Enhanced Implant Case Planning Using Dual Scan CBCT of an Existing Prosthesis: Report of a Case

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INTRODUCTION

The delivery of a complex dental prosthesis that is supported by dental implants is always a challenge for the implant team. Many clinical issues must be evaluated, and there should be good communication among the members of the team and the patient.

One of the most challenging parts of communication is the accurate transference of planning data between the restorative doctor and the surgeon. While the restorative doctor prepares models and provisional prostheses that address the patient's clinical issues, the surgeon must likewise address bone and soft tissue quality and quantity while designing a supporting foundation for the patient-specific prosthesis. This communication challenge comes to the forefront when the team must decide the number, location, size, depth, and long axis of each of the dental implants to be utilized in the case.

How does the surgeon assay the appropriateness of his implant selection and placement for the support of the planned prosthesis? The answer to that question could lie in the provisional prosthesis, but how is the data in the prosthesis transferred to the surgical plan?

Our case report demonstrates the dual scan technique for transferring the data held within the prosthesis to the implant planning process. Two scans of cone beam computerized tomography (CBCT) data were imported into SimPlant Pro software. The first scan was of the prosthesis alone, and the second scan was of the patient wearing the seated prosthesis. The software accurately merged the two scans, and implant placement was planned to support the prosthesis. This software document was also used to design and fabricate a surgical guide for the accurate placement of the dental implants. It is our opinion that this dual scan technique enhances the communication that is vital in the implant case planning, and it facilitates preparation of the surgical guide.

REPORT OF A CASE

History

A 59-year-old male presented with a failing single-abutted, fixed partial denture spanning maxillary teeth #4–9. The presenting circumstances are displayed in Figures 1 through 3. The patient had been involved in a motorcycle accident at 18 years of age, avulsing the anterior teeth and fracturing the alveolus. The single-abutted, fixed bridge worked well for many years, but abutments #4 and 9 subsequently developed root fractures and the bridge became loose. The abutment teeth were hopeless. Due of the avulsive trauma and loss of stimulating natural tooth roots, the alveolus of the maxilla became atrophic vertically and horizontally in the edentulous area between the abutments. The smile line was low, and the patient demonstrated a Class I occlusion. Note the asymmetry of the clinical crowns dictated by the loss of boney volume. Bicuspids had been removed at an early age for orthodontic treatment.

Planning and treatment

The treatment goal was to replace the lost anterior teeth with a fixed prosthesis using doubly abutted implant support at #4–5 and #8–9. During the treatment, the patient would be provided a removable partial denture (RPD) designed to mimic the final fixed prosthesis in tooth size and color, spacing, position, and long axis.

An initial surgery was done to remove the root fragments of #4 and 9 in a flapless, atraumatic manner, preserving the labial plates. The extraction sites were grafted for future implantation. The previously fabricated temporary RPD was inserted and is displayed in Figures 4 through 6. This "flipper"-type appliance was retained with wrought wire and temporarily replaced the lost teeth #4–9. Since the grafting process required several months of maturity and waiting, the patient and restorative doctor had an adequate opportunity to evaluate the appropriateness, the function, and the esthetics of the proposed restoration.

Five months after the extraction and grafting surgery, the patient returned for an iCAT CBCT scan for implant planning. At that time, he had a well-healed ridge and was functioning nicely with his RPD. The healed alveolar ridge is displayed in Figures 7 and 8. Note the vertical and horizontal atrophy, especially in the #6 and 7 areas. Preservation grafting retained the alveolus in the area of the extractions.

Consideration was given to ridge augmentation grafting in the edentulous area, but the patient’s low smile line precluded the need for this surgery and its additional morbidity, expense, complexity, and time.

Two scans were performed with a CBCT scanner. One scan...
was of the RPD prosthesis alone and a second was of the patient wearing the RPD in a fully seated position. The appliance, as it is prepared for the dual scan, is displayed in Figures 9 and 10. Note that Suremark radiopaque scanning markers were temporarily attached to the prosthesis for the purpose of merging the two scans using software. Five markers were attached to the RPD flanges with removable sticky tape.

