CASE STUDY

# Achieving Esthetic Goals While Maintaining Proper Bite Relationships Throughout Treatment


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The comprehensive nature of esthetic and restorative dentistry demands strong interdisciplinary support, laboratory support, and a clear understanding of the patient's desires.[1] Often the physiological parameters dictate considerations in the comprehensive treatment, which must be strictly adhered to. The patient must be evaluated and educated with thorough planning so that the most predictable long-term result matches the patient's wants and desires.[2] In the case presented in this article, the process of planning and listening to the patient's needs derived a comprehensive treatment, which was mapped out for laboratory communication and fabrication.

## Case Study

### Comprehensive Examination and Treatment Plan

A 40-year-old woman presented for consultation for rehabilitation of her failing anterior dentition and improvement of her occlusal relationship. The initial exam revealed significant anterior wear and tissue asymmetry from what would appear to be anterior extrusion (Figures 1 and 2). The basis for this diagnosis was on the significant wear noticed on the lingual anatomy and the incisal edge. In addition, the tooth length was below normal (7 mm), and there was a discrepancy between the tissue heights from first bicuspid back and the anterior dentition.

Occlusal wear patterns were visible on the upper and lower anterior teeth with failing direct composite facial restorations.[3] On further evaluation of the patient's dental history, the patient was carefully evaluated by an orthodontist and maxillofacial surgeon for orthodontic treatment and orthognathic surgery. She was aware of the skeletal disharmony and was advised this would be a comprehensive approach requiring orthodontic treatment, surgical intervention, and orthodontic finalization to ideal occlusion.[4] The patient was advised of the long-term consequences of the proposed treatment and it was decided that she would not undergo orthodontic and surgical correction. With this careful interdisciplinary approach, a second option was evaluated at the patient's request.

*Figures 1 and 2—The initial exam revealed significant anterior wear and tissue asymmetry from what would appear to be anterior extrusion. The basis for this conclusion is based on the significant wear noticed on the lingual anatomy and the incisal edge.*

Comprehensive records including a full-mouth radiographic series, mounted diagnostic models in centric relation (CR) were acquired using an anterior Lucia jig (Great Lakes Orthodontics, Ltd) positioned at the centrals stabilized with injectable putty. The muscles of mastication were allowed 20 minutes to allow for deprogramming. After this time frame, bimanual manipulation into the CR position was used with the jig in place and posterior putty bite records at an open vertical represented by the thickness of the jig. This is the initial CR position and it may not represent an accurate CR to restore to. An extensive series of digital photographs were acquired.[4] Records were gathered to derive a restorative option gaining esthetic and occlusal stability. The patient clearly understood the need for improved anterior guidance and the arch size discrepancy. Through dentist-ceramist communication, a treatment plan of involving ceramic restorations on the upper anterior six teeth and lower arch reconstruction was formulated using all the diagnostic records.[5] The initial premise revolved around a carefully designed diagnostic wax-up to facilitate esthetic and occlusal planning. Initial gingival modification needs were evaluated clinically based on sound biologic width guidelines.[6]

The patient was evaluated with short-term splint therapy to facilitate an understanding of the patient's CR position, and if the tolerance to a minor change in vertical dimension of occlusion was initially tolerable. In the authors' opinion, the definitive understanding of vertical dimension will be provided during the provisional phase.

### Diagnostic Wax-Up

After the authors received the case material, the impressions were poured and based. Three models of each arch were made. One of each arch was based using a standard basing method (these models were the additive/reductive models) and two models of each arch were based using a split-cast method. The first of the maxillary models was mounted using a face-bow on the Stratos® 200 articulator (Ivoclar Vivadent®, Inc). The mandibular models were then mounted to this maxillary model using the CR bite

