The CT/CBCT-Based Team Approach to Care

Part 1: Identifying the Implant Patient and Prosthetic Options

Michael Tischler, DDS

Scott D. Ganz, DMD

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INTRODUCTION

Replacement of missing teeth with dental implants involves a coordinated effort between surgical and prosthetics disciplines. A successful surgical and prosthetic result is directly related to proper planning and coordination between the dental surgeon, the dental laboratory team, and the restorative dentist. New digital workflows, online communication tools, and the integration of cone beam computed tomography (CBCT) technology helps to provide the foundation for a true team approach to dental implant reconstruction.

This is the first of a 3-part series of articles on the CT/CBCT-based team approach to implant dentistry. These articles will illustrate concepts of dental implant treatment planning within a team environment. Part 1 will outline the parameters of implant dentistry, the team philosophy and how CBCT technology integrates with the dental laboratory. Part 2 will provide further insight into the surgical aspects of an implant team, concepts related to site development, while reinforcing the importance of 3-dimensional (3-D) presurgical prosthetic planning for the restorative dentist. Part 3 will focus on the restorative details of the team necessary to deliver the desired prosthetic result through CT/CBCT prosthetically driven surgical planning.

TEAM APPROACH CONCEPT

When patients require medical attention, the different specialties of medicine coordinate together as a team to offer ideal care and achievement of clinical goals.[1] This "medical model" assumes that each member of the team will offer input to ensure clinical success. The same is true for patients who are missing teeth and require dental implants and related treatment protocols. Although implant dentistry is not an ADA recognized specialty, a "dental model" can be considered to represent a group of practitioners and adjunctive team members that must coordinate in order for surgical and prosthetic dental implant treatment success to happen.[2]

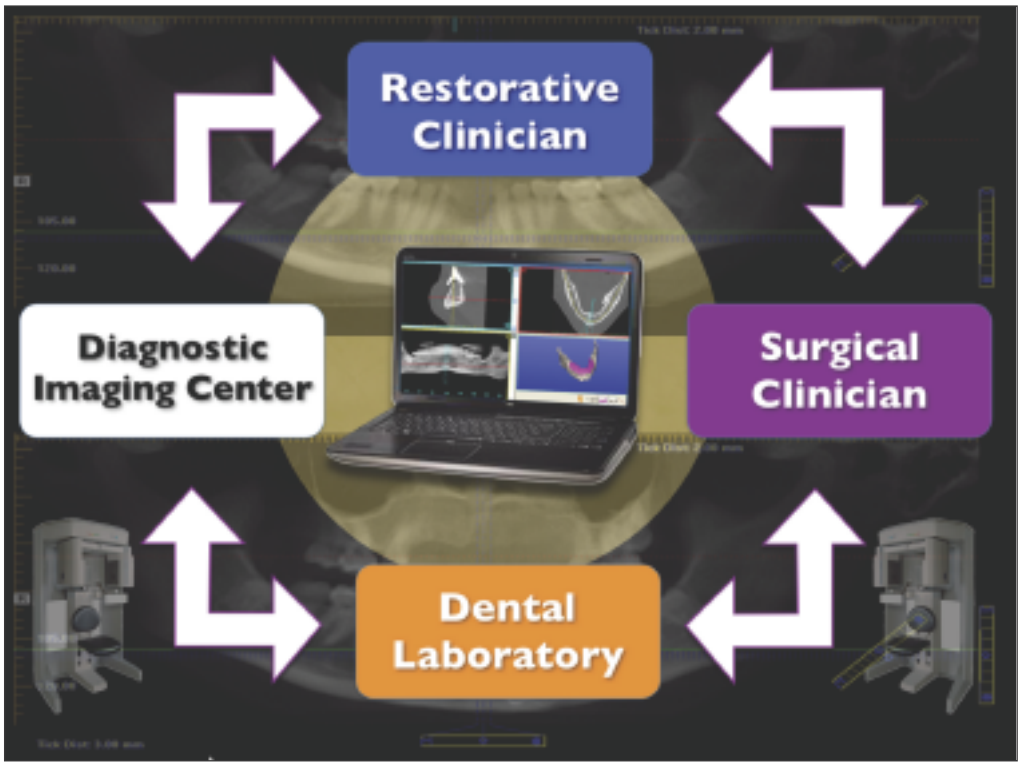

Figure 1. Diagram showing the interrelationship between a computed tomography (CT) scan and the team members.

