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Journal of Cosmetic Dentistry

Artistic Sensibility & Clinical Inspiration
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Noninvasive Trial Restorations
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Column

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> Contributions from a diverse author pool, including authors from other disciplines, help to expand and enrich our knowledge.

The *Journal of Cosmetic Dentistry* (*jCD*) recognizes the benefits and inspiration we all derive from fine digital dental photography. The vibrant work of Mr. Yuji Tsuzuki, a talented ceramist and photographer in Kyoto, Japan, is showcased on the cover of this issue and on pages 10 and 26-40. It is an unfortunate truism that, in our extremely busy lives today, we sometimes find ourselves merely "going through the motions." I urge you to stop for a moment to appreciate these vital images. Let them remind you of what inspires you in your own work. And as you read through this issue of the journal, take note of the different thought-provoking techniques your colleagues are using to solve their treatment challenges—perhaps these, too, will inspire your motivation!

To continue in that vein: You, in turn, can inspire and motivate your colleagues. Consider being not only a *jCD* reader, but also an author. The *jCD* is an important venue for information exchange that helps connect the cosmetic dental community worldwide. Contributions from a diverse author pool, including authors from other disciplines, help to expand and enrich our knowledge. Manuscripts concerning case studies, tips, techniques, research, and clinical reviews are welcome.

In closing, I would like to extend heartfelt thanks to Dr. J.A. Reynolds for his outstanding service over the past five years as a Contributing Editor for the *jCD*'s Accreditation Essentials section, helping the journal to publish the very best teaching cases. We look forward to building on his achievements, and we welcome Dr. Brian Gilbert as his successor.

Edward Lowe, DMD, AAACD
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Photo by Yuji Tsuzuki, CDT

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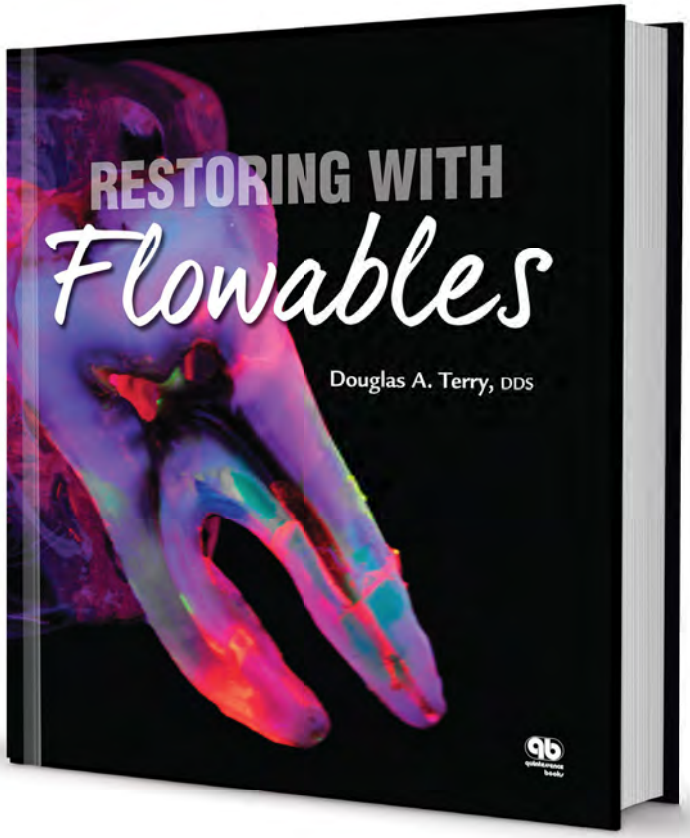

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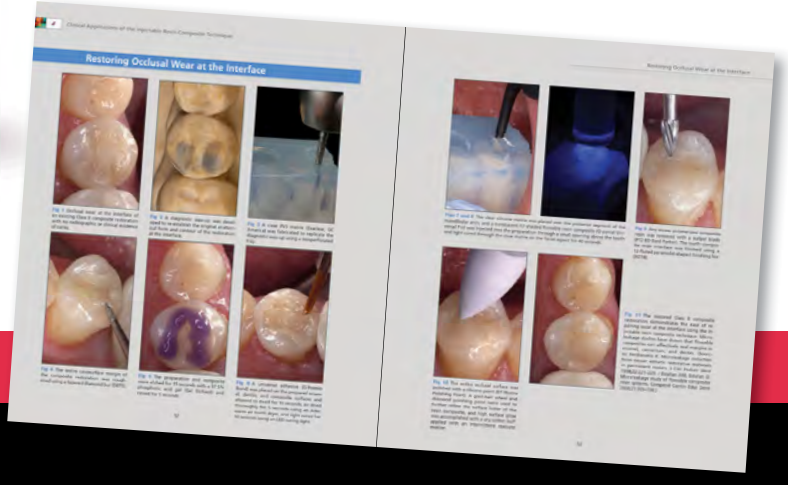

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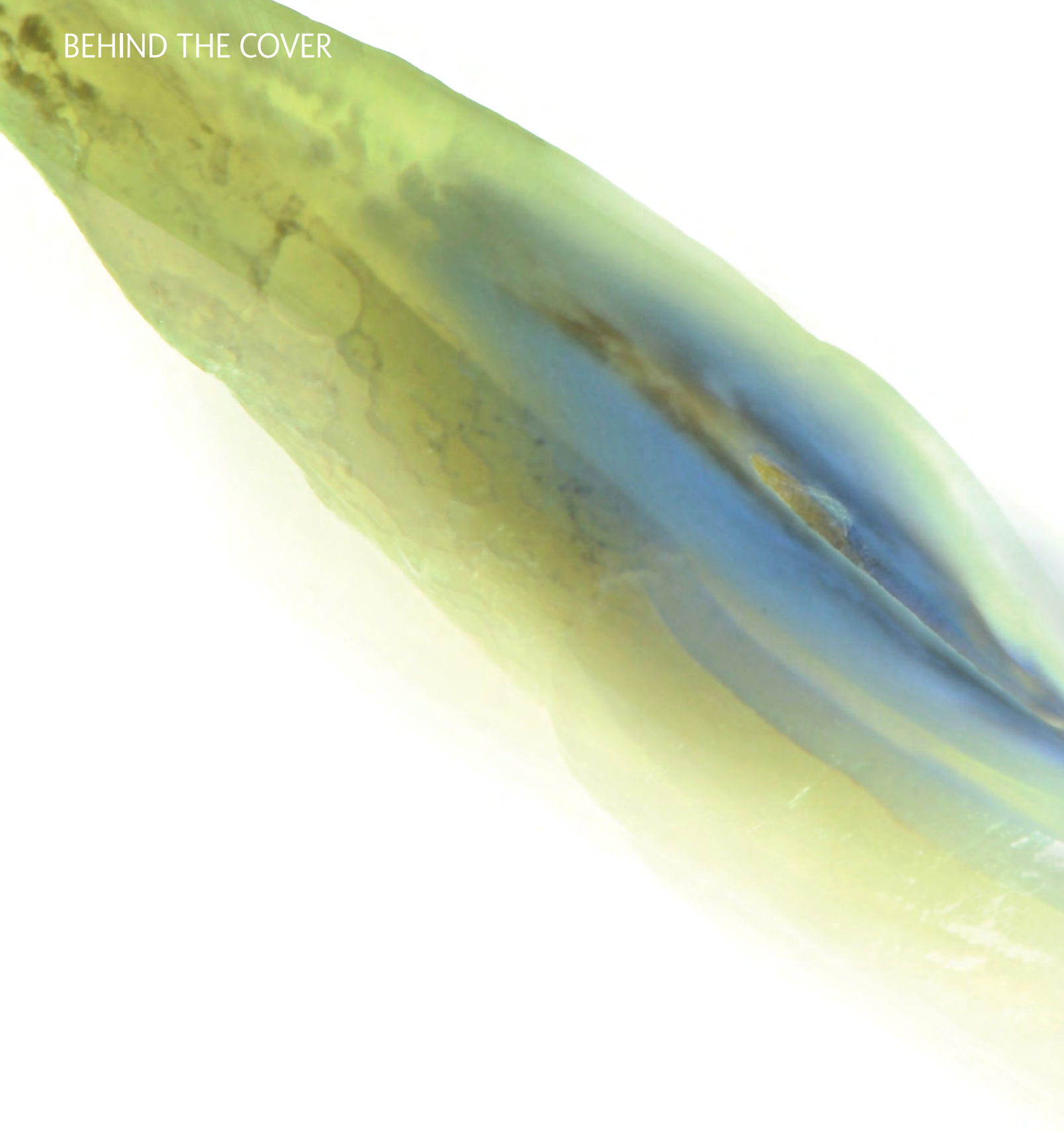

Artistic Sensibility & Clinical Inspiration

By Yuji Tsuzuki, CDT

> "The esthetic outcome is not supposed to be an accidental product; it must be *intentional*, completed through a purposeful plan."

Digital photography is tremendously beneficial to the expressive power of esthetic restorations. Beautifully crafted restorations can justly be considered a type of art. The esthetic outcome is not supposed to be an accidental product; it must be *intentional*, completed through a purposeful plan. The use of a digital camera can help to maximize our performance in producing meticulous, yet artistic, clinical work.

Although having a high-specification camera is helpful, I believe that composition and lighting are most important in achieving artistic imagery. You must capture the moment when you feel the possibility of beauty. Tap into your artistic sensibilities—let your experiences with and admiration of complex emotional and esthetic influences inspire your work.

Documenting your clinical cases visually can be motivating and also can offer inspiration for improvement, which is necessary in our field. Depicted here and on the cover are photographs of my work that provide me with inspiration for clinical success. And if my images move you, that brings me even greater happiness.

Finally, the most important thing is to enjoy dental photography. Your enjoyment will transform into creative energy…and inspiration.

To see more of Mr. Tsuzuki's work, turn to the Visual Cover Essay on page 26.

Cover image by Yuji Tsuzuki, CDT (Kyoto, Japan). Cover image shot with a Nikon D810 (Tokyo, Japan).

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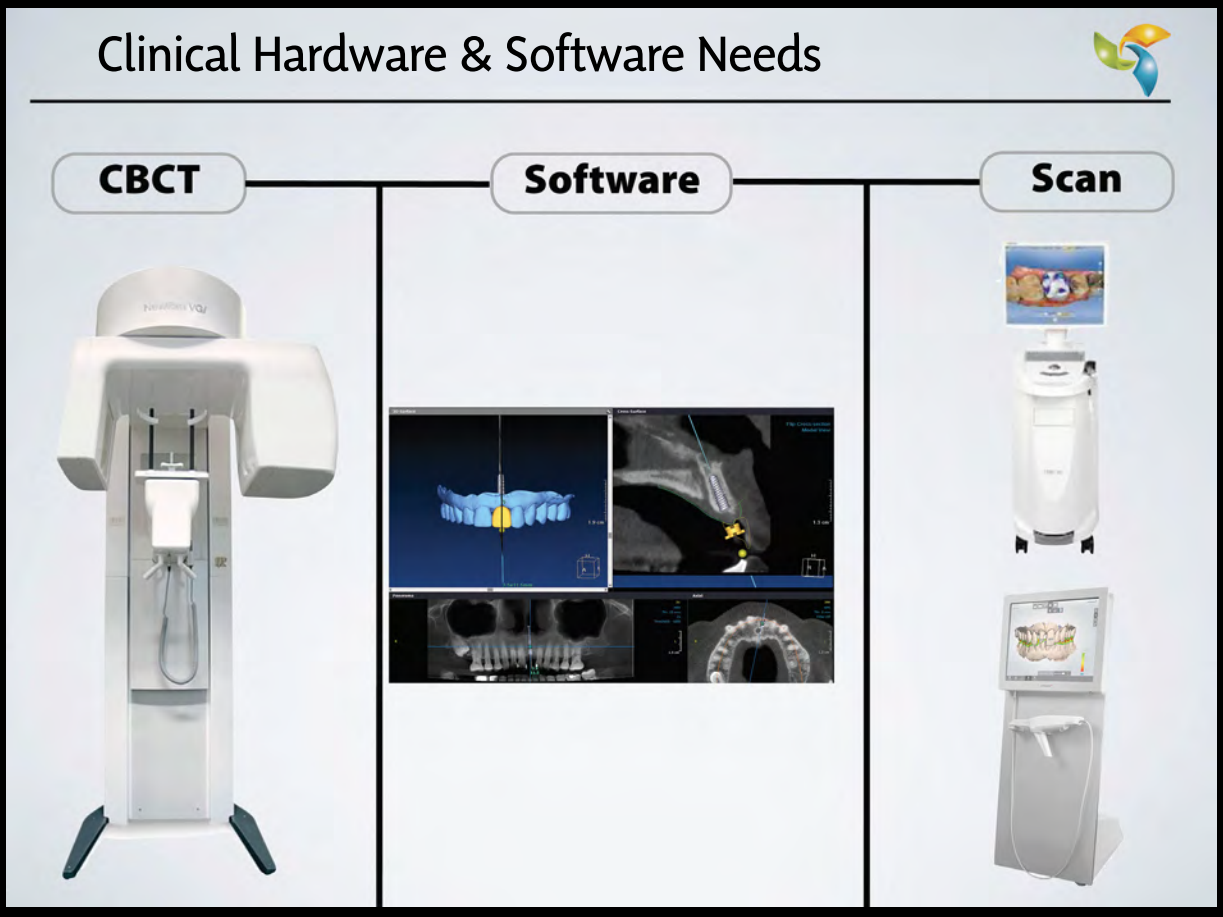
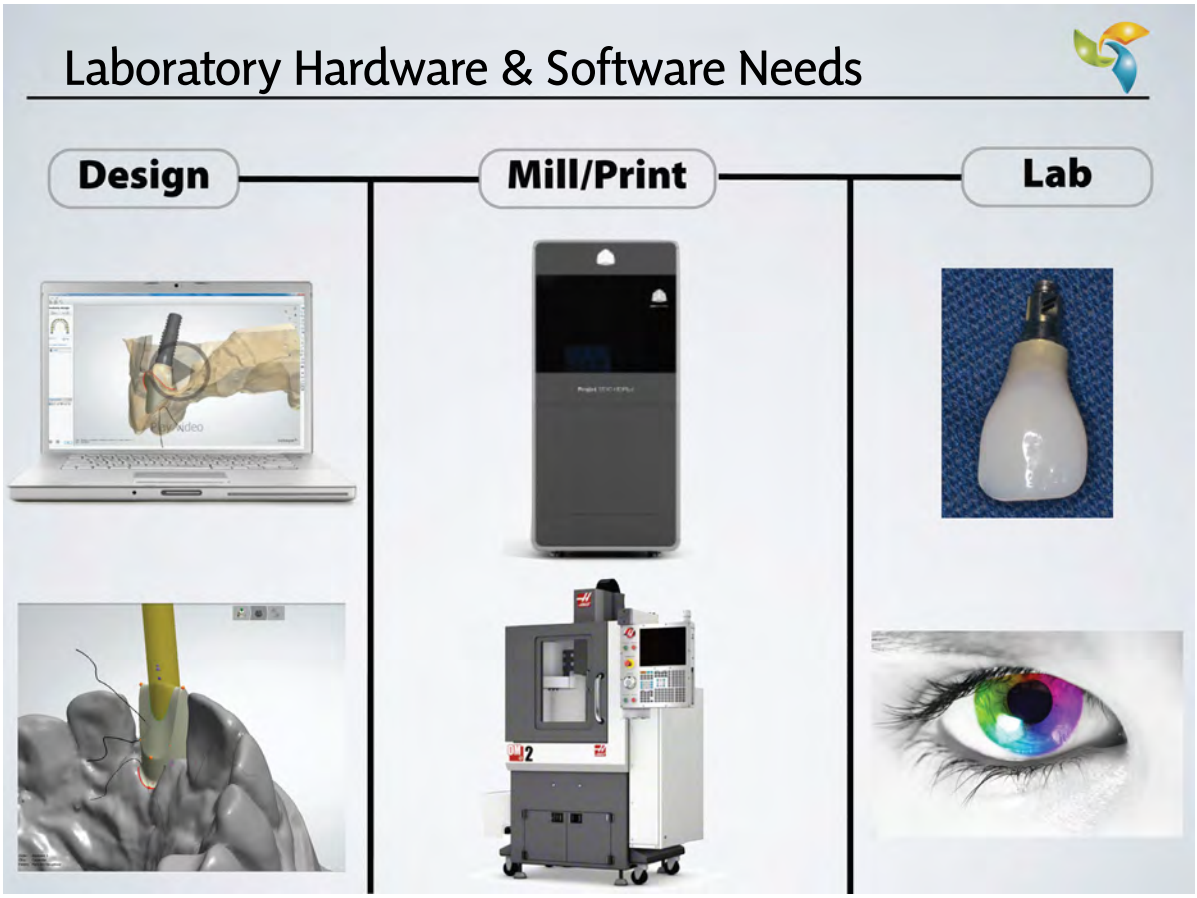
Exploring the "Brave New World" of Digital Workflow

An Interview with Dr. William Gianni

Dr. William Gianni owns and operates Kainos Dental Technologies in Walnut Creek, California. In this interview, he answers questions from AACD Professional Education Committee Chair Dr. Grace Sun. Dr. Gianni will present a lecture titled "Digital Flow in Dentistry" on Friday, April 21, during AACD Las Vegas 2017. In it, he will discuss how to work in a collaborative environment to efficiently manage and integrate complex digital workflows.