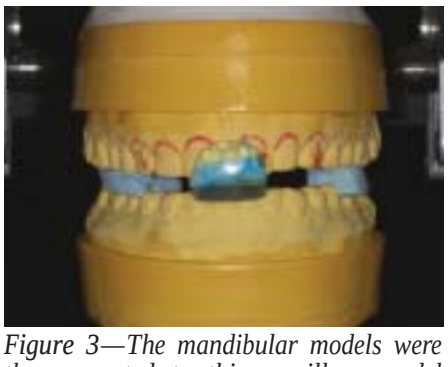


*Figure 3—The mandibular models were then mounted to this maxillary model using the CR bite in conjunction with the posterior bites.*

*Figure 4—The next phase of the diagnostic waxing process was referred to as the additive-reductive phase, where an ideal result was achieved by adding wax to areas deficient in contour and removing stone from over contoured areas.*

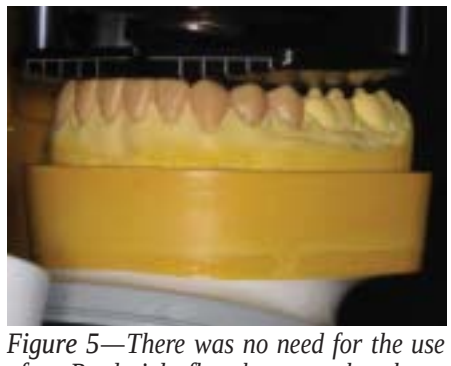


*Figure 5—There was no need for the use of a Broderick flag because the three-dimensional template was designed to establish the curve of Spee and Wilson.*

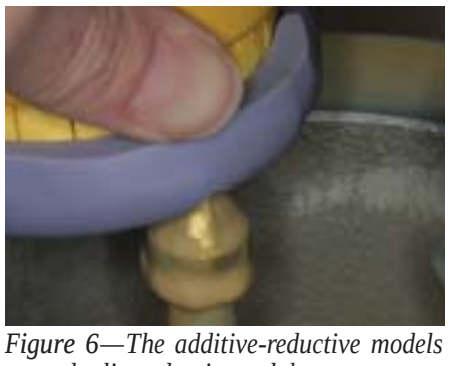


*Figure 6—The additive-reductive models were duplicated using a laboratory putty and the duplications were put on the prepared, based models, and liquid wax was injected using a wax injector.*

in conjunction with the posterior bites (Figure 3). The two remaining maxillary models were mounted resulting in all the models being accurately cross-mounted.

The first step in doing diagnostic planning in wax is to review the requests of the dentist and patient. In this case, the instructions were to wax teeth Nos. 6 through 11 and teeth Nos. 20 through 28 opening the bite minimally, but opening the bite enough to restore the dentition in a way that improved esthetics and established proper guidance.[7] The authors also wanted to create more ideal length-to-width ratios,[8] improve the tissue harmony, and eliminate the look of short, stubby teeth. After evaluating the patient's photographs, the patient's smile revealed it would have been beneficial to lengthen the teeth in the apical as well as the incisal direction thus improving the gingival architecture and length-to-width ratio. A clinical evaluation found that it was possible to remove tissue without violating biologic width requirements. Electrosurgery of this tissue maintained a sulcus depth of 1.5 mm from the crest of the bone.[9] The desired amount was communicated to the laboratory and drawn on the models with a red pencil line.

*A clinical evaluation found that it was possible to remove tissue without violating biologic width requirements.*

The next phase of the diagnostic waxing process was referred to as the additive-reductive phase, where an ideal result was achieved by adding wax to areas deficient in contour and removing stone from over-contoured areas (Figure 4). Studying this model and observing areas where wax was added and stone was removed helped determine marginal placement and preparation design. Areas where stone was removed required a more aggressive preparation whereas areas covered in wax needed less tooth structure removed to achieve the restorative goals. All areas added to or reduced needed to be restored, so the minimum marginal position required to achieve this result is defined as the end of the waxed or re-contoured area. This technique was especially useful when trying to visualize the ideal placement of lingual margins in the anterior region of the mouth.

