THE JOURNAL OF PROSTHETIC DENTISTRY

DENTAL TECHNIQUE

Radiopaque dental impression method for radiographic interpretation, digital alignment, and surgical guide fabrication for dental implant placement

Michael D. Scherer, DMD, MS[a] and Hyun Ki Roh, DDS, PhD[b]

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)

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.[1-3] 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.[4-7] Radiographic guides contain markers such as gutta percha,[8-10] ball bearings,[11,12] metal tubes,[5] metal strips,[13-15] or barium sulfate.[4,6,16,17] 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 provides 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

[a]Associate Clinical Professor, Advanced Prosthodontics, School of Dentistry, Loma Linda University, Loma Linda, California; and Clinical Instructor, Department of Clinical Sciences, School of Dental Medicine, University of Nevada, Las Vegas, Nevada.
[b]Clinical Professor, School of Dentistry, Seoul National University, Seoul Korea.

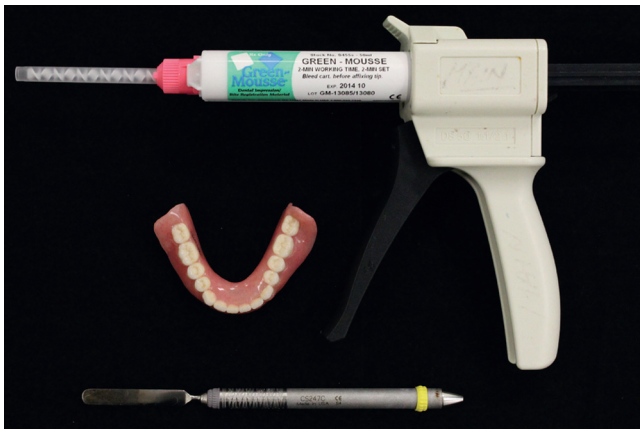

Figure 1. Remove denture, clean and dry thoroughly. Load radiopaque polyvinyl siloxane cartridge into automix gun.

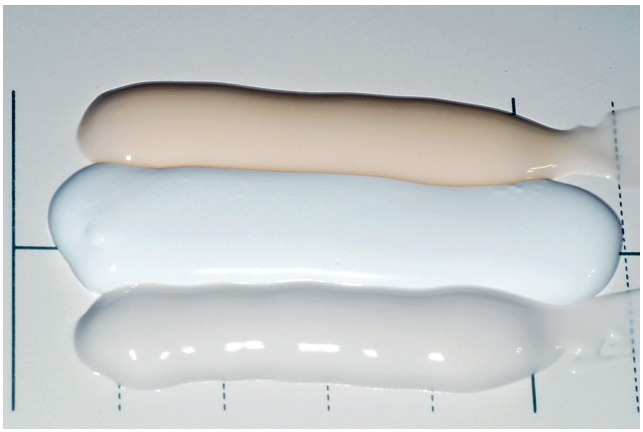

Figure 2. Alternative method: measure 2 strips of base and catalyst of fit disclosing media and 1 mL of barium sulfate suspension.

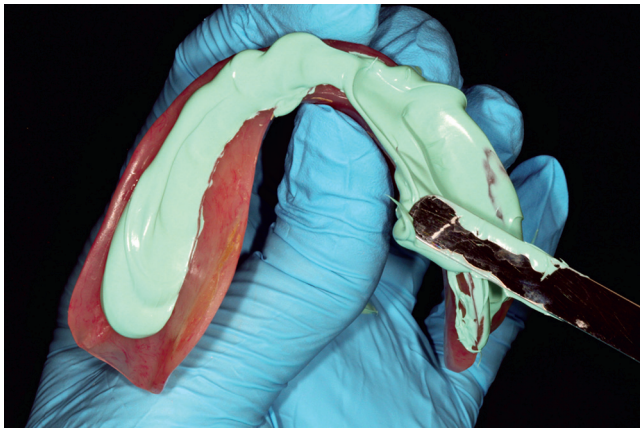

Figure 3. Evenly spread polyvinyl siloxane with spatula until intaglio surface is completely covered and lightly roll borders.

