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EFFICIENT, PREDICTABLE DENTURE FABRICATION

DIGITAL WORKFLOW PERMITS ADJUSTMENT OF THE EXISTING PROSTHESIS TO SIMPLIFY RECORD TAKING

Conrad J. Rensburg, ND, NHD

Conrad J. Rensburg, ND, NHD
CEO
Head of Implant Division
Absolute Dental Services
Durham, North Carolina

Some clinical innovations that were thought to have great potential have been rendered obsolete either because clinicians found them cumbersome chairside or because technicians found them arduous to fabricate. Ultimately, technical and clinical predictability is the differentiator between a good idea and a great solution. For many decades, the terms "predictable process" and "removable dentistry" could almost be considered oxymorons; however, the combination of digital design and additive processing is finally offering a solution to this restorative riddle.

One of the most significant challenges of removable dentistry is establishing an accurate vertical dimension of occlusion (VDO) by using a wax bite rim.[1] Clinicians have found this protocol to be not only the most unpredictable but also the most time-consuming and least profitable. A more predictable clinical workflow and repeatable fabrication techniques, as well as enhanced esthetics and superior strength, are only a few of the advantages in adopting a digital process.[2-4]

Although a digital design platform for removable applications was brought to market more than a decade ago, adoption was slow. Clinically, previously established workflows were not compatible, and technically, the products did not compare favorably to hand-fabricated versions.

Today, digital technology and CAD offer clinicians the ability to use a patient's existing denture, whether it is good or bad, as a prototype starting point.[5] This updated clinical workflow is faster and more predictable because it simplifies the record-taking procedure. The traditional record-establishing and -capturing appointment is reduced to a less complex patient expectation and data gathering procedure. Instead of fabricating a traditional wax rim, clinicians document diagnostic changes and simply adjust the already established data points.

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Digitally transferring the information captured with an intraoral scanner to a dental laboratory for processing allows patients to keep their original dentures. In addition, this process also greatly reduces the total number of clinical appointments required and enhances the clinician-to-technician analytical communication process. In cases in which an existing denture is not available, a traditional bite-rim process can still be employed without diminishing any of the other advantages of this updated digital workflow or its final product.

The increased adoption rate of this new digital process for removable prostheses, although primarily driven by the advancements in clinical productivity, is also greatly supported by the superior fit, esthetics, and strength of today's updated 3D printable denture base materials.[6,7]

Digital archiving, which some would argue is the most valuable benefit of using a digital process, is not often emphasized in today's marketing literature. The dental laboratory processing the final denture inevitably ends up with the design files. These files archive the tooth setup, bite, mold, intaglio surface, and other important records used in fabrication. Having the ability to digitally store and retrieve this information long-term provides crucial advantages. If a denture is lost or broken, this archiving allows for a remake to be made with only one clinical appointment. Furthermore, when replacing an old or worn denture, the ability to store a patient's approved smile results in the need for only two appointments.


FIG. 1


FIG. 2


FIG. 3


FIG. 4


FIG. 5

(1.) Existing denture of presenting patient with compromised esthetics. **(2.)** The intaglio surface of the existing denture is refreshed using a VPS material technique. **(3.)** To maintain the patient's VDO, it is measured before and after the addition of the VPS material. **(4.)** Preoperative smile photograph captured with diagnostic notes. Note the excessive gingival display that was this patient's primary complaint. **(5.)** Extraoral digitization of the VPS wash-relined denture with an intraoral scanner.

Denture Fabrication Using a Prototype Workflow

At the first clinical appointment, most denture patients present with an existing denture that has become compromised regarding function or esthetics (Figure 1). The existing denture provides a great way to make adjustments and ultimately capture enough data points to obtain a diagnostic starting point. To begin, the clinician border molds and refreshes the intaglio surface of the existing denture using traditional vinyl polysiloxane (VPS) material techniques (Figure 2). It is important to ensure that the pre-marked VDO is not unintentionally changed with the addition of the VPS material (Figure 3).

Acquiring Accurate Pictures

To ensure design accuracy, it is important to take smile pictures (eg, high and low smile) after the wash impression is verified (Figure 4). These pictures can be taken with any modern-day digital capture device (eg. SLR camera, smart phone, etc) as long as the correct lighting is used. It is important that the patient is in a standing position with his or her back and head flat against a wall and eyes parallel. Hold the camera level with the patient's face, and take the pictures straight on. Focus on the nose and upper lip area, and be sure to capture both the eyes and ears in the frame. Pictures taken with a patient turned to the side or that slant up or down cannot be accurately used for digital diagnostic purposes. Once the photography is completed, esthetic changes are discussed with the patient and thoroughly documented for accurate communication with the dental laboratory.

Digitizing the Prototype

Next, the VPS wash-relined denture and the opposing dentition are scanned using an intraoral scanner (TRIOS®, 3Shape; Primescan™, Dentsply Sirona). Scan the denture outside of the patient's mouth, capturing the entire prosthesis (Figure 5).

