PLAN AND EXECUTE

A novel full-arch immediate-load protocol for a dynamic navigation dental implant system

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MULTIPLE COMPANIES CURRENTLY OFFER a full-arch immediate-load system to dental implant surgeons. These so-called "stackable" systems are composed of a foundation guide, indexed static guide, and indexed full-arch provisional prosthesis. While each propriety system has unique features, they all deliver the same result at the end of the surgery: an implant-supported full-arch provisional restoration.

The use of dynamic navigation, however, can eliminate the need for a static guide component. Dynamic navigation is a form of computer-assisted surgery that relies on arrays—one attached to the patient and one attached to the dental handpiece—that are detected by the device's overhead stereotactic cameras. The cameras coordinate the position of the patient and handpiece, and display the information on the navigation monitor. The arrays are synced prior to the start of the procedure, and the surgeon watches the navigation monitor displaying the CBCT with overlying planned implant position while preparing the osteotomy and placing the implant. Real-time information is displayed during the surgery, including drill depth, position in relation to the virtually placed implant, angle of deviation from the virtual plan, and proximity to vital structures such as adjacent roots, sinus, or nerve. This protocol has been proven to be just as accurate as implants placed with static surgical guides.[1]

CASE REPORT

A 47-year-old female patient with an unremarkable medical history was referred by her general dentist to evaluate the mandible for extraction of remaining teeth, immediate implant placement, and immediate provisionalization. The intraoral examination was notable for multiple carious teeth with limited interocclusal space in the posterior due to loss of the mandibular molars and premolars. A phased treatment plan was created whereby the mandible would be addressed first via an all-on-X immediate provisional procedure. Upon osseointegration of the dental implants and insertion of a final prosthesis, the maxillary teeth would be restored with conventional crown-and-bridge restorations.

Initially, pertinent records were acquired, including photographs, intraoral scans, and CBCT scans of the patient. The laboratory technician designed and fabricated a bite prosthesis to aid in opening the posterior collapsed vertical dimension of occlusion. This was tried-in and verified to confirm sufficient opening and comfort for the patient. The appliance was scanned and used as the bite scan in the digital workup.

The laboratory technician then imported the CBCT data into the dynamic navigation treatment planning software (X-Guide, X-Nav

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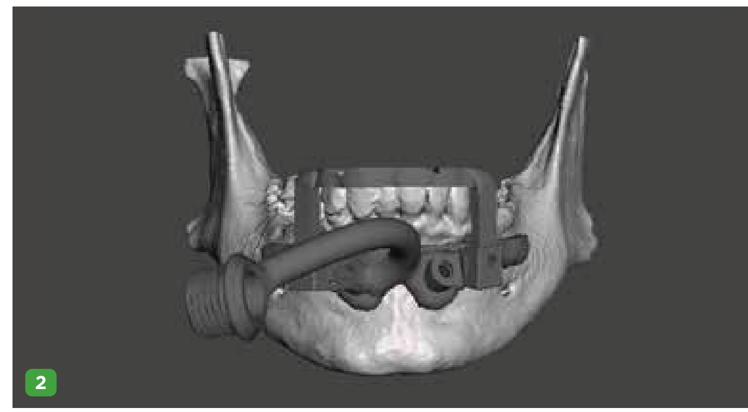

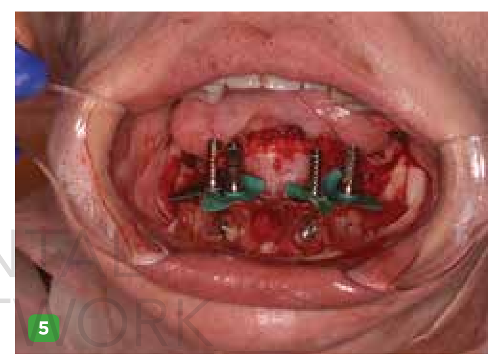

Fig 1. The virtual treatment plan is shown in dynamic navigation software. **Fig 2.** A CAD screenshot shows the occlusal positioning jig and foundation guide seated on the mandible. **Fig 3.** The intraoperative view of the occlusal positioning jig and foundation guide seated on the mandible. **Fig 4.** A CAD screenshot of the foundation guide with the attachment arm removed and bone reduction of the mandible. **Fig 5.** The intraoperative view of the foundation guide with the attachment arm removed, bone reduction of the mandible, and insertion of temporary cylinders.

Technologies.) The intraoral scans were aligned with the CBCT data, and the dental implants were planned in a restoratively driven manner. The virtual treatment plant was then exported from the software and imported into dental CAD software (DentalCAD, exocad). The technician designed the provisional prosthesis, and the implants were verified to be in suitable positions. Using a combination of other CAD software modules, the technician designed a foundation guide, occlusal positioning jig, and provisional prosthesis. The foundation guide included an attachment arm for the dynamic navigation patient tracker array (Figure 1). The foundation guide was designed to allow its superior edge to act as a bone reduction reference and two-guide tube for fixation screws. The fixation screw positions were designed to not intersect with the planned implant positions. The position of the attachment arm was designed with input from the surgeon to help prevent an obstructed view of the overhead stereotactic cameras during the procedure.

