

# The Missing Link in the Digital Workflow Clock

High-translucency zirconia facilitates full-mouth reconstruction

Conrad J. Rensburg, ND, NHD | David Hedgecoe, DDS

**D**uring the last decade, the dental industry has witnessed a true technological revolution. Initially, the progression was slow, and the early adopters quickly realized that the line between being at the leading edge and the bleeding edge was a faint one at best.<sup>1</sup> Once all of the cogs in the digital workflow clock started working together, the technological revolution truly turned exponential. Yesterday's question of whether or not to go digital has now been replaced with the question of how to stay abreast of all this technology.

In most technological revolutions, the development of the materials seems to lag behind the development of the concept and equipment. This revolution has been no different. At first, CAD and milling or grinding with glass-like materials was touted as the next "big thing."<sup>2,3</sup> Unfortunately, manufacturers soon realized that although CAD proved to be a very adaptable medium, transferring the design

into a material that was suitable for intraoral use was not as simple. Creating millable materials that were comparable to what was being created by hand with the same esthetics, marginal integrity, and longevity proved to be a daunting task. Then the market's focus quickly turned to a new material called zirconia.<sup>4</sup> This was where the true revolution began.

The first zirconia materials that were introduced were met with great excitement. Although its marginal integrity and functional strength were far superior to more traditional materials, the esthetics were bright and unnatural looking. Even though zirconia served as a strong and accurate millable material to complete the digital workflow, clinicians and patients were often disappointed with its high value and poor esthetics.<sup>5</sup> Zirconia quickly became known as a functional material appropriate only for replacing gold crowns.

The introduction of early-stage, multi-layered zirconia came with big promises.<sup>6</sup> However, even this great idea was accompanied by rocky beginnings. The claims of esthetics

that were equal to the exceptional glass ceramics were inaccurate and once again disappointed the market. Today, ongoing research has led to the creation of exceptional materials that more effectively combine high-strength zirconium oxide with high-translucency zirconium oxide (eg, IPS e.max<sup>®</sup> ZirCAD<sup>®</sup>, Ivoclar Vivadent). These materials are finally allowing the digital workflow clock to start ticking with Swiss precision.<sup>7</sup>

The following case demonstrates the predictability, accuracy, efficiency, and exceptional esthetics that technicians can achieve by using a digital workflow that is complimented by today's innovative multilayered monolithic materials.

## Patient Presentation

A 22-year-old female patient presented (Figure 1) upon referral from a specialist to formulate a treatment plan to restore her smile. Born with a cleft lip (Figure 2) and palate, she had previously undergone lip repair, palatal repair, alveolar ridge grafting repair, and LeFort



**CONRAD J. RENSBURG, ND, NHD**  
Owner  
Absolute Dental Services  
Durham, North Carolina



**DAVID HEDGECOE, DDS**  
Private Practice  
Fayetteville, North Carolina

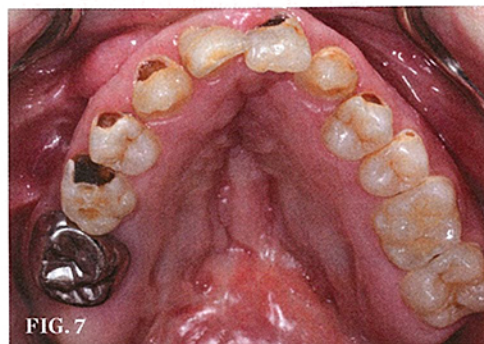
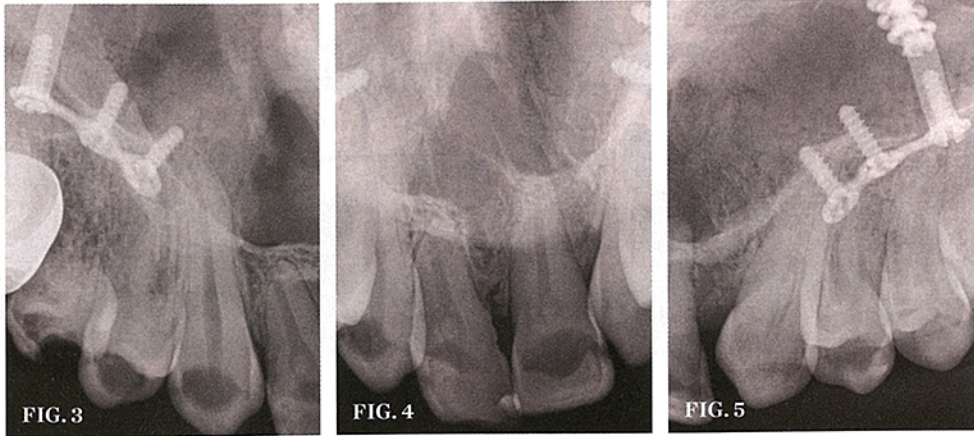


FIG. 1



FIG. 2

(1.) Preoperative patient portrait. (2.) Preoperative smile photograph.