It has been stated that "planning is everything" and this is especially true with dental implants due to the wide variation in patient hard- and soft-tissue anatomy, proximity of vital structures, occlusal requirements, and aesthetic demands. The dental team that will diagnose, treatment plan, and execute the reconstruction of an edentulous area should be well coordinated or risk less than ideal results.[3] Complications can occur that effect function, aesthetics, and long-term maintenance of the surrounding hard and soft tissues. Therefore the surgeon, restorative clinician, dental laboratory technician, and diagnostic imaging center must act in harmony in a team atmosphere to achieve long-term, consistent and repeatable success.

Perhaps the area of most scrutiny and highest demand for excellence are dental implants placed in the aesthetic zone of the maxillary arch.[4] The position of the implant(s) has to be correct from both a surgical and prosthetic standpoint. If there are changes in the supporting bone or soft tissue from undue stress, aesthetic challenges will ensue.

TEAM MEETING CONCEPT

With the many variations in implant treatment conventions available, a protocol that allows for common ground to be met for treatment decisions can be defined as a philosophical position necessary to provide ideal care for a patient. Therefore, the team approach to implant reconstruction is greatly facilitated by a team meeting, which we believe is the cornerstone for case acceptance and clinical success. The technological advances for communication and planning outlined out in this article is based on the key

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concept of CBCT 3-D imaging that can provide the team with the necessary anatomical information to aid in guiding the team.

First, a meeting venue, time, and agenda have to be determined. One person should be responsible for the agenda. Second, a treatment plan and sequence has to be agreed upon by the parties involved. Third, the prosthetic steps need to be fully communicated to the dental laboratory to review necessary components and cost for the restorative phase. Once these 3 steps have occurred, the coordinated communication not only creates a higher probability of clinical excellence, but also makes planning dental implant reconstruction a predictable endeavor.[5] The team meeting allows for a conversation between all parties that is based on 3-D CT derived planning to achieve a prosthetically driven end result[6] (Figure 1).

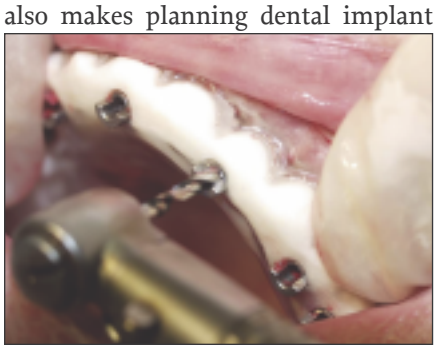

Figure 2. Surgical guide created from a CT scan plan.

CT/CBCT SCAN-BASED PLANNING AND MEETING: THE KEY TO A TEAM APPROACH

The concept of a CBCT scan-based prosthetic end result directing the entire team planning is key to the team approach presented in this article. Implant reconstruction should ideally be dictated by the desired tooth position as defined by conventional prosthetic parameters such as lip support, vertical dimension of occlusion, centric relation, midline position, phonetics, and much more.[7] Three-dimensional imaging and interactive treatment software allows for educated discussions within the team to agree upon implant placement position in an ideal implant-supported prosthetic location with consideration of the available bone. The CT-derived plan can be utilized for the fabrication of a surgical guide allowing for implant placement to follow the CT plan created.[8] While a surgical guide is not mandatory for implant success, it helps to predictably reproduce the CT plan removing most of the guesswork, and reducing operator anxiety at the time of surgery (Figure 2).

Figure 3. The iCat CBCT machine (Imaging Sciences International) in a dental office setting.