> "Dentists and dental technicians must implement technologies that are disruptive to the traditional dental business model."





Q: What have been some of the most dramatic advances in dental technology in the past five years?

A: The most profound change that has occurred in dentistry during that time is the integration of three-dimensional (3D) technologies such as:

- intraoral scanners (IOS)
- cone beam computed tomography (CBCT)
- 3D camera
- computer-assisted design (CAD) software
- computer-assisted manufacturing (CAM) (5+ axis milling and 3D printing).

Dentists and dental technicians today have access to affordable and precise 3D-based workflows. These platforms allow patients to be treated with 100% digital data. Dental technicians are fully embracing many of these technologies, and now is the time for dentists to share these amazing advances with their patients.

Q: What further advances do you anticipate in the next five years?

A: Automation. Essentially, this means that our workflows will become seamlessly integrated. Imagine 3D data being able to screen for pathology, make treatment-planning suggestions, and manufacture prostheses before clinical preparation or surgical appointments. While some dental professionals may be apprehensive about this "brave new world," the technological forces are too great to resist the automation of our profession.

Q: What are the pros and cons of adopting some of these new methods, instruments, and software into one's practice?

A: As small business owners we cannot afford to be on the wrong side of any technological innovation. Dentists and dental technicians must implement technologies that are disruptive to the traditional dental business model. The downside to this mindset is that the learning curve is steep and rarely is there an immediate return on investment. However, the following areas seem ripe for continued technological development: IOS, CAD/CAM, lasers, and implant planning software.

Q: How does the new technology benefit patients, from their perspective?

A: Today, patients and clinicians have access to most of the same information. As a result, patients expect their doctors to be up-to-date on the latest advances. The majority of patients really want someone who utilizes technology to enhance, not supersede, their clinical skills. Patients expect precision, comfort, and efficiency, but they regard technology merely as a vehicle along the way to receiving great dentistry at the hands of their clinician.

Q: Where should dentists who are unfamiliar with these advances begin? What is the initial time and capital investment needed?

A: Because technological innovation can occur overnight and every practice is unique, I am reluctant to make blanket suggestions. That said, however, I believe it is critical to master the science behind a technology. The ability to understand sound scientific principles will enable clinicians to apply the technology for the betterment of every practice, laboratory, and patient.

The *Journal of Cosmetic Dentistry* thanks Dr. Gianni and Dr. Sun for participating in this interview.

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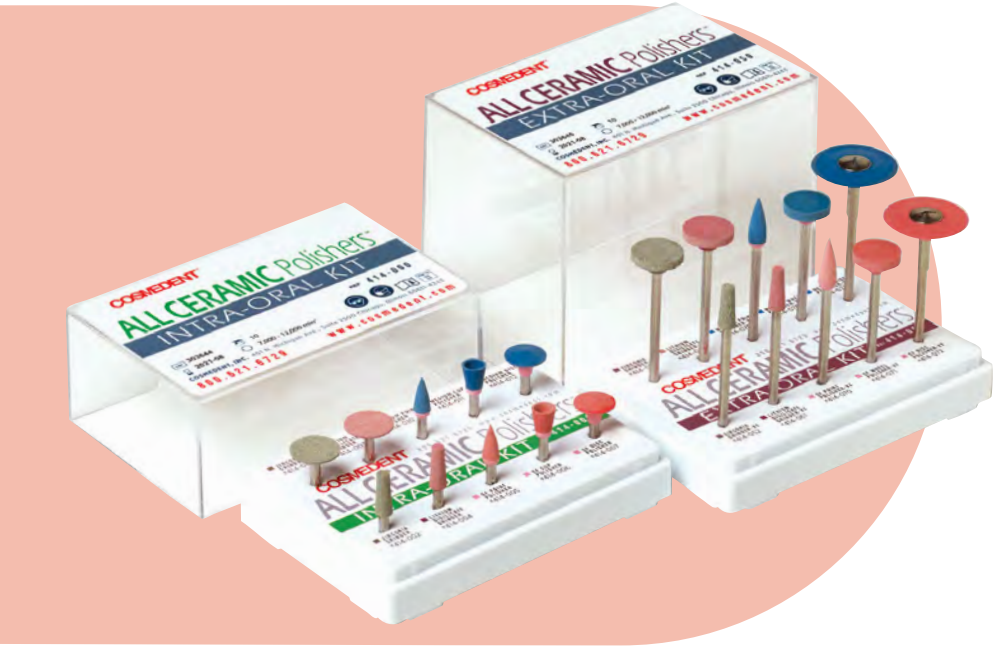

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Ensuring a Seamless Transition from Natural Tooth to Composite Restoration

Restoring a Lateral Incisor to Proper Dimensions After Orthodontic Treatment

Daniele Larose, DMD

> **"Because many Class IV restorations are performed on an emergency basis, this is an important technique for cosmetic dentists to master."**

Abstract

The most conservative method of restoring a Class IV fracture or correcting an anterior tooth size discrepancy often is with composite resin, which generally requires less removal of healthy tooth structure. Many dentists, however, choose porcelain over composite in this type of situation, as the blending of the restoration with the natural dentition can be a challenge. This article discusses a few simple composite techniques with minimal layering that can enable the dentist to mimic nature quickly and effectively, offering patients a quick, beautiful, and conservative result in a single appointment. Because many Class IV restorations are performed on an emergency basis, this is an important technique for cosmetic dentists to master.

Key Words: conservative, layering and tinting, incisal characteristics, hypocalcifications, primary anatomy, Case Type IV

Introduction

For a patient seeking the most conservative restoration, composite resin can offer a very natural appearance with little or no removal of healthy tooth structure.[1] This article discusses layering and tinting techniques to help ensure seamless transitions from natural tooth to composite restoration. Because Class IV emergencies are common, it is important for the practicing dentist to develop skills to hand-sculpt this type of restoration. In addition, using opaquers can create the necessary scattering of light that challenges the eye to differentiate the restored tooth from natural dentition **(Figs 1-4)**.

> **"...using opaquers can create the necessary scattering of light that challenges the eye to differentiate the restored tooth from natural dentition."**

Figure 1: Tooth #7's small size is noticeable on the preoperative full-face smile view.

Figure 2: The postoperative full-face smile view shows a much more balanced smile.

Figure 3: The preoperative full smile view reveals #7 is much shorter than #10.

Figure 4: Postoperative full smile view; the completed composite restoration.

Case Presentation

Chief Complaint and History

A healthy patient in her fifties wanted to enhance her smile. Her upper right lateral (#7) had always been small, creating an unesthetic imbalance. The patient had had orthodontics many years earlier but had not worn a night retainer, and crowding had gradually returned. She had composite dental repairs and had just finished additional orthodontic treatment to correct the crowding. The patient's teeth had been bleached at the beginning of her orthodontic treatment and she was satisfied with the shade.

Diagnosis

Examination and images, including the prescribed series of AACD photographs,[2] revealed that #7 was normal, but smaller in crown size than ideal. Some tissue inflammation, likely related to orthodontic attachments, was visible on the tooth's distal surface. The photographs and clinical data were reviewed with the patient. The main esthetic challenge would be to recreate incisal translucency and characteristics.

Treatment Plan

After the patient's crowding issues had been corrected with orthodontics, the gingival display at #7 was excellent. All that remained was to restore the tooth to proper dimensions. Different treatment options were discussed with the patient, including a composite veneer, Class IV restoration, and minimal-preparation porcelain veneer. Each option's expected longevity was explained. The patient chose to have the tooth restored with a Class IV mesial-incisal-distal restoration **(Figs 5 & 6)**.

Treatment

Preoperative

An anesthetic was not necessary to restore #7. All orthodontic attachments were removed and the facial surface was thoroughly polished. No tooth preparation was needed and only cleansing/air polishing of the surface (The Blaster, Bioclear; Tacoma, WA) with aluminum trihydroxide was necessary. The tooth's natural rounded shape did not require beveling to hide the composite/tooth margin.[3] Metal matrices were used to isolate #7. The entire facial surface was etched (Ultra-Etch, Ultradent Products; South Jordan, UT) for 15 seconds. The bonding agent (MPa MAX, Clinician's Choice; Brookfield, CT) was applied and thinned out with air prior to light curing **(Figs 7 & 8)**.[4]

Composite and Shade Selection and Technique

The composite, a prototype nano-optimized universal restorative material, was chosen because it is slightly translucent and has beautiful blending qualities. The handling properties of this new composite are excellent, enabling the operator to easily sculpt and contour to ideal shape. The prototype comes in three opacities: 80%, 85%, and 90% (prototype enamel, prototype, and prototype opaque, respectively).

The prototype shades match the Vita shade guide (Vita North America; Yorba Linda, CA), so no custom shade tabs were used. Prototype A2 is slightly more opaque than prototype enamel A2 and was placed as a thick lingual shelf to block out light and avoid show-through.[5,6] A small amount of A2-A3 Opaquer (Creative Color, Cosmedent; Chicago, IL) helped to eliminate the almost imperceptible transition line between the composite and tooth. A thin layer of A2 Enamel was sculpted into the facial lobes. Translucency was enhanced using Grey Tint (Creative Color) **(Figs 9 & 10)**.[7]

A technique that will help most restorations blend with the natural dentition is to create white craze lines that emulate those already present in the affected tooth or copy the surrounding dentition.[8] Preoperative close-up photographs will show that most teeth have some white lines, even though they cannot be seen by the naked eye. This characterization was added using a #1 artist brush (Cosmedent) and thinned out to a hairline thickness, which will cause light to scatter and create a beautiful blending effect within the restored tooth.[9]

Hypocalcifications were reproduced with Opaque White (IPS Empress Direct, Ivoclar Vivadent; Schaan, Liechtenstein), again applying the material with a #1 artist brush from the tooth structure to the incisal edge of the Class IV restoration. To create hypocalcifications, the Opaque White was applied in a diffuse manner to match the pattern on #7 and the adjacent teeth. A thin coat of translucent resin (Renamel Microfill Incisal Light, Cosmedent) was layered on top for its polishability and beautiful transparent quality, giving more depth to the restoration as it protects the tints/opaquers underneath. Tints must always remain sealed under composite resin as they will wear down quickly if unprotected.

Each layer of composite material and tints was cured with a high-power curing light (Valo LED, Ultradent). For the final curing, glycerin was placed on the restoration's surface to remove the oxygen-inhibited layer; this hardened the surface and made it easier to achieve a beautiful polish **(Figs 11-13)**.

Finishing and Polishing

The first step in finishing and polishing was to establish the correct incisal edge position. This was best viewed from the incisal perspective. It was helpful to trace a pencil line across the facial-incisal edges of the anterior teeth.[6,10] The next step was to craft the tooth's primary anatomy (the author recommends creating a diagnostic wax-up in advance to serve as a guide during the clinical appointment). A fluted carbide bur (ET-9, Brasseler USA; Savannah, GA) was used with a very light touch. The restoration's thickness was checked incisally at each layering stage to ensure the characterization would be perceptible once the restoration was completed; doing this also helped to reduce the need for postoperative adjustments.

Figure 5: Preoperative right 1:1 view; deep incisal embrasures and orthodontic attachments on #7.

Figure 6: Postoperative right 1:1 view; the characterizations resulted in a lifelike restoration that blends into the tooth and the dental arch.

Figure 7: Preoperative maxillary occlusal view; inadequate labial contour of the smaller tooth.

Figure 8: Postoperative maxillary occlusal view; ideal contour of the facial aspect.

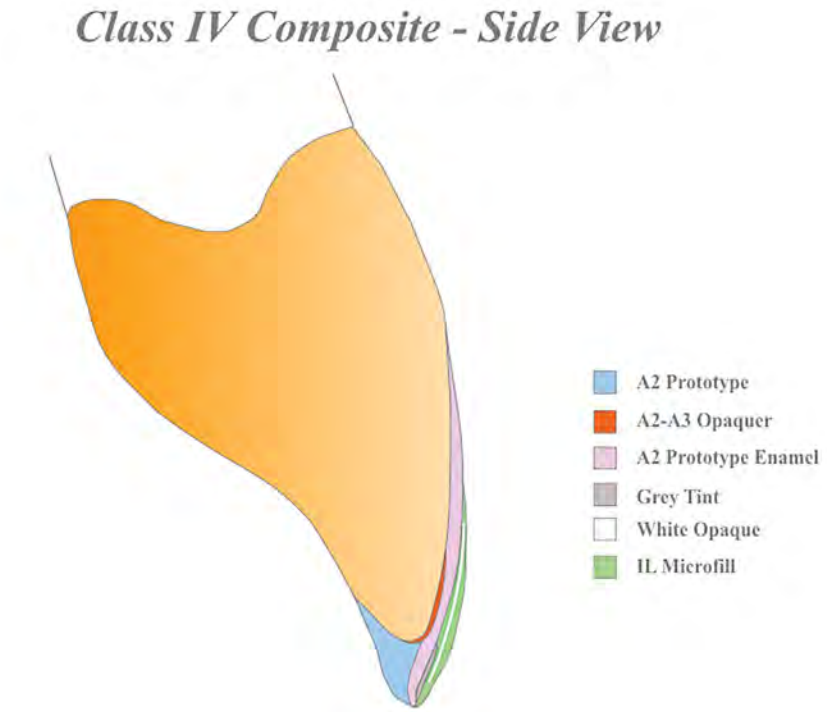

Figure 9: Color map depicting the order and thickness of all the composite layers.
(*Illustration by James H. Peyton, DDS, FAACD*)

