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CLINICAL ARTICLE

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Creating a hybrid smile design workflow: The analog brain drives the digital technology

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Abstract

Objective: This article will explain and demonstrate the application of analog smile design techniques and concepts as a precursor for digital smile design implementation. The application of these techniques will be described with two case presentations that will demonstrate the incorporation of these analog methods into digital smile design programs.

Clinical Considerations: Digital smile design workflows can be more efficient and require less chair time but must be based on an understanding and application of basic smile design principles to apply the digital techniques successfully.

Conclusions: The application of basic smile design techniques to digital workflows resulted in excellent clinical outcomes for both a localized treatment plan and a full mouth restorative rehabilitation.

Clinical Significance: Digital smile design is quickly being adopted into dental practices. However, the digital design must be created by the clinician and be based on a thorough understanding of basic esthetic and restorative principles to achieve predictable successful clinical outcomes.

KEYWORDS

digital smile design, esthetic dentistry, porcelain restorations

1 | INTRODUCTION

Dentists must maximize, leverage, and properly implement digital workflows. The rate of digital workflow implementation is increasing rapidly.[1] However, understanding the appropriate application of analog smile design techniques is a necessary precursor to successful digital smile design implementation.[2] Digital programs can only follow the dentist's input, which needs to be well thought out and correct. The dentist must also develop a system to identify mistakes while the case is still in the virtual platform so any errors can be corrected before the restorations are brought to the mouth. It is the application of old-school analog design techniques that allows the dentist to refine the design in the virtual program. Both the prototype and final restorations are improved when the digital mockup can be evaluated with the patient in the chair. This allows any necessary corrections of the digital mock-up, including form and function, to be made chairside.

This article will demonstrate the application of traditional analog smile design concepts into digital smile design programs, including how to create the illusion of a perfect smile. The steps to transfer analog strategies into the digital dental software will also be presented. Digital smile design is a hybrid of analog concepts entered into the computer program. The first step is a complete analog evaluation of tooth structure and esthetic needs. It is analog thinking that creates successful digital implementation and increases the predictability of the digital output. These concepts will be demonstrated using two clinical cases: one simple and one complex.

2 | CASE REPORT NO. 1

2.1 | Diagnosis and treatment planning

A 23-year-old male patient with lingual orthodontic brackets in place was referred to the author's practice by his orthodontist (Figure 1). The patient presented to the orthodontist one year earlier with a Class III brachyfacial skeletal type, end-to-end incisor relationship, and no overbite or overjet. The orthodontist aligned the arches, equalized the interincisal spacing, and opened the vertical dimension with occlusal turbo stops on the second molars using the Shimbashi measurement as a starting point. The Shimbashi measurement calculates the distance from the maxillary central incisor cementoenamel junction (CEJ) to the mandibular central incisor CEJ, which ideally is within 1 mm of 18 mm.[3] The orthodontist believed the patient was ready for orthodontic band removal and to begin the restorative phase of treatment. The orthodontist requested guidance to determine if the ideal vertical dimension and proper overbite-overjet and interincisal relationship was present to accommodate future restorative materials and create an ideal functional pathway in the restorative treatment plan. At the initial appointment, the patient received a comprehensive exam, full mouth series of radiographs, and a periodontal evaluation. His gingival tissues were inflamed and presented with a high scallop. Diagnostic photos were taken. The patient's medical history was noncontributory. The patient desired to change the anterior tooth length, shape, color, vertical display, and to return to his original appearance.

2.2 | Analog esthetic analysis

Maximum lip movement occurs when both the zygomatic major and the orbicularis oculi muscles are activated.[4] This patient presented with a high gingival scallop that was visible on all maxillary teeth except for the incisors during a full "E," or Duchene, smile (Figure 2).[5] The dental midline was concentric with his facial midline. One concern was to avoid lip incompetence after the restorations were completed. Since facial muscles change when the vertical dimension is opened, any changes in the vertical dimension must be planned so the lips will still close comfortably at rest. The form and length of the proposed restorations also need to accommodate lip closure in repose. In the preoperative photos, the gingiva of the maxillary incisors is not visible. Patients with esthetic concerns often adopt a guarded smile, so it would be a mistake to assume that those gingival contours would remain invisible after the final restorations were completed. He was diagnosed as a high-risk esthetic case with a poor prognosis for a successful esthetic outcome. The maxillary left first molar, with a hopeless prognosis, would be extracted. The extraction site would be grafted, and an implant placed in the future.

The first step in dento-facial treatment planning, for both analog and digital workflows, is determining the maxillary incisal edge position.[6]

In order to guide the digital design, a direct mockup of composite (Tetric Prime B1(Ivoclar)) was added to the maxillary left central incisal edge to assist in determining the final desired length. Starting with the knowledge that the maxillary central incisor mean length is 10.5 mm, and that men usually reveal between 0 and 2 mm of incisal edge in repose, a direct composite trial addition of composite resin was added to the maxillary left central incisor. Analysis of a Duchenne smile, a natural smile, and the face in repose from a frontal facial perspective was accomplished and the patient agreed that it looked correct. The gingival margins of the mandibular incisors had been leveled during orthodontic treatment, leaving an uneven mandibular incisal edge position. The ideal visible length of the mandibular incisors with lips in repose is 0–2 mm. Since the patient presented with −1 mm, it was determined to lengthen the incisal edges and raise the mandibular occlusal plane by 1.5 mm. Photographs and digital scans (iTero Align) were taken (Figure 3). A dental software design program (EXOCAD)

FIGURE 1 Preoperative view of the patient with a full smile.

FIGURE 2 Preoperative view. Note the misshapen, short, square, yellow teeth with worn edges.

was used to design the provisional prototype restorations. The prescription was created by choosing all teeth, except the four second molars, to be incorporated in the design. The second molars would be restored during the second restorative phase as they would serve as stable occlusal points of reference during the restoration of the other teeth.

FIGURE 3 Composite mockup on left central incisor to aid in designing the definitive maxillary incisal edge position and guide the digital workflow.