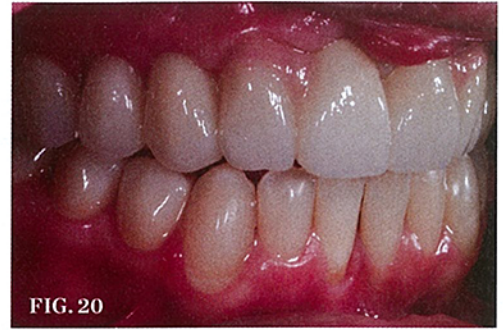
(3. THROUGH 5.) Preoperative radiograph showing the plates and screws from the patient's previous surgeries. The amount of decay can also be visualized. (6.) Preoperative retracted view. (7.) Preoperative occlusal view of the maxillary arch. (8.) Preoperative occlusal view of the mandibular arch. (9.) Approved upper temporary restorations. (10.) Postoperative occlusal view of final lower zirconia crowns.

osteotomy with calvarial bone grafts (Figure 3 through Figure 5). She presented missing teeth Nos. 4, 7, and 10 for congenital reasons, and teeth Nos. 2, 18, and 31 had been extracted due to decay. Some of the habits that contributed to the decay required attention prior to initiating a definitive treatment. These daily habits included “sipping” three sodas and a large iced tea as well as smoking 10 or more cigarettes. She also admitted to loving candy. The constant sipping of sugary drinks does not allow the pH of the saliva an opportunity to recover, which permits the sugar to remain on the teeth and greatly contributes to decay. The patient stated that after the orthognathic surgery, she had stopped taking care of her teeth (Figure 6).

The patient had also previously received orthodontic treatment that involved the palatal expansion of her mixed dentition (Figure 7 and Figure 8). Her second phase was attempted but removed early because of significant decalcification and other issues. The patient was not ready to do what was necessary from an oral hygiene perspective to ensure a successful orthodontic outcome. Having seen numerous dentists throughout her 22 years, she reported that she had experienced trouble getting numb for some of her dental work and that this ultimately led to the development of major anxiety about receiving dental treatment. At her initial appointment, she was very discouraged with her smile and stated that she only desired to have “normal teeth” and that she “just wanted to smile again.” Upon examination, in addition to her missing teeth, it was noted that she presented with varying degrees of decay on every tooth, multiple fractured teeth, periodontal disease, gingivitis, and some isolated areas of gingival recession.

### Hygiene and Behavior Management

A multilayered disease management protocol was initiated. Treatment began with multiple cleaning appointments to improve the patient's periodontal status and her gingival condition. An extensive amount of time was spent reviewing the use of an electric toothbrush, a water flosser (Waterpik® Water Flosser, Water Pik, Inc.), flossing techniques, and other standard oral hygiene procedures. In addition, her dietary and other oral habits were reviewed, and recommendations were made, including quitting smoking, reducing her soft drink consumption, and limiting her exposure to sugar (ie, through candy and by



(18.) Tissue discrepancies noted at initial final delivery of anterior maxillary restorations. (19.) Retracted facial view of adjusted tissue contour. (20.) Retracted lateral view of adjusted tissue contour. (21. AND 22.) Close-up views of the final anterior maxillary restorations. (23.) Retracted view of the final maxillary restorations.

were not planned for treatment at all. The mandibular canines would be treated with composite resin as a part of decay control; however, during treatment planning, it could not be determined if composite would be an adequate final option or if crowns would be required. The restorative team felt that composite restorations would be a good long-term solution for the anterior teeth but did not see a benefit of using composite on the posterior teeth.

Treatment began with Gary Jones, DMD, an oral surgeon from Sandhills Oral Surgery and Implant Dentistry in Fayetteville, North Carolina. First, the patient's decayed and fractured second molars were removed while she was under sedation. At the next appointment, models were mounted on an articulator (SAM® 3 Articulator, Great Lakes Dental Technologies) via facebow transfer. This facilitated the creation of a wax-up of both the upper arch and the lower posterior teeth. This was done at a vertical dimension that was determined by using a leaf gauge bite taken with a slightly opened vertical dimension. Smile design software (DSD App, Digital Smile Design) was used to determine the appropriate length, width, and proportions of the teeth; midline position and angle; occlusal plane position; and amount of buccal corridor show.<sup>10</sup> The next appointment involved the extraction of primary tooth A and teeth Nos. 8 and 9, the

preparation of the remaining uppers, and the fabrication of the provisional restorations using the digital smile design wax-up and a putty matrix. Teeth Nos. 8 and 9 exhibited extensive decay circumferentially. They were retroclined, malpositioned, and had shortened roots, most likely as a result of the previous orthodontic treatment. To facilitate optimal esthetics, it was necessary to sacrifice teeth Nos. 8 and 9 in the treatment plan. A bis-acryl material (Luxatemp® Ultra, DMG America) was used to fabricate the provisional restoration. After fabrication, the provisional restoration was sectioned into three pieces and cemented (Fynal® Crown & Bridge Cement, Dentsply Sirona) into place. A final maxillary impression was not immediately taken at this appointment in order to allow the extraction sites to fully heal for 3 months and the tissue to form around the ovate-shaped provisional restorations. The esthetics of the maxillary provisional restorations were evaluated for the next several weeks to see if any improvements or changes would be requested by the patient (Figure 9).<sup>11</sup>