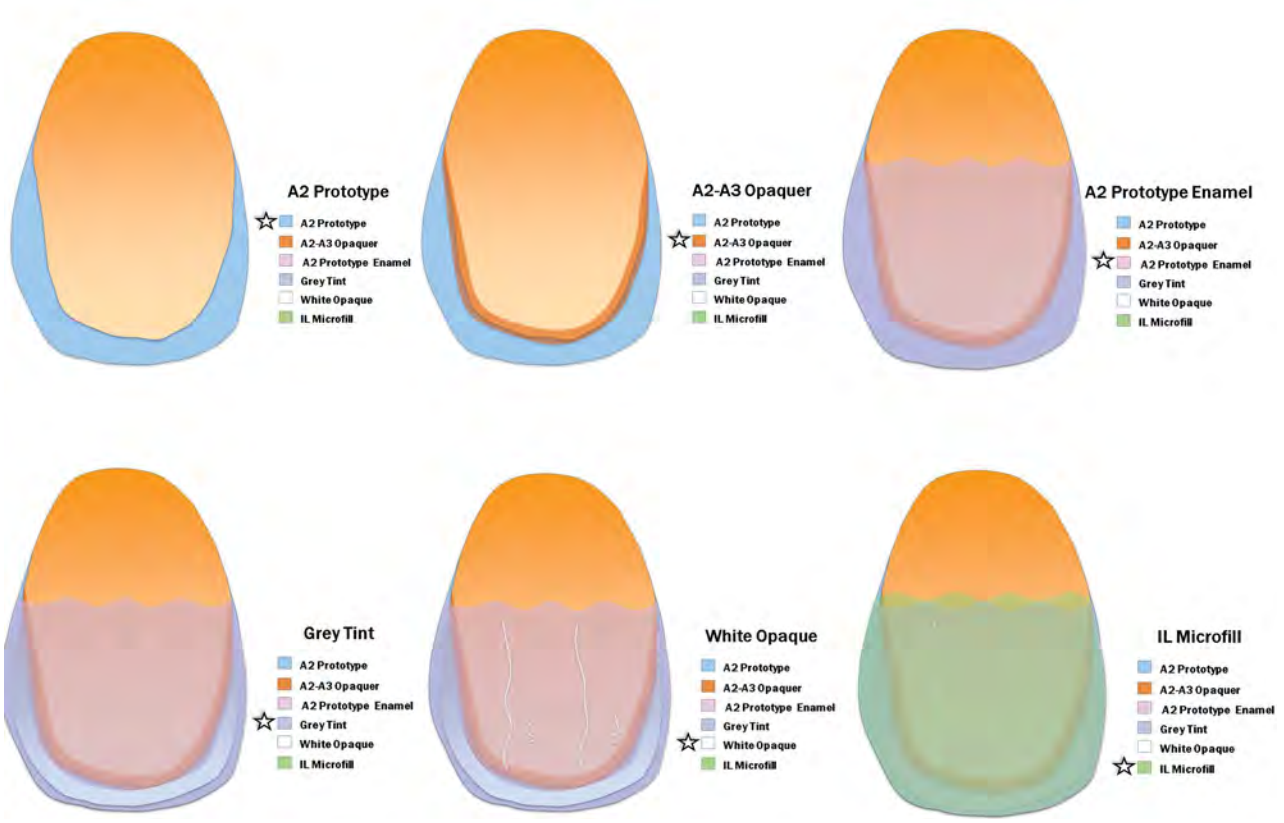

Figure 10: Step-by-step color map shows how each layer of material was placed on the tooth.
(*Illustration by James H. Peyton, DDS, FAACD*)

Figure 11: Postoperative x-ray shows no overhangs and an excellent interproximal contour.

Figure 12: Preoperative 2:1 retracted frontal view.

Figure 13: Postoperative 2:1 retracted frontal view.

The basic anatomic form of the tooth was achieved by contouring with a red disc (Sof-Lex, 3M ESPE; St. Paul, MN). Shallow mamelons were created with a pointed polisher (FlexiPoints, Cosmedent). The primary polish was obtained using disc polishers (ASAP, Clinicians Choice). Final luster was achieved with a polishing disc and paste (FlexiBuff and Enamelize, Cosmedent).[6,11] Photographs were taken to evaluate the esthetic outcome. The patient was shown her new restoration and was pleased with the results. She returned a few weeks later for a postoperative check, at which time the final AACD photographs[2] and x-rays were taken **(Fig 14)**. The tissue had healed well after removal of the attachments. Proper canine function was confirmed and lateral disclusion of the lateral was obtained, which is ideal with a Class IV restoration on such a small tooth.[12]

Summary

The missing incisal third of this patient's tooth was successfully restored with a prototype, easy-to-handle nanofill composite with superior blending qualities. The addition of tiny craze lines helped make the restoration even more undetectable and the transparent microfill surface ensured perfect polishability. Treatment was completed in one appointment and no touch-ups were needed. The patient was comfortable during the treatment and extremely pleased with the result. The best composite restoration is one that cannot be detected, because everything looks like natural tooth structure.

Figure 14: A happy, smiling patient.

> **"The main esthetic challenge would be to recreate incisal translucency and characteristics."**

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"The best composite restoration is one that cannot be detected, because everything looks like natural tooth structure."

Dr. Larose maintains a private practice in Saint-Laurent, QC, Canada.

Disclosure: The author did not report any disclosures.

Examiners' Commentary

Having a Free Hand in Creating a Dental Masterpiece

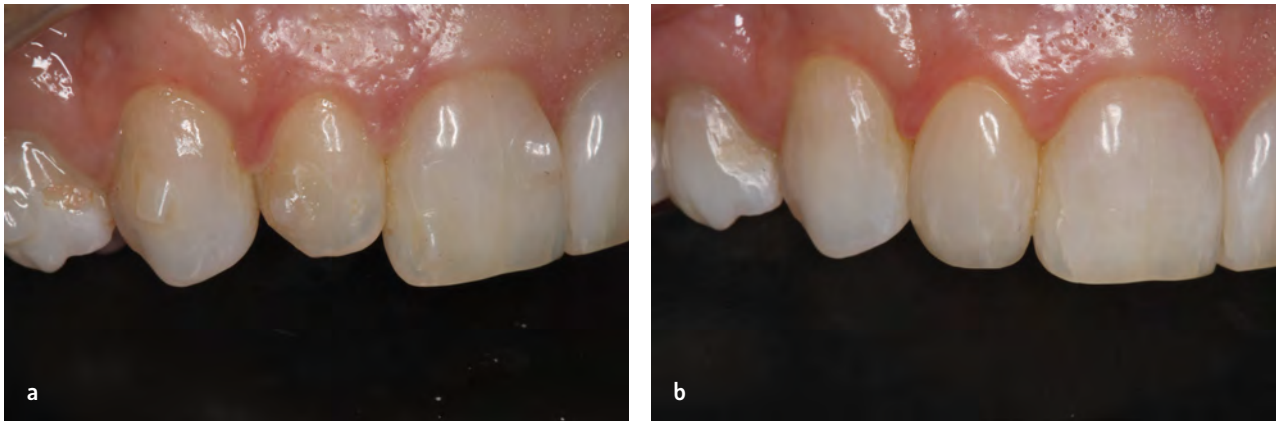
James H. Peyton, DDS, FAACD

> "A small, peg-shaped lateral incisor was transformed into a very natural-looking tooth that blended well with the adjacent dentition."

While esthetic composite restorations can be very conservative in nature, the restorative/cosmetic dentist also has a free hand in creating a dental masterpiece. Often there is no need to grind down healthy tooth structure; sometimes, the dentist only has to clean the outer surface of enamel and remove the aprismatic enamel layer.

Dr. Larose created a beautiful result for this case without removing healthy tooth structure. A small, peg-shaped lateral incisor was transformed into a very natural-looking tooth that blended well with the adjacent dentition. Tints and opaquers were used effectively and helped the restoration to blend imperceptibly into the affected tooth as well as with those surrounding it.[1,2]

Dr. Larose did an excellent job for her patient. This clinical situation demonstrates that a Class IV case for Accreditation does not have to involve a fractured tooth, as long as the restoration replaces more than 10% of the entire tooth **(Figs 1a-2)**.



Figures 1a & 1b: The before and after images show a fine job of layering the composite resin.

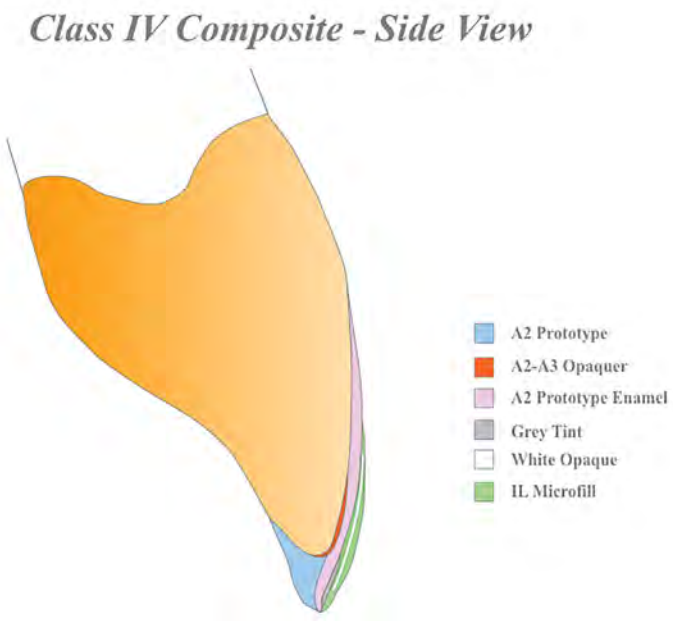


Figure 2: Color map illustrating how all the layers of composite material were applied to the restored tooth.

As with all dental restorations, however, nothing is perfect and the examiners noted the following faults:

- **Criterion 53:** *Is the color (hue, value, chroma) selection appropriate/natural, not monochromatic?* The restoration was low in value.
- **Criterion 83:** *Is the axial inclination appropriate?* There was a distal axial inclination.
- **Criterion 71:** *Is the periodontal health optimal?* There was mild tissue inflammation.

References

1. American Academy of Cosmetic Dentistry (AACD). A guide to Accreditation criteria. Madison (WI): AACD; 2014.
2. Peyton JH. Finishing and polishing techniques: direct composite resin restorations. Pract Proced Aesthet Dent. 2004 May;16(4):293-8. **jCD**

Dr. Peyton is an AACD Accredited Fellow and has been an AACD Accreditation Examiner since 2000. A part-time instructor at the UCLA School of Dentistry, he practices in Bakersfield, California.

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Congratulations to AACD's Newly Accredited Fellows!

The American Academy of Cosmetic Dentistry is proud to announce that Edgar Jimenez and Erik R. Haupt have become AACD Accredited Fellows!

AACD Fellowship is the highest level of achievement recognized by the Academy. It requires commitment and determination, and its status connotes education and excellence. It is necessary to first become AACD Accredited before one can attain the Fellow designation.

Well done, Mr. Jimenez and Mr. Haupt! Your dedication, enthusiasm, and insight are inspiring and we wish you many more years of great success!

Edgar Jimenez, FAACD
North Oaks, MN

Erik R. Haupt, FAACD
Brea, CA

Breathing Vivid Life into Our Creations

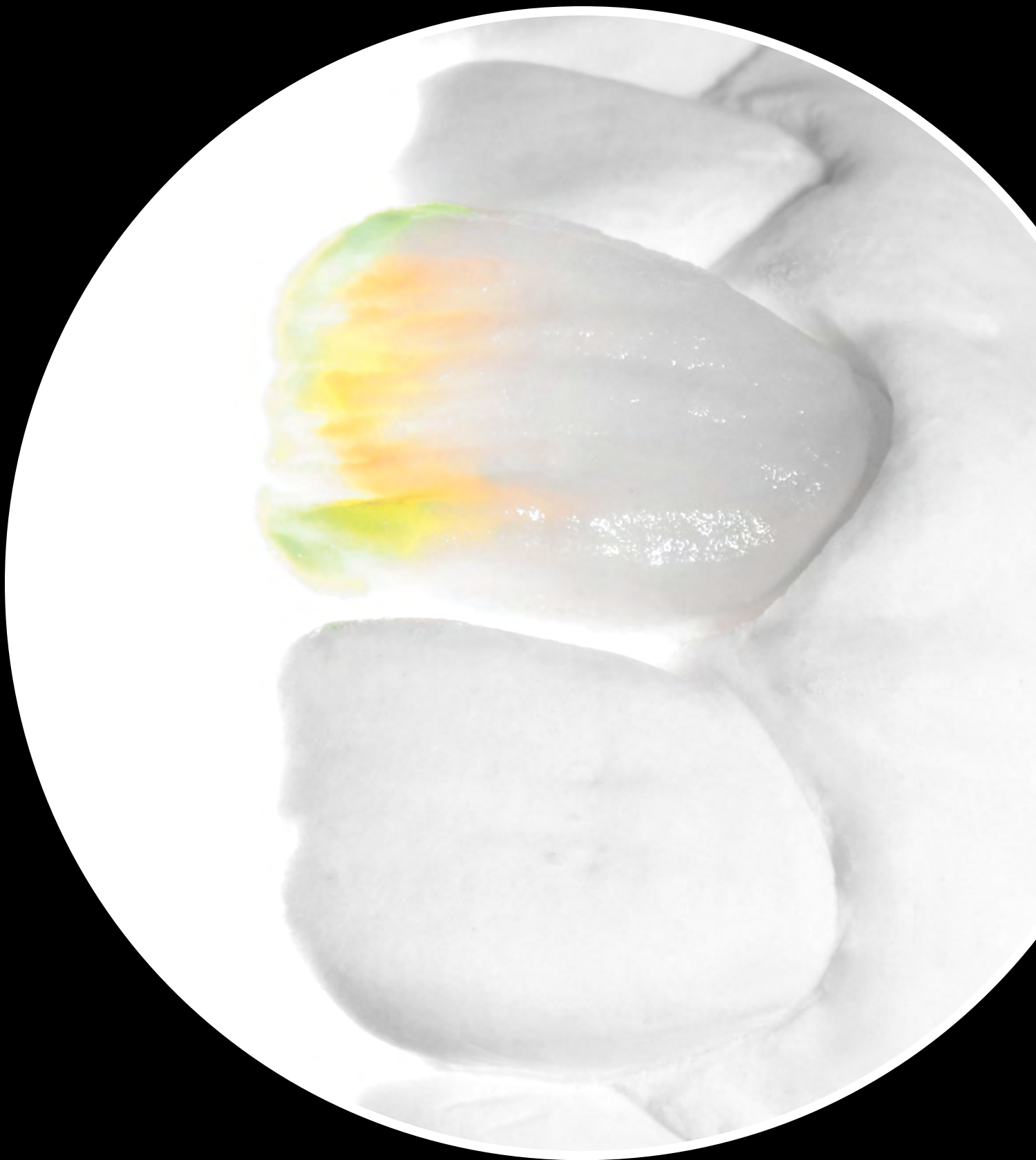
Combining Artistic Sensibility with Functional Essentials Achieves the Desired Outcome

Yuji Tsuzuki, CDT

Key Words: anterior restorations, anterior esthetics, cut-back and layering, tooth color

Introduction

Patients ultimately judge the restorative treatment of their anterior teeth based on our ability to realize two requisites for esthetics: natural beauty and ideal beauty. However, our restorative decisions must be guided by a number of functional and clinical considerations, including patient age, gender, number of compromised teeth, and current oral health status. By combining our artistic sensibility with knowledge of functional essentials, we can maximize the use of various esthetic materials to resolve the challenges we face when creating restorations that mimic multiple facets of natural teeth.



Natural Beauty

Reproducing natural beauty requires satisfying an insatiable curiosity about the unique characteristics of natural teeth through observation. This leads to the important realization that asymmetry is sometimes the hallmark of natural beauty that balances esthetics and function. For example, the angulation of a tooth, its incisal form, or the location of tooth surface characterizations can be reproduced to create an inherent beauty that patients feel comfortable with. Therefore, it becomes imperative for us to mimic in our restorative endeavors the interplay of color and form in a tooth based on the natural asymmetries that are present.

Natural *Beauty* in the Asymmetrical

A cut-back and layering technique was used with an esthetic pressable lithium disilicate (IPS e.max Press, Ivoclar Vivadent; Amherst, NY) to create a crown for tooth #9.

(Clinical work by Dr. Yusuke Yamaguchi)

Ideal Beauty

Achieving ideal beauty depends upon translating the patient's esthetic requests into final restorations that reflect their restorative desires. Close communication and collaboration between the laboratory technician and the dentist is of paramount importance to this process. Communication begins on the clinical side of treatment, where discussions with the patient identify their hopes, what kind of esthetic outcome is visualized, and how much can be improved restoratively.