The additive/reductive models were placed on the articulator. In the authors' opinion, this technique seems to be indispensable because of the fact that it is nearly impossible to lose sight of where a dentist is heading with a case. To achieve a level occlusal plane, the verified stick bite was placed on the maxillary anterior teeth and wax was placed on the cusp tips of the mandibular cuspids.[6] Slight reduction of the lingual of the maxillary canines had to be done to accommodate the lengthened mandibular cuspids. The maxillary model was removed from the articulator and replaced with the Stratos® 3D template (Ivoclar Vivadent®, Inc), which was used to achieve ideal curve of Spee and Wilson as the mandibular arch was waxed. There was no need for use of a Broderick flag because the three-dimensional template was designed to establish the curve of Spee and Wilson[10] (Figure 5). The mandibular cuspids were lined up on the template grid and an ideal plane was set. The screws were tightened, locking the occlusal plane template into position. The remaining teeth to be restored were waxed and contoured, and stone was reduced using the template as a guide. Posterior cusp tips were also spotted in, thus ensuring a proper plane of occlusion. The three-dimensional template was removed and replaced with the maxillary model. Replacing the mandibular additive reductive model with an unaltered preoperative model allows the stick-bite to be used to visualize a level plane of occlusion on the maxillary model. The vertical midline was marked. Wax was added to

*Figure 7—The finalized wax-up and models were polished before being duplicated with Sil-Tech® putty.*

the incisal edges, and stone was removed to make a rough guide for the incisal plane.

Knowing that the six anterior teeth needed to be lengthened and tissue symmetry needed to be established, it was decided to lengthen the lower anteriors both apically and incisally by removing and contouring tissue and adding wax to the incisal edges for length. The dentist sounded to the crest of bone, noting the allowance of tissue changes cannot exceed 1.5 mm without violating biologic width minimums on teeth Nos. 6 through 11.[9] The current measurement of the anterior teeth was 6 mm so these authors sculpted the tissue to the allotted amount of 1.25 mm to 1.5 mm and lengthened the incisal edges to 2.5 mm. Because the current width of the centrals is 8 mm, this will establish a more ideal length-to-width ratio. Again, wax was added and stone was removed from the teeth to be restored, posterior cusp tip positions spotted in using small cones of wax, constantly checking function against the additive/reductive lower model, until a balanced, functional occlusion system has been achieved in harmony with the esthetic desires of the treatment team.

On a second set of models, using the additive/reductive models as a guide, the stone teeth were prepared for restorations and this model was duplicated. The duplications were poured and trimmed so they can be used as a chairside reference during preparation design and margin placement to help the dentist prepare the patient. The additive-reductive models were duplicated using a laboratory putty and the duplications were put on the prepared, based models and liquid wax was injected (Figure 6). After a few minutes the wax cooled and the putty was removed revealing diagnostic models that were 80% complete. The contours were refined and the function verified by working through anterior guidance parameters leaving diagnostic blue prints for the final case. The functional envelope was evaluated to ensure that anterior guidance was compatable with posterior morphology. The finalized wax-up and models were polished before being duplicated with Sil-Tech® putty (Ivoclar Vivadent®, Inc) (Figure 7). This putty matrix was used clinically, with Luxatemp® (Zenith™/DMG), to create the provisional restorations in the patient's mouth.

## Summary of Diagnostic Waxing Phase

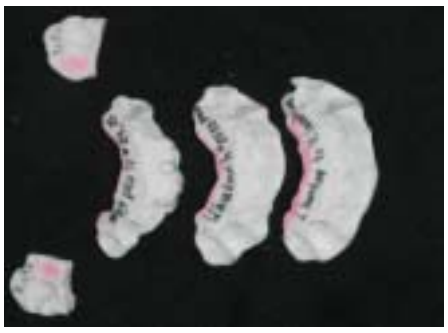
The additive/reductive waxing process produces information critical to case planning and preparation design. Extent of tooth coverage necessary and margin placement were deduced.

