The CT/CBCT-Based Team Approach to Care: Part 2: Communication With the Surgeon to Support the Final Prosthesis

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INTRODUCTION

In part one of this article series, "The CT/CBCT-Based Team Approach to Care: Identifying the Implant Patient and Prosthetic Options," the concept of proper diagnosis and treatment planning to achieve optimal surgical and prosthetic outcomes were explored. The concept of utilizing low-radiation cone beam computed tomography (CBCT) 3-dimensional (3-D) imaging modalities to facilitate the communication process within an online team meeting among the surgical doctor, prosthetic doctor, laboratory technician, and radiologist was presented. The use of an online meeting illustrated that the parameters of prosthetically based planning can readily occur, helping to accommodate treatment outcomes. Utilizing interactive treatment planning software, members of the team can evaluate and discuss each potential implant receptor site based upon the available bone and restorative requirements. An ideal number of simulated implants can then be positioned and assessed for angulations, length, width, and assurance of an ideal crown-to-implant ratio.

In this, the second part of a 3-part series, the surgical aspects of implant placement will be explored within the envelope of team communication based upon a foundation of diagnostic knowledge. The surgical aspect of site development and subsequent implant placement will be assessed and communicated in concert with the ideal final prosthetic result. Important surgical aspects that will be reviewed are: medical history considerations of treatment, site development with hard- and soft-tissue grafts, assessment of bone quality and anatomy, methods of provisionalization during treatment, influence of anatomy on the prosthetic treatment plan, and considerations for implants in the aesthetic zone. The surgical components of implant treatment involve all members of the implant team, as the surgical steps create the foundation for the restorative and laboratory phase, and are therefore interrelated.

MEDICAL HISTORY CONSIDERATION OF TREATMENT

In collaboration with the restorative and surgical doctor, the medical history should be the starting conversation of the team meeting.[1] Often times the implant surgical procedure encompasses tooth extractions, bone grafting, and soft-tissue grafting as adjunctive treatment modalities. The health status of a patient determines the healing capacity of the patient and how that patient may withstand the recommended procedures.

Figure 1. Blood pressure must be under control before undertaking any implant surgery.

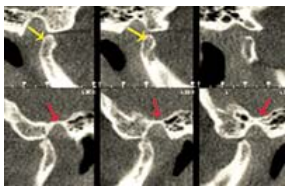

Figure 2. Cone beam computed tomography (CBCT) view showing temporomandibular joint abnormality of fossa and condyle. Yellow arrows show condyle and red arrows show fossa.

Oral-Systemic connection
Orthodontics
Pediatric Dentistry
Periodontics
Pharmacology
Pain Management
Prevention
Prosthodontics
Psychology
Radiography
Post-and-Core Technique
Regulatory
Restorative
Sleep Disorders
Sports Dentistry
Techno-Clinical
Technology
Technique of the Week
Treatment Planning
Viewpoint

Figure 3. View from CBCT scan showing pathology in sinus. Red arrows show opacification and yellow arrows show a normal sinus.

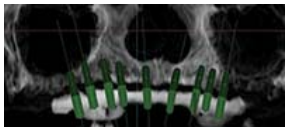

Figure 4. Final prosthetic end position on CBCT scan with 3-dimensional view, showing relationship of implants.

Figure 5. Relationship of bone to final prosthetic end-position, showing if bone grafting is needed.

Figure 6. Lack of keratinized tissue around an implant can lead to a dehiscence.

Contraindications for implant surgery are any uncontrolled disease, pregnancy, or uncontrolled substance abuse.[1] The medical history, physical observation, and a patient interview can offer information as to the status of a patient's health. Smoking, osteoporosis, and autoimmune diseases are examples of conditions to consider before having a patient undergo implant surgery, but are not absolute contraindications.[2] The medications a patient is taking can be a clue toward the areas of a patient's health that might need further investigation. For instance, a patient on blood thinners could indicate a possible previous stroke or cardiovascular incident. Once a health concern is noted, often a follow-up conversation with the patient's physician is indicated. The dentist on the implant team who sees medical concerns should flag these concerns, and then follow up with the other dentist team member for a clear resolution and medical clearance with the patient's physician.