Ideal *Beauty* in the Symmetrical

Teeth #7, #8, and #10 were functionally and esthetically restored to reflect natural beauty using porcelain laminate veneers, and #9 was restored with a crown created with a cut-back and layering technique and a pressable lithium disilicate material (IPS e.max Press).

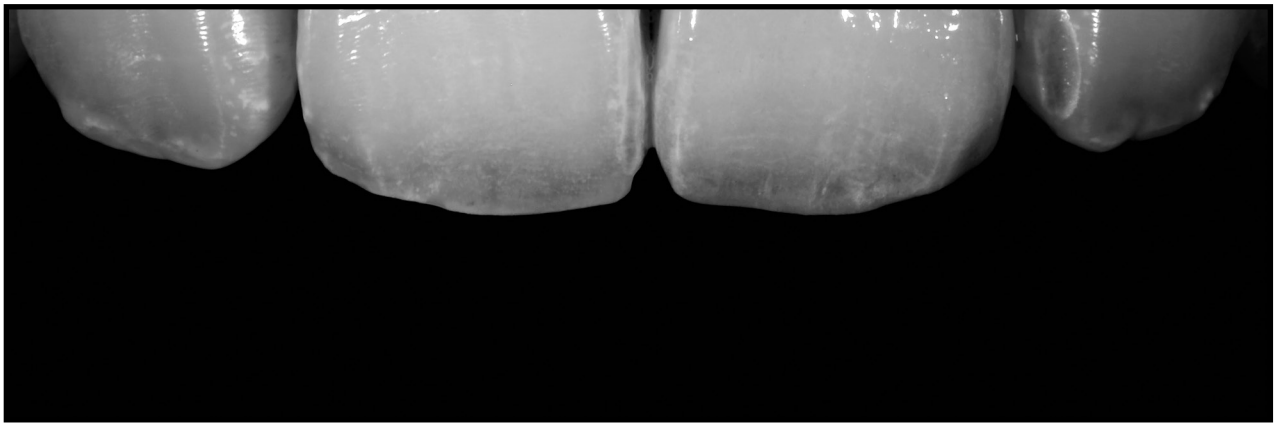
(Clinical work by Dr. Tatsunori Nagao)

(Clinical work by Dr. Tsutomu Kubota)

Mimicking Nature Through Understanding

A combination of external influences and the optical properties of internal tooth structure determine the color of natural teeth. Color characteristics such as brightness, chroma, shade, and opalescence result from the interaction of light with enamel and dentin layers and are perceived by the eye based on how external elements (e.g., lifestyle, lighting, oral health) affect them, and each of these can change over time. When we attempt to reproduce tooth color, we must consider—and replicate the effects of—these influences in our restorations. Therefore, excessive reproduction to capture "a moment in time" should be avoided. However, both internal and external characteristics comprise the totality of balanced tooth color, so reproducing them to suit the individual patient is essential. This requires magnification to visualize the various individual nuances of natural teeth so as to replicate these details in the final restorations.

Observe *Nature's* Individual Nuances



Tooth #9 would be restored with a cut-back and layered crown using a pressable lithium disilicate material (IPS e.max Press).

Artistic Sensibility

Esthetics encompasses many aspects of the smile (e.g., gingival symmetry, incisal edge position in relation to the lips, tooth proportion within the face) that must be artistically reflected when creating anterior restorations. Laboratory technicians develop their inherent intuitive skills in, and artistic sensibilities about, recreating the feelings experienced when observing a patient's smile in the context of all of their features through repetition. In order to replicate the essence of the individual—something that is intangible and not easily explained—detailed communication between the dentist and the laboratory technician is very important, along with a respectful partnership.

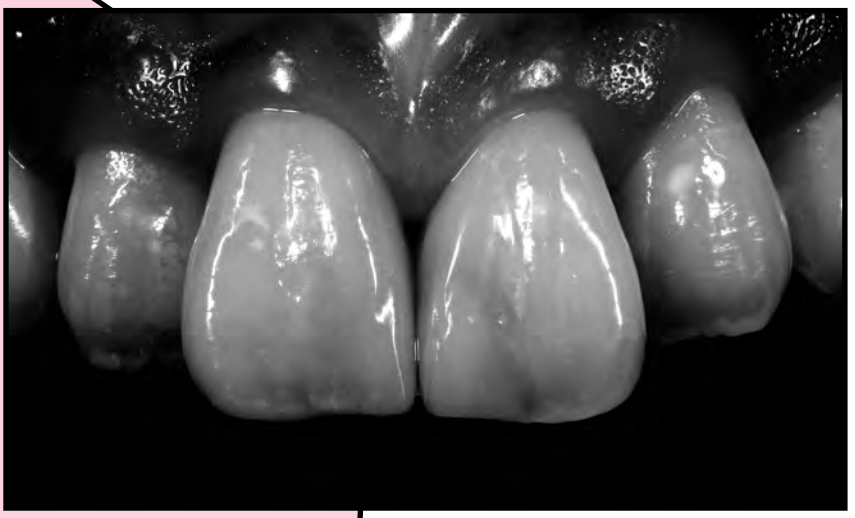
(Clinical work by Dr. Tsutomu Kubota)

Tooth #8 also would be restored with a cut-back and layered crown using a pressable lithium disilicate material (IPS e.max Press).

Light and Shade

There are many nuances of natural teeth that are invisible to the naked eye, yet which must be replicated in anterior esthetic restorations. A high level of esthetic treatment is therefore predicated on the laboratory technician's ability to demonstrate their expressiveness, creativity, technique, and skills in recreating these inherent subtleties in the restorations they produce. Today, the widespread availability of high-resolution and high-specification digital single-lens reflex cameras not only facilitates documentation of cases, but also enables confirmation and visualization of esthetic details. This raises our level of artistic skill and motivates us to achieve the best possible outcomes.

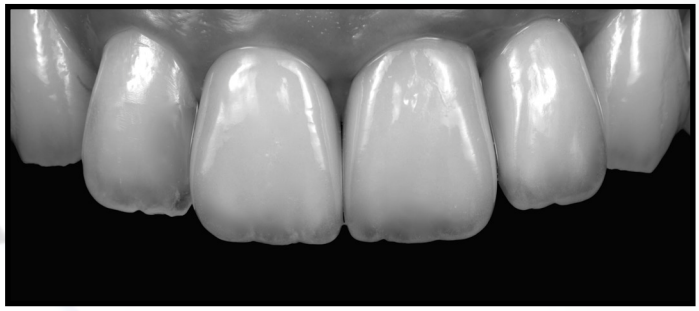
An artistic crown restoration was cut back and layered from pressable lithium disilicate (IPS e.max Press) for tooth #8.



(Clinical work by Dr. Tsutomu Kubota)

Teeth ##8-10 were expressively restored with cut-back and layered pressable lithium disilicate crowns (IPS e.max Press).

Detailed *Structure*

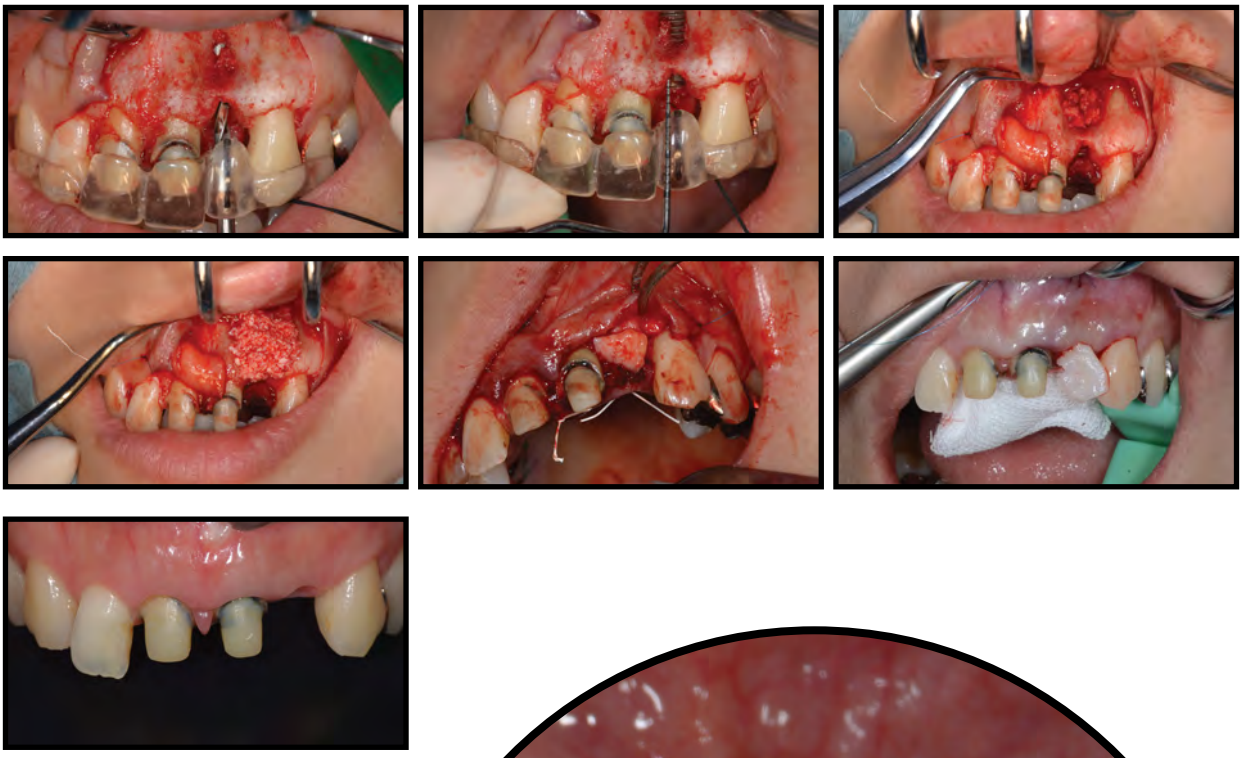


A pressable lithium disilicate material (IPS e.max Press) was used as a superstructure solution for the restoration on tooth #10.

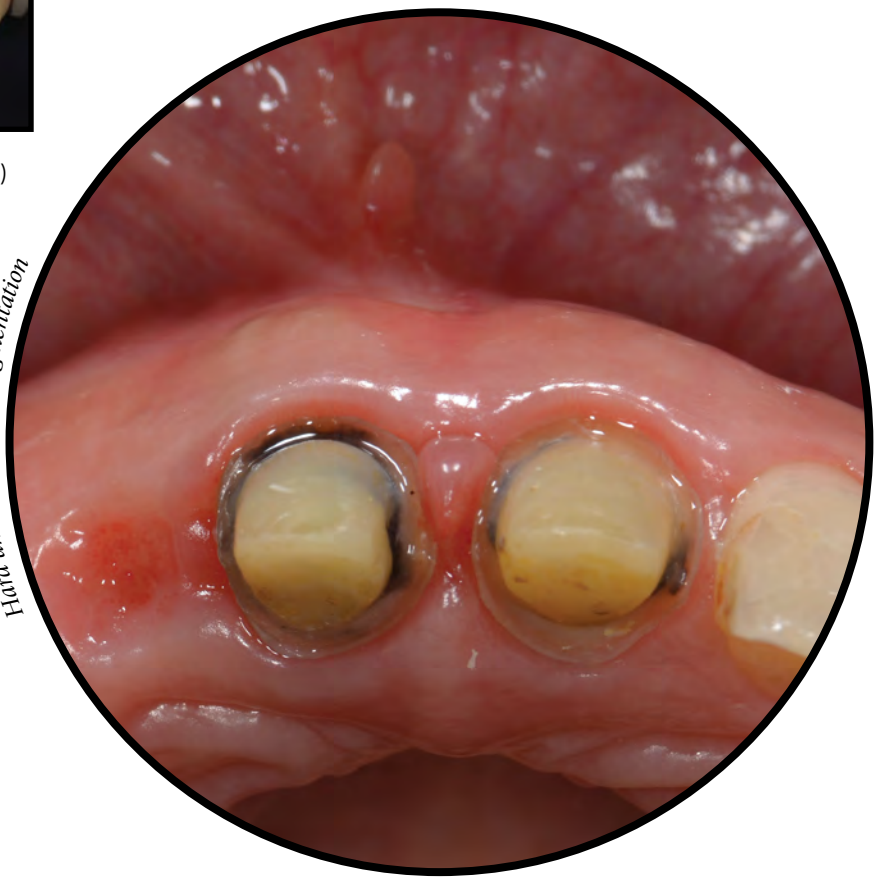
Vivid *Portrayal*

Realizing an Individual's *Essence*

The Foundation of *Brilliance*

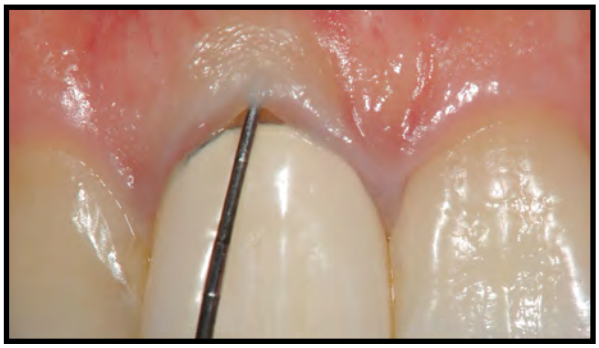


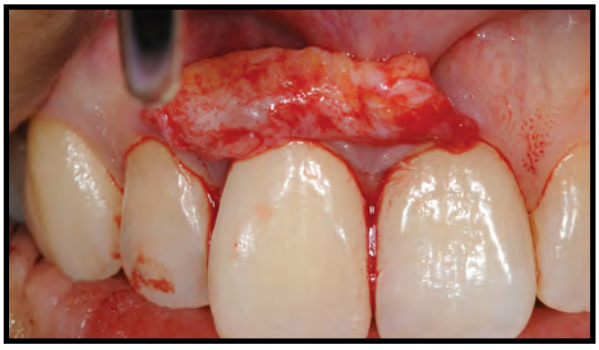
(Clinical work by Dr. Norimi Oda)



Hard and Soft Tissue Augmentation

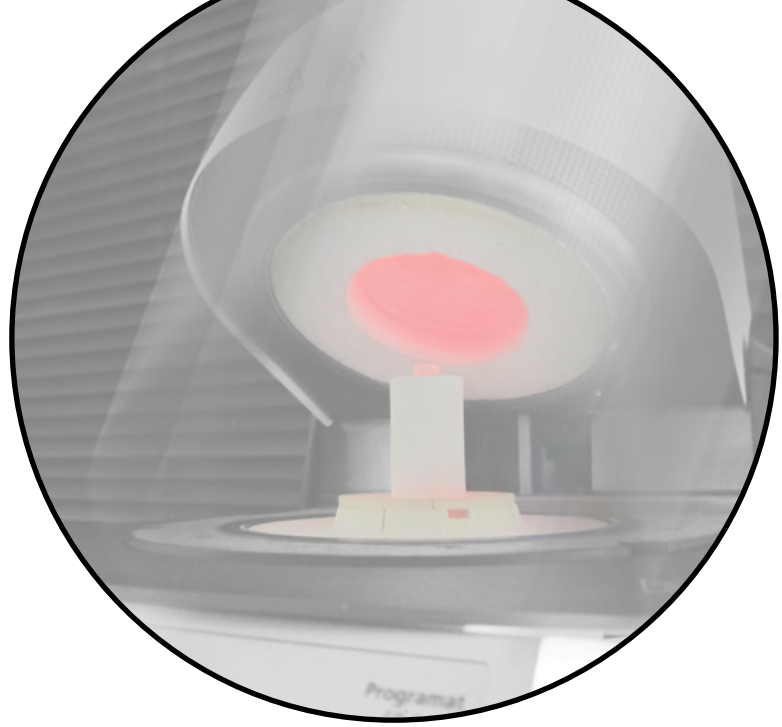
Surgical Approach for a Single Central





Soft tissue augmentation using a connective tissue graft.
By changing the tissue biotype, underlying tooth discoloration can be masked.

