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DENTAL TECHNIQUE

A technique to fabricate a custom CAD-CAM periapical radiographic film holder for implant assessment

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ABSTRACT

Standardized radiographs produced by using the paralleling technique play an important role in monitoring prosthetic misfit and marginal bone levels around endosseous implants. Under clinical conditions, parallel adjustment of the film with respect to the implant requires the use of positioning devices. This article describes the fabrication of a custom computer-aided design and computer-aided manufacturing (CAD-CAM) device suitable for implants adjacent to natural teeth. (J Prosthet Dent 2023;129:400-3)

The accurate assessment of changes in marginal bone levels around dental implants requires a longitudinal series of standardized radiographs, essential for monitoring the long-term success of dental implants.[1] A passive fit between the abutment and implant body is biologically and biomechanically essential for long-term success.[2,3] Standardized radiographs produced by using the paralleling technique play an important role in monitoring prosthetic misfit and marginal bone levels around endosseous implants.[4-7] The body of the implant is invisible because it is situated within the alveolar bone. In addition, the longitudinal axis of the prosthetic may be in a tilted position with respect to the implant.[8] Under clinical conditions, ensuring the film is parallel with the implant requires the use of positioning devices.

Different film holders have been modified to provide a true parallel alignment of the implant axis and film plane.[9-13] A film positioner attached to the implant body and abutment is commonly used to transform the implant longitudinal axis. However, removing the implant-supported prosthesis is an invasive procedure that may adversely affect the peri-implant soft tissue.[4,14,15] The Precision Implant X-ray Relator and Locator (PIXRL) combines occlusal registration material and implant-body-level film-positioning devices without the need to remove the implant prostheses repeatedly.[12] However, application of the PIXRL is relatively time-consuming in clinical practice, and radiographical data on dental films produced under compromised conditions are typically used. This article describes a straightforward computer-aided design and computer-aided manufacturing (CAD-CAM) technique for fabricating individual film holders suitable for implants adjacent to natural teeth.

TECHNIQUE

1. Predesign the film holder by using a reverse engineering software program (Geomagic Studio 2012; 3D Systems) (Fig. 1). Establish 2 perpendicular plates (occlusal plate and imaging plate) based on the size of the common imaging plate (IP). Add a guide-post in the center of the occlusal surface and a clip near the IP surface. Export the design data as a

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Figure 1. Predesign of film holder with 2 perpendicular plates (occlusal plate and imaging plate), guide post, and clip.

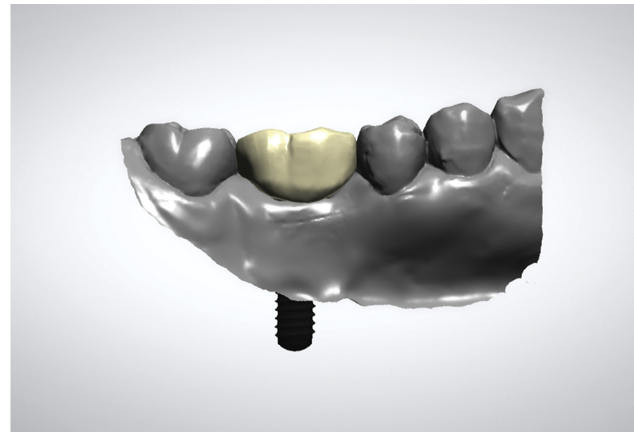

Figure 2. Implant crown fabricated by using implant-supported crown design workflow.

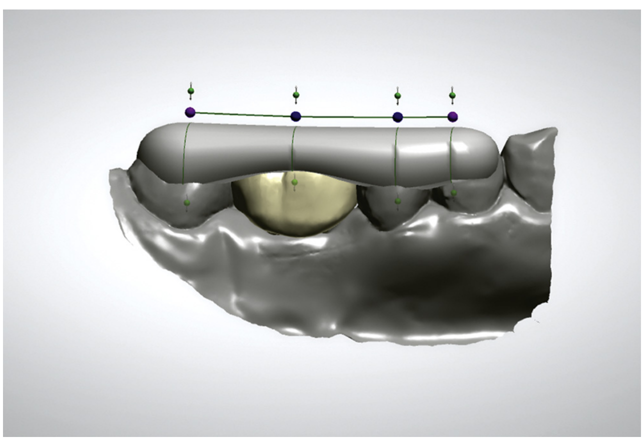

Figure 3. Guide positioned over teeth adjacent to implant.