Another medical consideration that should be discussed at the online team meeting is the physical dexterity of a patient and how that might affect home care maintenance of a treatment planned prosthesis.[3] A previous stroke or physical injury might affect a patient's ability to place a removable prosthesis or perform hygiene for maintenance. Information like this could curtail a plan for the final prosthesis and this online team meeting is an ideal time to discuss that.

The patient's baseline blood pressure should be recorded at the time a medical history is taken. Any blood pressure readings with a systolic pressure higher than 140 mm Hg, or a diastolic pressure higher than 90 mm Hg, should be referred to a physician for medical evaluation and clearance for surgery (Figure 1). Often a patient with hypertension is unaware of this condition.[4] Any patient with an American Society of Anesthesiology II status or greater for implant procedures should be sent for surgical approval to the patient's physician also. The team discussion of a patient's health status and subsequent follow-up with reports adds medical legal protection for the treating doctors and safer care for the patient being treated.

Once the CBCT scan has been performed, it is important to review any potential pathology within the field-of-view of the maxillomandibular region. From a medical/legal standpoint, extragnathic areas outside the implant areas should also be inspected for pathology.[5] A cross-sectional CBCT view, for instance, can show pathology of the temporomandibular joint (TMJ) fossa and condyle (Figure 2). At times, a radiology report by an oral maxillofacial radiologist can note sinus abnormalities, TMJ pathology, cysts, carotid artery calcification, and other medical pathologies that might have to be addressed prior to implant treatment. Often pathology will be readily apparent, such as a thickening of the sinus membrane, or complete opacification. The coronal slice of a CBCT scan reveals complete opacification of the right maxillary sinus (red arrows) and a clear and normal appearing left sinus presentation (yellow arrows) (Figure 3).

SITE DEVELOPMENT WITH HARD- AND SOFT-TISSUE GRAFTS

Part one of this article series illustrated advantages to the desired final prosthetic position being shown on the CBCT scan via the use of radiopaque material or virtual occlusion[6] (Figure 4). With this information of tooth position visualized through interactive treatment planning software, the team meeting can focus on how the available hard tissue can support dental implants to fulfill the prosthetic needs. If there is insufficient bone volume or bone quality within a given receptor site based upon CBCT evaluation, hard-tissue grafting may be required. The CBCT scan will indicate the quantity of bone needed and the time involved for the surgery and the healing phase (Figure 5).[7,8] A discussion with the team can review the type of graft material that is appropriate for site development and subsequent implant placement.

The CBCT scan can also offer information to the amount of bone for intra- and extraoral autogenous donor sites for grafting.[9,10] The mandibular symphysis or ramus area can vary with regards to the quantity of available bone, and a CBCT can accurately convey the amount of bone available. The CBCT will also reveal vital adjacent anatomy to determine if the donor site is feasible. A CBCT team online meeting can provide very pertinent and vital information that is necessary for the development of a definitive treatment plan; this includes the sequence of events and the cost of each phase of the reconstruction so that it can be presented accurately to the patient. The conversation at the team meeting might also reveal that a patient may not want to undergo bone grafting procedures, does not wish to use bone bank bone, or is not a candidate for medical reasons. If it is decided that bone grafting is not a viable treatment modality, an alternative plan may include placing more implants, shorter implants, or changing the overall prosthetic plan.

The clinical examination should also focus on an assessment of the soft tissues and biotype for the potential implant receptor sites. Planning for adequate keratinized tissue around dental implants is crucial for implant success.[11] Keratinized tissue can be gained in a site through either using donor connective tissue or from a patient's own transplanted connective tissue. The team meeting once again offers an opportunity for the surgical and prosthetic doctor to discuss this important assessment of the soft tissues, to develop the appropriate plan that can be conveyed to the patient. When discussing soft-tissue issues, it is helpful to have intraoral photographs of the patient's ridge and measurements of keratinized and mucosal tissue (Figure 6). This allows for a more informed decision at the team

meeting.