All of the components were manufactured with a 3D printer (NextDent 5100, 3D Systems). The foundation guide and occlusal positioning jig were printed with surgical guide resin (NextDent SG, 3D Systems) and the provisional was printed with crown and bridge resin (NextDent C&B MFH, 3D Systems). Post-processing was performed per the manufacturer's instructions. The patient's preoperative photographs were used to modify the provisional with light composite material to deliver a realistic result.

At surgery, the overlying mandibular buccal mucosa was reflected in a full thickness manner. The occlusal positioning device/foundation guide was seated and verified to be in correct position (Figures 2 and Figure 3). Fixation screws were placed to secure the foundation guide to the mandible. The occlusal positioning jig was removed and the dynamic navigation tracker array was attached to the attachment arm. The fiducial free method (XMark, XNav Technologies) of calibration was used to calibrate the dynamic navigation system to the patient. Once calibration was confirmed by system checks, the remaining mandibular teeth were extracted and the alveolar bone was reduced to the top level of the foundation guide designed to act as the bone reduction level (Figure 4). Dynamic navigation was used to create the osteotomies and place the dental implants in their virtual treatment planned positions. After implant placement was complete, the attachment arm portion of the foundation guide was sectioned and removed with a fissure bur. Temporary cylinders were placed on the implants and the provisional was adjusted to seat passively in the foundation guide's indexed slots (Figure 5 through Figure 7). The temporary cylinders were luted to the provisional with light-cured resin. The prosthesis was then removed and finished chairside. The mucosa was sutured and the finished prosthesis was reinserted and secured in standard fashion.

The preoperative photograph was compared to the 2-week postoperative photograph (Figure 8 and Figure 9), and the esthetics and occlusion were found to be satisfactory. After 3 months of osseointegration, a final hybrid prosthesis was

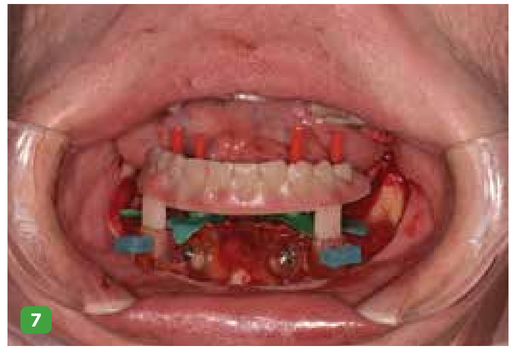

Fig 6. A CAD screenshot of the foundation guide with the attachment arm removed and the provisional seated. Fig 7. The intraoperative view of the foundation with the attachment arm removed and the provisional seated. Fig 8. A preoperative intraoral view. Fig 9. A 2-week postoperative view with the immediate-load provisional in place. Fig 10. The final zirconia hybrid prosthesis. Fig 11. An intraoral view showing the inserted final lower prosthesis and the maxillary zirconia restorations.

designed and fabricated out of zirconia (Figure 10.) Maxillary rehabilitation was then undertaken and restored with zirconia crowns (Figure 11).

DISCUSSION

This technique offers multiple advantages when compared with conventional static-guide full-arch systems. This method can be performed in a less invasive manner because the foundation mount is only fixated to the buccal bone, eliminating the need for extensive flap elevation of the lingual or palatal mucosa. Rigid fixation of the foundation guide is accomplished with bicortical screws, whereas foundation guide loosening can be encountered in other systems utilizing fixation pins, leading to incorrect implant placement and provisional pickup. It also serves a dual function as the indexed guide for the occlusal positioning jig and prosthesis as well as the attachment arm for the dynamic navigation patient tracker array. This eliminates the need for additional fixation of the standard edentulous dynamic navigation tracker arm, saving limited intraoral space. As each guide is patient- and surgeon-specific, the attachment arm design can be catered to the user.

Since dynamic navigation is used as the method of guidance, a static guide component is not required. The surgeon is able to use a standard dental implant surgical kit. This is highly advantageous because it allows the use of shorter-length drills, eliminates the need for surgical keys, and does not require the surgeon follow a surgical drill report to complete the osteotomies. The implant information, including diameter and length, is displayed on the dynamic navigation monitor during the procedure. Also advantageous is the ability to alter the implant position during the surgery, a feature that is not possible with a static guide.

While most immediate full-arch systems mill the provisional, this system fabricates the provisional out of a 3D printed material that has been FDA Class II approved for temporary use. This helps with cost containment and can provide a quick turnaround for a duplicate, should one be needed.

The technique does have some noted limitations. Currently, the complete workflow cannot be accomplished within a single dental treatment planning/CAD software. Careful alignment of the CBCT with all of the various designed components must be verified at each step in order to avoid introducing errors. Additionally, the upfront cost of dynamic navigation hardware is significant.

Digital technology continues to evolve at a rapid pace in implant dentistry. To the authors' knowledge, this is the first description of a full-arch, immediate-load provisional system utilizing dynamic navigation. This next evolution of guided surgery helps to overcome some of the challenges associated with traditional static guided systems and has been found to be a predictable, accurate, time-efficient, and cost-effective method.

Acknowledgement

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Reference

1. Wu D et al. Accuracy of dynamic navigation compared to static surgical guide for dental implant placement. *Int J Implant Dent.* 2020;6(1):78.

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