Areas of aggressive and conservative preparation were identified and potentially incomplete treatment plans can be exposed. Gingival architecture changes were identified and planned for. A silicone stint was generated to transfer all this information into the provisional restorations, thus giving the patient a chance to clinically test and evaluate the restorations before the definitive restorations were fabricated.

A face-bow was taken. A stick bite was also taken with the patient standing up. Care was taken to make sure the stick was level with the horizon and parallel to the interpupillary line. A full-face photograph was taken of the patient with the stick bite in place to verify accuracy, it is critical that this photograph be taken straight on, with the patient standing, not from a deflective angle (off to the side). Photographs were taken of the preparations with a shade guide in the picture to communicate to the laboratory the shade of the underlying dentine.

Prep-to-prep bite registrations were taken at a CR position via bimanual manipulation technique.[11] This bite was taken in three segments: the anterior segment, which records the relative position of the prepared teeth; and the two posterior segments, which record the positions of the unprepared distal molars. The maxillary arch was provisionalized using the silicone matrix from the diagnostic wax-up. This matrix was filled with Luxatemp® and carefully seated in the patient's mouth for 1 minute, and then removed. The provisional restoration came out with the matrix and was allowed to finish polymerization in the stint so as not to distort. The provisionals were carefully removed from the stint and placed immediately back onto the teeth to check for the fit and marginal integrity. For reasons of stability, the provisional was left in one segment (not separated into individual teeth). Margin finishing was completed and thickness was evaluated. If any thin areas are identified, further reduction of the teeth can be accomplished at this time, or contour of provisional restorations can be evaluated to determine if thickening the restorations would compromise the esthetic goals of the treatment.

Final impressions of preparations were taken on the maxillary arch at that time. After a clear impression was obtained, the provisional restorations were placed onto the unetched teeth with a drop of OptiBond™ 2 (Kerr Corporation) adhesive unfilled resin in each to serve as a provisional adhesive. No spot etching was used. Marginal areas were finished with great care to the tissue and margin itself. To allow cross mounting of the models of the provisional restorations and the prepared tooth models it was necessary to take a bite registration from the lower preparations to the maxillary provisional restorations. This was accomplished by reinserting the posterior bite segments taken in the initial bite registration and carefully manipulating the mandible allowing complete closure into those bites. An anterior bite was taken from lower preparation to upper provisional restoration. By leaving the posterior bites in place there should be exact replication of the mandibular position achieved with the first bite. The mandibular provisional restorations were fabricated and delivered using the same procedure previously described for the maxillary provisionals. The occlusal relationship of the two arches was checked with the posterior bites in place to ensure proper anterior coupling and eliminate any prematurities. After the patient was provisionalized, the posterior bites were seated in the patient's mouth a final time and an anterior bite was taken from lower provisional to




*Figures 8 through 11—This sequence of recording bite relationships allows full-cross mounting and interchangeability of the provisional and working models.*

upper provisional. This sequence of recording bite relationships allowed for full cross mounting and interchangeability of the provisional and working models (Figures 8 through 11), thus allowing the laboratory to replicate what was successfully achieved in the provisional restorations. Impressions were taken of the provisional restorations using the same care, which was employed when taking the impressions of the prepared teeth.

The patient was recalled for evaluation and photography several days after the initial preparation appointment. Esthetics, phonetics, anterior coupling and guidance, posterior disclusion, balancing interferences, and overall patient comfort were evaluated. Esthetic improvements can be achieved by recontouring or with flowable resin augmentation. Centric relation–centric occlusion compatibility was checked, and if necessary equilibration was undertaken to alleviate any discrepancies. The re-evaluation appointment several days later allowed for clinical trial at the new anterior guidance and vertical dimension. The success may be immediately apparent or take several sessions to refine according to patient comfort and function. This provisional phase was critical to long-term success and the understanding of the final restorative parameters. If any changes are needed to satisfy any of these parameters, new models and bite records must be taken.

A series of photographs were taken to help the laboratory to visualize the clinical situation. It is important that this series be taken at a separate appointment (after preparation) to eliminate the effects of anesthesia and

swelling and to include any esthetic changes that were made.