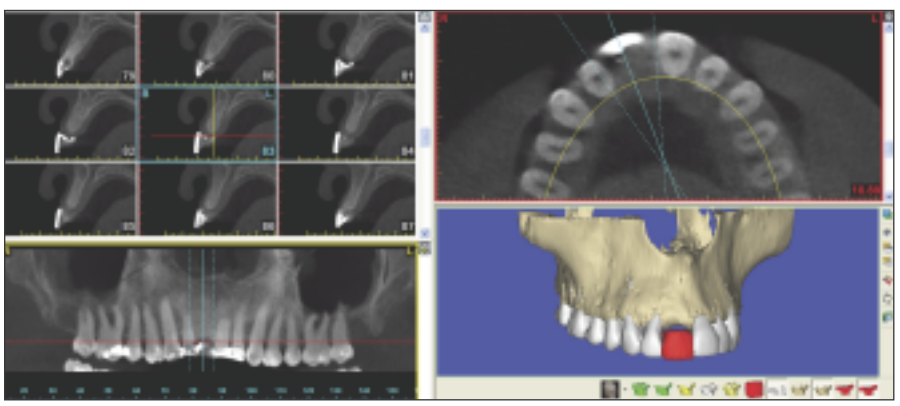

Figure 4. Four-pane view from SimPlant (Materialise Dental) showing cross-sectional, axial, panoramic, and 3-dimensional (3-D) views.

DATA ACQUISITION

This protocol requires a CT scan of the arch or arches that require reconstruction. It is our opinion that the standard of care for CT imaging in dentistry is the CBCT. The advantages of a CBCT over traditional hospital based fan beam CT include substantially less radiation, a more targeted view of the treatment area, and the realistic financial availability and physical footprint to allow for an in-office CBCT machine.[9] A CBCT scan machine captures radiographic energy in voxels, which are then reformatted through software into a discernible image that is interactively manipulated on a computer screen. The CBCT machine takes radiological slices around an axis and that offers various views of the head and neck.[10] Today, there exist a wide selection of CBCT machines available including but not limited to the iCAT Classic (Imaging Sciences International), Gendex (Gendex Dental Systems), Picasso Pro (Vatech, E-WOO Technology), Carestream Dental, NewTom (Cefla Dental), and PreXion (Figure 3).

Image data from a CBCT device can be visualized with the native software for each individual machine for diagnostic purposes. However, the software may or may not have the appropriate digital tools to provide the restorative planning described in this protocol. Fortunately the digital dataset or digital imaging and communications in medicine (DICOM) files can be exported for use with numerous interactive treatment planning applications available to the clinician, or third-party diagnostic centers. These include but are not limited to: SimPlant (Materialise Dental), VIP (BioHorizons), Invivo5, (Anatomage), and NobelClinician (Nobel BioCare) The DICOM files from a CBCT scan are imported into these interactive software applications and reformatted so that a proper treatment plan can be developed[11] (Figure 4).

Numerous CBCT imaging centers exist throughout the United States, in addition to companies that will even bring a mobile CBCT device to a clinician's office for an on-site scan of the patient (Facial Mobile Imaging) and aid in the processing of the DICOM data and the 3-D reconstructed views presented to the clinician in a variety of formats. These alternatives remove many barriers to the technology—as it is not necessary for a clinician to own a CBCT machine. The DICOM data can also be sent via the Internet to various diagnostic 3-D imaging service providers to be review, process, and if desired have the data read and reported on by an oral and maxillofacial radiologist. These third-party service providers can also assist in the planning phase, template fabrication, and more (3D Diagnostix; 360 Imaging). Therefore a clinician is no longer required to pur-

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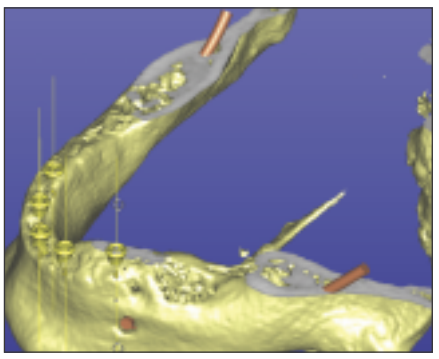

Figure 5. The 3-D view of mandible in SimPlant showing implant positions.

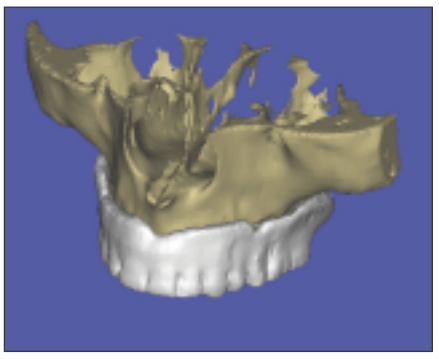

Figure 6. Radiographic template evident on 3-D view of scan.