ASSESSMENT OF BONE QUALITY AND ANATOMY

The CBCT scan offers invaluable information with respect to analyzing the quality and anatomy of bone of the implant site being evaluated. An accurate method to quantify bone density with medical CT is through the Hounsfield scale, and relative density with CBCT and visualizing the various views these 3-D scans offer.[12] Figure 7a illustrates 2 regions (yellow and pink) in a maxillary cross-sectional view that reveal differences in bone density according to the Hounsfield scale. The mandibular cross-sectional slice reveals thicker cortical plates and higher values (Figure 7b). With respect to bone quality, the density of bone varies between D1 (dense bone) and D4 (soft bone), according to Misch.[13] The density of available bone has an effect on the treatment plan in various ways. Variations in the thickness of the buccal and lingual cortical plates and density of intermedullary bone will play a role in the immediate fixation and stability of a dental implant.

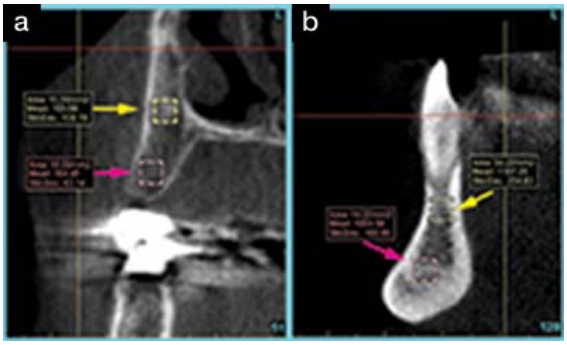

Figure 7a. Cross-sectional CBCT view of maxillary arch showing diversity of bone density within an implant site in Hounsfield numbers. Yellow box indicates denser bone than pink box.

Figure 7b. Cross-sectional view of mandible showing diversity of bone within an implant site in Hounsfield numbers.

Figure 8. Bone density will determine if an implant is placed as a one- or 2-stage procedure.

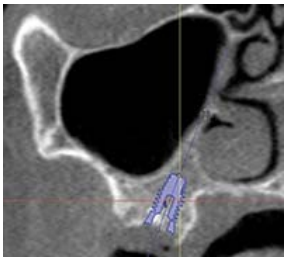

Figure 9. CBCT scan cross-sectional view showing implant placed angled to the palate.

Figure 10. Model of fixed provisional on natural teeth during implant healing.

Figure 11. Relined denture after healing caps are placed.

Figure 12. Fixed prosthesis 1 (FP1) showing lateral incisors replaced with dental implants.

Figure 13. Implant abutments on model showing FP1 relationship.

Therefore, it can be determined in advance of treatment the healing time or whether an implant can be placed in a one-stage or 2-stage approach, or when a dental implant might be loaded (Figure 8). This information is critical when developing a treatment plan and

determining how long treatment will take. Having this information prior to surgery allows the online team meeting to be more productive toward achieving an ideal treatment plan for the patient, and a more accurate prediction of the sequence of events. Information on the available bone density also can guide a clinician to the correct implant size or shape to be used.[14] If the bone density is soft, it has been suggested that a wider or longer implant might be chosen to better engage the cortical place for implant stabilization. Information of bone density, volume, and density is valuable information for the surgeon and the team as a treatment plan is created.

The CBCT scan data, along with interactive treatment planning software can also guide the team toward implant placement positions, based on the anatomy of bone, as this 3-D modality offers more information and is more accurate than 2-dimensional radiography. There are circumstances in the mandible for instance, in which an implant might be placed mesial or distal to an area of deficient bone, and avoid the need for grafting.[15] Another example is placement of an implant toward the palatal to avoid the sinus membrane in the maxilla (Figure 9). These clinical choices made from the CBCT scan allow for the online team meeting to have an important impact on treatment planning an implant case.