2.3 | Application of the design in EXOCAD

a. Since the tooth had not been prepared, the "anatomic pontic" command was chosen. The design program will add wax to the top of that tooth.
b. The STL files were loaded. Rotating these files allows confirmation through visualization of the overjet spacing available for restoration design (Figure 4A–C).
c. Traditionally, an analog facebow would be used to record natural head posture and to align the maxillary arch on the upper member of the articulator. Using a digital workflow, the retracted smile photo with the patient wearing the Kois Facial Reference Glasses was loaded and aligned by choosing two corresponding alignment points on the left and right image, then the images were superimposed (Figure 5) and adjusted to ensure the maxillary arch was aligned perfectly (Figure 6)
d. The patient's eyes are auto detected by the EXOCAD program. To align the face from right to left, the dot markers in the center of the eye are fine-tuned by moving them to the bullseye on the side of the glasses and locking the position. This allows correction, if needed, of the alignment of the photo from right to left (Figure 7A,B). These alignment corrections in the digital workflow will improve the analog techniques in gaining predictability of correct occlusal orientation and canting errors.

FIGURE 4 Rotating the STL files to evaluate the available restorative space. (A) Right lateral view. (B) Frontal view. (C) Left lateral view.

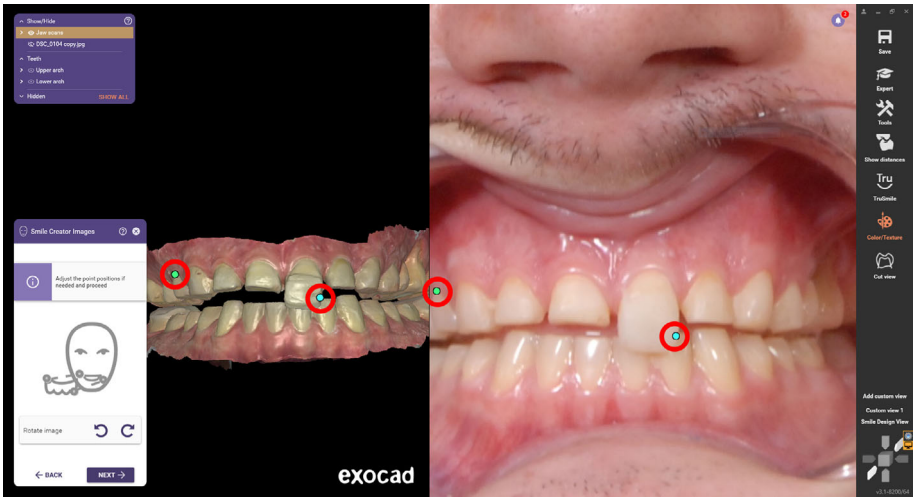

FIGURE 5 Note the presence of the blue dots used to synch the STL file with the photograph.

FIGURE 6 The photo and STL file are aligned perfectly.

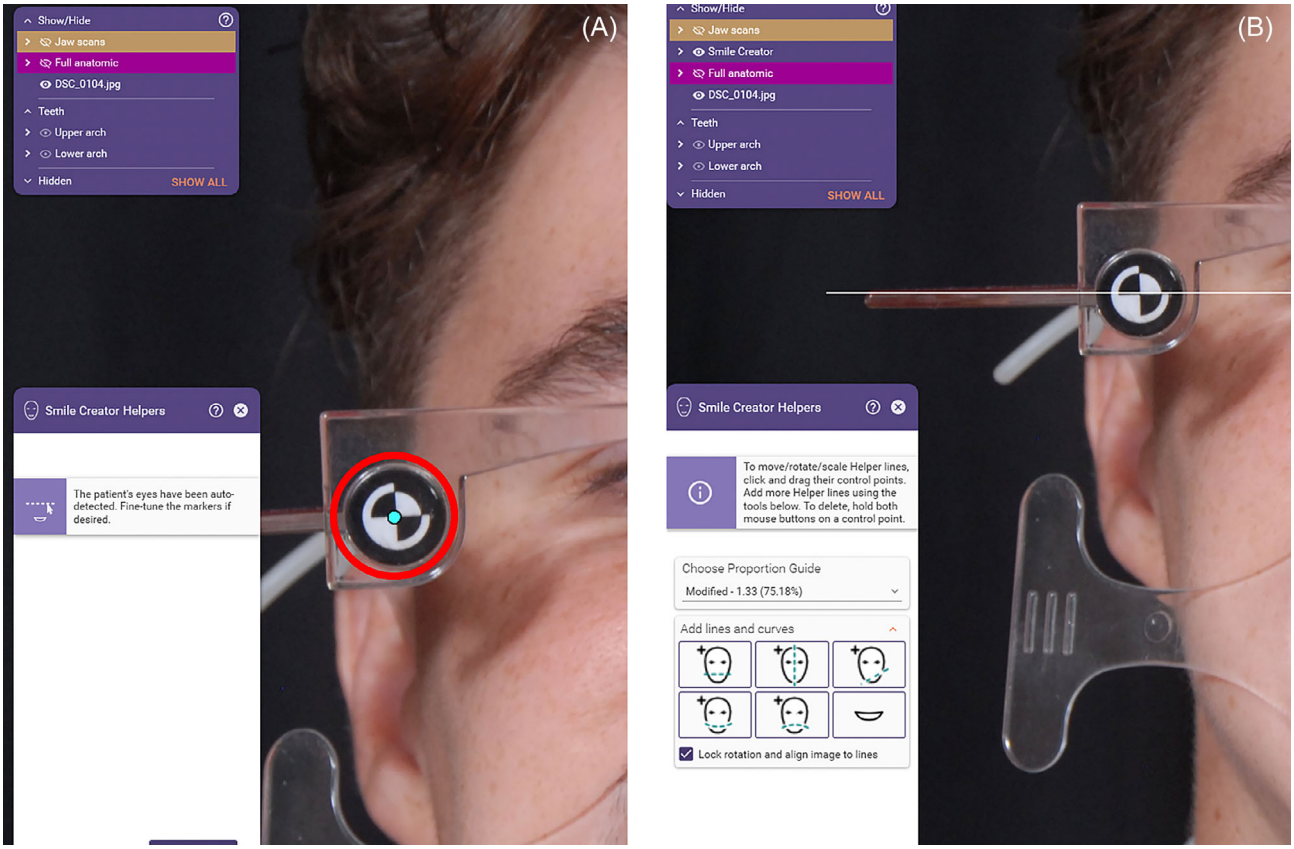

FIGURE 7 (A) The photo is aligned from right to left by placing, then locking, the blue dot markers on the bull's eye of the KFRG. (B) Set the helper lines in the center of the bullseye, then choose "lock."

