

# Utilizing Digital Technology to Facilitate Dentofacial Integration

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**Abstract:** As digital technology evolves, an increasing number of tools are becoming available to improve team communication during the treatment planning and provision of restorative dentistry. The esthetic relationships among the face, teeth, and tissue can be analyzed using high-quality photographs, presentation software, and video capture, all critical elements for cases requiring digital dentofacial integration. Video capture communicates maximum lip movement and tooth reveal during speech with precision and ease. This article demonstrates predictable and successful use of these digital tools to enhance dentist-to-laboratory communication in an esthetically challenging case.

In the age of digital dentistry, many protocols that clinicians have traditionally performed manually are being facilitated by newer, technologically advanced resources, making restorative procedures faster, simpler, and more dimensionally comprehensive. Use of video and presentation software is an effective method to communicate desired outcomes to the laboratory and allows the clinician to preoperatively plan the smile design and visualize treatment outcomes prior to treatment initiation.

## Clinical Case Overview

A 28-year-old woman presented with esthetic concerns regarding her existing anterior provisional restorations. Previous facial trauma had resulted in large soft-tissue and bone defects surrounding teeth Nos. 7 through 9. She had undergone multiple bone and soft-tissue grafts and desired to finalize her treatment without further surgery. Presenting with full gingival display at postured smile (Figure 1), the patient wanted natural-looking teeth with no evidence of the defect visible (Figure 2 and Figure 3). Her medical history was non-contributory.

## Diagnosis, Risk Assessment, and Prognosis

**Periodontal:** The periodontal examination revealed four areas with 4-mm pocket depths around the molars and all other pockets depths 3 mm or less. There was no bleeding on probing. Alveolar bone levels were generally within 2 mm of cementoenamel junctions. Teeth Nos. 7 and 9 had 2 mm to 4 mm of bone loss sustained from an accident 21 years ago (Figure 4). No teeth were mobile. The diagnosis was AAP type II (mild periodontitis), generalized.

**Risk:** Generalized low; moderate for teeth Nos. 7 and 9

**Prognosis:** Overall good; fair for teeth Nos. 7 and 9

**Biomechanical:** There was no history of interproximal carious lesions, and no active caries noted. Structural compromises were observed in teeth Nos. 6, 7, and 9 through 11 due to large, full-coverage restorations and root canal therapies.

**Risk:** Generalized low; high locally for teeth Nos. 6, 7, and 9 through 11

**Prognosis:** Overall good; poor for teeth Nos. 6, 7, and 9 through 11

**Functional:** The patient had no functional concerns and gave no positive responses to any dental history questions concerning function. She had full range of motion with no deviation upon opening or closing. There was little to no wear exhibited throughout the dentition. She was diagnosed with acceptable function.

**Risk:** Low

**Prognosis:** Good

**Dentofacial:** With the patient's lips in repose the canine cusp tips displayed level with the lips ("cuspid zero"), but in full smile the entire tooth and an additional 2 mm to 3 mm of tissue displayed. While videographing the patient, upon pausing the video at the precise moment when she was uninhibited and the lip was at its highest point, there was actually 4 mm to 5 mm of tissue displayed (Figure 5). This position might also be captured by having the patient demonstrate the Duchenne smile.<sup>1</sup> The patient disliked the shape and size of her existing provisionals and the tissue discrepancies.

**Risk:** High

**Prognosis:** Hopeless

**Treatment Goals**

The treatment goals were developed to accommodate the patient's wishes—ie, no further surgery, natural-looking teeth, no visible evidence of the defect—without increasing the preoperative risk in any of the diagnostic categories. It was important for

the clinician to understand the etiology of the excessive gingival display to successfully treat the patient's esthetic concerns. If the etiology is excessive lip mobility, for example, then treatment such as botulinum toxin can be administered to reduce the lip dynamic and thereby minimize the amount of gingival display. If the excessive gingival display is due to vertical maxillary excess then orthodontics, surgery, or crown lengthening would be treatment options. The patient demonstrated 12 mm of lip mobility; average



**Fig 1.** The patient presented with esthetic concerns due to previous facial trauma that had impacted the area around teeth Nos. 7 through 9, and she desired a beautiful, symmetrical smile. **Fig 2.** Close-up view showed the soft-tissue defect visible in the area of teeth Nos. 7 through 9. **Fig 3.** The existing right side temporary restoration. **Fig 4.** Preoperative radiograph showed the bony defects adjacent to teeth Nos. 7 and 9. **Fig 5.** Still photograph from the video captured the extent of the soft-tissue reveal in the area of the soft-tissue deficiency.

lip mobility is 8 mm, with a range of 6 mm to 10 mm.<sup>2</sup> She declined any lip repositioning surgery or botulinum toxin treatment.

It was decided that treatment would involve the following: (1) No further surgery would be planned due to time, finances, and emotional stress. (2) The smile design would be improved by providing proper tooth shapes and contours. (3) The bone/tissue defect would be masked with restorative material to create the illusion of proper gingival architecture.