Figure 7. Example of a radiopaque scan appliance to be worn when a CT Scan is taken.

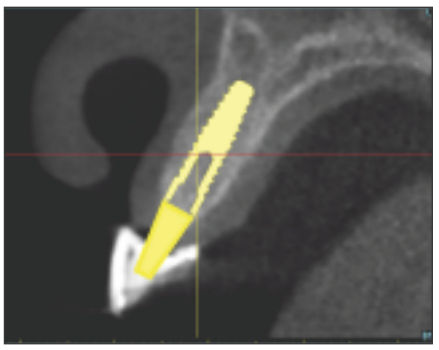

Figure 8. Cross-sectional view of CBCT scan showing relationship of bone to final prosthetic position.

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chase a specific software application. Clinician's who have an in-office CBCT device have an advantage of immediate access to the DICOM data for diagnostic and planning purposes.

All members of the team can visualize the 3-D data represented in 4 basic views regardless of the software. These are the: panoramic overview, axial view revealing the coronal/apical perspective, cross-sectional view from buccal to lingual perpendicular to the axial, and an interactive 3-D reconstructed view (Figure 5). It is important that these basic views be assimilated together and interactively to provide the clinician with a total overview of the dental arch and to maximize presurgical prosthetic planning.[9,10]

Ideally, to relate the desired tooth position to the underlying bone, a radiopaque representation of the final restoration should be incorporated into the planning process. Therefore to best visualize the prosthetic result a scannographic or radiographic template should be fabricated and utilized during the scan acquisition[12-14] (Figure 6). This key concept in 3-D planning involves the restorative doctor fabricating a diagnostic wax-up or accurate duplicate denture or a fixed temporary acrylic prosthesis for the region being treated representing the desired prosthetic result. A radiographic material such as barium sulphate is placed into the tooth position of this prosthesis and then a CBCT scan is taken (Bariopaque [Salvin Dental]) (Figure 7). Once the scan is taken, the radiopaque tooth position will be visualized on the CBCT scan in all views. Implants can be virtually placed relative to the tooth position and the quantity and quality of the bone within the receptor site according to the "Triangle of Bone.[14]" If the potential receptor site is deficient it may require bone grafting to support an implant in the desired position (Figure 8). To transfer the virtual implant plan from the computer to the patient, a surgical guide can then be produced allowing for accurate guidance during the surgical intervention. Surgical guides can be fabricated by several methods depending upon the software and manufacturer. The incorporation of intraoral optical impressions (or optical scans of the stone casts) can also aid in the accuracy of planning, and template fabrication.

Figure 9. Online (Skype [Microsoft]) meeting between doctors to discuss implant planning.

Figure 10. Clinical example of abundant bone and keratinized tissue.

This effective exchange of information can take place during an online meeting at a convenient time for all parties.

THE CBCT-BASED TEAM ONLINE MEETING

The meeting between the surgeon, restorative doctor, and laboratory technician will be done online at a mutually defined time. A representative from the imaging service provider should be included as the fourth member at the meeting especially during the initial learning curve related to interpreting CBCT images and 3-D planning. If required, the image service provider representative can help to manipulate the software via online remote access to facilitate the interpretation of the various CBCT images. While a meeting can be set up without an imaging company representative, having the expertise of someone adept at managing the 3-D data is crucial (Figure 9).

Prior to the team CBCT meeting to take place a few things must occur. The restorative doctor should have a basic concept of where implants are needed based on a patient's desired prosthetic outcome. This plan should be based on a general workup after a clinical exam of remaining teeth, soft- and hard-tissue analysis, medical history, temporomandibular joint function, analysis of a panoramic x ray, and more.[15] A general assessment of an implant recipient site can be made using a panoramic x-ray and clinical observation (Figure 10). This preliminary plan can be relayed to the diagnostic imaging company so they can start to formulate a plan prior to the scan being taken.

A prosthetic workup should be completed for either a complete immediate denture or a tooth borne provisional that fulfills the aesthetic, phonetic, and functional requirements of the patients' treatment requirements. Once these parameters are documented, a duplicate of the provisional is fabricated with a radiopaque material to represent the teeth on the scan.[16] This can be done by most dental laboratories using barium sulfate or similar material to convey tooth position in relation to the underlying bone. The implant positions can then be prosthetically planned to support the desired final result.