METHODS OF PROVISIONALIZATION DURING TREATMENT

The type of provisionalization during implant treatment is an extremely important aspect to treatment planning.[16] The online team meeting is an ideal method to coordinate the many options that are available for each case, and to discuss the pros and cons of each. The provisionalization phase can affect the patient's speech, chewing ability, and quality of life, serving as the model for the definitive restoration. In addition to patient issues, it is important for clinicians to address loading forces on implants as they heal, the longevity of the chosen provisional material and design, and how the provisional restoration fits into the surgical and prosthetic sequence of treatment events (Figure 10).[17]

There are pros and cons to the different provisional options available, and each option has clinical ramifications. Fully edentulous patients often have an existing denture, or will require a new transitional denture during implant reconstruction. If a denture is being used during the provisionalization phase, then it is usually elected to place the implants buried under the soft tissue in a conventional 2-stage fashion, helping to buffer the forces of occlusion (Figure 11). This is especially common for the maxilla, where the bone is generally softer. In the mandible, when there is good quality and abundant bone, implants could be placed above the soft tissue in a one-stage approach that would allow for immediate loading of the implants with either a removable or a fixed-type provisional.[18] Another option for provisionalization might be to utilize existing teeth for a tooth-borne fixed provisional while the implants are healing. The provisionalization decision process must also be based upon feedback from the patient with informed consent of the choices provided. The initial online team meeting with a CBCT scan is the ideal time to review the various provisional modalities, and to discuss the ramifications on implant treatment and the associated restorative and/or laboratory steps.

INFLUENCE OF ANATOMY ON THE PROSTHETIC TREATMENT PLAN

Misch[19] classifies fixed implant prosthetic options as fixed prosthesis 1, 2, and 3 (FP1, FP2, FP3). With regards to fixed prosthetic implant supported options, FP1 is the most similar to a natural tooth relationship, where tooth length is similar to natural teeth, and there is adequate soft tissue for an aesthetic emergence profile without the need for artificial gingiva (Figures 12 and 13). This FP1 relationship is possible because of a combination of the availability of abundant bone, adequate lip coverage, or an appropriate occlusal relationship. Depending on the prosthetic space available, an FP1 prosthesis could be screw- or cement-retained. With the advent of an all-zirconia option, an FP1 restorative option is possible due to less required prosthetic space than a metal-ceramic or metal-acrylic combination.[20]

The FP3 option is similar to an FP1 option but the teeth are longer and there is simulated artificial gingiva involved. FP3 prosthetic treatment plans are for situations where there is deficient bone height, and/or a high lip-line. An FP3 prosthesis can be either cement- or screw-retained (Figure 14).
The CBCT-based team meeting will help ascertain the appropriate prosthetic option(s) for the patient. This decision is made by discussing patient priorities, patient financial concerns, the patient's medical history, and assessing the available bone. The CBCT scan will define the surgical prerequisites of the prosthetic options available. The bone height, width, and location of anatomical structures will dictate the surgical steps needed to create the desired prosthetic end result.

For patients who want the shortest treatment time, least surgery, and often least expense, a cantilevered implant-supported FP1, FP2, or FP3 option is sometimes the best choice. This cantilevered option, providing first molar occlusion, utilizes implants placed between the sinuses on the maxilla and between the foramen on the mandible (Figure 15).[21] Avoiding the restrictive anatomy of the sinuses and proximity to the mandibular nerve, the healing time, surgery, and cost of bone grafting can often be avoided. The amount of prosthetic cantilever from the implant must be minimized, and it is dependent on arch form and implant placement positions.[22]

Figure 14. All-zirconia FP3 showing the need for artificial gingiva because of the prosthetic space.

Figure 15. Panoramic radiograph showing maxillary and mandibular FP3 cantilevered bridges.

showing importance of lingual implant placement for screw holes.