The lateral wings on the Kois Facial Reference Glasses guided the facial alignment from front to back. The lateral wings of the glasses are red on the top of the wing and green on the bottom. When the head is positioned so neither color is visible, the face is correctly aligned, anterior to posterior, and the photo is taken.

e. The patient wanted to recreate the smile he used to have. An analog historical photo was obtained and the tooth form evaluated. The tooth shape library available digitally has hundreds of options for tooth shapes and forms which facilitates ease and accuracy in obtaining a close match. A tooth form was selected from the software library that matched the appearance of the patient's teeth as

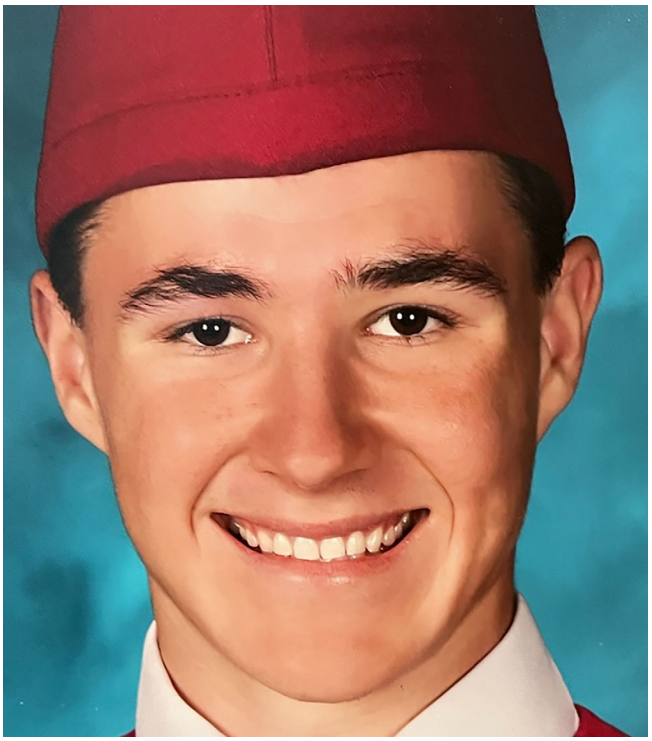

FIGURE 8 Historical photo to aid in choosing tooth form.

a young man (Figure 8). The best match in the software was Generic (Figure 9).

f. Selecting mirror movements allows all movements, rotations, and scaling to be done symmetrically. The corner dots allow scaling, and the double arrows will rotate the teeth (Figure 10). The proposed restoration design can now be visualized virtually and provides a multitude of options for size and axial inclinations of the proposed definitive design without losing symmetry from right to left.

g. No standardized measurements have been determined that define tooth dimensions in relation to proportions. Available choices range from golden rule of proportions to continuous proportions to choosing the width of the lateral to be 2 mm less that the width of the central, and the canine width being 1 mm less than the width of the central. Strict application of these rules, however, may be too limiting, and the clinician must determine the appropriate sizes of the teeth in each individual patient taking into consideration the unique arch form, lip dynamics, and facial proportions. Digital technology allows a preview of each proportion choice by superimposing the protype over the existing dentition. The slide bar is then used to visualize the underlying tooth and determine whether the selected proportion fits over the natural tooth and if the design can be obtained with minimal preparation. In this case, the interincisal spacing fit perfectly when the lateral incisor width was 2 mm narrower than the width of the central incisor. This dimension was then chosen as the starting point and would require minimal to no removal of tooth structure interproximally (Figure 11).[7,8]

h. A standard shade was selected, and the digital prototypes were virtually placed in the full-face photo (Figure 12). The technology allows you to change the color of the prototype and can be used to communicate color to the patient. Sliding the bar allows evaluation of the preoperative view with proposed facially generated esthetics.

i. To move the mandibular tooth forms as one unit, select "chain mode" and place the tooth forms over the occlusal surfaces, from the distal contact of the lower left mandibular molar to the distal contact of the lower right mandibular molar (Figure 13).

j. Clicking on the green dots will change the color to red and lock that tooth in place. Future movement can occur in the chain, preserving proportions and symmetry, without altering the locked teeth. In contrast, analog design is dependent on the ceramist's ability to maintain symmetry with their artistic ability. Using this tool, the mandibular incisors were lengthened, and the mandibular occlusal plane was leveled.

k. Choose "tooth placement single move" to allow movement of one tooth at a time, which prevents the movement of the other teeth.

The case was mounted on a virtual articulator to evaluate the occlusion during dynamic movement. The final approved design was exported as an STL file and sent to the 3D printer for fabrication of a maxillary and mandibular model. The evaluation of the printed model was completed and flowable composite was added to smooth any imperfections. Then a siltech provisional matrix (Ivoclar Virtual XD) was fabricated chairside to create the provisional restorations.

2.4 | Preparation appointment

Local anesthetic was administered on the maxillary arch. The provisional matrix was used as a preparation guide to ensure appropriate, but minimal reduction. The matrix was filled with bis-acrylic composite (DMG Luxatemp B1) and seated over the maxillary arch. The resulting prototypes were previewed for color, length, and shape, then approved. Diamond burs (Brasseler RWMIN 0.3/0.5/0.7828.31.030, Brassler USA) were used to place depth cuts across the facial gingival and middle third to establish the amount of facial reduction necessary.[9,10] Then 2 mm was removed from the prototype at the previously approved incisal edge length, revealing that no incisal reduction of the teeth was necessary. The maxillary teeth from right first molar to left first molar were prepared for full coverage restorations (Figure 14). The mandibular arch was then prepared following the same protocols as described for the maxillary arch.

FIGURE 9 Tooth library options; generic chosen.

