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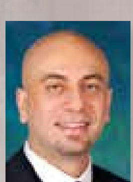
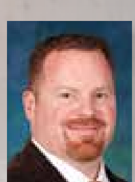
Immediate Final Restorations: A Comprehensive Digital Approach to Implant Dentistry





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Accounting for anatomical limitations and restorative goals while placing implants is a clinical necessity, as placement without such considerations can potentially compromise patient health and case success in terms of function and esthetics. Modern digital treatment planning (DTP) technology advances the diagnostic phase of implantology by enabling the clinician to plan the surgery and clearly visualize patient anatomy in a virtual environment prior to implant placement. The result is a precise, restoratively driven treatment plan.

In DTP, intraoral scans and cone-beam computed tomography (CBCT) data of the patient's anatomy and edentulous spaces are used to produce a digital model, which in turn drives the design and placement of the surgical and restorative components. To reconcile the application of this virtual data to clinical practice, implant manufacturers and doctors have incorporated surgical guides into their treatment protocol. Along with the additional information gained through DTP, the utilization of surgical guides allows the clinician to place the implant in the exact position required for maximum support and strength, increasing the likelihood of a situation in which immediate loading of the final restoration might be indicated.

The following case demonstrates the utilization of DTP and guided surgery to immediately deliver two final restorations in the maxillary anterior at the time of implant placement, resulting in a greatly increased level of accuracy while reducing the number of surgical and restorative interactions with the implant sites.

Case Report: Guided Surgical Placement of Anterior Implants

The patient presented with edentulous spaces in the areas of tooth #7 and #10, including a retained root tip in the area of #10 *(Fig. 1)*. The patient was wearing a removable interim prosthesis at the time. Prior to treatment planning for guided implant surgery, surgical removal of the bony impacted root tip was necessary. Papilla-sparing incisions were made, stopping short of the adjacent teeth to minimize gingival recession. A small flap was created in order to visualize the bone covering the root tip, and a periotome was utilized to extract the root tip. Puros® Cortico-Cancellous Particulate Allograft material (Zimmer Dental; Carlsbad, Calif.) was then placed to restore the crestal bone of the maxilla, and four interrupted sutures (Coated VICRYL™ [Ethicon; Somerville, N.J.]) were used to close the incision *(Fig. 2)*.

Following a healing period of four months, the patient returned to begin the guided surgery treatment planning phase. A PreXion3D scanner (PreXion Inc.; San Mateo, Calif.) was used to obtain CBCT images in the DICOM file format *(Fig. 3)*. The CBCT scanner captured the subsurface anatomy of the patient and constructed a three-dimensional image out of a series of two-dimensional slices. The DICOM file was then transferred into the In2Guide™ digital treatment planning software (Cybermed Inc.; Irvine, Calif.), which presents the subsurface scan data adjacent to the STL file gathered from the intraoral scanner. For the purpose of DTP for this case, the diagnostic intraoral scan of the patient's dental anatomy was taken utilizing the IOS FastScan® (IOS Technologies; San Diego, Calif.).

The CBCT DICOM file does not actually contain data of the surface texture of the dentition, although it represents the teeth, tissue and underlying structure in a three-dimensional space by creating a false edge formed from the two-dimensional slices. The treatment planning software allows the operator to define the surface of the CBCT model using tools to outline and segment the dentition and tissue. However, as CBCT scans are susceptible to inaccuracies due to factors such as pre-existing metal restorations and patient movement, the newly created surface data runs the risk of being less than accurate. Intraoral scanners capture and construct the surface data in the more accurate STL format. In the DTP software, the two distinct file types are merged to create a single digital model that contains both the surface and subsurface information *(Fig. 4)*. The tools found in the surgical software enable the surgeon to plan and simulate implant therapy digitally, including placement of the implant and final prosthesis, as well as seating of the surgical guide.

By the time of surgery, DTP had eliminated many of the possible unknowns. From the previously constructed data sets,

Figure 1: *Radiograph of the retained root tip in the area of tooth #10.*

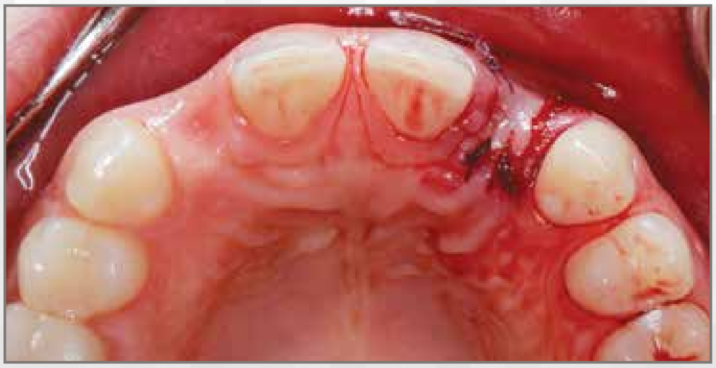


Figure 2: *Sutures in place after the removal of maxillary root tip and closure of the flap.*