(Clinical work by Dr. Kotaro Nakata)



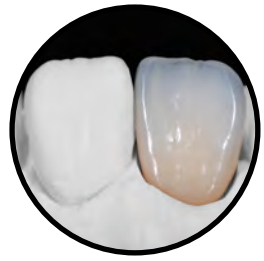
Ideal Materials and Multilayered Structure

Proper color development within each restoration is important for imparting a vital and lifelike appearance. Achieving this is dependent upon ingot selection, material and restoration thickness, and artistic application of deep dentin and enamel ceramics. Expertly incorporating ideal materials (e.g., IPS e.max Press and IPS e.max Ceram) can facilitate brightness and opacity control, which is key to achieving the best results.

Base control

Opacity control

Internal characterization



Completion

Proper *Reproduction* of Natural Tooth Composition

A cut-back and layered lithium disilicate crown (IPS e.max Press) provided a natural-looking treatment for tooth #8.

Multilayered structures can be achieved using a lithium disilicate layering ceramic (IPS e.max Ceram).

Ingot selection	LT A1
Opacity control	DD A2
Base dentin	DA A2
Mamelon structure	MM salmon
Opal effect	OE1
Enamel layer	TI2+OE2 (1:1)

Ingot selection	LT A1
Opacity control	DD A2
Base dentin	DA2
Mamelon structure	MM yellow-orange
Opal effect	OE1
Enamel layer	TI2+OE2 (1:1)

Ingot selection	LT A2
Opacity control	DD A2
Base dentin	DA3
Mamelon structure	MM salmon+CT orange-pink (2:1)
Opal effect	OE1
Enamel layer	TI2

Ingot selection	LT A1
Opacity control	DD A2
Base dentin	DA2
Mamelon structure	MM light+yellow-orange (2:1)
Opal effect	OE2
Enamel layer	TI2+OE2 (1:1)

Ingot selection	LT BL2
Opacity control	DD A1
Base dentin	DA2
Mamelon structure	MM light+salmon+yellow-orange (1:1)
Opal effect	OE2+T blue (1:1)
Enamel layer	TIBL+OE4 (1:1)

Multilayered Concept

Step 1 – Base Control

Controlling the base color of a restoration depends upon ingot selection, which itself is based on several criteria, including opacity of the natural tooth structure to be emulated (the "target" tooth), opacity of the underlying tooth, discoloration of the underlying tooth, and preparation clearance. When a cut-back and layering technique is used, a low-translucency ingot (e.g., IPS e.max Press LT) can be selected. For the framework material, it is best to choose an ingot that is one to two shades lighter than the target tooth to compensate for a reduction in brightness, minimize show-through of underlying discoloration, and enable better light reflection from the inside. This will create a more natural-looking color for the restoration once in the oral cavity, particularly along the gingival margins.

Step 2 – Opacity Control

In addition, the cut-back and layering technique requires opacity and brightness control, particularly in the cervical area, where brightness is typically lacking. This can be accomplished with an LT ingot by applying Deep Dentin porcelain, but the technique may not be appropriate for all cases. Based on the brightness of the natural tooth to be emulated, an opaque layer is applied on the cervical area according to the range of brightness change from within the natural tooth structure using the following porcelain mixture ratios: 1) Deep Dentin 100%; 2) Deep Dentin 50% with Dentin 50%; 3) Dentin 100%; etc. Then, the build up of the cervical areas over the 0.6-mm LT framework is completed with an approximately 0.6-mm dentin layer, followed by an approximately 0.3-mm enamel layer.

Step 3 – Internal Characterization

To enhance the subtle nuances of the restoration, the enamel porcelain layer is built up by arranging opaque porcelains and internal stains (e.g., Mamelon, Deep Dentin, Opal Effect) in an artistic and appropriate manner, in addition to adding internal characterizations to the incisal area. Contrast is also controlled along the incisal edge. Cutting back from the lingual is very important when adjusting transparency at the incisal edge, and typically the mamelons are built up from the labial and lingual to demonstrate three-dimensional depth in thin incisal areas. This process is very important for imparting vitality to esthetic anterior restorations.

Step 4 – Luster Control

The restoration form is complete following enamel porcelain build up and modification, after which adjustments to texture and surface effects are made manually, partially to control glossiness and luster. Variations in a restoration's gloss affect the appearance of surface texture, how restoration surfaces reflect light, and how its color will be perceived. Therefore, final gloss is adjusted after glazing and polishing to replicate the intensity of the natural tooth to be emulated. Because glazing procedures (i.e., burning temperatures) alter the surface properties and gloss of restorations, over glazing should be avoided. Areas requiring emphasis of surface characteristics, however, may require the use of glazing paste.

Step 5 – Optical Effects

After completion, it is important to confirm under various lighting conditions that the optical effects and properties of the restoration reflect those of the tooth to be mimicked. When considering the optical effects of the restoration in the context of the individual patient, keep in mind that natural tooth fluorescence and opalescence tend to decrease with age. However, if additional optical effects are required, Transpa Incisal porcelain and Opal Effect porcelain can be mixed in a 1:1 ratio and applied for additional customization.

Summary

Laboratory technicians and dentists alike strive to achieve ideal esthetic anterior restorations based upon their experience, knowledge and skill sets, and on individual patient desires. Communication and mutual respect between dentist and laboratory technician are critical to these endeavors so that each party can do their best as professionals, as well as integrate their thoughts and concepts for achieving esthetic goals. This visual essay has showcased seven collaborative cases to present the requisites for achieving success in creating highly esthetic anterior restorations. **jCD**

Acknowledgment

The author and the dentists whose cases are featured in this article—Drs. Yusuke Yamaguchi, Tatsunori Nagao, Tsutomu Kubota, Norimi Oda, and Kotaro Nakata—express their respect for Mr. Naoki Hayashi, RDT (Irvine, California), and their gratitude to him for inspiring them.

> “Communication and mutual respect between dentist and laboratory technician are critical to these endeavors so that each party can do their best as professionals, as well as integrate their thoughts and concepts for achieving esthetic goals.”

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Disclosure: The author did not report any disclosures.

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Noninvasive Trial Restorations

A Technique to Improve Diagnostic Mock-Up Fabrication and Direct Provisionalization

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Abstract

This article discusses the importance and advantages of incorporating noninvasive trial restorations into the esthetic treatment plan workflow. A new index fabrication technique using an overtray that ensures rigidity during mock-up fabrication or provisionalization is described. The overtray decreases distortion, improves cervical adaptation, and reduces chairside adjustment time.

Key Words: trial smile, diagnosis and treatment, communication, esthetic technique, functional dentistry

Introduction

The ability to predict the final outcome prior to beginning treatment is highly desirable in all areas of dentistry.[1] This is especially true whenever the treatment produces an immediate alteration in esthetics and/or in function. Various technologies and techniques were developed and have evolved in an attempt to predict final outcomes and guide nonreversible interventions.[2] Their value has become well accepted as part of the standard of care in orthodontics, oral surgery, periodontics, and prosthodontics.[3-5] It is essential that the restorative team (clinician and laboratory technician) be aware of the patient's expectations before performing elective restorative treatments. Likewise, it is critical that the patient be able to visualize and understand possible treatment limitations.[2, 6-10]

Communication Tools and Techniques

There are several methods and tools to facilitate the vital communication between restorative team and patient. These include a verbal or written expression of expectations, and two-dimensional (2D) and three-dimensional (3D) visualization techniques such as:

- preliminary impressions and articulated diagnostic casts (3D)
- preoperative clinical photographs (2D)
- digital imaging manipulation (2D/3D)
- diagnostic wax-ups (3D)
- noninvasive intraoral trial restorations (NTRs) (3D).

These tools complement each other and provide valuable information; however, it is ultimately desirable to provide the patient with an intraoral blueprint of the final restoration to provide an integrated visualization and functional testing.

Several techniques were developed to achieve this goal. They can be grouped into three main categories: direct, semi-direct, and indirect.

Direct techniques include intraoral additive modifications of the existing dentition, generally achieved with light-polymerizing composite resins.[6,9] These can be easily adjusted and promptly evaluated by both patient and clinician. When a satisfactory result is achieved the diagnostic information can be transferred objectively to the laboratory technician through photography or preliminary impressions.[2]

Semi-direct techniques may follow after the previously described category through the fabrication of a diagnostic wax-up. This can follow objective as well as subjective guidelines. A refined indirectly fabricated blueprint can then be presented to the patient and directly transferred intraorally through the utilization of a vacuum-formed template or a silicone matrix,[9] improving visualization as well as functional and esthetic reevaluation.

> "It is essential that the restorative team…be aware of the patient's expectations before performing elective restorative treatments."

Finally, indirect techniques include the fabrication of a noninvasive overlaying trial restoration by the laboratory technician. These can provide additional esthetic value through the utilization of multilayered laboratory fabrication techniques to produce a more lifelike result.[8]

Considering the different approaches previously described to achieve the same ultimate goal, it is the authors' belief that the NTR can be described as a 3D template that enables the patient and the restorative team to envision the predicted treatment outcome and evaluate its functional and esthetic value prior to initiation of invasive procedures.

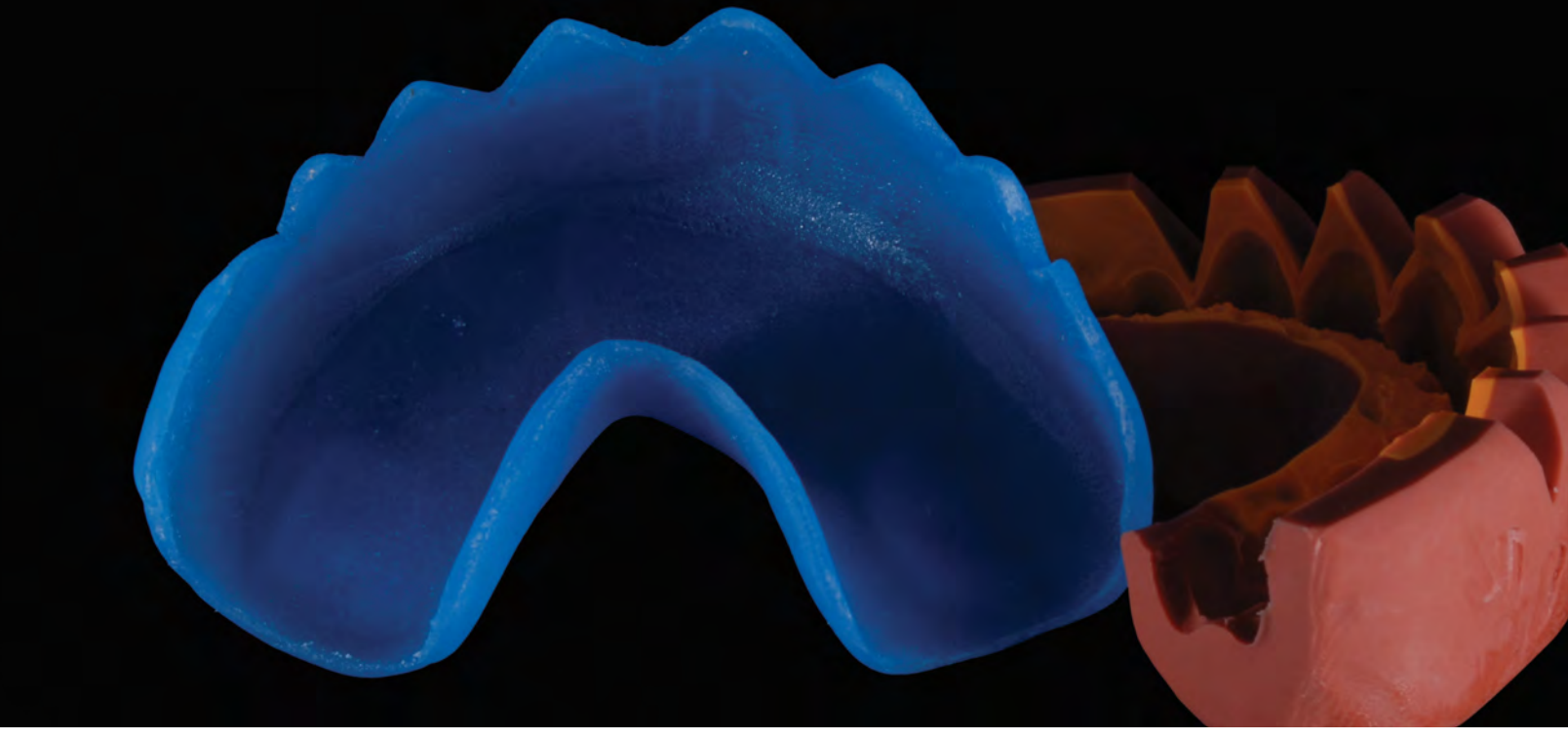
Advantages of incorporating an NTR into the treatment workflow include the following:

- objective and effective communication among the dentist, patient, and laboratory technician[1,7,8,11]
- 3D visualization of the restorative result intraorally over a period of time[7,8,11]
- diagnostic evaluation that may reveal the need for specific pre-prosthetic interventions[1,8,12]
- if converted into provisional restorations, permits the conditioning of the soft tissues surrounding abutment teeth[12]
- controlled reduction of mineralized tissues during tooth preparation[1,6,11,12]
- guided fabrication of cast post-and-core restorations[12]
- final patient approval before fabrication of final restorations.[1,6,8,11,12]

Semi-direct techniques are more frequently reported in the literature because they allow for a simple, relatively precise and inexpensive transfer of 3D information from the diagnostic wax-up to the patient's mouth.[1,2,7,10-13] However, the transferring index's lack of rigidity may lead to decreased accuracy and dimensional instability,[14] resulting in volumetric inaccuracy, increased chairside adjustments, and time-consuming removal of excess material.

This article describes a new index fabrication technique using an overtray that ensured rigidity during NTR fabrication on a partially edentulous patient with a significant lack of tooth-supporting structures **(Fig 1)**. The use of the overtray decreases distortion, improves cervical adaptation, and reduces chairside adjustment time.

Figure 1: Initial presentation.



Technique Steps

1. Create a wax-up of the envisioned restorative result **(Fig 2)**.
2. Fabricate an index of the diagnostic cast combining light-body and heavy-body polyvinyl siloxane impression materials (Reprosil VPS Impression Material Light Body and Reprosil VPS Impression Material Putty, Dentsply; York, PA) and allow it to set under 2 to 4 atm of pressure.
3. After the impression materials set, trim the obtained index to the desired extension and ensure a smooth cameo surface with no undercuts. Create V-shaped notches in the gingival embrasure areas for easy removal of excess material **(Fig 3)**.
4. To fabricate the overtray, with the index positioned over the diagnostic cast, apply a layer of light-polymerizing custom-tray material (Megatray, Megadenta GmbH; Radeberg, Germany) to the same approximate extension. Incorporate three finger rests for tripodization and then polymerize **(Figs 4-6)**.
5. Remove the overtray and trim the excess material **(Fig 7)**.
6. Verify the intraoral fit and path of insertion.
7. Inject autopolymerizing resin (e.g., Luxatemp Ultra, DMG America; Englewood, NJ) into the index and seat the index with the overtray intraorally, applying pressure on the finger rests **(Fig 8)**.
8. Remove any excess resin.
9. Remove, first the overtray, then the índex, from the mouth.
10. Finish and polish the NTR if necessary **(Figs 9-11)**.

Figure 2: Diagnostic wax-up.