Digitally Capturing Bite Changes

If the VDO will remain unchanged or if it will require less than 3 mm of adjusting, the patient's bite can be scanned in centric occlusion and any VDO changes can be indicated

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in the communication with the laboratory (Figure 6). A design technician can predictably open the bite up to 3 mm in the design software without distortion of the condyles' rotational axis.

If a VDO adjustment of more than 3 mm is required, set the bite intraorally with a rubber base type material, and once verified, split it at the midline. Remove one of the separated pieces, left-side or right-side, and scan the bite on the contralateral side. Replace the piece, and repeat the process on the other side to set the adjusted bite within the digital media.

Diagnostic Communication

After the dental laboratory imports the collected data points into the denture module of the design software (3Shape Dental System, 3Shape; exocad DentalCAD, exocad), files are digitally separated for the opposing dentition, prototype denture (Figure 7), intaglio surface, and VDO mounting position. A true digital diagnostic wax-up is then processed, which is based off of the tooth position of the original denture (ie, prototype) and incorporates any design changes directed by the diagnostic notes submitted by the clinician (Figure 8).

In the case presented here, the patient's primary concern was the appearance of a gummy smile (Figure 4). Once the diagnostic changes were made in the software, the preoperative model was matched with the patient's original smile pictures and the suggested wax-up was superimposed using that model match position (Figure 9). This model matching process provides an extremely accurate representation of the suggested wax-up as it relates to the patient's smile and is a powerful digital tool that has greatly enhanced clinician-technician communication. It has also allowed for extremely efficient denture processing, rendering the proximity of the laboratory to the clinician's office irrelevant.

Try-In or Final Delivery?

In cases in which the prototype denture only requires intaglio refreshing or small cosmetic changes, it is not out of the ordinary to skip the try-in appointment and request final processing of the new denture for final delivery. However, it is important to understand and to communicate to the patient that the advantage of a 3D printed try-in (M2 Printer, Carbon®; Lucitone Digital Try-In™ 3D Trial Placement Resin, Dentsply Sirona) is in the fact that it is an exact functional copy of the suggested final denture (Figure 10). Although the printed teeth do not represent the esthetics of the final carded teeth, the try-in is an extremely valuable tool for transferring the data from digital to analog. This device accurately represents the flange length, denture thickness, fit, bite, and tooth positions of the final appliance. If changes (additive or reductive) are required for any of these items during the try-in appointment, they can be made directly to the 3D printed try-in (Figure 11). The changes are then digitally transferred and incorporated into the final.


FIG. 6


FIG. 7

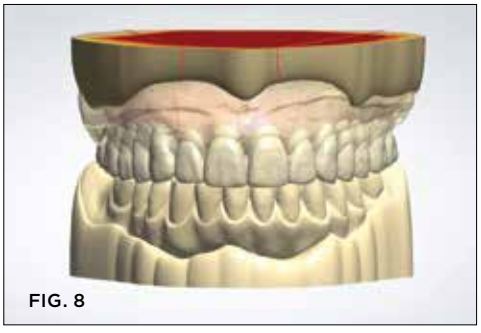
FIG. 8

FIG. 9


FIG. 10


FIG. 11

(6.) Digital STL file of the bite scan. **(7.)** The prototype data imported into the denture design module. **(8.)** Diagnostic wax-up based off of the prototype position and clinician's notes to the laboratory. **(9.)** The diagnostic proposal matched with and superimposed over the preoperative smile picture. **(10.)** A 3D printed try-in was produced to ensure the accuracy of the diagnostic changes. **(11.)** Additional adjustments were made directly to the 3D printed try-in and communicated to the laboratory.


FIG. 12


FIG. 14


FIG. 13

(12.) The final denture base printed from the approved file. **(13. AND 14.)** Carded teeth were luted into the base to complete the final prosthesis.

Final Processing

Once any necessary changes have been made to the try-in and recorded, the data is used to 3D print the final denture base (Lucitone Digital Print™ 3D Denture Resin, Dentsply Sirona) (Figure 12), and the carded teeth of choice (IPN 3D™ Digital Denture Teeth, Dentsply Sirona) are luted into receptacle sockets that were digitally designed to fit them exactly (Figure 13 and Figure 14).

> *The ability to accurately capture clinical data and transfer it to the laboratory digitally has increased clinical efficiency and patient acceptance.*

Conclusion

The ability to accurately capture clinical data and transfer it to the laboratory digitally has increased clinical efficiency and patient acceptance. Furthermore, the ability to design dentures using a digital workflow combined with the ability to process them with minimal need for procedures that are done by hand has greatly decreased the rate of post-delivery issues associated with traditional analog methods. The introduction of advanced printing platforms and extremely strong and esthetic smart polymers has finally brought credibility to the once almost abandoned process of fabricating traditional removable dentures.

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