Figure 3: *Pre-surgical CBCT image of the patient's maxilla with the root tip removed from the area of tooth #10.*

Figure 4: *Merging of the CBCT DICOM file and the intraoral scan STL file utilizing In2Guide digital treatment planning software.*

Figure 5: *Implant placement using a handpiece and the surgical guide.*

Figure 6: *Orientation of the internal hex connections with the flat sides parallel to the facial wall.*

Figures 7a, 7b: *BruxZir screw-retained crowns in place, delivered immediately following placement of the implants.*

a tooth-supported guide was fabricated. Viewing windows were incorporated, allowing the position of the guide to be assessed in order to ensure that it was fully seated. A tissue punch was placed through the metal drill sleeves to remove soft tissue at the implant sites, establishing access to the cortical plate so the osteotomies and site preparation could proceed. This case utilized two 3.7 mm x 13 mm Inclusive® Tapered Implants (Glidewell Direct; Irvine, Calif.). A series of Inclusive Surgical Drills, ending with the 2.8/2.3 mm diameter drill, was used along with the incorporated sleeves of the surgical guide to prepare the osteotomies. Both implants were placed through the surgical guide and seated in the maxilla *(Fig. 5)*. In order to ensure proper alignment of the final screw-retained restorations from the laboratory with the placed implants, a flat side of the coronal internal hex of each implant was oriented parallel with the facial wall of the anterior zone upon final seating *(Fig. 6)*.

With the implants in place, their stability was measured to evaluate the possibility of immediate loading using the Osstell® ISQ implant stability meter (Osstell USA; Linthicum, Md.). This device uses resonance frequency analysis to determine the structural soundness of a seated implant. The device's measurement probe causes the SmartPeg™ attachment (Osstell USA) — a precision-crafted metal rod that is loaded into the implant's coronal hex — to resonate. The device calculates the initial stability of the implant by measuring the resonating frequency of the peg and comparing it against predetermined values. The machine then displays a number on the Implant Stability Quotient (ISQ) scale, with numbers closer to 100 depicting greater stability. For this case, both implant sites produced values, which, along with the occlusal design of the restorations, would allow for immediate loading.

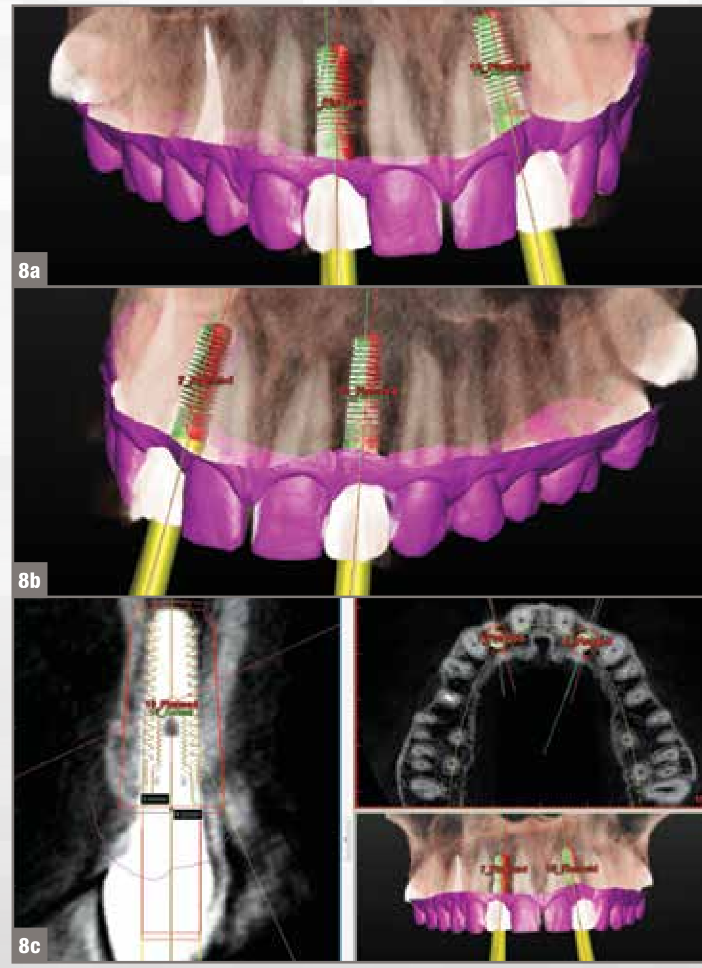
Taking all of the available information into account, the final restorations were delivered at the time of implant placement. Due to the proper axial orientation of the implants, the need for angle-correcting custom healing abutments and cement-retained restorations was eliminated, allowing for the use of BruxZir® Solid Zirconia screw-retained crowns (Glidewell Laboratories; Newport Beach, Calif.). Teflon tape was placed in the area of the screw access holes, which were then sealed with packable composite. The case was treatment-planned and the implant crowns were positioned to promote growth of the papilla. The immediate results were determined to be esthetic and pleasing *(Figs. 7a, 7b)*.