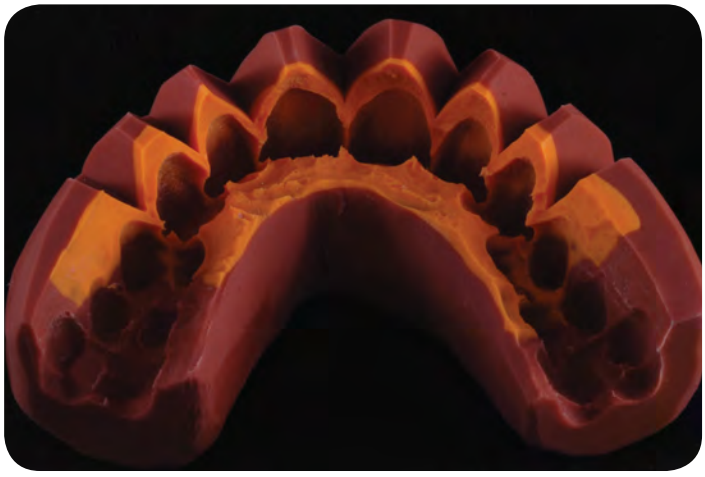


Figure 3: Silicone index prepared over the diagnostic wax-up.

Figure 4: Adjusted buccal extension of silicone index and overtray.

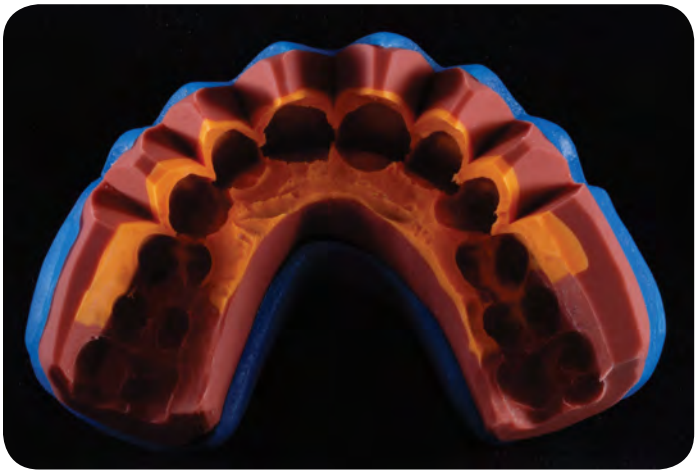


Figure 5: Relationship and adaptation of overtray with silicone index.

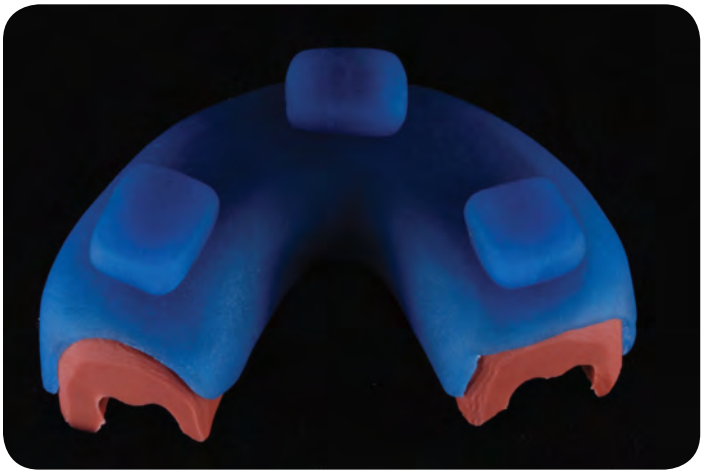


Figure 6: Finger rests for tripodization.

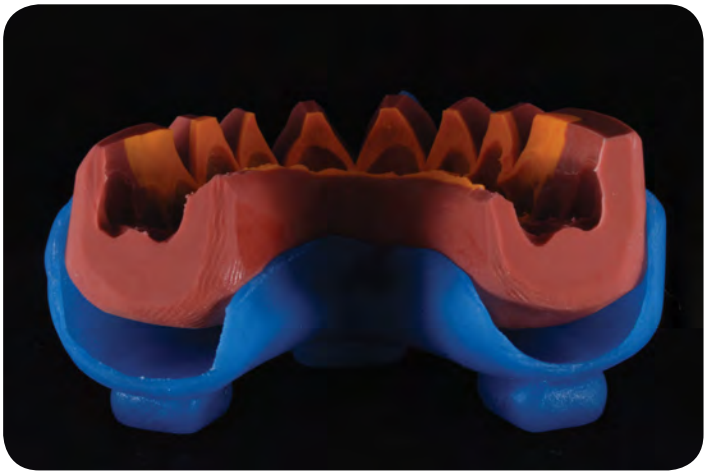


Figure 7: Adaptation of overtray over the silicone index for two-step intraoral removal.

> “...the NTR can be described as a 3D template that enables the patient and the restorative team to envision the predicted treatment outcome and evaluate its functional and esthetic value prior to initiation of invasive procedures.”

Figure 8: Intraoral seating and application of tripodized pressure.

Figure 9: Left lateral view of the NTR.

Figure 10: Frontal retracted view of the NTR.

Figure 11: Frontal view of the NTR.

> “The use of the overtray decreases distortion, improves cervical adaptation, and reduces chairside adjustment time.”

Discussion

The presented technique represents an important improvement of the silicone index commonly used for NTR fabrication and provisionalization because the incorporation of a rigid shell "overtray" to fully support the index ensures rigidity and minimizes distortion. This is accomplished without the need to overcompensate by increasing the thickness of the silicone index, which is particularly difficult in the cervical and interproximal areas.[13] The cervical opening effect produced when applying occlusal pressure over a nonrigid index is also avoided.

The lack of undercuts in the cameo surface of the silicone index also allows for the initial intraoral removal of the rigid overtray, followed by removal of the flexible silicone index itself. This facilitates the disengagement of undercuts, thus preventing distortion, dislodgement, or fracture upon removal.

The NTR serves as a diagnostic and communication tool that allows 3D information to be transferred from the diagnostic wax-up to the patient's mouth. If esthetic alterations are required or requested by the patient, the silicone index can be poured and the alterations produced over a new model, saving the original diagnostic wax-up design **(Fig 12)**. Together with clinical photographic documentation, pouring the NTR index improves patient-clinician-laboratory communication because a 3D record representing the evolution of the esthetic design is saved and can be revisited at any time during the treatment.

Another advantage of the presented technique is the optimization of finishing procedures due to the flexure resistance provided to the silicone matrix by the rigid overtray. Finishing and polishing procedures are an important—albeit time-consuming—aspect of interim restoration fabrication. Marginal refinement; reduced risk of fracture; reduced surface imperfections; decreased plaque retention; improved oral function and mastication (by facilitating the flow of food during mastication); facilitated oral hygiene procedures; smooth restoration contact on opposing and adjacent dentition; and, last but not least, improved esthetics are the clinical goals of finishing and polishing procedures.[15]

Numerous instruments and tools are available for finishing and polishing. These include diamond and carbide finishing burs, stones, coated abrasive finishing and polishing discs and strips, rubber wheels, cups and points, polishing pastes, abrasive-impregnated brushes, and felt devices. Number 12 and 15 scalpels have also been used as tools for finishing composite restorations and have been suggested as a more "tooth-friendly" alternative to high-speed instrumentation due to the operator's increased control.[15,16] An NTR, by reducing excess material and controlling dimensional stability, can help to optimize the time-consuming yet important finishing and polishing procedures.

Figure 12: Poured NTR index model with additive alteration of the initial design.

The precision and accuracy of guides is also considered an important factor in other areas of dentistry, particularly implant dentistry.[5,15-18] Similarly, improving the accuracy of the NTR fabrication method is highly desirable since it may be used to determine the need for preprosthetic interventions such as surgical, periodontal, orthodontic, or endontic treatments, as well as serve as an intraoperative guide for periodontal procedures and tooth preparation.[1,2,6,9,11]

Summary

The incorporation of noninvasive trial restorations is a desirable step for elective restorative treatments. Achieving a high level of accuracy and precision should be a goal of all the steps, including those involved in fabrication of the NTRs themselves, as they will provide information when decisions are made regarding possible invasive adjunctive treatments. Further research is recommended regarding the accuracy of various techniques for fabricating noninvasive trial restorations.

> "Further research is recommended regarding the accuracy of various techniques for fabricating noninvasive trial restorations."

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Increasing Contact Between Soft Tissue Graft and Blood Supply

A Technique for Managing Connective Tissue Grafting Over Prominent Root

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Seyed Amir Danesh-Sani, DDS
Pooria Fallah Abed, DDS
Alejandro Castaño, DDS

Abstract

When repairing gingival recession in areas of malpositioned teeth and prominent roots, even if there is no interproximal hard and soft tissue loss, conventional soft tissue grafting techniques can lead to unpredictable results. Teeth with prominent roots or root surfaces positioned outside the alveolar housing often have concavities between the tooth and the adjacent bone. Placing a soft tissue graft over a prominent root and these adjacent concavities can result in dead space and reduced blood supply to the donor soft tissue graft, which can affect graft success. This article presents a modified soft tissue grafting technique that utilizes particulate bone graft to support donor connective tissue as a means to reduce dead space, increase contact between soft tissue graft and blood supply, and achieve predictable esthetic and harmonious root coverage in areas of recession over prominent roots.

Key Words: cosmetic and esthetic dentistry, gingival contouring, periodontics, soft tissue grafting

Introduction

Correction of gingival recession and mucogingival deformities around natural teeth through soft tissue grafting to improve the health, esthetics, and harmony of the gingival margin has become common practice. There are a number of options for treating gingival recession, including free gingival grafts, connective tissue grafting, sliding pedicle grafts, coronally repositioned flaps, and the use of accellular dermal matrices.[1-5] Advances in these techniques as well as in diagnosis and classification of defects have led to predictable outcomes in treatment of Miller Class I and II defects, but predictable root coverage is still difficult to achieve through conventional means in more advanced defects or areas of root prominence and malpositioned teeth.[6]

Correction of gingival recession in areas of malpositioned teeth and prominent roots, even in cases with little to no interproximal hard or soft tissue loss, can have variable outcomes.[7] The lack of predictability in these cases is the result of reduced blood supply to the donor soft tissue during graft healing. Teeth with prominent roots and root surfaces positioned outside the alveolar housing have adjacent concavities between the root and bone, and placing a soft tissue graft over a prominent root and its adjacent concavities will lead to dead space between the alveolar bone and the donor tissue. This lack of contact between the donor tissue and the blood supply of the alveolus and periodontal ligament (PDL) reduces the blood supply to the graft.[8] Such a reduction, especially during the first few days when a graft is dependent on plasmatic circulation, can negatively affect the graft's success and therefore decrease the amount of achievable root coverage.[9]

A technique designed to reduce dead space and increase contact between soft tissue grafts and blood supply was implemented in a series of 20 cases. The purpose was to achieve soft tissue coverage in cases of gingival recession on teeth with prominent roots based on the biologic foundations of wound healing. Two cases are presented in their entirety and photographic long-term follow-up of the other 18 cases has been included to demonstrate the technique's predictability **(Figs 1a-18b)**.

> "The purpose of the bone graft material is to form a ramp on either side of the prominent root, creating a level recipient bed for the donor tissue."

Modified Connective Tissue Grafting Technique

Preoperative

The technique was used in 20 cases that presented with gingival recession in areas of root prominence, with minimal loss of interproximal hard and soft tissue. Patients were treated with a one-week course of antibiotics beginning the day before treatment as well as with an antimicrobial rinse beginning 24 hours after completion of the grafting procedure. Immediately before the procedure patients were disinfected periorally and intraorally.

Tissue Harvesting

A full thickness envelope flap with intrasulcular and papilla slicing incisions was created in the area of the recession, spanning from one to two teeth on both sides of the area in need of soft tissue augmentation. No vertical incisions were made. Donor connective tissue of adequate width and height to repair the defect was harvested from the palate. The authors recommend beginning harvesting of the connective tissue from the distal of the canine and extending to the midpalatal of the second molar if needed, being careful to remain 3 to 4 mm from the free gingival margin, as well as taking all other palatal anatomical limitations and landmarks into consideration.[10] Connective tissue was harvested through the use of a full thickness envelope flap on the hard palate. After harvesting, the palate was sutured with a continuous or interrupted approach. The exposed root surfaces were thoroughly cleaned with hand scalers (they also can be treated with a root conditioner such as ethylenediaminetetraacetic [EDTA] acid to further aid in removing debris from the root surface). The exposed alveolar bone was thoroughly debrided. The concavities in the alveolar housing adjacent to the prominent roots were noted and this area was carefully decorticated with a small-diameter bur.

Bone Graft Material

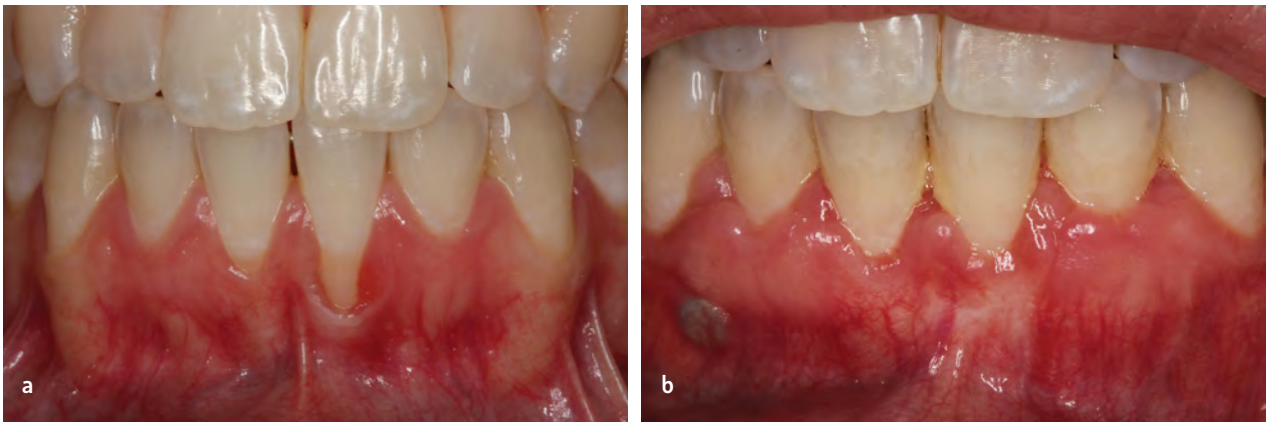
Small-particle mineralized cancellous bone allograft (MCBA) (Puros, Zimmer Dental; Carlsbad, CA) was packed into the concavities to create a level recipient bed for the connective tissue graft. Small-particle mineralized allograft was chosen due to its handling and physical properties, but clinicians may choose to employ the bone graft material that they feel adequate. The purpose of the bone graft material is to form a ramp on either side of the prominent root, creating a level recipient bed for the donor tissue. The graft material also serves to eliminate dead space and to wick or draw blood from the exposed alveolar bone up to the recipient graft bed.