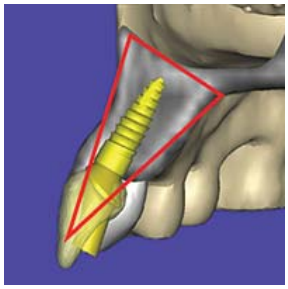

Figure 18. A CBCT can allow planning for parameters of implant success in the triangle of bone in the aesthetic zone.

height will determine the visibility of the implant tissue interface and need for soft- and or hard-tissue grafting.

Figure 19. It is important to plan for lip coverage of the artificial gingival interface in an FP3 prosthesis.

When a screw-retained option is chosen for an FP1, FP2, or FP3 prosthesis, it is important in the anterior region to place the implant screw position to the lingual of the arch (Figure 16). The lingual position is necessary to allow for the screw access hole to emerge within the envelope of the clinical crown avoiding the incisal edge, embrasures, or through the facial (or buccal) aspect of the desired tooth position. Posteriorly, the screw hole can be effectively placed through the occlusal surface. The use of CBCT scan imaging and interactive treatment planning software will empower clinicians with the proper tools to visualize the correct angulation and emergence profiles for the desired restoration.

CONSIDERATIONS FOR IMPLANTS IN THE AESTHETIC ZONE

Tooth replacement supported by dental implants in the aesthetic zone requires multiple clinical criteria for success. In the anterior aesthetic zone, tissue architecture changes are often visible when a patient smiles.[23] Because of the specific demands required for this prominent region, everything possible must be done to ensure accuracy and predictability. The online team meeting is an ideal venue to assess the clinical criteria that will bring aesthetic and functional success. The aesthetic zone can be individually determined by an initial evaluation of the patient's lip-line. The online team meeting will focus on how much gingival tissue is exposed when the patient smiles. In a patient with a high smile-line, consideration must be given to achieving a natural gingival-to-implant interface and emergence profile for the final restoration. Team members can review intraoral photographs and study models for an accurate assessment and determination of the soft-tissue components and biotype (Figure 17).

For an FP1 situation, ensuring a natural appearance can involve hard- and/or soft-tissue grafting. It is crucial to have adequate osseous support and keratinized gingiva around a dental implant to achieve ideal aesthetics. The CBCT scan can offer invaluable information with respect to implant placement positions, spacing, and implant size, for ideal aesthetic results. The literature supports placement parameters for aesthetic success, that when followed can offer predictable outcomes (Figure 18).[24]

For an FP3 clinical presentation in the aesthetic zone, the online team meeting should focus on the junction where the smile-line and the artificial gingiva meet. The artificial gingival junction should not be exposed when the patient smiles, or the results will obviously be less than optimal. Proper planning, utilizing the radiographic tooth position information on the CBCT scan, will help to avoid a poor aesthetic result. Information on the scan will show if an alveoloplasty is required to hide the gingival interface so that it is not revealed when the patient smiles (Figure 19). The communication among members of the team and the surgical doctor is critical to avoiding complications and achieving repeatable and predictable success.

IN SUMMARY

All members of the implant treatment team should be involved with the surgical planning for implant treatment. The surgical aspect should not be planned without a thorough understanding of the desired restorative outcome. In addition, the clinician should develop an ideal treatment plan for a patient prior to the scalpel ever touching the patient. The following needs to be considered in order to do this properly: an assessment of medical history; hard- and soft-tissue site development; assessment of bone quality and anatomy; methods of provisionalization during treatment; influence of anatomy on the prosthetic treatment plan; and implant positioning for screw- versus cement-retained prosthetics. In addition, the clinician must have a thorough understanding of the specific demands for implants placed in the aesthetic zone.

With the utilization of an online team meeting that will appreciate and review these topics, the clinicians can better communicate the entire sequence of treatment, costs to the patient, and the time involved to complete each phase of treatment. Following these protocols insures improved treatment outcomes, and better medical-legal protection for the treating doctors.

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Disclosure: Dr. Tischler lectures for Biohorizons and occasionally receives honoraria for doing so.

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Disclosure: Dr. Ganz lectures for Imaging Sciences, Inc, and Materialise Dental. He receives honoraria for doing so.

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