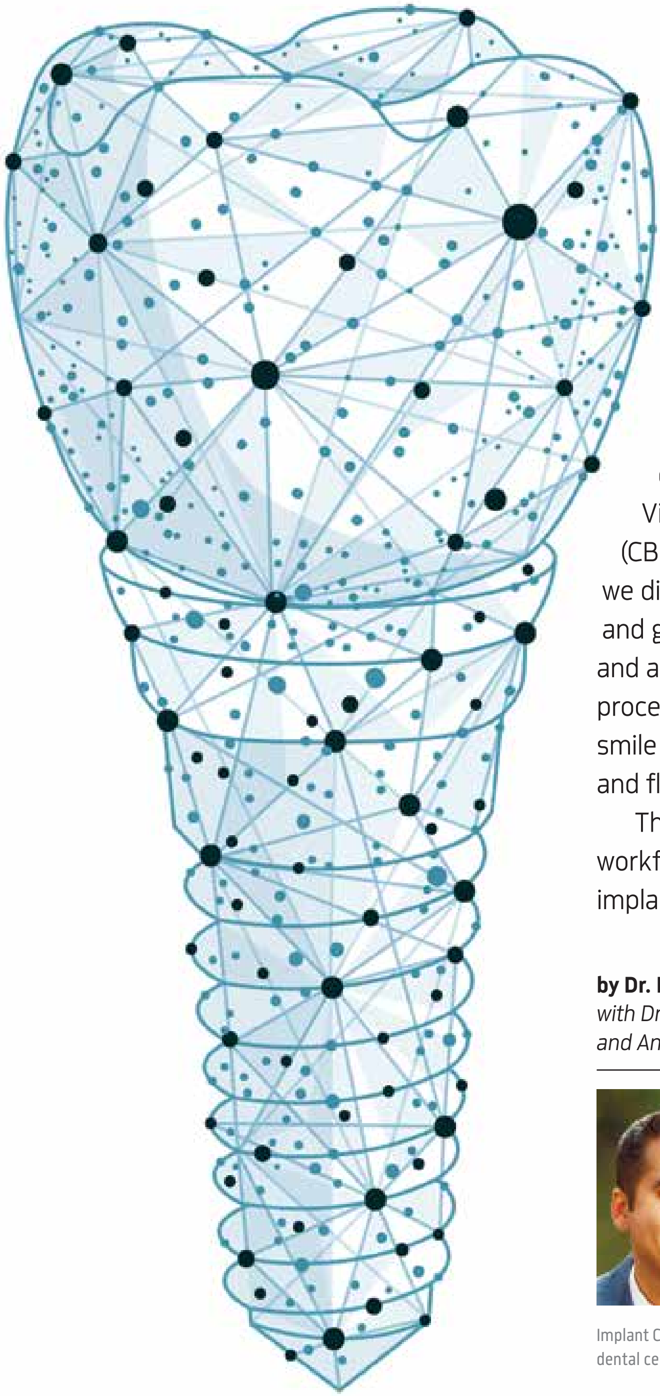
DIGITAL IMPLANT THERAPY: From SIMPLE to COMPLEX



Digital technology in the dental profession has been advancing at a rapid pace, becoming an integral component in our everyday practice. Digital technology allows for better communication between the clinician, laboratory, dental team and patient. Virtual planning and assessment also permit more predictable treatment outcomes, often in a more efficient manner.[1,2]

The integration of digital technology in implant dentistry has been a game changer in many ways. Virtual study models (intraoral scanning) and 3D imaging (CBCT) allow us to digitize our patients and enhance how we diagnose and treatment-plan. Virtual implant planning and guided surgical protocols have improved the precision and accuracy when placing dental implants. The restorative procedure utilizing scan bodies, intraoral scanners, virtual smile design and CAD/CAM technology allows for accuracy and flexibility when proper protocols are followed.[3]

This article will demonstrate how a complete digital workflow can be used to plan, place and restore dental implants in simple and complex cases.

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Digital workflow

The digital process is initialized by obtaining and using CBCT and digital impression technologies. By applying this digital information, the three-dimensional position of the final restoration can be planned.[4] This is the primary step in the digital workflow process for simple and complex cases; it is only after the ideal contours of the proposed final restorations have been planned and approved that the surgical structures can be correctly evaluated to precisely and decisively plan the best implant position that will support that restorative plan. Furthermore, with the utilization of digital facial images and video content, the aesthetic outcomes can also be predicted digitally.

The fusion of CBCT imaging and digital impressions is essential in the overall digital implant workflow. (This is accomplished by using various available software.) However, just the fusion of this information is not sufficient; the full detailed planning of the final restoration, as well as the corresponding implant position, must be completed in the same software. Once again, the precise planning of the 3D position of the final restoration and the technical aspects of the final restorative design are important to allow for ideal and proper implant placement. When the correct restoratively driven and biologic digital implant position has been attained, this can then be transferred from the digital world to the oral cavity via dynamic or static computer-guided surgery.[5] This is the vital phase of the digital workflow.

