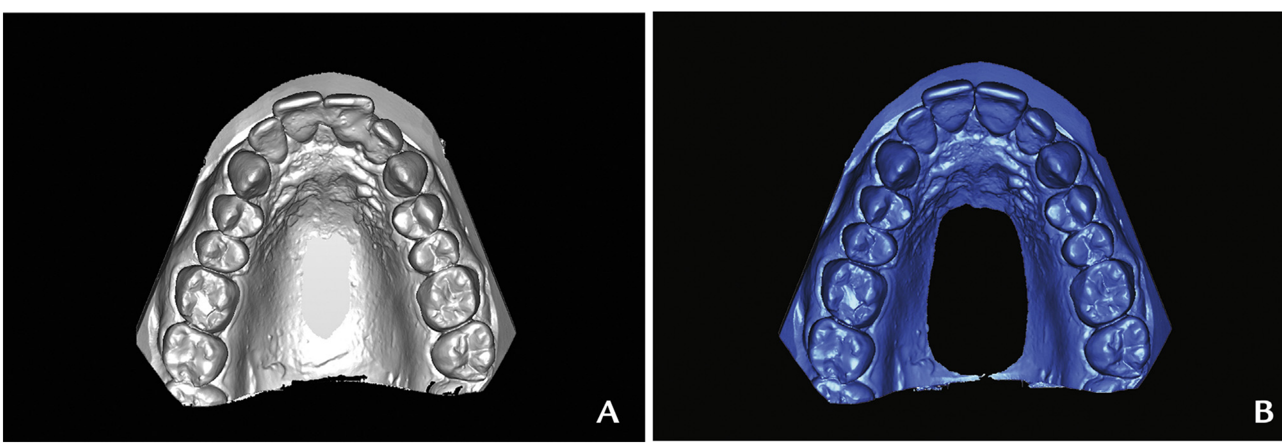

Figure 2. STL files. A, Cast with pretreatment situation. B, Cast with simulated prosthesis. STL, standard tessellation language.

that the implant can be properly positioned based on the biologic and prosthetic parameters. Plan the position 3 mm from the neck of the future tooth (blue line in Fig. 3).

5. Draw a stereolithographic guide (Simplant; Dentsply Sirona) on the cast with the tooth extracted to control the drilling depth and implant placement.
6. Create the restoration in 3D using an implant planning software program (Simplant; Dentsply Sirona) (Fig. 4). Save the virtual restoration as an STL file and fabricate it using a laboratory milling machine (M5; Zirkonzahn). A laboratory milling system provides a choice of shades from a resin block (Multistratum A1/A2; Zirkonzahn) for the interim restoration (Fig. 5).
7. Create a new definitive cast by duplicating and inserting the interim restoration in the mold before pouring the new cast. Remove the milled tooth once the gypsum has set to capture the emergence profile (Fig. 6).
8. Proceed with the implant placement surgery. Prescribe amoxicillin 1 g every 12 hours for 8 days. Extract the nonrestorable tooth by an atraumatic approach to reduce postextraction bone resorption. Place the implant (NobelActive [4.3 mm×10 mm]; Nobel Biocare) following the principles of guided surgery.
9. Place an impression coping and inject resin (LuxaBite; Pred) around the coping to position the coping in the previously prepared cast. Bond the replica to the coping and replace the whole assembly on the cast. Adjust the milled tooth using an acrylic trimming bur guided by the interim titanium cylinder used (Temporary Cylinder; Nobel Biocare).
10. Because of the size of the gap between the implant and the buccal cortical bone, backfill with a bone