Provisional restorations were fabricated by loading the provisional matrix with bis-acrylic composite (DMG Luxatemp B1), then placing the matrix over the prepared teeth. The outline forms of the contralateral teeth were contoured to create slightly different shapes, allowing the patient to view the different shape options and decide which he preferred. He chose symmetry, which is an exact duplication left to right, for his maxillary anterior six teeth. A digital scan of the provisional restorations was taken, then sent to the lab to fabricate a Kois deprogrammer. The deprogrammer would allow the lower jaw to relax and settle into a repeatable occlusal position, centric relation. Two days later, the deprogrammer was fitted, and the patient was instructed to wear the deprogrammer as close to 24 h a day as possible for 2 weeks, removing it only to eat and perform oral hygiene. The patient wore the deprogrammer as instructed, then returned 2 weeks later. When the deprogrammer was removed, there was a repeatable point of first contact, centric occlusion.[11] Using the deprogrammer, the provisional restorations were then equilibrated until all posterior teeth displayed equal bilateral, simultaneous contact. The functional occlusion was evaluated with the patient sitting up in the chair and chewing on thick (22 micron) articulating paper, which simulates the chewing envelope and activates the closing muscles. An evaluation of the shape, length, color, speech, and function of the provisional restorations was performed over the next 12 weeks. A digital scan and bite of the approved maxillary and mandibular provisional restorations was taken, sent to the lab and was used as the master guide to design the maxillary and mandibular definitive (e.max HT BL1 ingot Ivoclar) porcelain restorations from right first premolar to left first premolar. The maxillary anterior teeth and the mandibular teeth from first premolar to first premolar were restored first with e.max (Ivoclar), followed by Prime zirconia (IPS e.max Zircad Prime Ivoclar) restorations on the maxillary posterior teeth. The mandibular posterior teeth were also restored with zirconia but were fabricated last to provide the ability to evaluate the vertical dimension over time, with the flexibility to modify the vertical dimension, if necessary, without affecting the maxillary esthetics (Figures 15 and 16).

3 | CASE REPORT NO. 2

3.1 | Diagnosis and treatment planning to minimize the compromise

A 19-year-old female patient presented for a thorough dental assessment. She was missing her maxillary right cuspid and was unhappy with her canted smile and uneven gingival display (Figure 17). A comprehensive exam, full mouth series of radiographs, a periodontal evaluation, diagnostic photos, and digital scans (iTero Align) were completed.

Her history of orthodontics began at age 8 when she presented with arch length deficiencies in the mixed dentition. While space was being created, the unerupted upper right permanent cuspid developed an aggressive expanding dentigerous cyst, which caused severe root resorption to the adjacent teeth, resulting in considerable alveolar bone loss and significant gingival recession on the upper right maxillary first premolar and severe root resorption on both upper right incisors. Very light forces were used during the following orthodontic treatment to minimize further resorption (Figure 18).

3.2 | Analog esthetic analysis

The upper right first premolar had been positioned in the right cuspid space leaving a 3 mm gap between the repositioned upper right first premolar and the lateral incisor. The upper right second premolar presented with a short clinical height and excessive gingival display. In the patient's Duchene smile, the gingival zenith was displayed on all maxillary teeth except the right maxillary incisors. Bilateral gingival symmetry was not present (Figure 19).

The midline and anterior maxillary teeth were canted with the axial inclination of the centrals and laterals angled distally from vertical line drawn through the center of the tooth.[7] Treatment options for correction were limited. No further orthodontic treatment could be

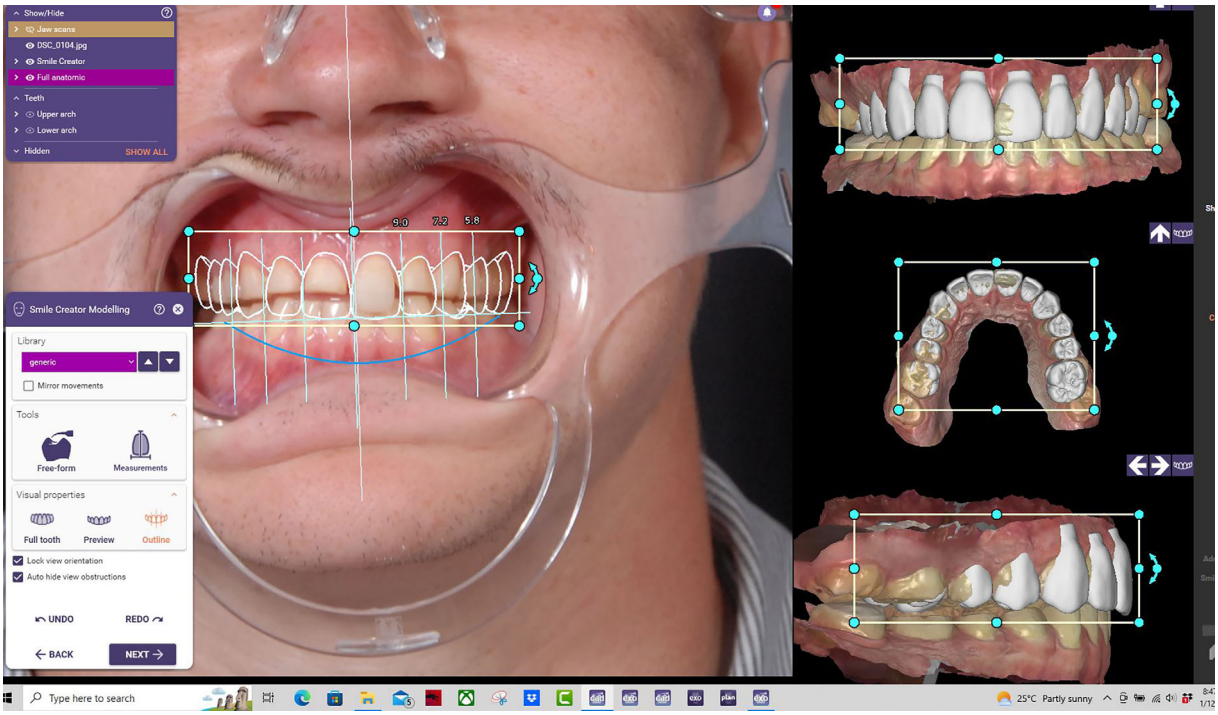

FIGURE 10 Scaling rotation accomplished symmetrically as one unit in mirror mode.