Computer-guided implant surgery

The transmission of the virtually planned implant position to the real world via computer-guided surgery (static or dynamic) is a critical step in the digital workflow. Furthermore, it is only when the final implant position is planned, based on the ideal design and 3D position of the final restoration, that the need for adjunctive procedures such as osseous or soft-tissue grafting can be properly evaluated.

For static guided surgery, the surgical guide is 3D-printed and transfers the precise digital planning from the software to the oral cavity.[6] For dynamic guided surgery, the software and monitoring system performs this transfer of the virtually planned implant position and aids in guiding the clinician while placing the dental implant by acting like a surgical GPS system. The overall step of transferring the virtual plan of the implant position to the real world is crucial to the restorative success of implant therapy because the specific position of the dental implant dictates emergence profiles and aesthetics. Utilizing static or dynamic guides allows for more accurate and precise placement of implants when compared to freehand placement.[7–9]

Intraoral scanning

There are numerous advantages to intraoral scanning, such as easier transfer of information, more efficient communication with the lab, instant feedback, more preferable patient experience and time efficiency.[10] Intraoral scanning is one of the first steps in the digital workflow, so the accuracy of every subsequent step depends on the accuracy of the initial digital acquisition method. Accuracy and reliability of intraoral scanners have exponentially improved in recent years. They have comparable, if not better, precision than conventional impression techniques.[11–13]

Besides the method of impression taking (digital versus analog), the other main difference between analog and digital impressions for implants is the actual impression coping. Unlike conventional implant impressions that use either a closed-tray or open-tray impression coping, digital impressions utilize

Digital technology allows for better communication between the clinician, laboratory, dental team and patient.

Fig. 1

cylinders that screw into the implants and act as positioning "flags" in the intraoral scan. These allow for the exact 3D position of the implants to be transferred to the virtual world. These digital impression copings are called *scan bodies* and are specific for each implant type and connection size of the implant utilized (Fig. 1).

CAD/CAM-milled final restorations

Today, the abutment design, material choice (such as zirconia or lithium disilicate) and technical design (monolithic or layered) of the restoration can also be planned digitally before surgery. Soft tissues have been shown to react more favorably with the presence of a highly polished zirconia or titanium surface, so it's recommended that the area of an implant restoration that will be subgingival be composed of highly polished zirconia or titanium. Also, subgingival extension of ceramic restorative materials may not be as favorable. The use of CAD/CAM technology allows for the milling of final restorations in a more precise and repeatable fashion.[14] Generally, implant restorations should be designed to reduce prosthetic complications such as chipping. With new innovations in restorative design, materials such as monolithic zirconia have become a reality and offer a very biocompatible option. A full-contour zirconia crown allows for the aesthetics of a tooth-colored material to be utilized with minimal porcelain layering on the buccal aspect for aesthetics. The following cases will demonstrate this. ■

SIMPLE CASE: 3-unit implant bridge

A 57-year-old healthy patient self-referred to the practice because she was having issues with her existing fixed dental prosthesis (18/X/X/21/22) due to recurrent caries under abutment tooth #21, which had already been endodontically treated. The long-term prognosis of abutment tooth #21 was deemed to be poor, whereas the other abutment teeth appeared to have a fair prognosis (Figs. 2–4).

Fig. 2

Fig. 3

Fig. 4


Fig. 5


Fig. 6

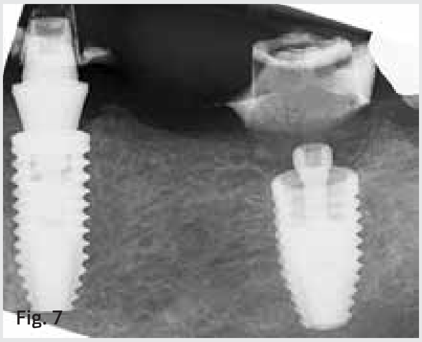


Fig. 7


Fig. 8


Fig. 9

After discussing various options with the patient, she approved the treatment plan of sectioning the bridge at the mesial of tooth #18 and the distal of tooth #22. Tooth #21 would be extracted, and immediate implants would be placed at sites #19 and #21 to support a three-unit implant-supported bridge.

Photographs, digital intraoral scans and a CBCT were taken, which allowed for virtual implant treatment planning, based on the desired restorative design and position. Dynamic surgical guidance would be used to place the implants in the desired position and a milled polymethyl methacrylate TempShell was fabricated to allow for immediate loading of the implants.


Fig. 10


Fig. 11

The bridge was sectioned and tooth #21 was extracted atraumatically. Implants were placed at sites #19 and #21 using dynamic guided surgical protocols with an attained initial primary stability greater than 35 nanocentimeters (Figs. 5 and 6). As a result, an immediate provisional implant bridge was fabricated using the TempShell and was delivered (Fig. 7).

Twelve weeks after the surgical procedure, the implant integration was verified and final digital impressions were taken using an intraoral scanner and scan bodies. The tissue contours and tooth shade were also captured with the intraoral scanner (Figs. 8 and 9). This information was sent to the laboratory, where a monolithic zirconia-based bridge was fabricated with a shade selected by the scanner (Fig. 8). This bridge was delivered successfully, with good color matching of the monolithic zirconia (Figs. 10 and 11).