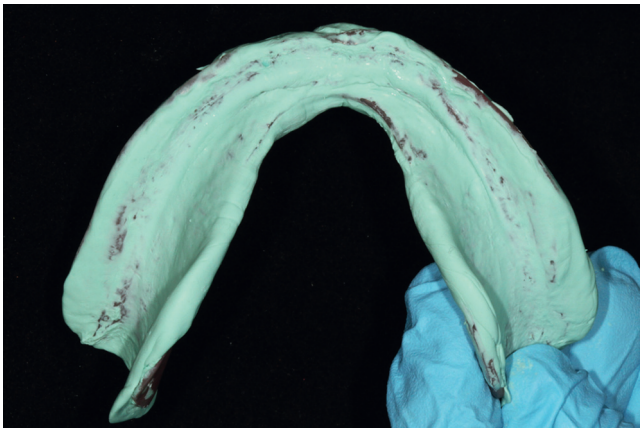

Figure 4. Place denture onto edentulous ridge, have patient close into light centric/maximum intercuspation position, and border mold edges of denture. Remove denture, ensuring adequate tissue-surface impression.

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.[18]
2. Clean the denture with a denture-specific toothbrush (Denture brush; Oral-B) and unscented soap (Dial Soap; Dial). After cleaning, dry completely. 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.
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. 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.[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

Figure 5. Place cotton rolls in following configuration in relation to prosthesis: 3 buccal, 2 occlusal, and 2 lingual. Instruct patient to remain still and make cone-beam computed tomography scan.

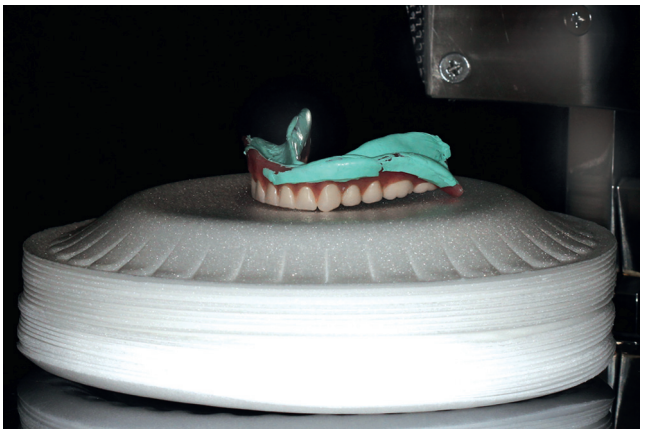

Figure 6. Remove cotton and denture and perform conebeam computed tomography scan of denture alone.

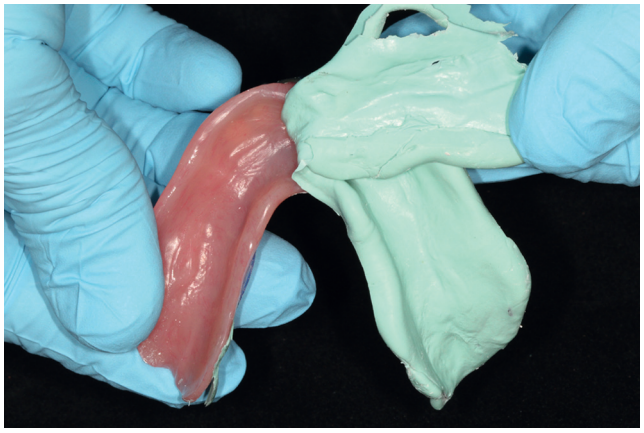

Figure 7. Remove liner using gentle finger pressure. Since no adhesive was used, this procedure is quickly performed without irreversible change to the denture.

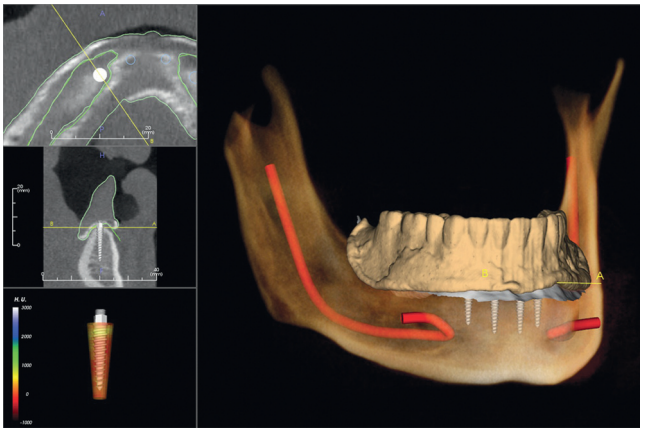

Figure 8. Plan dental implants in computer software that will allow importation of 2 scans, digital registration, and surgical guide planning.