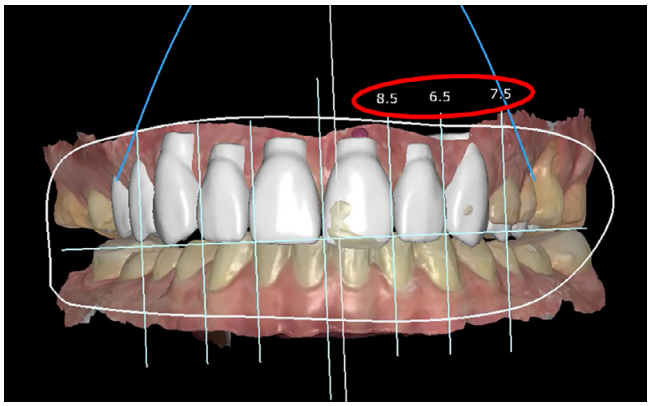

FIGURE 11 Tooth proportions chosen that coincide with the anatomic position of the anterior teeth.

performed due to her root resorption and bone loss (Figure 20). She liked the appearance of her teeth and was adamant about not wanting any composite or porcelain restorations on her compromised incisors. A periodontal consult was ordered.

The patient accepted crown lengthening on the upper right second premolar and upper left lateral incisor, followed by recontouring the existing maxillary incisors and placing full coverage crowns on the upper right premolars. The patient understood that symmetry, an exact duplication left to right, was not possible but harmony, defined as a recurring theme, was. It was determined that restoring the upper right premolars to mimic the upper left cuspid and first premolar would provide harmony and the illusion of symmetry.

3.3 | Merging analog and digital smile design

Since this patient's tooth position could not be changed it was futile to use the smile creator technology which begins with loading a face photo and moving the teeth to align them in the face. This case had to be designed to accommodate all the existing compromises while minimizing the visibility of the compromise. This was accomplished by mirroring the contralateral side as closely as possible.

One of the most challenging procedures in dentistry is to mirror a tooth and create an exact duplication. There are no key elements of analog smile design that compare to the simplified workflow outlined below. Historically, analog design depended on the designer's ability to maintain symmetry using their artistic ability. The advantage of the digital workflow is the ability to analyze the proposed design by superimposing it over the existing dentition. In this way, the available space can be compared and evaluated to the contralateral side, allowing tooth and soft tissue placement to be virtually determined in order to create an imperceptible result.

When using this digital workflow it is imperative that the analog brain decide where the pontic prototype design is possible, and where the tooth may be safely prepped. Once this has been accomplished, the digitally created design can be used clinically. The simplified workflow outlined below demonstrates how to design provisional prototype restorations using the "mirror tooth" tool in wizard mode:

a. To design a provisional where the tooth has not been prepared, choose "anatomic pontic" for the upper right premolars.

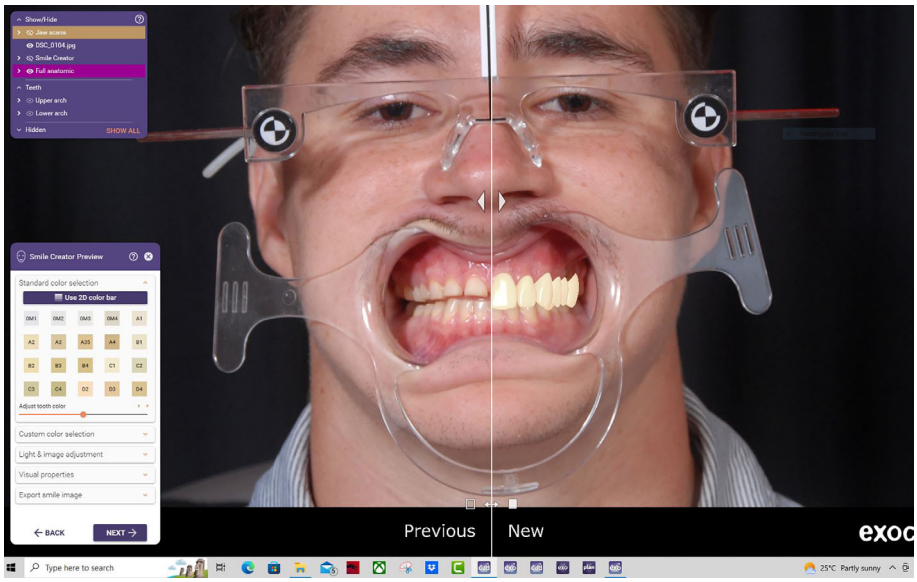

FIGURE 12 Digital prototypes placed in a standard shade and the sliding bar allows evaluation of preop position with the proposed position.

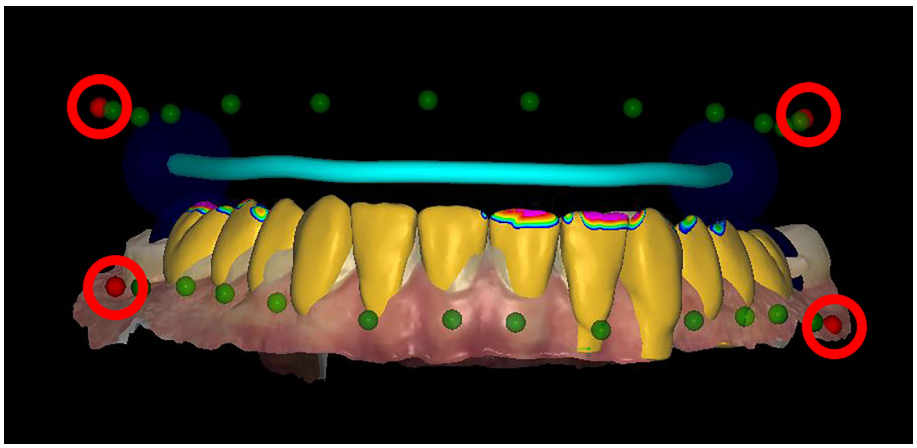

FIGURE 13 Moving mandibular teeth as one unit in "chain mode." The teeth marked with the red dots cannot be moved, while those marked in green can be moved.