The DICOM files of the scans were imported into SimPlant Pro v.15 software (Densply, Mannheim, Germany). The dual scan process is displayed in Figures 11 through 16. Figures 11 and 12 depict the "segmented" bone of the maxilla. With the soft tissue drape removed by the software, the atrophic bone of the alveolus is readily exposed. The section of atrophic alveolus in the #6 and 7 area is less suitable for implantation without further grafting. In Figures 13 through 16, the scanned RPD is evident with its radiopaque markers. In the dual scan process, the markers are used to orient and merge the two scans in 3D. The surgical team had an accurate representation of the patient wearing the fully seated RPD.

Figures 17 through 20 show the process of using the two merged scans to locate and orient implants in positions #4, 5, 8, and 9. These four implants support the planned fixed partial denture. The views afforded by the 3D software allow the implants to be sized and placed in the available bone at the appropriate depth, location, and long axis. In this circumstance, the center of the implant platform was positioned to align at the bone level with the cingulum of the prosthetic tooth. The apex was then adjusted to retain the implant body within the alveolus confined by the lingual and labial plates. The diameter of the implants was adjusted to comply with the labial and lingual plates while spacing the implants to preserve the biologic width. The length was adjusted to offer the maximum support that the bone height would allow.

Both the restorative doctor and the surgeon approved the implant choices and positions depicted by the SimPlant software. The software document was emailed to Materialise Dental for fabrication of a stereolithic surgical guide. This SurgiGuide (Medford, NY), as displayed in Figures 21 and 22, is borne by the remaining natural dentition and precisely confines the sequence of drills to form the osteotomy in position, long axis, and depth.

The implant placement is displayed in Figure 23. This radiograph shows the insertion of Osseotite Tapered Certain Prevail implants (Biomet 3i, Palm Beach Gardens, Fla) at locations #4, 5, 8, and 9. Platform switching implants were chosen for the anterior maxilla. The patient’s original RPD was then replaced for use during the healing phase.

Uncovery surgery was performed at 4 months postimplantation. Figure 24 shows BioMet 3i Encode abutments chosen and placed for prosthetic fabrication.

Figures 25 and 26 show the laboratory phase of the final prosthesis in the form of a fixed partial denture spanning teeth #4–9. Pink porcelain was used to replace the lost volume of hard and soft tissue.

Figures 27 and 28 show the final clinical result. The shape,
length and position of the clinical crowns are in accordance with the adjacent teeth, while the low smile line covers the transition from the pink porcelain to the natural gingival.

Figures 29 and 30 demonstrate the accuracy that is gained by the use of the dual scan technique. These screen shots of the post-treatment scan show that the implants are well positioned to support this fixed prosthesis.

FIGURES 9–20. FIGURE 9. Attachment of radiographic markers to the removable partial denture (RPD) for the dual scan process. FIGURE 10. Five markers are attached to the flanges of the RPD for computer merging of the two scans. FIGURE 11. The segmented maxilla in SimPlant Pro after the first surgery. FIGURE 12. Occlusal view of the segmented maxilla showing the atrophic section of the ridge. FIGURE 13. Segmented RPD that has been isolated in SimPlant Pro. FIGURE 14. The RPD is fully seated against the maxilla and adjacent teeth. FIGURE 15. The RPD showing the radiographic markers on the flanges. FIGURE 16. Palatal view of the seated RPD. FIGURE 17. Emergence restorative spaces for long axis planning in SimPlant Pro. FIGURE 18. Restorative spaces in the occlusal view showing relationships to the prosthetic teeth. FIGURE 19. Implant positions are adjusted to preserve the cortical plates, and maximum implant length is chosen for stability. FIGURE 20. The implant diameters and spacing are selected to preserve the biologic width and cortical plates.