The online meeting can be easily accomplished utilizing one of various online PC/MAC remote computer sharing services that can facilitate a common meeting from different locations (GoTo Meeting/GoToMyPC [Citrix Systems]; Skype [Microsoft]). The various views of a CBCT scan will be seen via remote access for the purposes of discussing the various treatment plan options. Implants and abutments can be simulated and manipulated into the ideal position to support the planned restoration. It is important that for each potential receptor site, each of the 4 software views be visualized by the participants at the online meeting. Each person at the meeting will have their own perspective and together a mutually agreed upon plan can be created.

CLINICAL GOALS OF THE CBCT MEETING: CLINICAL PARAMETERS OF TEAM PLANNING

Once a team is assembled for a CBCT team meeting, and the online venue is created, the clinical objectives become the main focus. With the radioopaque representation of teeth in the final prosthetic position incorporated into the scan, the team can formulate a final plan based upon clinical realities. The implant positions can be planned along with the provisional restoration to be fabricated by the laboratory (Figure 11).

A successful clinical plan takes into consideration the potential stress from the forces of mastication. The implant placement should support the desired prosthetic result, ideal mastication, phonetics, lip support, and aesthetics. The CBCT scan definitively reveals the amount of cortical and trabecular bone defining new paradigms to assess the available bone and the potential need for augmentation procedures. The available bone has been classified by Misch[17] as division *A*, *B*, or *C*, with division *A* or "abundant" bone being the most advantageous for implant placement. Division *B* or *C* bone often required bone grafting in order to have enough bone to support a dental implant in the desired prosthetic end position. In general the more bone that is available, the more placement options are possible that will reduce stress on a dental implant or implants.[12] The CBCT interactive software application can simulate the desired prosthetic result shown, allowing for the correct angulations, number of implants, size of the implant, potential abutments, and visualization of the implant-to-crown ratio (Figure 12). The goal is to choose receptor sites that reduced stress on the implants under the forces of mastication.

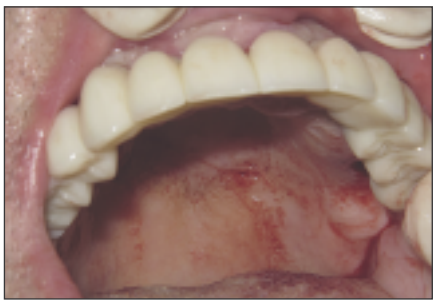

Figure 11. Long-span laboratory fabricated provisional restorations.

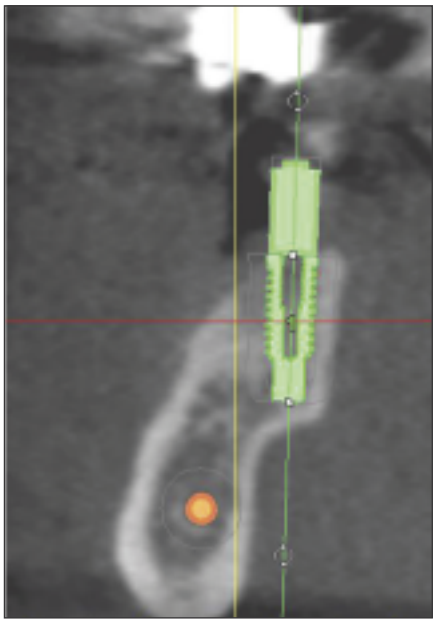

Figure 12. Cross-sectional view of CBCT scan; showing how angulations, implant length, and anatomy can be visualized.

CORRECT ANGULATIONS

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In general the more vertical an implant within the bone, the less stress there will be at the crestal module area of an implant. Division *A* bone by definition has less angulations. Most bone loss occurs at the bone crest surrounding an implant when there is undo stress. The cross-sectional view definitively shows the buccal/lingual representation, and axial view reveals the mesial/distal representation. The axial and cross-sectional views help to define the ideal placement of the implant within the envelope of the tooth to reduce implant stress while fulfilling support for the desired prosthetic outcome. The interactive 3-D view is used to confirm the ideal placement within a given receptor site (Figure 13).