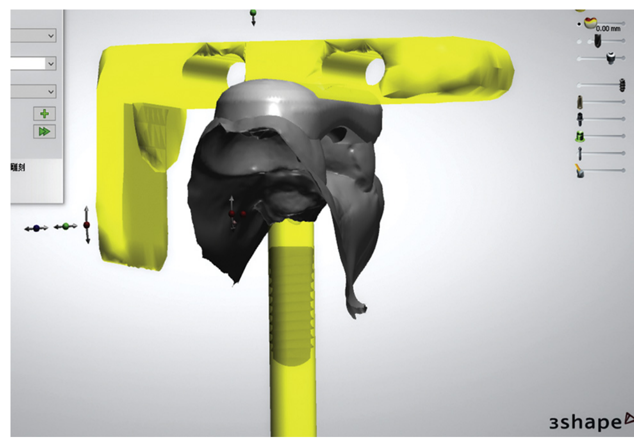

Figure 4. Predesigned film holder adjusted to match guide-post with virtual implant in suitable position in digital implant cast by using design attachment function.

standard tessellation language (STL) file. Import the predesigned film holder as an attachment into a CAD software program (3Shape Designer; 3Shape A/S) by using the 3Shape Dental System Panel Control.

2. Fabricate the implant-supported crown (Fig. 2). Acquire a 3-dimensional digital scan with an implant-specific scan body (Straumann CARES Mono Scan body for implant-level scanning; Straumann AG) screwed onto the implant intraorally or a scan body fixed onto the implant analog in the definitive cast. Import the scan data into the CAD software program and design the crown on top of the virtual titanium base by using the implant-crown-design workflow.
3. Design the custom film holder. Start the positioning-guide workflow after completion of the crown design. Place the positioning guide cover adjacent to the implant-supported prosthesis (Fig. 3). Place the predesigned film holder using the attachment function. Match the guide-post to the virtual implant in the digital implant cast. Adjust the attachment to a suitable position (Fig. 4). Combine the attachment with the positioning guides to form the custom film holder. Export the design data as an STL file (Fig. 5).
4. Complete the film holder (Fig. 6). Print the custom film holder by using a fused deposition modeling (FDM) 3D printer (Lingtong I; Beijing SHINO) with polylactic acid (PLA) material; set the layer height to 0.2 mm. Polish the surface of the device and then fit.
5. Make the radiograph procedure. Place the imaging plate in the film holder. Use the conventional parallel cone technique when making the radiographs (Fig. 7).

DISCUSSION

This technique efficiently integrates a custom film-holder design into the implant-supported crown-fabrication process by using a CAD software program. Once the

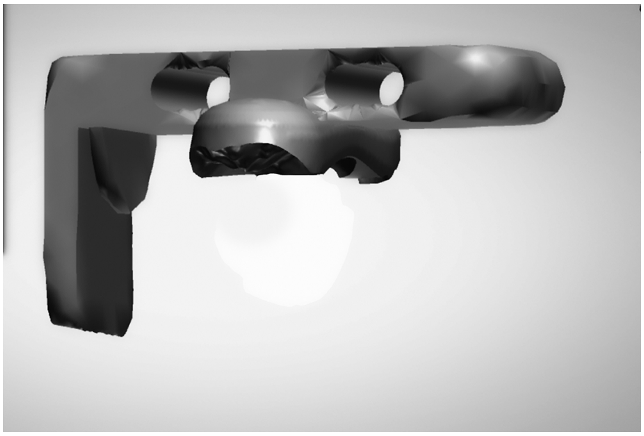

Figure 5. Attachment combined with positioning guides used to create custom film holder. Design data exported as STL file. STL, standard tessellation language.