## Treatment Planning

### Phase I: Dentofacial Documentation

A short, 30-second video captured all possible dental and smile positions. The video was taken while engaging the patient in conversation and included full-face, 45-degree, and profile views. The use of the

video is a significant tool for smile design, because it allows an assessment of the patient's expressions and uninhibited facial movements. Any members of the interdisciplinary team who are not present at the initial appointment can become much more familiar with the patient through the video than with traditional still photographs.

Utilization of the video allows simplification and condensing of the dental photograph protocol to six basic views: full-face repose, full-face smile, full-face retracted teeth apart, full-face profile smile, 12 o'clock position, and maxillary occlusal. These six photograph views, when combined with the video, provide the dentofacial information necessary to plan and successfully execute an esthetically challenging case. These six views demonstrate the relationship of the lip and tooth position, the arch-form and alignment, and how these factors integrate with the face.<sup>3</sup> These

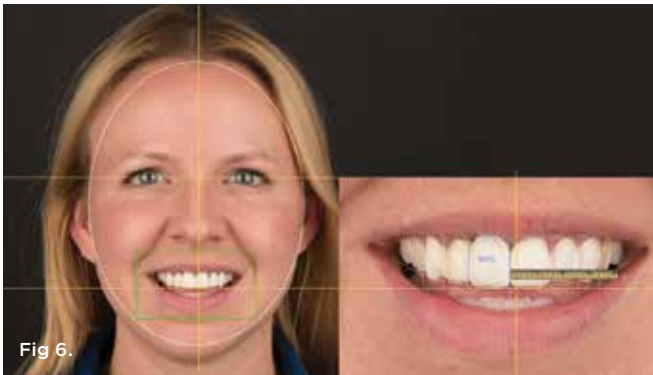


Fig 6.



Fig 7.

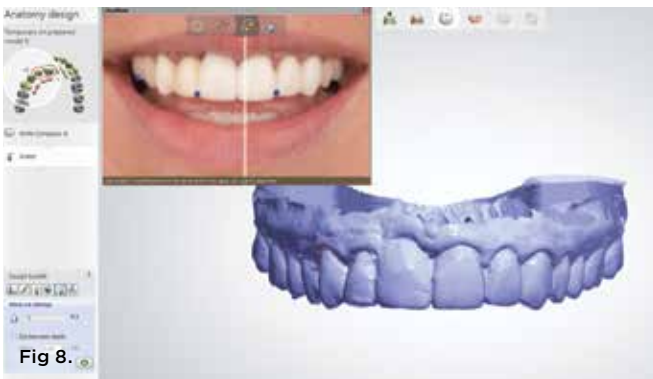


Fig 8.



Fig 9.



Fig 10.

**Fig 6.** The digital facebow was created. **Fig 7.** Tooth shapes and positions were designed digitally to guide the wax-up. **Fig 8.** Landmarks were selected to allow the superimposition of the cast on the patient photographs. **Fig 9.** The cast was placed “in the face.” **Fig 10.** The dentist was able to approve the smile design before the wax-up was milled.



**Fig 11.** Pink porcelain was housed on the abutment to facilitate cement removal and healthy tissue. **Fig 12.** The porcelain crown in place on the model. **Fig 13.** Tissue shade guides placed intraorally. **Fig 14.** The provisional restorations in place.

photographs also are used to allow superimposition of images for the smile design planning.<sup>4</sup>

### *Phase 2: Smile Design by Clinician*

To achieve consistent outcomes, the functional and biological issues must be integrated into an esthetic treatment design to avoid unwanted surprises or disappointments during treatment. The first step in creating the 2-dimensional (2D) drawings is relating the full-face smile photograph to the horizontal plane. The entire face must be analyzed to determine the best reference to achieve symmetry and balance. The interpupillary line is often cited as the preferred option, but in some cases the horizontal reference may be the nose, chin, ears, or sides of the face.<sup>5</sup>

Software programs such as Keynote (Apple) or PowerPoint® (Microsoft) can be used to create the smile-design process. Many applications are available for any type of device, but the fundamental requirement for any software used is that the user is able to insert photographs and videos and create line drawings. After two lines are digitally inserted to form a cross, the photo or video frame capture is repositioned to align with that cross (Figure 6), and this becomes the digital facebow. The photographs are then calibrated with each other and with the digital ruler. Lines and drawings are added to create the smile design framework of tooth shapes and positions on the still photos, with consideration always given to the cervical limitations revealed by the video analysis. Tooth shapes can be uniquely created or selected from a library of existing tooth outlines. Once these measures are established, the treatment planning capabilities are limitless.

The drawings allow the dental team to visualize any concerns or problems with the dentofacial integration, for example, when the smile design is outside the range of ideal mathematical proportions.<sup>6</sup> This is highly beneficial for guiding the wax-up process (Figure 7). Historically, the laboratory creates the smile design based on the dentist's written prescription, which conveys limited information about the dentofacial specifics of the case. This limited communication may result in a final outcome that fails to fully satisfy the esthetic goals.