NUMBER OF IMPLANTS

Stress reduction can also occur by placing more implants and increased surface area within the bone to support a prosthesis. Three-dimensional planning allows for a proper assessment of these parameters to have an adequate number of implants properly positioned without impinging on adjacent teeth or vital structures. Implants placed too close together can result in decreased vascularity that can lead to bone loss and other complications. Implants placed too close to adjacent tooth roots can also cause iatrogenic damage. These are complications that can be avoided through the use of 3-D imaging, correct diagnosis, and the proper plan (Figure 14).

SIZE OF THE IMPLANT

A CBCT plan can offer information on the exact size of an implant that will be placed. The size of an implant for surface area support should be maximized with regards to height and width, subject to available bone, adjacent anatomy, and adjacent teeth.[13] The CBCT plan will offer various helpful views, but the axial view will offer the best information with regards to spacing and in combination with the cross-sectional view for implant width (Figure 15). The length of the implant can best be determined in the cross sectional view.

CROWN-TO-IMPLANT RATIO

When planning an implant case, a clinician should have the most favorable crown to implant ratio possible. The radiopaque prosthetic representation

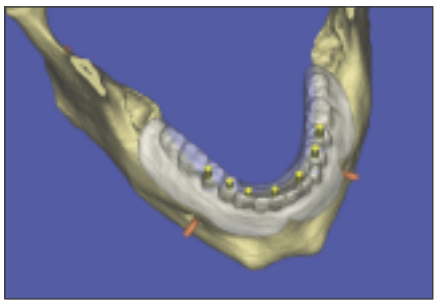

Figure 13. The 3-D view of CBCT scan showing relationship of implants to bone.

Figure 14. Positioning of implants prior to impressions showing ideal spacing through CBCT scan planning.

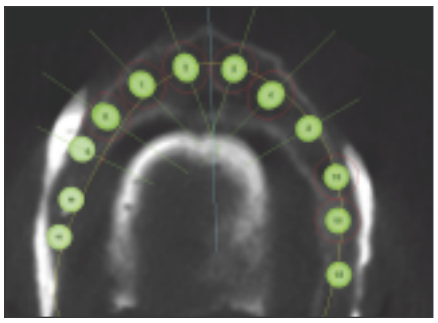

Figure 15. The axial view of a CBCT shows the team the availability of spacing between adjacent implants.

Figure 16. Cross-sectional view of CBCT scan showing the crown-to-implant ratio in relation to final prosthetic tooth position.

on the CBCT scan empowers the clinician with information regarding the quality and volume of available bone relative to the desired prosthetic outcome. A favorable crown-to-implant ratio can be determined. Bone grafting may be required to achieve a favorable crown to implant ratio. If there is reduced bone height from the final prosthetic position and bone grafting is not done, then the implants could be subjected to increased stress based upon the prosthetic demands (Figure 16). Through understanding these key principles during a CBCT planning meeting, the surgeon, prosthetic doctor, and lab team member can determine the appropriate clinical steps necessary to maximize implant success.

IN SUMMARY

Through a CBCT based team meeting, the surgical, restorative dentist, and laboratory team member can better coordinate dental implant treatment on many levels. Once the desired restorative result has been established through conventional means, the information can then be transferred via a radiographic template during the scan acquisition. The type of implant, angulation, width and diameter of the implant, need for grafting, can be determined with great accuracy. This effective exchange of information can take place during an online meeting at a convenient time for all parties. The treatment planning that is possible within the framework of this digital workflow defines the essence of a team approach to implant reconstruction.

The protocol as described in part 1 of this 3-part series allows for improved diagnosis, treatment planning, and successful clinical outcomes. Part 2 of this series will focus on the surgical aspects of the team approach, in collaboration with the restorative clinician and diagnostic imaging center.✦