## Bite Recovery Procedure

The bite recovery procedure was as follows:

1. New polyvinyl impressions of provisional restorations were taken.
2. New face-bow of provisional may be taken or original face-bow mounting of prepared teeth may be used.
3. New posterior bite registrations were taken of the unprepared molars with provisionals in place.
4. Anterior provisional-to-provisional registrations were taken with the posterior bites in place. Care needs to be taken to ensure full closure into the posterior bites in all the following steps.
5. Two to four lower anterior provisionals were removed.
6. A bite from lower preparation to upper provisional was taken with posterior bites in place.
7. Upper central provisionals were removed.
8. A bite from upper preparation to lower preparation with posterior bites in place.
9. Provisional restorations were recemented.

All impressions were poured, pinned, and based. A face-bow transfer jig was used to mount the maxillary master model to the Stratos® 200 articulator (Ivoclar Vivadent®, Inc). This insures the distance from the condile to the teeth, and the resulting arc of closure and excursive movements are approximated on the articulator. The face-bow also recorded the angulations of the maxillary plane from anterior to posterior, which affected how protrusive or retrusive teeth appear in the oral environment. Mandibular models were mounted with the prep-to-prep bite registrations. The maxillary provisional model was then mounted to the mandibular preparation model using the lower preparation to upper provisional bite registration. Finally the upper provisional model was mounted to the lower provisional model using the provisional-to-provisional bites. Because the same two (left and right) posterior bites were used for all three



*Figures 12 through 14—After lubricating the dies the matrices were placed. A wax injector was used to inject liquid wax through a small hole cut in the incisal edge of one of the central incisors.*

*Figures 15 and 16—Contours were fine-tuned if needed and surface morphology was enhanced.*

*Figures 17 and 18—Restorations were fit to a solid model, glazed, then polished and etched before delivery.*

*Figure 19—Provisional restorations were removed and ceramic restorations were bonded to place.*

mountings, there was very little potential for discrepancies and all mounted models should interchange completely.

To transfer the shape and position of the successful provisional restorations to the final restorations, an impression was taken of the provisional model then transferred to the preparation model. The pinned, sectioned models were cleaned of any stone abnormalities that would keep the matrices from seating. All the dies were sealed and die spacer was applied. After lubricating the dies, the matrices were placed and a wax injector was used to inject liquid wax through a small hole cut in the incisal edge of one of the central incisors (Figures 12 through 14). Good technique will transfer an accurate replica of the provisionals. These wax injections should be interchangeable with provisional models and should display the same occlusal contacts, etc.

Slight discrepancies because of the seating of the silicone stint are normal but should be very minor in nature. If significant discrepancies are observed the usage of the bite registrations in the laboratory should be reviewed first, then the wax injection should be redone. If the same results are repeated, it is a strong indication of a clinical difference between the bite position

of the provisional restorations and the position of the CR prep-to-prep bite. To resolve this discrepancy, a bite recovery procedure described previously should be preformed. Fabrication of the definitive restorations should not be undertaken until full agreement between the mounting of the provisional and prepared models is obtained.

Another benefit of the wax injection transfer technique is the reproduction of the entire envelope of function, which is worked out and verified with provisional restorations, to the final restorations. This minimizes or eliminates the need for custom guide tables on the articulator and transfers the exact shape and position of the lingual surfaces of the provisional restorations, which were adjusted on the best articulator in the world, the patient's own mouth.