FIGURE 14 Maxillary and mandibular preparations of all teeth except the second molars.

b. Click "adjacent teeth" on the tooth you want to replicate. In this case, this would be the upper left first premolar, followed by the upper left cuspid.
c. Copy/mirror tooth mode is selected and the upper right first premolar is clicked, the upper left cuspid is replicated. The replicated upper left cuspid prototype pontic form is then moved over the upper right first premolar and clicked to position.
d. Click on "mirror copy another," then click on the upper right second premolar to replicate the contralateral tooth (in this case the upper left first premolar). Next move, the left premolar over the right premolar. (Figure 21).

Since the upper right premolars will be prepared for full coverage restorations, the dentist must evaluate the proposed design and then decide what part of the tooth can be removed in order to replicate the contralateral side while concurrently determining which part of tooth must remain in order to prepare the tooth in the most minimally invasive way. Using the Free form scan data option allows the operator to manipulate the scan data by either adding or removing tooth structure and gingiva. Removal of tooth structure, represented by the scan data, is accomplished by holding the shift key and removing tooth structure until the desired prototype tooth shape is exposed (Figure 22A,B).

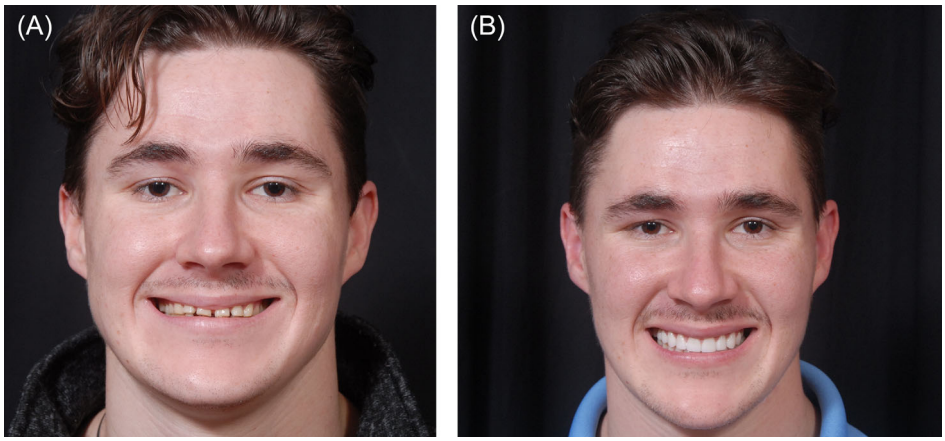

FIGURE 15 Comparison of (A), preoperative full-face view. (B) With postoperative full-face view.

FIGURE 16 (A) Compare maxillary anterior teeth pre-operative view. (B) With maxillary postoperative view.

Understanding where tooth structure cannot be removed is critical to the success of this technology. Rotating the design in all planes allows visualization of the buccal fullness necessary to mimic the contralateral side. The designer chose not to add prototype material in the facial gingival gaps and instead fabricate an additive subtractive design where later flowable composite would be added to the printed model to create the proper shape in these gaps. This allows viewing the fullness of the proposed prototype in three dimensions while also visualizing the existing preoperative tooth form.

Virtual case design on a computer screen can be rotated and scaled so it appears three-dimensional, but it is still only created in two dimensions. Visualizing the differences between the proposed reconstruction and the preexisting tooth on a three-dimensional printed model helps the clinician identify the actual spatial relationship and allows the design concepts to be analyzed before a handpiece is picked up and laid on the tooth.

The STL file was saved, and a model was printed. An evaluation of the gap in the printed model is completed and flowable composite is added to fill in any imperfections. Then a siltech provisional matrix (Ivoclar Virtual XD) is fabricated chairside.

FIGURE 17 Preoperative view of a 21-year-old female; note the angulation of the midline and anterior maxillary teeth.

3.4 | Preparation appointment

Shape is related to the anatomy of the interproximal ridges, which are also called transitional line angles. These lines are slightly curved and vertically oriented and represent the intersection of the facial surface and the reflective surface that emerges from interproximal contact.[12] Line angles are placed strategically to change how the light reflects off the tooth. The contralateral teeth are mimicked by creating an illusion of symmetry with changed contours, outline forms, and line angles. When evaluating and performing the recontouring procedures it is imperative that the dentist is positioned directly in front of the patient and the patient's head tilt is parallel to the floor. The tooth axis of the central incisors is positioned slightly distal toward the apex when compared to the vertical midline. When compared to the central incisors, the lateral incisors exhibit a more distal inclination (Figure 23).

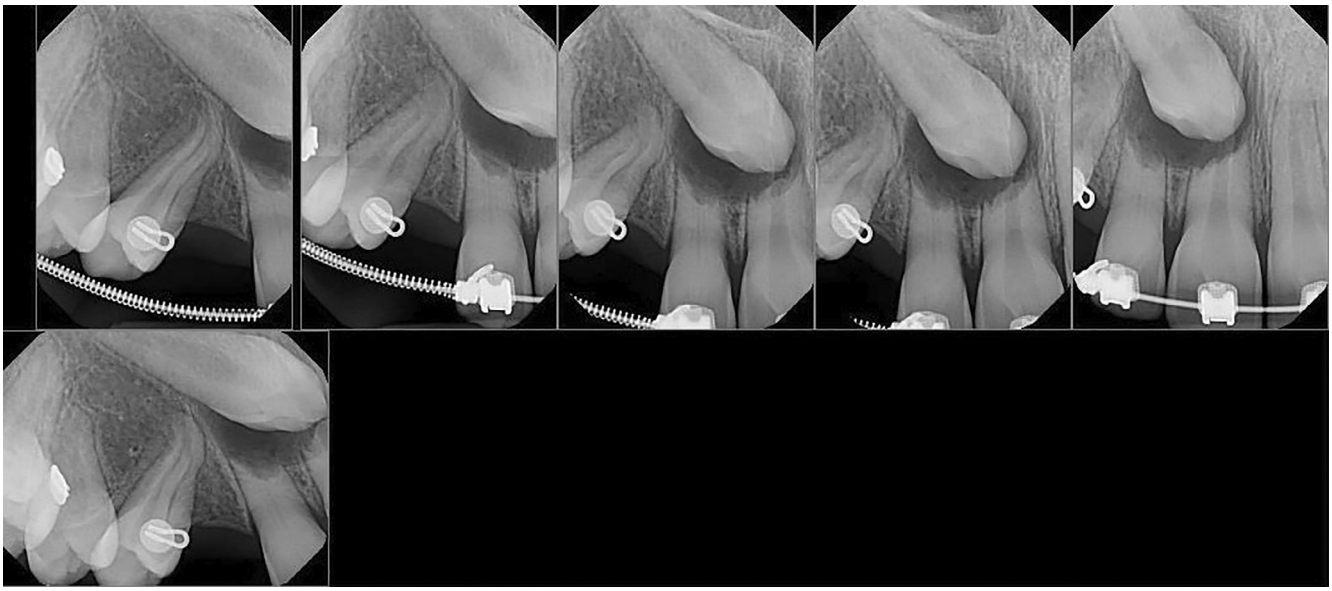

FIGURE 18 The dentigerous cyst on impacted right canine caused severe root resorption on right maxillary anterior teeth.