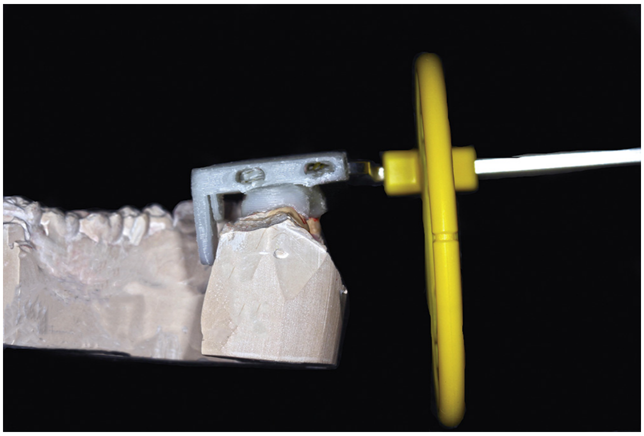

Figure 6. Finished film holder.

predesigned film holder in step 1 has been imported into the design software program and stored in the database, subsequent patient treatments can proceed without repeating the design. A virtual implant can be established by using data from a scan of the implant scan body. The virtual implant can be used to represent the relative position of the implant in the jaw. The dental laboratory technician can set the position of the film holder precisely to ensure the IP surface is parallel to the axis of the implant in the CAD software program, which will allow clinicians to evaluate the marginal bone and prosthetic misfit around an implant accurately. The occlusal surface of the film holder is directly formed on the implant-supported crown and adjacent teeth, providing good stability and retention, and this technique can be used both for screw-retained and cemented single crowns. Additionally, the size of the film holder can be changed to avoid anatomic limitations.

The CAD data of the custom film holder can be saved for future use, and the technique avoids the distortions and the requirement for repeated disinfection of the occlusal registration material used in a standard film holder. Printing the custom film holder by using an FDM 3D printer and PLA material is a straightforward procedure for a dental laboratory technician and the PLA is an economical and environmentally friendly material. Laboratory polishing and fitting on a definitive cast can save clinical time. The requirement for an FDM 3D printer to fabricate the device may be a limiting factor. As the device is seated on the adjacent reference dentition, the loss of additional teeth may affect application. Therefore, a design suitable for splinted multiunit implant-supported restorations is indicated.

Figure 7. Imaging plate placed in film holder. Conventional parallel cone technique used when making radiographs.

SUMMARY

The described technique efficiently integrates a custom film-holder design into the implant-supported crown fabrication process by using a CAD software program, with the CAM procedure completed in the laboratory. The workflow is straightforward, and the technique saves chair time.

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Noteworthy Abstracts of the Current Literature

Computational biomechanical analysis of engaging and nonengaging abutments for implant screw-retained fixed dental prostheses

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Purpose. To evaluate the stress distribution, using 3-dimensional finite element analysis (FEA), on different implant components of a mandibular screw-retained fixed dental prosthesis (FDP) situation when using different combinations of engaging and nonengaging abutments.

Material and methods. A model of artificial bone was digitally designed. Dental implants were positioned in the lower right posterior area of teeth #'s 28 (premolar - pm) and 30 (molar-m). Restorative implant components were digitally designed and placed into the implant model. Four different implant abutment situations were simulated through FEA: (1) Both engaging abutments (mE-pmE), (2) both nonengaging (mNE-pmNE), (3) molar nonengaging and premolar engaging (mNE-pmE), and (4) molar engaging and premolar nonengaging (mE-pmNE). Thirty-five (35) Ncm preload to the abutment screws and 160 N static load at 45° angle to the occlusal plane were applied in each group.

Results. The equivalent Von Mises stress was measured on each component. Stress distribution changed among the different configurations and ranged from 516.0 to 1304.6 MPa in the implants, and from 554.6 to 994.5 MPa with the abutments. Higher stress was found for the mNE-pmNE designs (1078.6-1106.9 MPa). Engaging and nonengaging abutments had different stress distributions on the screw (698.8-902.5 MPa). Peak stress areas were located on the upper part of the screws for the nonengaging configuration, and on the lower areas for the engaging abutments. The sum of the stress on both implants decreased in the following order: mNE-pmNE>mE-pmNE>mNE-pmE>mE-pmE.

Conclusions. Under conditions of this study, abutment design produced different stress patterns to the implant components. The lowest and most balanced stress distribution was found for the mE-pmE configuration followed by the mNE-pmE configuration.

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