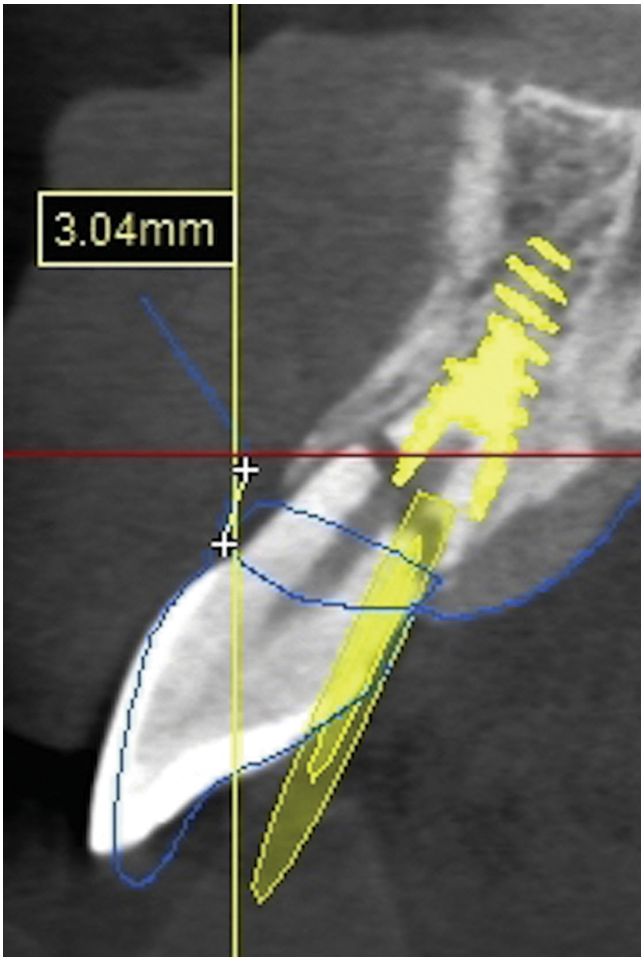

Figure 3. Oblique section of implant planning (implant positioning criteria).

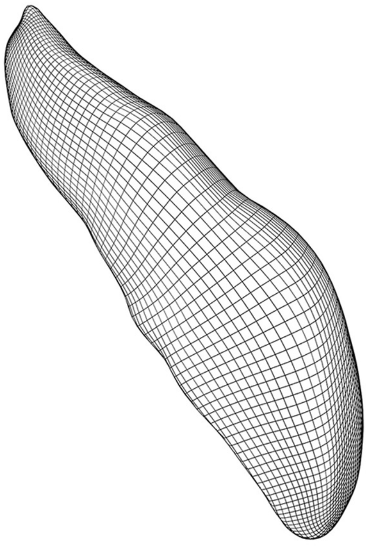

Figure 4. STL image of virtually extracted tooth. STL, standard tessellation language.

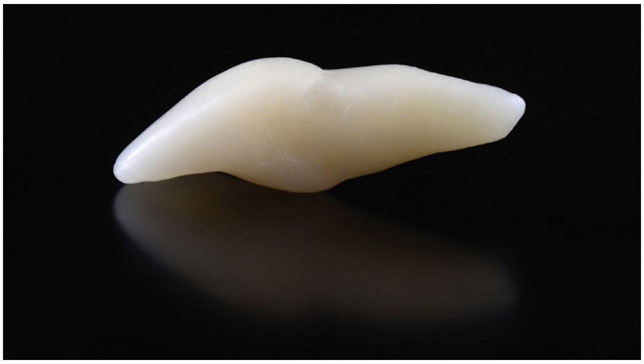

Figure 5. Tooth obtained after milling and polishing.

Figure 6. Occlusal view of the model with the milled tooth; emergence profile obtained.

substitute material (Bio-Oss; Geistlich). A connective tissue graft was also placed. Place the interim restoration (Fig. 7).

11. After the osseointegration period, scan the cast used for making the interim restoration. Make an impression to record the modified gingival volume of the peri-implant area. Unscrewing the interim restoration is therefore unnecessary and avoids disruption to the soft tissues.
12. Fabricate the definitive restoration from zirconia (Procera; Nobel Biocare) on a titanium base (Universal Base; Nobel Biocare) veneered with feldspathic porcelain (LiSi; GC); the zirconia was not veneered in the emergence profile area to ensure biocompatibility (Fig. 8).

DISCUSSION

This technique ensures the maintenance of the soft tissue architecture and facilitates the fabrication of the interim restoration for immediate restoration. The technique copies the shape of the natural tooth (crown and emergence profile), reducing the time taken to make the interim restoration, which is obtained before surgery. The

Figure 7. Interim restoration. A, Milled tooth. B, Placement after 4 hours.