**DISCUSSION**

Much has been studied and written regarding the myriad issues that must be addressed before proceeding with any dental treatment that includes an implant supported prosthesis. Freely flowing, accurate communication is required between the various members of the clinical team and with the patient.
Enhanced Communication and Accurate Implant Planning

A typical sequence of planning events in the complex implant case is for the initial discussion to take place between the patient and the restorative doctor without the surgeon being present. Within the confines of the patient’s expectations, wishes, and clinical presentation, an ideal prosthesis is frequently decided without the surgeon’s input. The next step is often a visit to the surgeon where an opinion is requested about the availability of bone for placing implants. This is where a breakdown in communications can readily occur. Without knowing the clinical aspects of the chosen prosthesis, an opinion for that implant suitability might be based on inappropriate data. With the patient wearing a functioning trial prosthesis, true “top-down implant planning” can take place.

In our case, the prosthesis is the “top” and is scanned by CBCT into the record along with the patient’s anatomy. The implants, representing the “bottom,” are chosen by location, length, diameter, and long axis to support the top. With the
patient’s prosthesis in full view during the implant planning, validity is given to the surgeon’s opinion of the suitability of the implant support.

It is not uncommon that the surgeon might request a “bottom-up revision.” If the existing anatomy prevents placement of implants at the appropriate locations to support the chosen prosthesis, then the surgeon must bring about the discussion of modification of the plan. That modification might include grafting of deficient tissues for implant placement, or it might involve revision of the final prosthesis. With the 3D depiction of the prosthesis and the anatomy allowed by the dual scan technique, this back-and-forth communication is enhanced.

Quick and accurate assessment can be made for the appropriateness of the size, location, and long axis of the implant. Without visualization of the prosthesis, implant planning remains at a less accurate estimation in regard to its support.

Simplicity

Compared to other processes, the dual scan technique is faster and simpler. In our case, since the patient needed a provisional appliance in the first place, an effort was made by the restorative doctor to supply an accurate trial device that addressed the patient’s clinical and personal needs. Our laboratory efforts stopped there.

With other scanning appliance techniques, additional steps are required. Duplications of the model and the prosthesis are done while mixing barium sulfate and acrylic to add radiopacity to the device. A common complication associated with this approach is that the radiographic scatter generated by the barium interferes with the accurate identification of anatomic landmarks.3–5

The Surgical Guide

Following the prosthetic and implant planning, the next challenge is the accurate transference of the data of the implant plan to a device used to guide the surgeon in the three-dimensional surgical placement of the implants. Many techniques have been advocated for transferring this data through the use of surgical guides.6–9

Experience shows that each type of guide presents advantages and disadvantages. Some guides are simple to construct while others are time consuming and complex due to their inherent sequential processes. Accuracy might be compromised in the simplest guides.10 Some processes require the purchase of additional costly equipment with added complexity.11

Our particular case demanded accuracy of guidance. We chose a milled stereolithic SurgiGuide supported by the remaining natural dentition. Whether the demand comes from placing implants in close approximation to each other or to adjacent teeth, anatomy that is restrictive, or by selection of an unusual long axis for a given implant, the stereolithic guide affords the greatest control.12–13

Our technique also simplified the guide construction. Only an accurate model of the patient’s existing dentition is required for the milling process. No additional laboratory steps are involved since the guide is generated from the software document.

Conclusion

The entire process of accurately planning and completing a complex implant case is formidable. These cases are subject to the development of complications and poor outcomes that are poorly tolerated by the consuming public. The public demands near perfection and expects precision. Avoiding complications and producing precision is enveloped in enhanced planning and communication by the implant team, and it is delivered by accurate techniques.

Presented is a case report utilizing a dual scan technique for implant planning and surgical guidance in SimPlant Pro software. Enhanced communication between the clinicians and the patient is afforded. In the arena of “top-down-implant-planning,” the dual scan technique affords the next logical step that we term “bottom-up-revision.” In this technique, the implant team is allowed to see how well matched the planned prosthesis meets the surgical anatomy. Then, a revision is made, either to the prosthesis or to the anatomy in the form of grafting. With this technique, all the complexity is evaluated and settled before treatment begins. This enhanced communication, accuracy, and simplicity is improved using dual scan over other available techniques.

ABBREVIATIONS

CBCT: cone beam computed tomography
RPD: removable partial denture

NOTE

The authors declare no conflicts of interest.

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