Radiographic visualization of the restorative space, tooth position, and bone level is a necessary step in the treatment sequence and planning of implant restorations. The use of cone-beam computed tomography (CBCT) has gained in popularity in that it allows for 3-dimensional evaluation, thus potentially improving the assessment of critical anatomic structures. Various methods of radiographic assessment have been described in the literature, with many reports and techniques involving the duplication of the existing or proposed restoration and fabrication of a radiographic guide. Radiographic guides contain markers such as gutta percha, ball bearings, metal tubes, metal strips, or barium sulfate. These markers can be used as tooth analogs, base contour indicators, or fiduciary markers to assess implant placement.

Limited information exists regarding digital registration methods for edentulous ridges with simplified techniques for the purposes of computer-guided implant surgery. Traditional methods used to visualize completely edentulous patients include duplicating an existing complete denture or diagnostic tooth arrangement with barium sulfate and orthodontic acrylic resin to fabricate a radiographic template. This template is worn during a CBCT scan and the barium sulfate shows as a radiopaque object representing tooth and denture base contours, providing a rudimentary visualization of proposed restorative outcomes. Alternatively, 4 to 8 gutta percha markers are typically placed in a patient’s existing complete denture before CBCT scanning is done, with the clinician making 2 CBCT scans: 1 of the patient wearing the prosthesis and the other of just the prosthesis. The second scan can provide additional information for a computer algorithm to digitally superimpose the 2 scans to improve the visualization of the proposed dental implant site.

Radiographic templates provide substantial restorative information related to implant treatment planning; however, these templates require additional procedural steps, clinician and laboratory time, and increased cost to the patient. The purpose of this article is to introduce a method of relining a patient’s existing prosthesis with a readily available radiopaque impression material in combination with soft tissue separation to facilitate digital visualization of the edentulous ridge, tooth position, and denture base contours. This technique provides sufficient radiographic information without having to fabricate a distinct radiographic template or modify the existing prosthesis, reduces laboratory and patient chair time, ensures accurate digital representation of soft

**ABSTRACT**

Adequate visualization of existing/proposed tooth position, denture base contours, and prosthetic space is critical to treatment planning of dental implants. Multiple techniques exist for fabricating radiographic guides; many involve duplicating the patient’s existing prosthesis or fabricating a new diagnostic template. This article describes a technique that provides anatomic and restorative information by using an existing prosthesis and a radiographic impression method without the need to fabricate a duplicate or new template. (J Prosthet Dent 2015;113:343-346)
tissues, and may improve the accuracy of the fit of the computer-guided surgical guide to the edentulous ridge.

**TECHNIQUE**

1. Evaluate the acceptability of the existing complete denture in regard to tooth selection, tooth position, fit, tongue space, and border contour and positions as outlined by Sato et al.\(^\text{18}\)

2. Clean the denture with a denture-specific toothbrush (Denture brush; Oral-B) and unscented soap (Dial Soap; Dial). After cleaning, dry completely.

3. Alternatively, measure 2 even strips of base and catalyst, approximately 3 to 4 cm in length, of a fit-disclosing PVS material (Fit-Checker II; GC America) and 1 mL of barium sulfate suspension (Liquid E-Z-Paque; E-Z-EM) (Fig. 2).

4. Insert a cartridge of slow-set, nonrigid radiopaque fit-disclosing polyvinyl siloxane (PVS) material (Green-Mousse; Parkell, Inc) into an automixing dispenser (Fig. 1). The use of fast-set, rigid occlusal registration materials is not recommended because the increased rigidity and expedited polymerization displaces tissues and makes it more difficult to capture sufficient tissue details.

5. Inject the PVS material into the intaglio surface of the denture. Evenly spread the PVS with a spatula, completely covering the surface with a thin layer and rolling the borders slightly (Fig. 3).

6. Place the denture containing the mixture on the intaglio surface onto the edentulous ridge, have the patient close into light centric/maximum intercuspation position, and border mold edges of denture. Remove denture, ensuring adequate tissue-surface impression.

3. Alternately, measure 2 even strips of base and catalyst, approximately 3 to 4 cm in length, of a fit-disclosing PVS material (Fit-Checker II; GC America) and 1 mL of barium sulfate suspension (Liquid E-Z-Paque; E-Z-EM) (Fig. 2).

4. Inject the PVS material into the intaglio surface of the denture. Evenly spread the PVS with a spatula, completely covering the surface with a thin layer and rolling the borders slightly (Fig. 3).