Final contouring, surface morphology, and posterior anatomy were done.[12,13] Each unit was separated using a fine blade and dies were trimmed to enable the sealing of margins. The diagnostic wax-ups were then invested and placed in a burnout oven to eliminate the wax; and ceramic material was liquefied and pressed into the mold. After cooling, the investment was blasted away with 50-µm glass beads, revealing the IPS Empress® (Ivoclar Vivadent®, Inc) restorations. Each unit was fitted back to the working model and any necessary contact adjustments were preformed and verified with a Mylar strip (Patterson Dental Supply Company). After the sprues have completely been removed, the function and occlusion are evaluated and finalized. Contours were all fine-tuned if needed and surface morphology is enhanced (Figures 15 and 16). Incisal matrixes were made to assist in cutback. The No. 1 ceramic material selected to press the restorations was of an appropriate translucency and chroma for the gingival two thirds of the restorations, but lacked the translucency desired in the incisal one third. The incisal one third of the pressed restorations were cutback with a Dialite™ wheel (Brasseler USA®), and restorations are lightly sandblasted, washed, and dried. Each unit was placed on a moistened stumph die (Ivoclar Vivadent®, Inc) (special effects powder) and color was added, in this case a slight bit of 110 (IPS Empress® Stain) to the cervical and middle thirds (blended slightly to the incisal) and blue/grey on the incisal mesial and distal for an added translucent effect and a slight amount of copper on the middle lobe of the incisal to create an amber color zone which helps to produce a polychromatic, natural appearing incisal effect. A glaze bake was completed. Internal effects were further enhanced using yellow-grey and white incisal porcelains to form the internal dentine lobes. After these were fired two additional bakes of the Translucent Super Opal (Ivoclar Vivadent®, Inc) (special effects powder) were applied to complete the desired contour and were then fired. The added porcelains were contoured and blended into the previously finalized areas.

Restorations were fit to a solid model, glazed, then polished and etched before delivery (Figures 17 and 18). Provisional restorations were removed and ceramic restorations were bonded to place (Figure 19). Conservative posterior onlays were subsequently used to complete treatment and finalize the patient's occlusion.

## Conclusion

Although treatment tends to focus around satisfying esthetic concerns and requires consideration of both hard- and soft-tissue needs, many times too little attention is paid to condular position and bite relationships. To predictably and successfully complete comprehensive cases, patient comfort and esthetic satisfaction need to be achieved in provisional restorations. Furthermore this comfortable position must be recorded and transferred to the laboratory in a way that ensures the definitive restorations replicate the position achieved with the provisional restorations. It is only by systematically approaching this bite recovery process that the laboratory is able to mount both provisional and preparation models interchangeably thus ensuring the replication not only of tooth form and position to esthetically reproduce the provisionals, but also of the condular position in which the patient was comfortable while wearing provisional restorations. ◯

## Disclosure

Dr. Trinkner received material support from Ivoclar Vivadent®, Inc, Brasseler USA®, and Zenith™/DMG.

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## Product References

**Products:** Stratos® 200 articulator, Stratos® 3D template, Sil-Tech® putty, IPS Empress®, stumph die, Translucent Super Opal
**Manufacturer:** Ivoclar Vivadent®, Inc
**Address:** 175 Pineview Drive, Amherst, New York 14228
**Phone:** 800.533.6825
**Fax:** 716.691.2285

**Product:** Luxatemp®
**Manufacturer:** Zenith™/DMG
**Address:** 242 South Dean Street, Englewood, New Jersey 07631
**Phone:** 800.662.6383
**Fax:** 201.894.0213

**Product:** OptiBond™ 2
**Manufacturer:** Kerr Corporation
**Address:** 1717 West Collins, Orange, California 92867
**Phone:** 800.KERR123
**Fax:** 800.KERR345

**Product:** Mylar strip
**Manufacturer:** Patterson Dental Supply, Inc
**Address:** 1031 Mendota Heights Road, St. Paul, Minnesota 55120
**Phone:** 800.328.5536
**Fax:** 651.686.9331

**Product:** Lucia jig
**Manufacturer:** Great Lakes Orthodontics, Ltd
**Address:** 200 Cooper Avenue, Tonawanda, New York 14150
**Phone:** 800.828.7626
**Fax:** 716.685.0810

**Product:** Dialite™ Wheel
**Manufacturer:** Brasseler USA®
**Address:** 1 Brasseler Boulevard, Savannah, Georgia 31419
**Phone:** 800.841.4522
**Fax:** 888.610.1937