References

1. Levine RA, Nack G. Team treatment planning for the replacement of estheticzone teeth with dental implants. *Compend Contin Educ Dent.* 2011;32:44-50.
2. Schnitman PA. Implant dentistry. Will it be the ninth recognized specialty? *N Y State Dent J.* 1993;59:51-54.
3. Hochwald D, Arcan S, Farnad F. The team approach: simplifying complex care. *J Calif Dent Assoc.* 2008;36:609-614.
4. Tischler M. Dental implants in the esthetic zone. Considerations for form and function. *N Y State Dent J.* 2004;70:22-26.
5. Jivraj S, Corrado P, Chee W. An interdisciplinary approach to treatment planning in implant dentistry. *Br Dent J.* 2007;202:11-17.
6. Ganz SD. Cone beam computed tomography-assisted treatment planning concepts. *Dent Clin North Am.* 2011;55:515-536, viii.
7. Ganz SD. Computer-aided design/computer-aided manufacturing applications using CT and cone beam CT scanning technology. *Dent Clin North Am.* 2008;52:777-808, vii.
8 Ganz SD. Techniques for the use of CT imaging for the fabrication of surgical guides. *Atlas Oral Maxillofac Surg Clin North Am.* 2006;14:75-97.
9. Tischler M. Utilizing digital imaging to enhance the team approach to implant treatment. *Dent Today.* 2009;28:86-91.
10. Mandelaris GA, Rosenfeld AL. The expanding influence of computed tomography and the application of computer-guided implantology. *Pract Proced Aesthet Dent.* 2008;20:297-305.
11. Rubio Serrano M, Albalat Estela S, Peñarrocha Diago M, et al. Software applied to oral implantology: update. *Med Oral Patol Oral Cir Bucal.* 2008;13:E661-E665.
12. Tischler M. Treatment planning implant dentistry: an overview for the general dentist. *Gen Dent.* 2010;58:368-376.
13. Amet EM, Ganz SD. Implant treatment planning using a patient acceptance prosthesis, radiographic record base, and surgical template. Part 1: Presurgical phase. *Implant Dent.* 1997;6:193-197.
14. Misch CE. Consideration of biomechanical stress in treatment with dental implants. *Dent Today.* 2006;25:80-85.
15. Misch CE. Divisions of available bone in implant dentistry. *Int J Oral Implantol.* 1990;7:9-17.
16. Priest GF. The esthetic challenge of adjacent implants. *J Oral Maxillofac Surg.* 2007;65(7 suppl 1):2-12.
17. Ganz SD. Implant dentistry: the reality of anatomy and the triangle of bone. *Inside Dentistry.* 2006;2:72-77. [AUTHOR: Please verify page numbers.]

Dr. Tischler is a general dentist in private practice in Woodstock, NY. He is a Diplomate of the American Board of Oral Implantology Implant Dentistry, a Diplomate and Fellow of the International Congress of Oral Implantologists, a Fellow of the American Academy of Implant Dentistry, and a Fellow and graduate of the Misch International Institute. He is on the CE editorial board for *Dentistry Today* and on the editorial advisory board for the *Journal of Implant and Advanced Clinical Dentistry.* He has published many articles in various dental journals and lectures internationally on the principles of implant dentistry and bone grafting. He is the director of implant education for Davinci Dental Studios and is also on the BioHorizons educational speakers' panel. He offers in-office courses at his teaching facility in Woodstock many times during the year and has a popular instructional DVD available that covers the principles of implant dentistry and bone grafting. He can be reached via (845) 679-3706 or the Web site tischlerdental.com.

Disclosure: Dr. Tischler is occasionally compensated by BioHorizons for lecturing.

Dr. Ganz graduated from the University of Medicine and Dentistry of New Jersey (UMDNJ) Dental School, and then completed a 3-year specialty program in maxillofacial prosthetics at MD Anderson Cancer Center in Houston, Tex. Dr. Ganz is now on the board of directors of the International Congress of Oral Implantologists. He maintains a private practice for prosthodontics, maxillofacial prosthetics, and implant dentistry in Fort Lee, NJ. He is on the implant faculty of many preceptorship programs nationally, is on the staff of Hackensack University Medical Center, and is presently on faculty at UMDNJ Dental School. He currently serves as associate editor for the peer-reviewed journal Implant Dentistry and is on the editorial staff of many other publications. He has published more than 55 articles in various scientific journals. Dr. Ganz authored a book, *An Illustrated Guide to Understanding Dental Implants*. He has presented internationally on the prosthetic and surgical phases of implant dentistry. He can be reached at (201) 592-8888, via e-mail at sdgimplant@aol.com, or by visting the Web site drganz.com.

Disclosure: Dr. Ganz is a lecturer and receives honoraria from BioHorizons and Imaging Sciences.