5. Place the denture containing the mixture on the intaglio surface onto the edentulous ridge, have the patient close into light maximum intercuspation position, and border mold the denture. Instruct the patient to move the lips, cheeks, and tongue as if performing a denture reline impression.\(^\text{19}\)

6. Remove the denture and inspect the intaglio surface for an adequate capture of the tissue-bearing surface (Fig. 4). Replace the denture, place 2 cotton rolls between the tongue and lingual slope of the denture, 3 cotton rolls between the cheek and
buccal surfaces of the denture, and 2 cotton rolls on the occlusal surface of the mandibular denture. Instruct the patient to close down lightly on the cotton rolls and to keep tongue tipped backward away from the denture surfaces (Fig. 5). Obtain a CBCT scan at 0.3 mm voxel resolution, ensuring that the patient remains motionless during the scan.

7. After obtaining the scan and confirming an accurate capture, remove the cotton and denture with radiopaque PVS liner. Place the denture tooth-side down onto a foam plate/block surface (Fig. 6). Scan the denture at 0.2 mm voxel resolution with horizontal centering lines parallel to the denture bearing surface.

8. Remove the radiopaque PVS liner from the patient’s denture (Fig. 7), clean with spray disinfectant (CaviCide, Metrex), and rinse before returning to the patient.

9. Import the patient scan DICOM files into dental implant planning software (Invivo; Anatomage). Plan dental implants according to bone volume, tissue surface conformation, prosthetic space, and restorative objectives (Fig. 8).

10. Submit digital files to an imaging center or laboratory with surface registrations, dental implant plan, a cast of the edentulous ridge, and instructions to fabricate a mucosa-supported surgical guide.

DISCUSSION

Computer-based planning is rapidly becoming a fast, effective, and universal method for treatment visualization and planning of dental implant placement. Three-dimensional application and digital interpretation have evolved from rudimentary visualization software to full-fledged software that allows for detailed 3-dimensional surface/volumetric rendering, a dynamic implant...
and abutment library, and an ability to design surgical guides around a virtual restorative plan.\textsuperscript{20-22} Image-to-physical transformation methods allow for digital representation, mapping, and the registration of physical objects such as a dental cast, denture, diagnostic waxing, or treatment prostheses. This process depends on 1:1 mapping between coordinates in a physical space such as the mouth, cast, or prosthesis and a virtual space as seen the radiographic images.\textsuperscript{21} This mapping allows the alignment of coordinate systems of 2 distinct data sets and enhances diagnostic visualization and isolated manipulation.

The separation of soft tissues during cone-beam radiography allows the clinician to rapidly evaluate the tooth position and denture base contour of the patient’s existing denture or diagnostic tooth arrangement. The radiodensity of cortical bone (1700 HU) makes it more easily discernable on CBCT radiographs than air (\textasciitilde1000 HU) and tissues (50 HU).\textsuperscript{23} The comparison of tissue radiodensity and that of denture acrylic resin (70 HU), however, makes it more difficult to discern the differences between the resin and tissues.\textsuperscript{23} The separation of tissues and the creation of air space around acrylic resin allows the radiodensity of air to contrast with that of acrylic resin. Radiolucent objects, such as cotton rolls, create radiolucent air space around objects of similar radiodensity, allowing previously unidentifiable structures to become visible. This radiographic appearance is independent of hardware or software interpretation tools and is visible with any readily available CBCT imaging packages. The creation of air space around acrylic resins in combination with radiopaque PVS liners facilitates digital registration methods and allows for surface-base registration algorithms with the now visible cusps tips allow for marker-based registration algorithms to be applied. This combination allows the clinician to easily visualize a restorative plan in relation to proposed implant sites facilitating implant treatment planning.

**SUMMARY**

Presented is a clinical technique to incorporate a radiopaque, tissue-bearing surface impression onto an existing prosthesis, allowing a clinician to digitally visualize tooth position, denture base contours, and the edentulous ridge. This article describes a technique in which a clinician can use readily available materials to register the soft tissue ridge and visualize the proposed restorative plan without having to fabricate a distinct radiographic template. Separating the soft tissues during cone-beam radiography allows the clinician to easily evaluate the aforementioned clinical variables. The advantages of this technique include the elimination of a second appointment and laboratory fabrication time and expense and the possibility of non-reversible modification of the prosthesis. The disadvantages include the technique sensitivity of digital thresholding and surface registration algorithms, the learning curve, and the cost of CBCT software packages.

**REFERENCES**

3. Dreisde. T, Mischkowski RA, Neugelbauer J, Ritter L, Zöller J, Compari-

**Corresponding author:**
Dr Michael D. Scherer
School of Dentistry, Room 3313
Loma Linda University
11902 Anderson Street
Loma Linda, CA 92350
Email: mds@scherer.net

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