FIGURE 19 A close-up view of the preoperative smile.

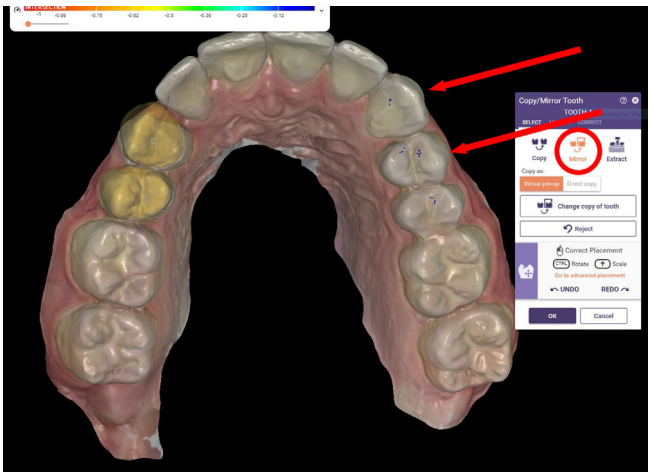

FIGURE 21 Using the "mirror tooth" tool, copy the upper left cuspid and move it into the upper right first bicuspid space. Then the upper left bicuspid is copied and moved into the upper right second bicuspid space, positioned so it mimics the contralateral side.

FIGURE 20 In the right lateral view note the missing upper right canine. The first bicuspid is positioned in the canine space with a visible gingival defect and the second right bicuspid has a short clinical height.

To correct the axial inclination of the right central incisor so that the tooth would appear more distally inclined, the distofacial line angle was moved toward the center of the tooth and uprighted. Enamel was removed judiciously, while preserving any enamel at the distal contact point (Figure 24). This corrected the alignment while making the tooth appear thinner from a frontal perspective.

The right lateral incisor was treated in the same manner followed by changing the contour of middle third, triangular facial surface and redirecting this middle section toward the midline (Figure 25). This corrected the alignment of the lateral incisor and also made this tooth appear thinner than the contralateral side.

In order to create the illusion of symmetry, the left incisors must appear to have the same width as the right incisors (which now appear thinner). This is accomplished by moving the distal and mesial line angles of the left incisors toward the center of the tooth

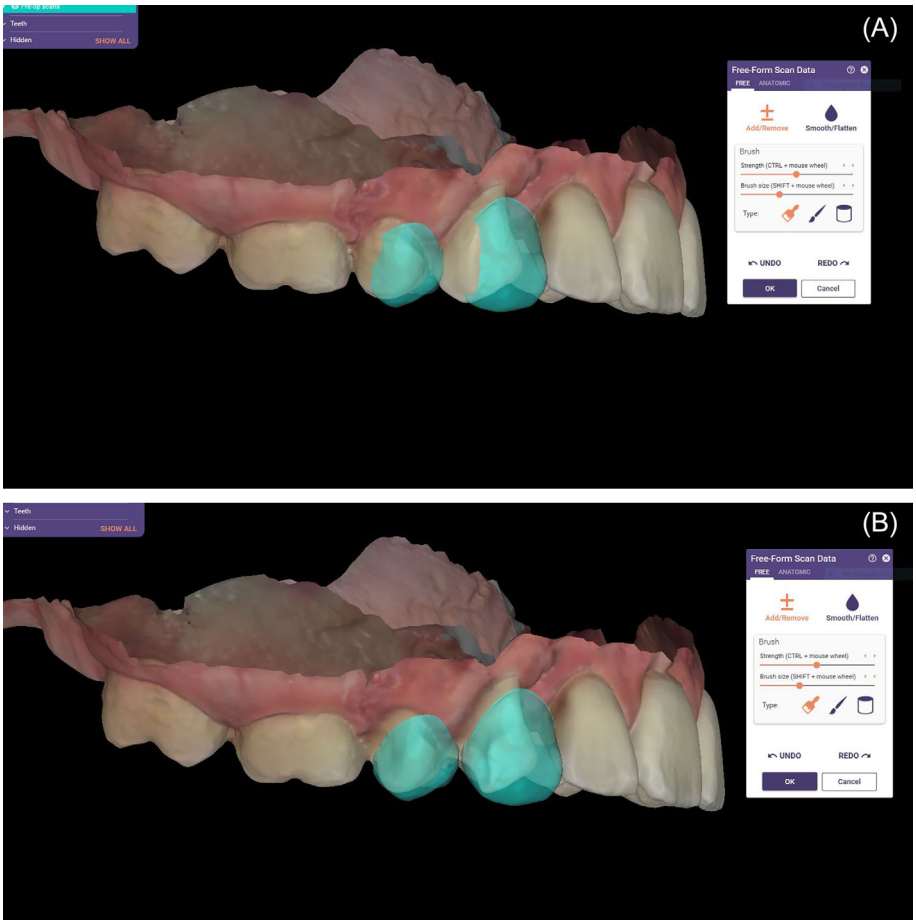

FIGURE 22 (A) Using the free form scan data remove the tooth structure until the pontic prototype is exposed. Note the original contour. (B) After using the free form scan data, the pontic prototype is exposed.