### *Phase 3: Creating 2-Dimensional to 3-Dimensional in the Laboratory*

The laboratory used the 2D images and replicated the drawings using CAD/CAM software to create a 3-dimensional (3D) cast. This could have been done conventionally with a wax-up, but the CAD/CAM method is faster than waxing by hand.

The technician selected a few easily identifiable landmarks on the 2D image and matched them with the same landmarks on the 3D scan of the cast, so the cast could be positioned correctly over the facial photograph and over the images and drawings done by the clinician (Figure 8 and Figure 9). After the virtual design was created in the lab and inserted into the full-face image, the dentist reviewed and approved the design (Figure 10). The wax-up was then milled.

The key challenge in this case was the presence of the soft tissue and bony defects that created "black triangles" where interproximal papillae were missing. Use of pink composite along with a screw-retained hybrid abutment crown would allow future retrieval and

repair; however, due to the implant angulation, an access through the facial crown surface would be necessary. A cement-retained restoration with pink porcelain would not require facial access, would frame the restoration, and give the illusion of natural papillae.

The pink porcelain contours would need to fill the undesirable soft-tissue voids while still allowing access for proper oral hygiene. To facilitate this, the pink porcelain was housed on the implant abutment, designed to sit passively on the tissue, and extend only as far as the defect with minimal facial overlap. If the pink porcelain had been attached to the crown, a path of insertion would have been impossible. Housing the pink porcelain on the abutment also allowed the abutment-crown interface to be supragingival for simple cement cleanup (Figure 11 and Figure 12).

#### Phase 4: Restorative Execution

Teeth Nos. 6 through 11 had already been prepared for full-coverage crowns by a previous dentist; preparations would only be smoothed and refined. No-preparation veneers would be placed on teeth Nos. 5 and 12 to widen the buccal contour and create a more harmonious smile design.<sup>7</sup> Final impressions were taken using light-body wash and monophasic polyvinyl siloxane (Aqualis<sup>®</sup> Ultra, Dentsply Sirona, dentsplysirona.com). Provisional restorations (Luxatemp<sup>®</sup> Ultra, DMG America, dmg-america.com) were luted with unfilled resin (OptiBond<sup>™</sup> FL part 2, Kerr, kerr-dental.com).

Pink composite was added chairside to create the appearance of papillae. Shade tabs were used to select the proper pink shade for use by the ceramist. Photographs were taken of the pink shade tabs intraorally, and a physical sample of the pink composite was also sent to the laboratory so the ceramist could see the actual color being used and photographed in the mouth (Figure 13). A photograph of the patient with the provisional restorations was also taken and sent to the laboratory (Figure 14).

Once the patient approved the provisionals, the previously described photograph and video protocol was performed to communicate to the laboratory any minor changes for the final restorations. The new restorations would model the provisional restorations in shape and arrangement.

The final porcelain restorations were placed using an adhesively retained bonding protocol<sup>®</sup> (teeth Nos. 5 and 12) and cohesive protocol (teeth Nos. 6 through 11). Teeth Nos. 5 and 12 were microabraded with 27-micron aluminum oxide using a PrepStart<sup>™</sup> (Zest Dental Solutions, zestdent.com) at 40 psi and 35% phosphoric acid for 15 seconds, and several layers of unfilled adhesive resin were applied and light-cured. The internal surfaces of the veneers were etched with 35% phosphoric acid (Opal Etch<sup>®</sup>, Ultradent Products Inc, ultradent.com) and silanated (RelyX<sup>™</sup> Ceramic Primer, 3M ESPE, 3M.com). The implant abutment was then screwed in and torqued. The crowns were luted with dual-cure cement (RelyX<sup>™</sup> Unicem, 3M ESPE), and the veneer restorations were luted with light-cure-only resin cement (RelyX<sup>™</sup> Veneer, 3M ESPE).



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Fig 15.



Fig 16.



Fig 17.

**Fig 15.** Close-up photograph of final restorations. **Fig 16.** Retracted view of the final restorations and soft-tissue contours. **Fig 17.** With the final restorations successfully in place, the patient expressed joy and satisfaction.

Occlusion was refined and the chewing envelope evaluated with the patient sitting up and chewing on a piece of gum with 200-micron articulating paper (Bausch, bauschdental.com) inserted between the teeth. All streaks on the lingual surfaces of the maxillary central and lateral incisors were removed to ensure there was no friction in the chewing envelope (Figure 15 through Figure 17).<sup>9</sup>

## Conclusion

Digital dentistry utilizes various tools and devices that enhance the protocols that clinicians have manually performed in the past. Video and presentation software can be effective for communicating desired outcomes to the lab and letting clinicians preoperatively plan the smile design and visualize treatment outcomes before initiating treatment.

The digital analysis protocol described in this case report enables dentists to visualize issues that they may otherwise not notice clinically. This digital laboratory communication protocol allows the entire process, from delivery of provisional restorations to final restorations, to be controlled with high precision and accuracy, leading to minimal adjustments clinically. These critical data and methods undoubtedly will continue to improve outcomes and create opportunity to exceed patient expectations.

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