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.[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.[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 (–1000 HU) and tissues (50 HU).[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.[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 cusp 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-irreversible 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

1. White SC, Heslop EW, Hollender LG, Mosier KM, Ruprecht A, Shrout MK; American Academy of Oral and Maxillofacial Radiology, ad hoc Committee on Parameters of Care. Parameters of radiologic care: An official report of the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;91:498-511.
2. Benavides E, Rios HF, Ganz SD, An CH, Resnik R, Reardon GT, et al. Use of cone beam computed tomography in implant dentistry: the International Congress of Oral Implantologists consensus report. Implant Dent 2012;21:78-86.
3. Dreiseidler T, Mischkowski RA, Neugebauer J, Ritter L, Zöller JE. Comparison of cone-beam imaging with orthopantomography and computerized tomography for assessment in presurgical implant dentistry. Int J Oral Maxillofac Implants 2009;24:216-25.
4. Basten CH, Kois JC. The use of barium sulfate for implant templates. J Prosthet Dent 1996;76:451-4.
5. Takeshita F, Tokoshima T, Suetsugu T. A stent for presurgical evaluation of implant placement. J Prosthet Dent 1997;77:36-8.
6. Kopp KC, Koslow AH, Abdo OS. Predictable implant placement with a diagnostic/surgical template and advanced radiographic imaging. J Prosthet Dent 2003;89:611-5.
7. Oh WS, Saglik B. A simple method to duplicate a denture for an implant surgical guide. J Prosthet Dent 2008;99:326-7.
8. Verde MA, Morgano SM. A dual-purpose stent for the implant-supported prosthesis. J Prosthet Dent 1993;69:276-80.
9. Pesun IJ, Gardner FM. Fabrication of a guide for radiographic evaluation and surgical placement of implants. J Prosthet Dent 1995;73:548-52.
10. Stellino G, Morgano SM, Imbelloni A. A dual-purpose, implant stent made from a provisional fixed partial denture. J Prosthet Dent 1995;74:212-4.
11. Tal H, Moses O. A comparison of panoramic radiography with computed tomography in the planning of implant surgery. Dentomaxillofac Radiol 1991;20:40-2.
12. Engelman MJ, Sorensen JA, Moy P. Optimum placement of osseointegrated implants. J Prosthet Dent 1988;59:467-73.
13. Urquiola J, Toothaker RW. Using lead foil as a radiopaque marker for computerized tomography imaging when implant treatment planning. J Prosthet Dent 1997;77:227-8.
14. Almog DM, Sanchez R. Correlation between planned prosthetic and residual bone trajectories in dental implants. J Prosthet Dent 1999;81:562-7.
15. Chong J, Seong WJ, Conrad HJ. Lead foil technique for partially edentulous radiographic guide. J Prosthet Dent 2012;108:268-70.
16. Israelson H, Plemons JM, Watkins P, Sory C. Barium-coated surgical stents and computer-assisted tomography in the preoperative assessment of dental implant patients. Int J Periodontics Restorative Dent 1992;12:52-61.
17. Mecall RA, Rosenfeld AL. The influence of residual ridge resorption patterns on implant fixture placement and tooth position. 2. Presurgical determination of prosthesis type and design. Int J Periodontics Restorative Dent 1992;12:32-51.
18. Sato Y, Tsuga K, Akagawa Y, Tenma H. A method for quantifying complete denture quality. J Prosthet Dent 1998;80:52-7.
19. Knechtel ME, Loney RW. Improving the outcome of denture relining. J Can Dent Assoc 2007;73:573-7.
20. Verstreken K, Van Cleynenbreugel J, Marchal G, Naert I, Suetens P, van Steenberghe D. Computer-assisted planning of oral implant surgery: a three-dimensional approach. Int J Oral Maxillofac Implants 1996;11:806-10.
21. Orentlicher G, Goldsmith D, Abboud M. Computer-guided planning and placement of dental implants. Atlas Oral Maxillofac Surg Clin North Am 2012;20:53-79.
22. Scherer MD. Presurgical implant-site assessment and restoratively driven digital planning. Dent Clin North Am 2014;58:561-95.
23. Mah P, Reeves TE, McDavid WD. Deriving Hounsfield units using grey levels in cone beam computed tomography. Dentomaxillofac Radiol 2010;39:323-35.

Corresponding author:
Dr Michael D. Scherer
School of Dentistry, Room 3313
Loma Linda University
11092 Anderson Street
Loma Linda, CA 92350
Email: mds@scherer.net

Acknowledgments
The authors thank Anatomage for assistance in generating the digital registrations and visualization of the images provided.