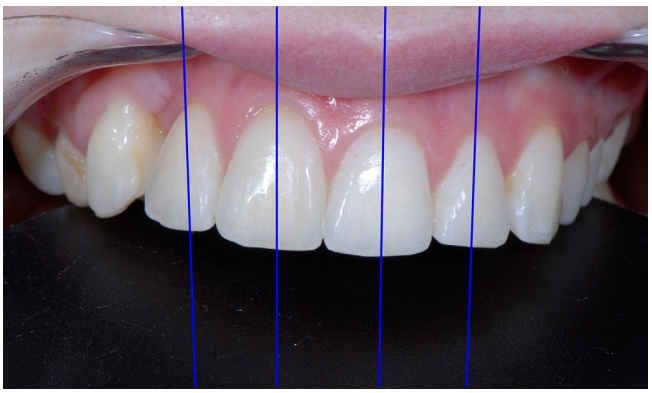

FIGURE 23 The lines represent the ideal tooth axis when compared to the vertical midline.

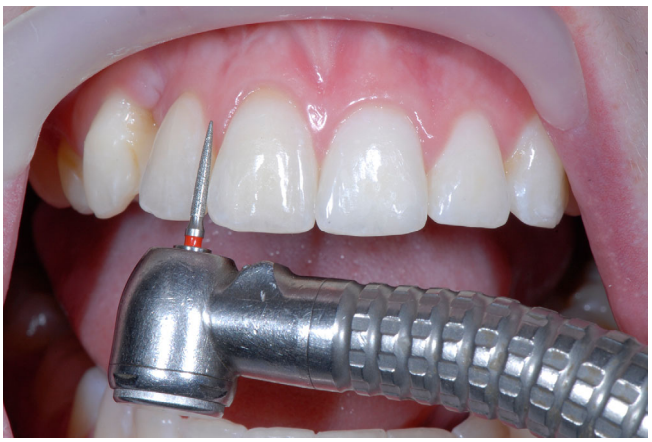

FIGURE 24 To make the right central incisor appear more upright, the distofacial line angle is moved is moved toward the center of the tooth.

(Figure 26). Once the teeth were recontoured, the provisional matrix was loaded with bis-acrylic composite (DMG Luxatemp B1) and seated over the maxillary arch. After a preview of the prototypes, the gingival third of the right cuspid was slightly flattened in order to mimic the contralateral cuspid from a frontal perspective (Figure 27). Depth cut diamonds (Brassler RWMIN 0.3/0.5/0.7828.31.030, Brassler USA) were placed across the facial gingival and middle third to establish the facial reduction. Full coverage preparations on the maxillary right bicuspids were completed. Shade photos were taken of the tooth, stump, and gingiva. Occlusal records and arch scans were also taken (Figure 28). Records can be taken using a digital, analog, or hybrid workflow.

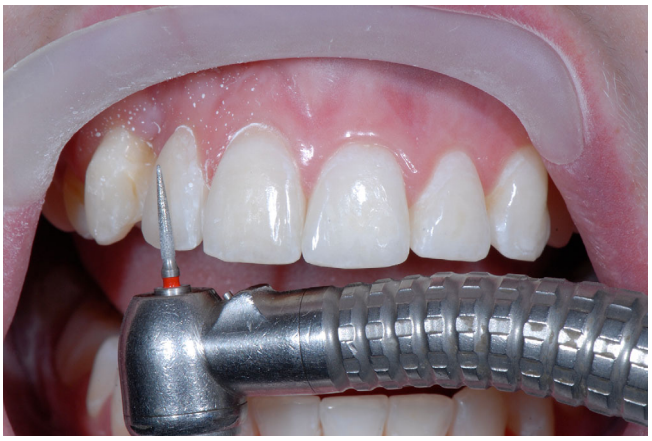

FIGURE 25 The middle third triangle of the right lateral incisor is recontoured toward the midline, creating the illusion of a more upright tooth.

FIGURE 26 The distal line angle of the upper left central incisor creates the illusion of a narrower tooth, to better match the right side.

FIGURE 27 Provisional preview. Note that the gingival facial contour of the upper right cuspid will need to be flattened.

FIGURE 28 Selection of a gingival shade.

FIGURE 29 Using a mirror to verify symmetry in all planes.

FIGURE 30 A close-up view of the approved provisional smile with pink composite resin added.

One week later, the patient returned for an evaluation of the shape, form, color, and function of the provisional restorations. The recontouring procedure is perfected by evaluating the facial contours from an incisal perspective, through a mirror placed on the incisal surface. Evaluation of symmetry right to left is verified. Asymmetries are adjusted by removal of enamel with a disc. Once symmetry is obtained in that plane the mirror is rotated 10 degrees and the procedure is repeated until the facial plane and line angles are mimicked right to left (Figure 29). Minor additional contouring

FIGURE 31 The approved provisional restoration with pink composite added.

FIGURE 33 Completed restorations, frontal view.

was performed that enhanced the illusion of symmetry of the right and left sides.

As the contour of transitional line angles progresses, the deficiency present in the pink portion backdrop of the smile became visible. This deficiency could not be corrected with additional contouring, so augmentation was necessary to create an illusion of symmetrical gingival contours. Pink composite resin (Shofu Beautifil II) was sculpted into the papilla area on the mesial of the upper right maxillary cuspid (Figures 30 and 31).

Photographs followed by a digital scan of the approved provisional restorations were sent to the ceramist to print and use as the master guide to design the porcelain restorations. At the delivery appointment after the patient approved the shape, color, and length, the restorations were bonded.

The final photos demonstrate an excellent esthetic result (Figures 32 and 33).

4 | CONCLUSION

These two cases provide a detailed explanation of the steps necessary to treat a case from initial data collection through design using in-house CAD software. As digital technology is implemented into the treatment planning process, the dentist cannot rely too heavily on the software algorithm. If used correctly digital tools are an adjunct that can enhance, simplify, and speed up the creation and implementation of esthetic, minimally invasive treatment plans.

Digital design offers the clinician an opportunity to evaluate the chosen restorative treatment plan to ensure that it is minimally invasive and will not compromise tooth or supporting structures before it is brought to the mouth. Systems with checks and balances and chairside evaluation of the digital mockup prototypes throughout the procedure will optimize both patient communication and the restorative outcomes.

FIGURE 32 Completed restorations, close-up lateral view.

DISCLOSURE

The authors declare that they do not have any financial interest in the companies whose materials are included in this article interest.

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