This case exhibits a completely digital workflow for a simple implant case and also demonstrates the aesthetics that are possible with monolithic zirconia.

COMPLEX CASE: Quadrant replacement with dental implants

A 60-year-old healthy woman presented to the practice referred by her family dentist for a failing fixed dental prosthesis (bridge) in Quadrant 1 (8/X/X/5), and a crown on tooth #3 with a mesial cantilevered pontic #4 (Figs. 12 and 13). The four-unit fixed dental prosthesis had been dislodged multiple times and exhibited recurrent caries, open margins and suspected vertical root fracture. The long-term prognosis of the abutment teeth was deemed to be poor.

After discussing a variety of options, a treatment plan was devised to extract teeth #8 and #5, section off pontic #4 and immediately place implants in the areas of #8, #6, #5 and #4. This would allow for the fabrication of a three-unit


Fig. 12


Fig. 13

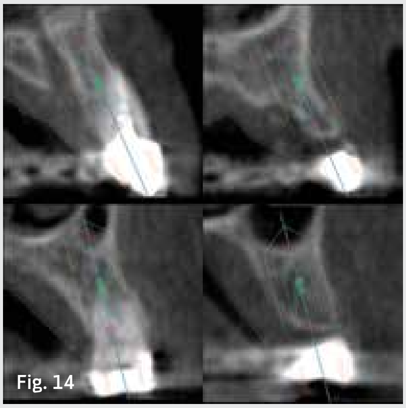
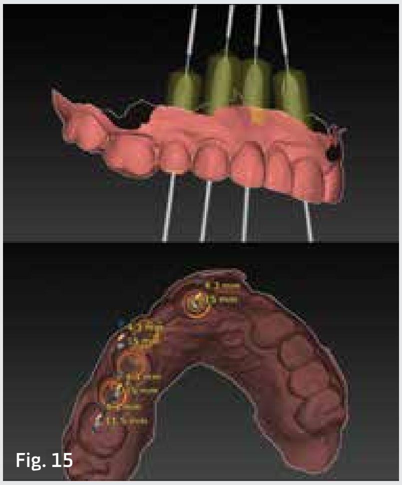


Fig. 14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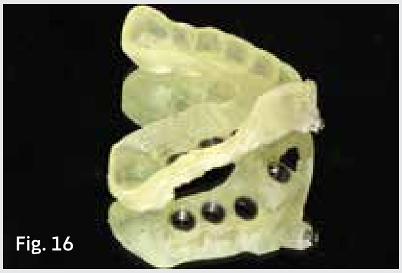
Fig. 16


Fig. 17


Fig. 18

COMPLEX CASE: Quadrant replacement with dental implants

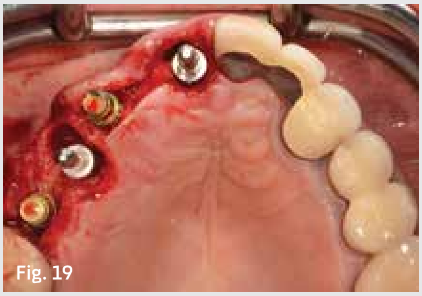
Fig. 19


Fig. 20


Fig. 21


Fig. 22


Fig. 23

implant-supported fixed dental prosthesis (8/X/6) and two implant-supported crowns (#5 and #4). We also discussed the options for tooth #3, which had supraerupted into the opposing edentulous site. The patient opted to not have anything done and attempt to preserve the existing crown on that tooth.

Photographs, intraoral scan and CBCT were taken, allowing for virtual implant treatment planning based on the desired prosthetic outcomes (Figs. 14 and 15). A fully guided 3D-printed surgical stent (Fig. 16) and a milled TempShell were fabricated (Fig. 17).

The bridge and cantilevered pontic were sectioned off and the teeth were extracted atraumatically. Implants were placed using the appropriate guided surgical protocols. Initially, primary stability greater than 35NCm was achieved (Figs. 18–20), which allowed for utilizing the TempShell to fabricate an immediate provisional bridge (Fig. 21). The provisional bridge emergence profiles and pontic sites were modified and contoured to allow for ideal tissue reaction and adaptation.

Sixteen weeks later, implant integration was verified and final impressions were taken using an intraoral scanner. The intraoral scanner allowed us to capture the provisionals and the soft-tissue emergence profile once the provisionals were removed (Fig. 22), then to utilize scan bodies to capture the position of the implants (Fig. 23). The scan also captured the occlusal vertical dimension, jaw relationship record, and shade of the provisional bridge and adjacent

Fig. 24

Fig. 26

Fig. 25

Fig. 27

prostheses. This information was sent to the laboratory, where the final screw-retained implant-supported crowns made of layered zirconia on titanium bases were fabricated using CAD/CAM technology (Figs. 24–27).

This case exhibits a completely digital workflow for a complex implant case. It demonstrates that using digital technology with proper planning and execution allows us to provide our patients with predictable care in an efficient manner.

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