Upon completion of the surgical phase, the pre-treatment data was compared against the postsurgical data. For the purposes of this study, a post-treatment CBCT scan was taken following surgery. In the case of tooth #7 and #10, the implants were placed very close to the cortical wall so a driver tool could be used to access the area behind the incisal edge of the final screw-retained restorations. Utilizing implant planning software to examine the case, an overlapping comparison of the data was created, with the pre-existing plan displayed in red and the positions of the actual implants colored in green *(Figs. 8a–8c)*. The software allowed for measurement of the discrepancy between the planned and placed implant positions, which was less than 0.4 mm in both cases, indicating that there were no issues with fit during placement of the final screw-retained crowns. Surgeries led by DTP deliver a noticeable improvement over traditional implantation in terms of predictability and case success. This is a result of the increased accuracy gained from the coupling of CAD/CAM technology with CBCT and intraoral scanning.

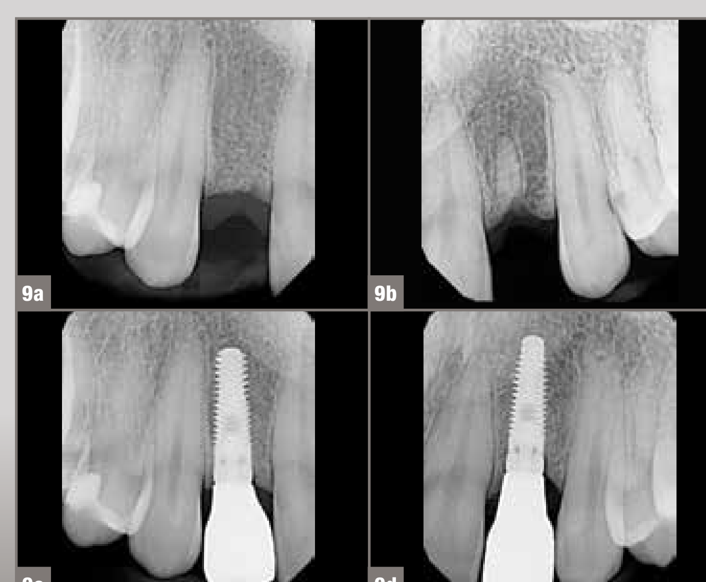
A comparison of the preoperative and postoperative radiographs highlights the success of the surgery *(Figs. 9a–9d)*. At a follow-up appointment four months post-delivery, the patient returned to the operatory so the periodontium and the success of tissue contouring in the case could be evaluated *(Figs. 10a–10d)*. Prior to the follow-up appointment, new final restorations with a more precise shade match were fabricated based on the initial digital treatment plan. The new screw-retained crowns were delivered at this visit without the need for physical final impressions. The accuracy gained through guided surgery maintained the interproximal spaces between the implants and the adjacent roots, encouraging growth of the interproximal papilla and making for a highly esthetic case outcome *(Figs. 11a–11e)*.

Conclusion

The knowledge gained through CBCT scanning, intraoral scanning and digital implant placement enables the surgeon to place implants with a level of accuracy and consistency that can be difficult to obtain through conventional implant placement. Computed tomography, digital treatment planning, guided surgery and CAD/CAM technology have advanced to the point where it is increasingly possible to deliver final restorations at the time of implant placement. By reducing the number of postsurgical appointments and contact with the implant site, immediate final restorations can benefit both the clinician and the patient. **IM**



Figures 8a–8c: *Overlay of presurgical planning and postsurgical images of the area of implantation. The red represents the planned and the green represents the actual implant placement.*



Figures 9a–9d: *Pre-extraction and post-delivery radiographs of the case.*

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For more information on DTP and guided surgery, read Dr. Perry Jones' article "iTero® Digital Scanning Technology and Tooth-Supported Surgical Guides" (Inclusive Vol. 4, Issue 2) — available online at www.inclusivemagazine.com.

Figures 10a–10d: *Four-month postsurgical removal of the final screw-retained prostheses. Note the natural tissue contours resulting in part from the ideal positioning of the implants.*

Figures 11a–11e: *Comparison of the before (11a) and after (11b) facial views, as well as the occlusal (11c) and lateral views (11d, 11e) of the finished arch.*