computer-milled abutments were then delivered to the patient, and the temporary splint was relined to seal the new margins. The duplicate abutments were then utilized on the master working cast as the die for the fabrication of the cast coping. A separate coping was cast for the natural molar tooth, and the custom cast post was created for the canine implant. Two weeks after the abutments were delivered, the cast copings were evaluated intraorally for fit. Three weeks later, the bisque bake of porcelain was evaluated for function and aesthetics. Upon patient approval, the final case was delivered two weeks later (Figures 23 through 25).

Discussion
Presurgical prosthetic planning is the foundation for successful immediate loading of implants. Positioning the implant in terms of the functional and aesthetic demands of the tooth is difficult due to limitations inherent with the most common two-dimensional imaging techniques. Computed tomography and sophisticated diagnostic software provide clinicians with an enhanced vision of bone anatomy. Such software applications permit an evaluation of the bone and simulated placement of implants. As advocated by the author, when a barium sulfate radiopaque CT template is utilized (representing fully contoured tooth morphology), additional planning for abutment type within the confines of the individual tooth position can be achieved with unparalleled accuracy.17-19

The primary criticism of this technology, however, has been in translating the simulated plan to the patient at the time of surgical intervention. The introduction of stereolithographic RP models and resultant surgical templates merges technology with reality, bringing the plan directly to the surgical site.14,16 The use of CT-derived templates fabricated to incorporate simulated virtual implant placement gives the surgeon an efficient, accurate mechanism for creating osteotomies within a high degree of correlation to the original plan, diminishing surgical time as well as reducing the length of osseous exposure.20

Immediate load protocols require adequate host bone as well as evaluation of the occlusion, an appropriate implant design that maximizes bone fixation and osseocompression, secure connection between implant and abutment to avoid micromovement, and accurate surgical guidance. The patient’s bone anatomy was evaluated and found to be acceptable in volume and density in terms of Hounsfield units, a determination that can be successfully assessed presurgically from CT scan data, differentiating this imaging modality from linear tomography.19 Specific implants were chosen based upon surface design features, mechanical stability, and the internal friction-fit connection of the abutments.21 In accordance with the planning software, four implants were then virtually placed in positions to maximize an immediate loading protocol.

Surgical templates of various designs have been utilized to accurately position implants according to the patient’s restorative demands. Computed tomography-derived templates have been found to be more accurate.
than other methods, including the use of the SurgiGuide protocol.\textsuperscript{13,20,22} This presentation describes a novel approach where the stereolithographic replica of the patient’s maxilla served as the receptor site for the implant replica analogs. This differs from other methods described in the literature that utilize stone casts created from impressions of the patient’s dentition or diagnostic waxup. The analogs were placed into the stereolithographic model as guided by the prefabricated template processed from the software treatment plan data set. This allowed for the fabrication of milled provisional titanium abutments and laboratory-processed transitional restoration prior to the surgical procedure. The ability to thoroughly assess the existing bone anatomy and plan for both surgical and restorative phases enabled the procedure to be performed with confidence. The result was decreased surgical time, improved restorative efficiency, and a highly accurate predictable method for immediate loading protocols.

During the eight-week healing phase, a working cast that contained analogs replicating the intraoral implant positions was created. Using a diagnostic waxup, computer-milled abutments were created to meet the tooth-specific shapes of the missing dentition. The virtual abutment design process allowed for precise fabrication of each original abutment and its duplicate as well as for parallelism that ensured the passive fit of the prosthesis. The original abutments were then used intraorally after integration was initially achieved to help with the continued soft tissue maturation around the transitional restoration. The duplicate abutments were utilized as dies on the same working cast that was created from the initial fixture-level impression at the time of surgery to fabricate the metal-ceramic copings. Therefore, the laboratory had precise control of the coping fit, as the die was the actual abutment. Utilizing CAD/CAM technology enabled the restorative phase to be completed with the highest degree of accuracy with a minimal number of impressions and office visits.\textsuperscript{23}

\textbf{Conclusion}

Implant dentistry has expanded to include advancements in computer-based imaging technology. This presentation demonstrated an expanded use of stereolithographic models in the presurgical phase, which is of utmost
importance for immediate provisionalization protocols. The described technique enables a more complete understanding of the ultimate prosthetic goal in anticipation of implant support. The surgical placement of the implants guided by the precise treatment plan through the application of the template was followed by the immediate placement of transmucosal abutments and transitional restorations. The methodologies as described reduced surgical chairtime and the number of involved restorative steps, and accelerated treatment phases, ultimately achieving the expectations of both clinician and patient.

As immediate loading protocols gain momentum in accelerating treatment times closer to those of conventional prosthodontics, CT scan treatment planning and CT-derived template design become a necessary diagnostic and surgical tool to understand anatomy, identify pathology, avoid complications, and to ensure predictability and long-term success. Additional research will be required to confirm the protocol as described herein.

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References

To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article, “Use of stereolithicographic models as diagnostic and restorative aids for predictable immediate loading of implants,” by Scott D. Ganz, DMD. This article is on pages 763-771.

1. Presurgical, prosthetic planning is essential in delivering the restorative component to the patient following implant placement. This is particularly true when implants are to be loaded at a separate time from surgical placement.
   a. Both statements are true.
   b. Both statements are false.
   c. The first statement is true, the second statement is false.
   d. The first statement is false, the second statement is true.

2. Varying designs of surgical templates have been fabricated to help:
   a. Determine proper fixture placement based upon restorative demands.
   b. Allow the restorative clinician to assess the quality of bone.
   c. Position the temporary prosthesis properly.
   d. All of the above.

3. For correct transfer of ideal tooth position, clinicians often use:
   a. The patient's existing denture.
   b. A diagnostic waxup.
   c. Both a and b.
   d. Neither a nor b.

4. How long has CT been used to fabricate replicas of the maxilla and mandible through stereolithography?
   a. ~ 8 years.
   b. ~ 10 years.
   c. ~ 15 years.
   d. ~ 20 years.

5. The use of CT is an integral part of which treatment phase?
   a. Planning.
   b. Surgical.
   c. Restorative.
   d. All of the above.

6. Which of the following characteristics of bone is practically unobtainable without the use of 3D imaging?
   a. Quality.
   b. Volume.
   c. Width.
   d. All of the above.

7. In the author’s opinion, CT and sophisticated diagnostic software permit:
   a. Bone evaluation.
   b. Implant placement simulation.
   c. The enhancement of bone anatomy visualization.
   d. All of the above.

8. What is the primary criticism surrounding the use of CT technology?
   a. The translation of simulated plans to the patient at surgical intervention.
   b. Increased surgical time.
   c. Poor determination of bone quality.
   d. Difficult to master.

9. The use of stereolithicraphic models guided by CT-derived templates aid implant placement through:
   a. Improved restorative efficiency.
   b. Provision of an accurate method for immediate loading protocols.
   c. Both a and b.
   d. Neither a nor b.

10. In what way did 3D imaging aid the author during implant placement?
    a. It established adequate interimplant distance.
    b. It allowed for improved emergence profile.
    c. Anatomical landmarks and neighboring tooth roots could be avoided.
    d. All of the above.