Suturing

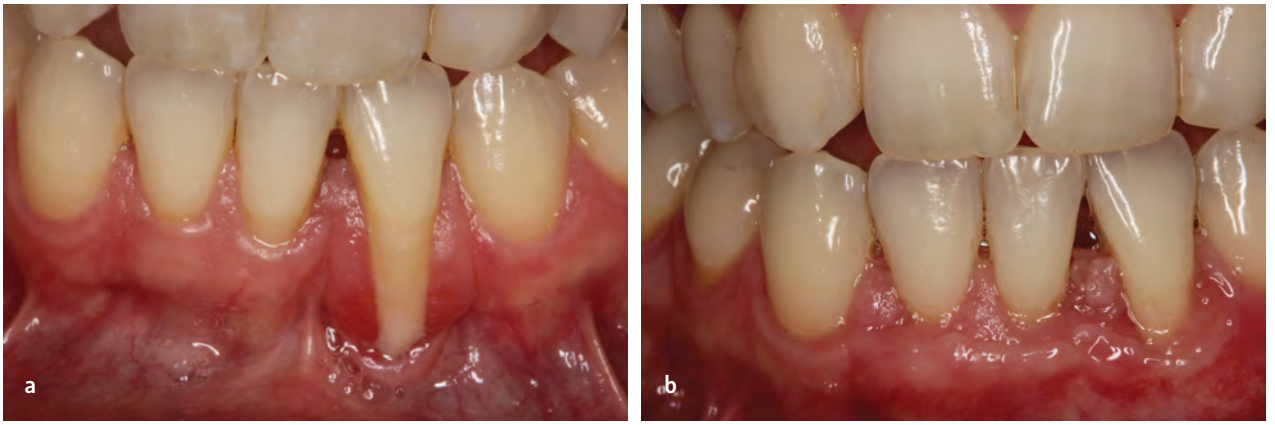
The harvested connective tissue graft was placed over the bone graft and areas of recession and stabilized with interrupted sutures through the coronal portion of the graft and the sliced papilla. The full thickness flap was then repositioned coronally and secured in place with a combination of sling sutures and soft tissue glue. The graft was stabilized with single interrupted sutures and the coronally repositioned flap of the recipient site was stabilized with single sling sutures. The criss-cross suture technique secures soft tissue grafts in place by grabbing the base of the flap and extending the suture over the graft; going through the papilla or around the teeth is purposely avoided. The criss-cross technique compresses the soft tissue graft, limits the coronal advancement of the overlaying flap, and creates tension at the base of the overlaying flap. Single interrupted sutures through the coronal portion of the graft and sliced papilla are employed to avoid compression of the donor tissue and bone graft and facilitate advancement of the overlying flap. Securing the flap at its coronal portion with single interrupted sutures and avoiding criss-cross sutures extending through the base of the advanced flap allows greater advancement of an intact overlying flap and prevents an apical migration of the overlying flap from tension at its base. The authors' chosen method of suturing is an integral part of the modified connective tissue grafting technique. This technique's success can be seen in all the postoperative images.

> "Increasing the blood supply to the grafted tissue is critical because it is entirely dependent on plasmatic circulation or diffusion of nutrients from the surrounding area during the first few days of healing."

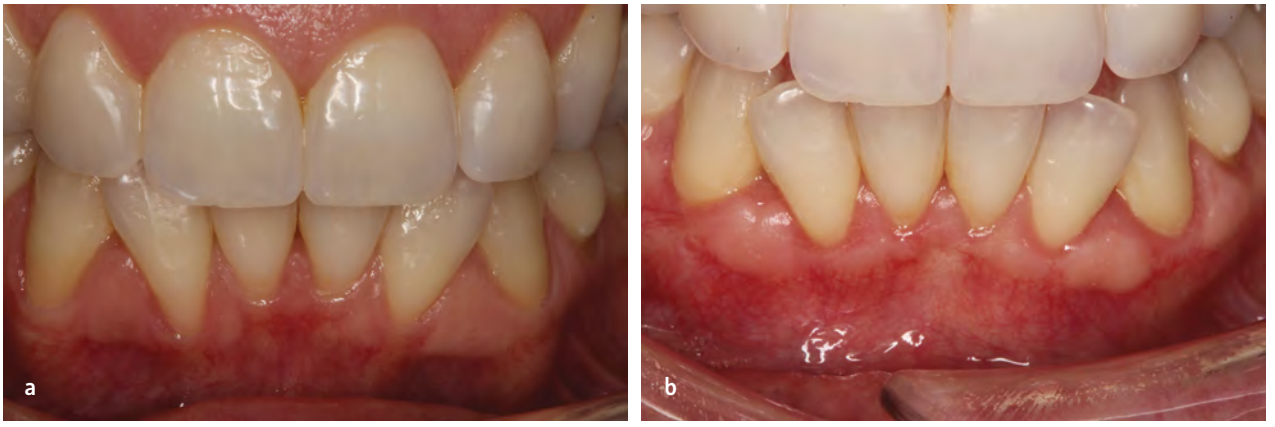
18 Long-Term Follow-up Cases, Miller Classification



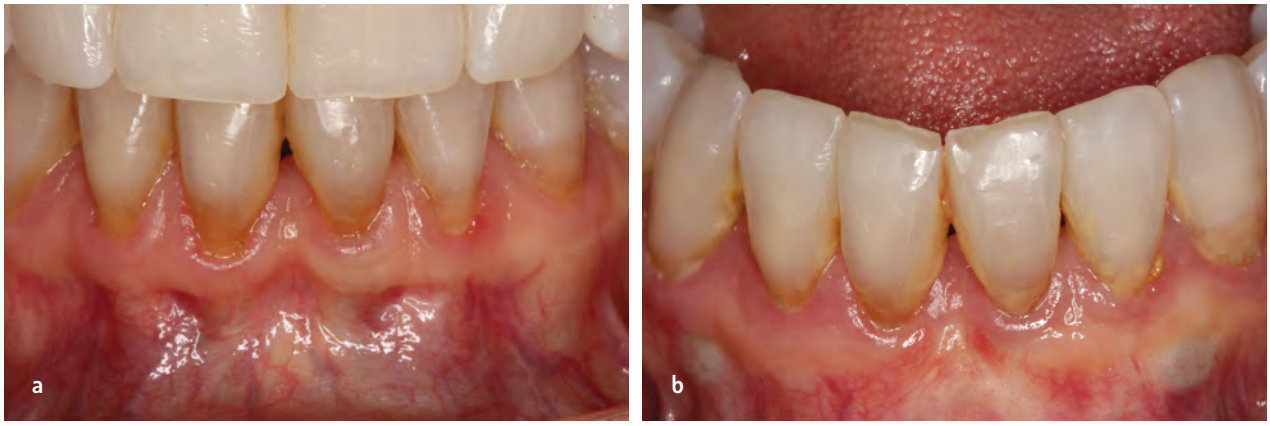
Figures 1a & 1b: Class II on #24, and six months postoperative.



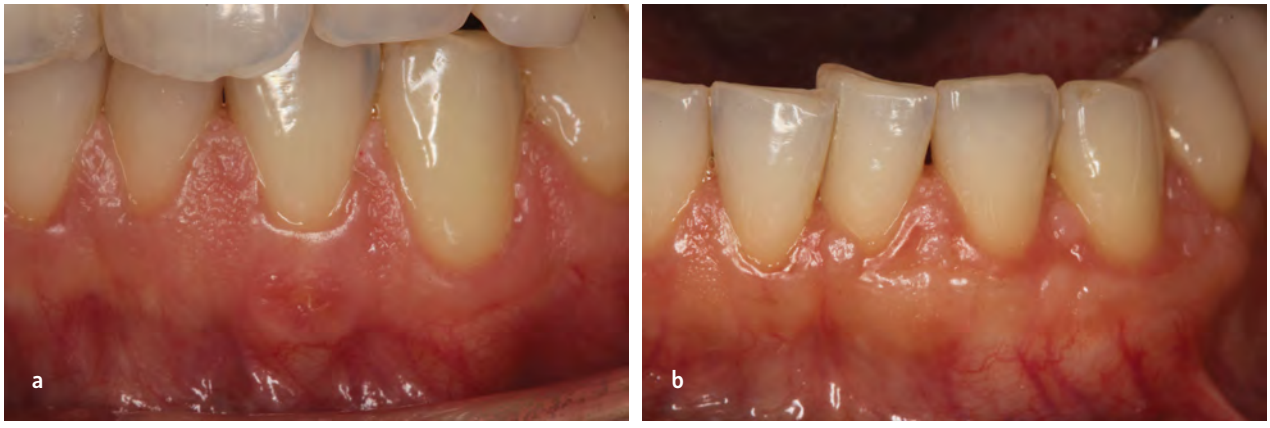
Figures 2a & 2b: Class III on #23 with root prominence, and three years postoperative.



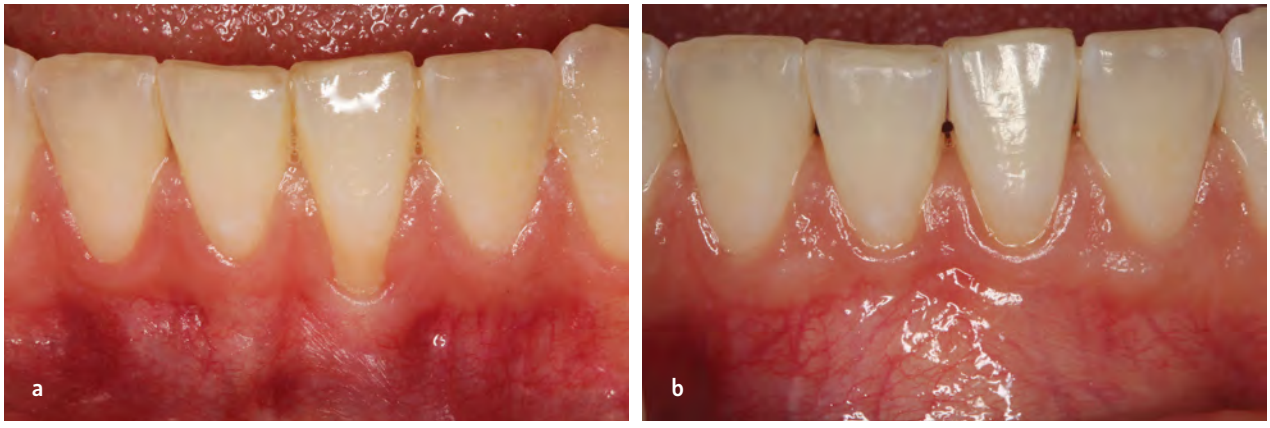
Figures 3a & 3b: Class II on #23 and #26, and one year postoperative.



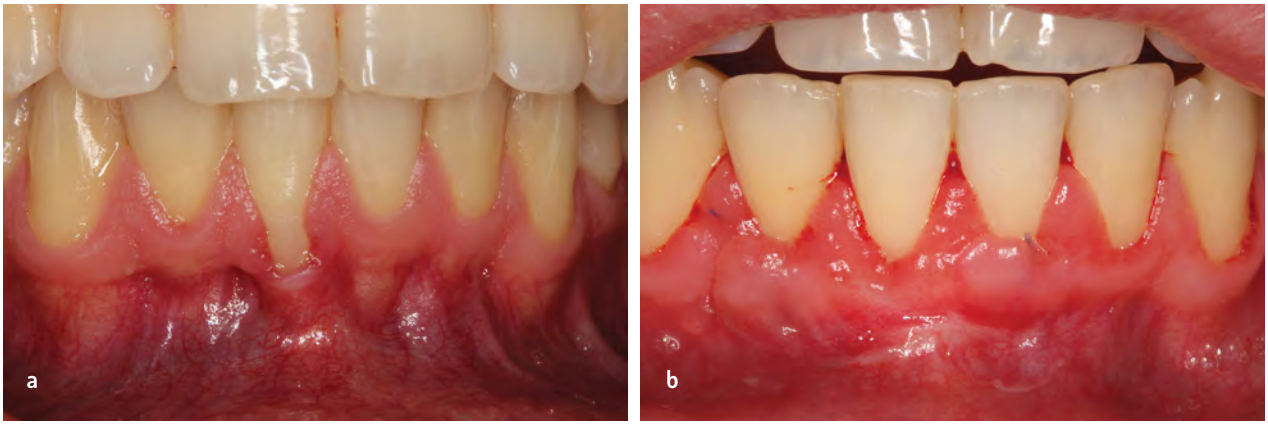
Figures 4a & 4b: Class II on ##23-26, and two years postoperative.



Figures 5a & 5b: Class II on #23 with root prominence and tissue dehisence, and one year postoperative.



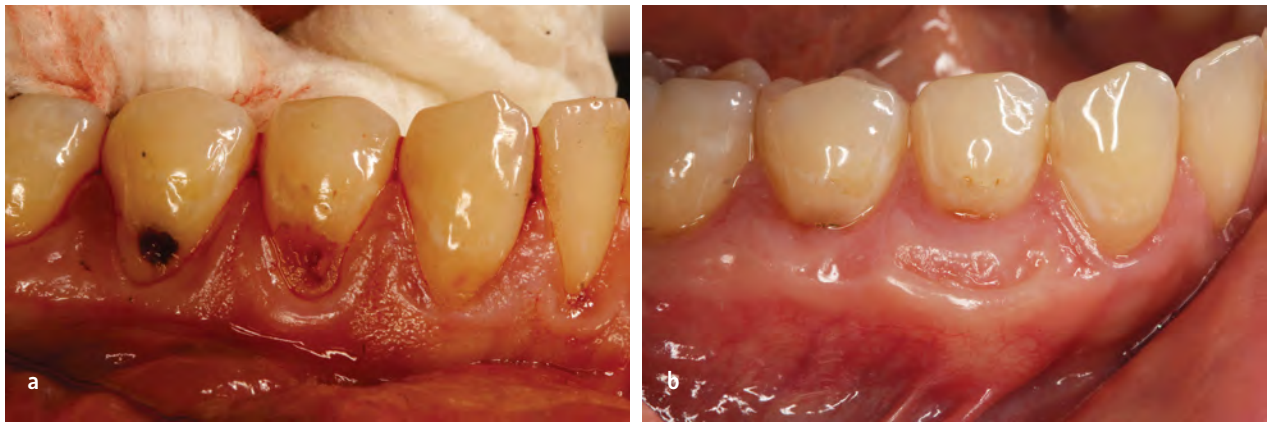
Figures 6a & 6b: Class II on #24, and two years postoperative.



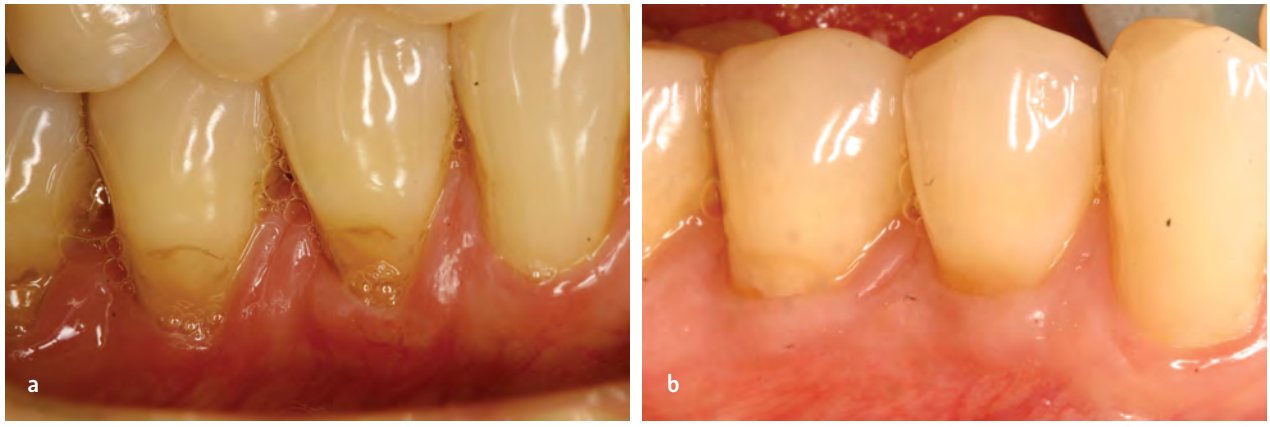
Figures 7a & 7b: Class II on #25 with root prominence, and six months postoperative.

Figures 8a & 8b: Class III on #25, and one year postoperative.