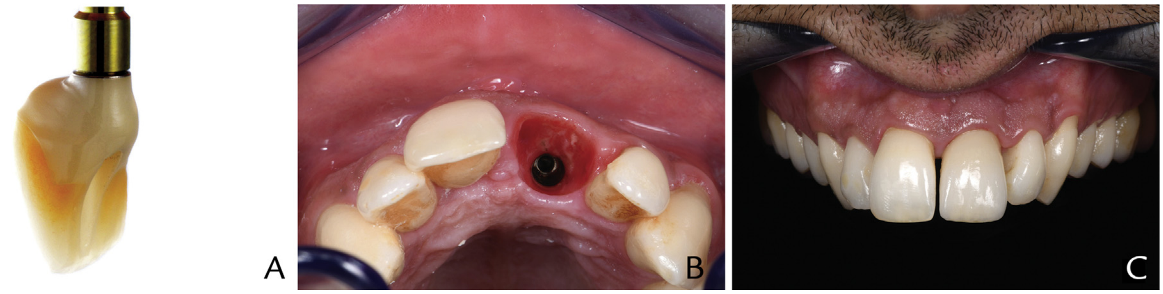

Figure 8. Definitive restoration. A, Before placement. B, Emergence profile after 6 months. C, Emergence profile after 10 months.

use of a screw-retained restoration increases the fabrication time but makes healing safer because of the absence of excess cement.

The technique has limitations. An existing metal-ceramic crown may create artifacts in the CBCT image. A solution is to combine the DICOM data from the emergence profile and from the mouth impression for the coronal part. If the crown cannot be extracted in one piece or if the tooth is fractured or absent, the contralateral teeth can be mirrored. This situation requires more digital work because the tooth needs to be repositioned in the space. An optical scan can simplify the workflow and complement the DICOM data because only the CBCT scan can give the subgingival emergence profile before surgery.

CONCLUSIONS

The combination of modern technologies, including CBCT, laboratory scanners, and digital photography, has allowed clinicians to replicate patients digitally. In the technique presented, DICOM and STL data were used to generate the optimal restoration and emergence profile without user bias. The photographic software enabled the restoration to be colored so that it could be used as an interim restoration before the implant surgery. The contours obtained by replicating the natural tooth were used for the definitive restoration. Because the contours were the same, the definitive restoration could be fabricated directly without an additional impression or the need to unscrew the healing cap. This approach can be used to optimize the esthetics of both the definitive and interim restoration and minimize the adverse biologic impact of the prosthesis.

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Noteworthy Abstracts of the Current Literature

Real-time in-depth imaging of gap formation in bulk-fill resin composites

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Objectives. This study visualized in real-time the gap forming of bulk-fill resin composites during polymerization using optical coherence tomography (OCT).

Methods. Light-cured bulk-fill resin composites; Tetric N-ceram Bulk Fill (TNB), SonicFill (SNF), Surefil SDR (SDR), dual-cured bulk-fill resin composite Bulk EZ (BEZ), and light-cured core resin composite Clearfil Photo Core (CPC) were investigated. Swept-source OCT real-time cross-sectional monitoring was obtained during resin composite placement and curing procedure. Gap formation was observed in bonded cylindrical resin composite molds (4-mm depth, 3-mm diameter) and free shrinkage volume was observed at the top and bottom of a tube with similar dimensions (n=10). OCT 3D data were analyzed to calculate sealing floor area percentage (SFA%) and volumetric shrinkage in bonded tube (VS%). Data were analyzed by ANOVA at significance level of 0.05. The bottom-top degree of conversion ratio (DC%-R) through 4-mm depth was measured using the XploRA Plus micro-Raman spectroscopy.

Results. BEZ showed no gap formation at the cavity floor in any specimens while SNF showed the highest gap formation; the statistical order in terms of SFA% was BEZ (100 ±0)>TNB (84.97 ±2.98)>CPC (52.13 ±8.23)=SDR (45.97 ±9.21)>SNF (16.23 ±6.00) ($P<0.05$). On the other hand, total VS% was statistically ordered as BEZ (3.40 ±0.14) >SDR (3.22 ±0.09)>TNB (1.82 ±0.11)>SNF (1.65 ±0.04)=CPC (1.56 ±0.04) ($P<0.05$). Unlike BEZ, the light-cured resin composites showed larger shrinkage at specimen bottom than top. TNB showed the lowest DC%-R followed by SNF ($P<0.05$).

Significance. Light-cured bulk-fill resin composites showed various degrees of gap formation and shrinkage at 4-mm deep cavity. The dual-cured bulk-filled resin composite showed no decrease of degree of conversion through the depth and the highest cavity adaptation despite its tendency for higher volumetric shrinkage.