After the healing and evaluation period, the next appointment involved preparing teeth Nos. 19, 20, and 21 for full-coverage restorations. In addition, tooth No. 22 was prepared, the decay was removed, and a composite restoration was placed. A final impression was taken at this visit, and provisional restorations

were made based on the shape of our wax-up. Because the proper occlusal plane was established at the previous visit, the laboratory could simply process the final lower left restorations to the ideal contour and then fit the upper temporary restorations. At the next visit, the final lower left restorations were delivered, and the lower right was prepared, impressed, and provisionalized.

Several weeks later, the definitive lower right restorations were delivered (Figure 10 through Figure 12), and an impression was made of the entire maxillary arch for fabrication of the final upper restorations (Figure 13).

### Digital Laboratory Fabrication

After the provisionalization period, the laboratory's diagnostic design team imported a digital picture (Figure 14) of the patient's approved "transitional smile" into their design software (3Shape Dental System, 3Shape) and matched this data with an STL file of the vinyl polysiloxane-based study cast of the smile (Figure 15). The team designed the final case by working within the parameters that were set by the clinician and approved by the patient.<sup>12</sup> Once the clinical team had achieved patient approval regarding function and esthetics, the digital workflow assisted in minimizing the potential for changes to be made to the case that were influenced by

human opinion. This technology guarantees the clinician and patient a final result that mimics the approved transitional phase almost exactly. After the original digital design was fine-tuned (Figure 16), the case was digitally delivered to the restoring clinician via a remote video meeting. The software allows the design team to superimpose the suggested final diagnostic design onto the patient's original smile pictures for approval (Figure 17).

During this remote digital diagnostic meeting, the design team can easily shift between and compare preoperative, transitional, and suggested final diagnostic data files. This process allows the clinician to evaluate parameters of the final design such as the buccal corridor, incisal edge position, arch plane, etc. Any necessary changes are implemented live, and a full digital function evaluation of those changes can be made instantaneously.

If any questions are raised or remain after this remote meeting, the case can be processed with an esthetic long-term transitional polymethyl methacrylate material (eg, Temp Esthetic, Harvest Dental). This material can allow the clinician and patient an additional opportunity to evaluate the final design intra-orally or give the patient the ability to further test the function of the suggested design before processing the final.

The biggest advantage of this digital diagnostic design and prototyping workflow is predictability, and as a result, less chairtime is required at final delivery. If this workflow is diligently followed, a stress-free final delivery requiring zero (or only minimal) adjustments can be expected—even in the most complex cases.

## Final Delivery

The initial final delivery revealed tissue discrepancies around the pontic areas of teeth Nos. 8 and 9 (Figure 18). This was attributed to bone loss around the site as well as to the missing lateral incisors. After try-in, minor tooth form improvements relating to height, width, and emergence profile were requested, which necessitated the addition of minimal pink tissue ceramics to fine-tune the line angles (Figure 19 and Figure 20).

At a subsequent visit, the upper restorations were delivered (Figure 21 and Figure 22), and lower anterior composite restorations were performed on teeth Nos. 23 through 26. Although the gingival defect was still present on the facial surface of tooth No. 24, it was stable and not an immediate concern, so the decision was made to keep it under supervision. To improve the long-term prognosis of the case, the next phase of treatment will involve grafting the gingival defect and releasing the labial frenum.

The final result was very pleasing to the patient and her family, and it fulfilled her grandmother's wish to once again witness her granddaughter's beautiful smile (Figure 23 through Figure 25). Since the completion of treatment, the patient has stopped smoking, cut out soft drinks, and faithfully kept her cleaning appointments. Her family reported that they noticed a positive change in her confidence, demeanor, and overall happiness, and mentioned that since having her smile restored, she has decided to return to pursuing her college degree.

This typically complex and unpredictable case was treated with low clinical stress, and

the patient's life was changed with a predictable, long-term, and highly esthetic outcome. Its success can be attributed to the synergy created among a talented restorative team that effectively utilized today's innovative materials and revolutionary technologies. 🌟

## Disclosure

The authors have no formal affiliation with any company mentioned in this article and were not compensated for their opinions or the use of any products.

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FIG. 24

(24.) Postoperative final smile photograph. (25.) Postoperative patient portrait.



FIG. 25