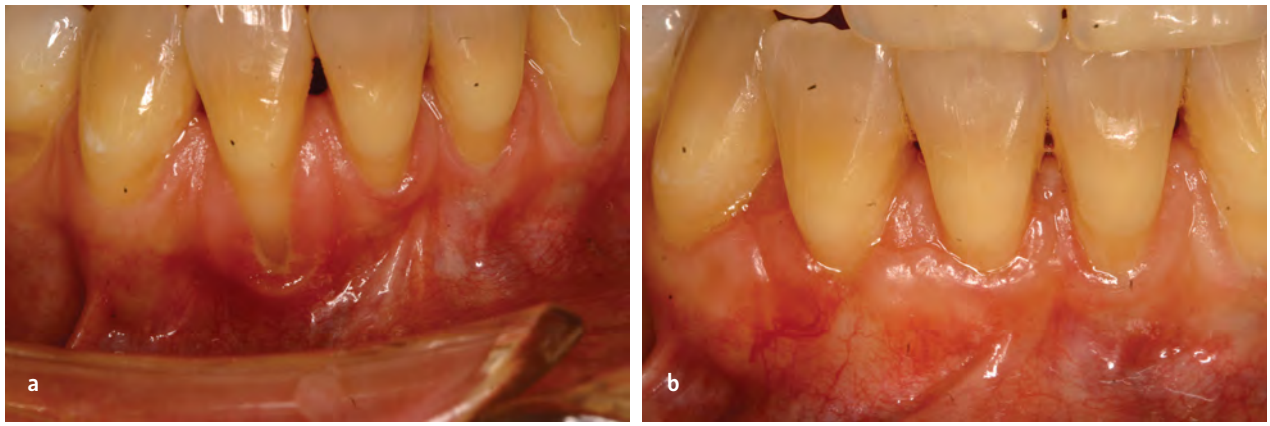
Figures 9a & 9b: Class III on ##22-24 with root prominence (crowns were placed six months after grafting), and two years postoperative.



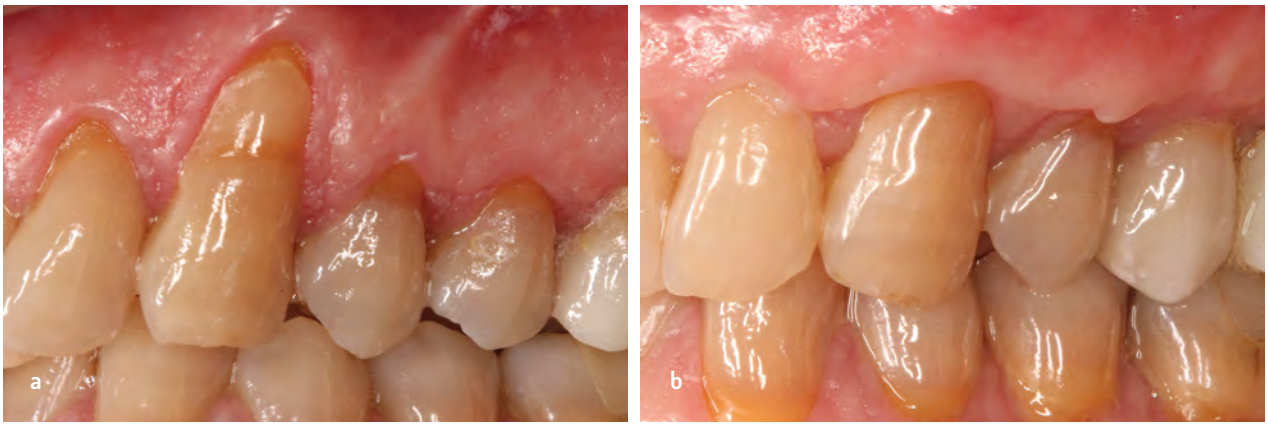
Figures 10a & 10b: Class II on #28 and #29 (the decay at the margin was excavated followed by soft-tissue grafting), and two years postoperative.



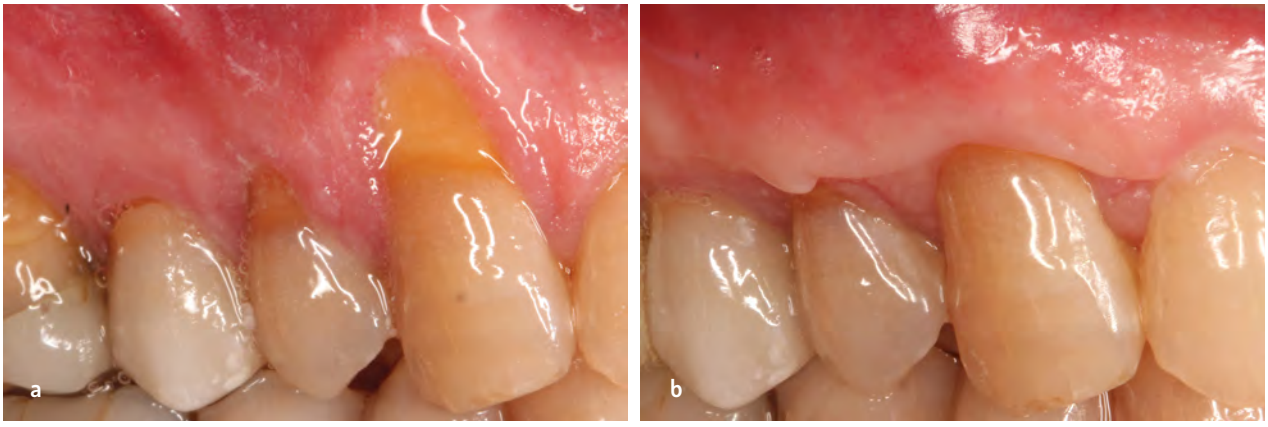
Figures 11a & 11b: Class II on #28 and #29 with root prominence, and five years postoperative.



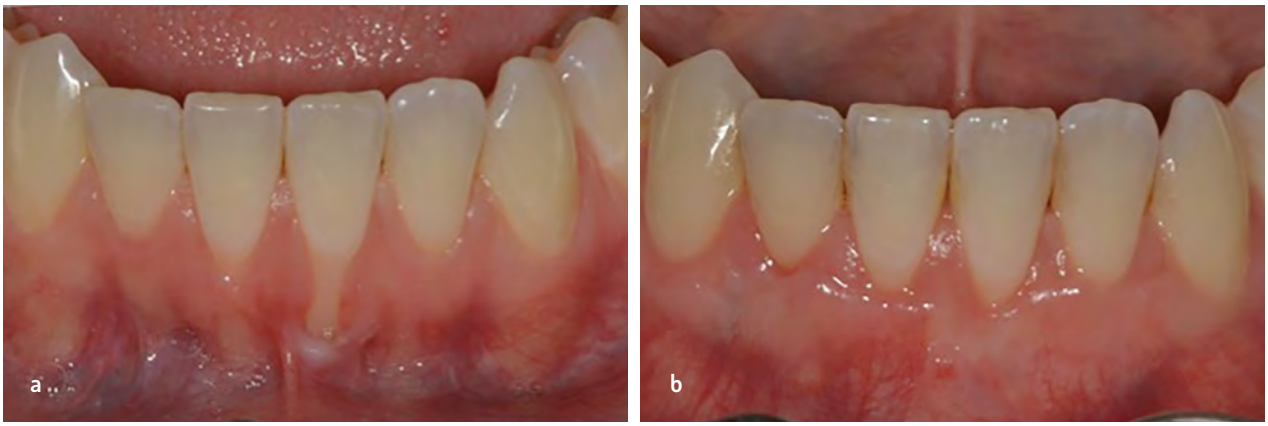
Figures 12a & 12b: Class III on ##23-26, and five years postoperative.



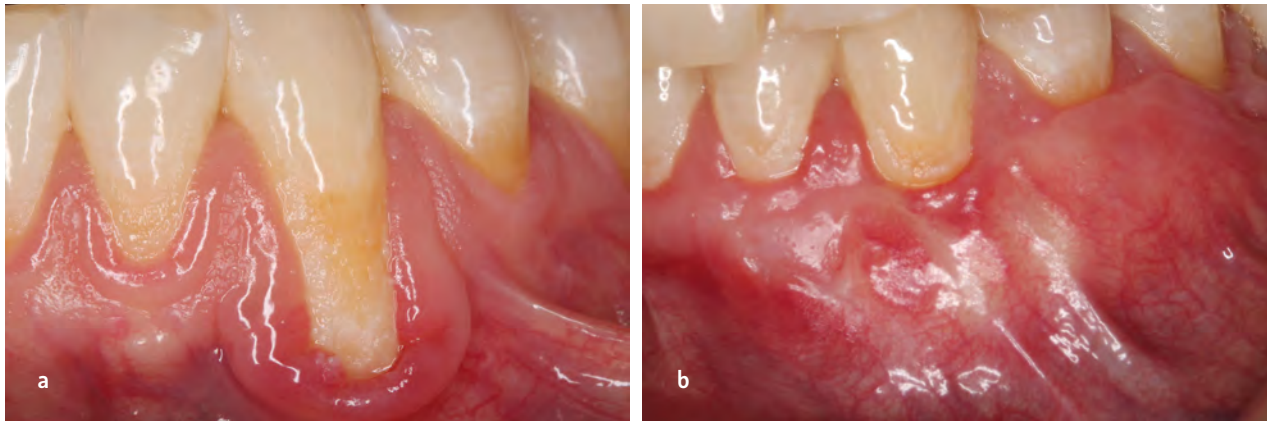
Figures 13a & 13b: Class II on #11 with root prominence and bonding (the bonding was removed and the area grafted), and one year postoperative.



Figures 14a & 14b: Class II on #6, and one year postoperative.



Figures 15a & 15b: Class II on #24, and seven months postoperative.



Figures 16a & 16b: Class II on #22, and six months postoperative.

Figures 17a & 17b: Class II on #22, and six months postoperative.

Figures 18a & 18b: Class II in the area of #24, and four months postoperative.

Case Reports

Case 1

A 28-year-old female presented with an esthetic concern regarding the gingival discrepancy between her maxillary canines (#6 and #11) **(Fig 19)**. The patient had no significant medical history and a dental history of an impacted left maxillary canine (#11). The patient reported that this tooth had been surgically exposed and moved into her arch during orthodontic treatment. She also stated that upon completion of the orthodontic treatment her restorative dentist placed bonding over the tooth root in an effort to decrease the tooth's sensitivity and improve esthetics. Clinical examination revealed no interproximal bone loss, a Class V composite restoration on #11, thin biotype, lack of keratinized attached gingiva, and a prominent root resulting from orthodontic movement.

The above-described technique was selected as a means of connective tissue grafting due to the root prominence at #11 and adjacent alveolar concavities **(Fig 20)**. A full thickness envelope flap from #10 to #12 was created with intrasulcular and papilla slicing incisions. The bonded restoration was removed and the root surface was cleaned and scaled **(Fig 21)**.

Adequate donor connective tissue was harvested from the palate and Puros small-particle MCBA was packed into the adjacent concavities, creating a level recipient bed for the donor tissue **(Fig 22)**. The donor connective tissue was secured in place through the sliced papilla with interrupted sutures (Vicryl 5-0 P3, Ethicon; Blue Ash, OH) **(Fig 23)** and the full thickness flap was coronally advanced and secured with single sling Vicryl sutures **(Fig 24)**. Healing was uneventful; **Figure 25** shows the area three years postoperative. The tissue is healthy and the gingival margin is stable, the amount of root coverage achieved is visible when comparing the before and after images and when noting the gingival margin at #11 relative to the adjacent teeth.

Figure 19: Marked discrepancy in the gingival margin between maxillary canines. Note the existing Class V bonded restoration over the #11 root. The concavity in the alveolus due to the root prominence is visible through the soft tissue on either side of #11.

Figure 20: Class II on #11.

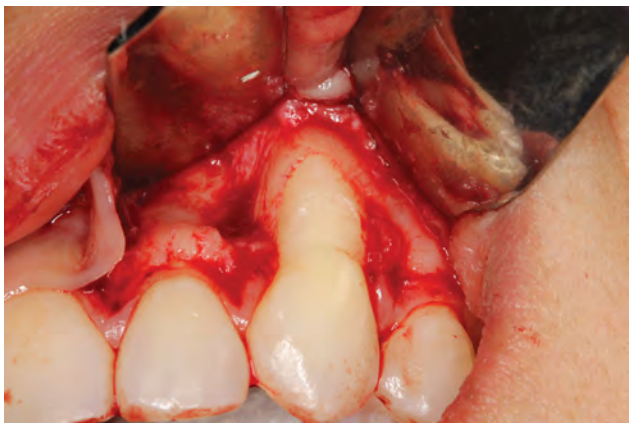


Figure 21: After the bonded restoration at #11 was removed, a full thickness envelope flap spanning ##10-12 was created with intrasulcular and papilla slicing incisions. The concavities adjacent to the prominent root are visible following flap elevation.

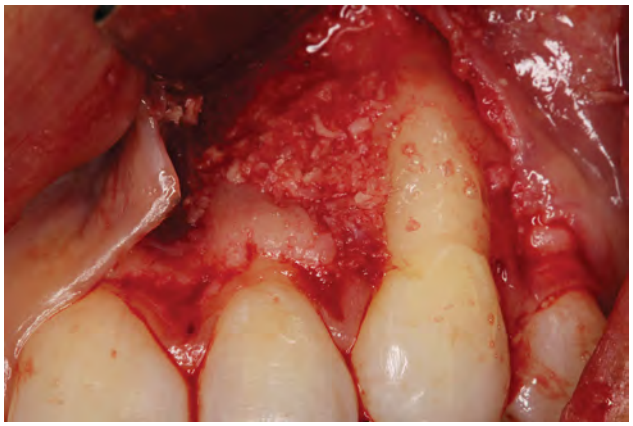


Figure 22: A level recipient bed for the donor tissue was created with MCBA. Note that the bone graft has turned red as it absorbs and wicks the blood from the underlying bone to its surface.

Figure 23: Donor connective tissue was placed over the level recipient bed and sutured into place through the coronal portion of the graft and the sliced papilla.

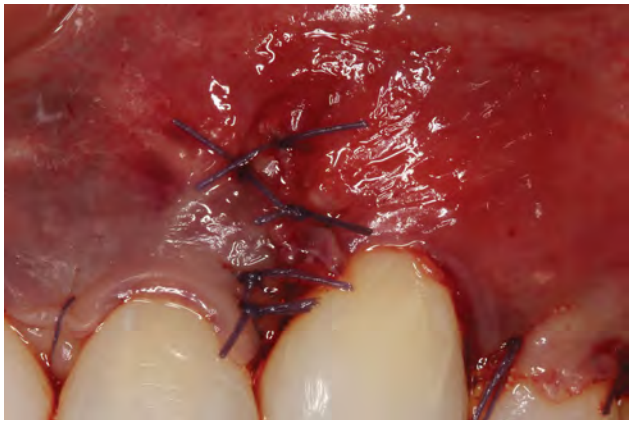


Figure 24: The full thickness flap was coronally advanced and sutured into place, completely covering the grafted tissue.

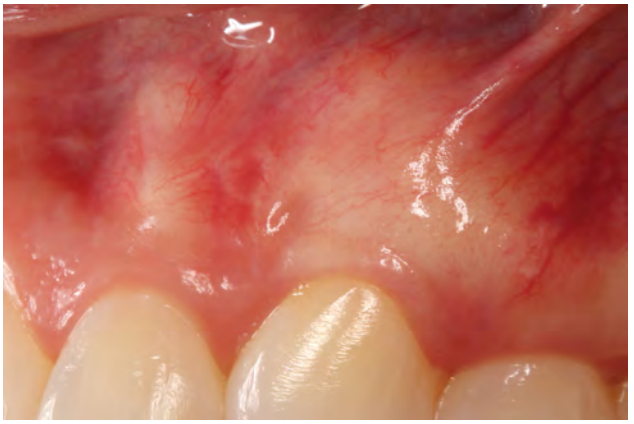


Figure 25: Three years postoperative; note the height of #11 relative to the adjacent teeth.

> "The exposure of the alveolar bone with decortication allows blood from the bone marrow to easily permeate the cortical plate and supply the underside of the grafted tissue."

Case 2

A 31-year-old female presented with a chief complaint of gingival recession in the area of her right mandibular central incisor (#25). She had no significant medical history, and a dental history of orthodontics as a teenager. Clinical and radiographic examination revealed mild interproximal bone loss, gingival recession extending beyond the mucogingival junction of #25, prominent root form in the area of the mandibular anterior, and a thin biotype **(Fig 26)**.

The previously described technique was selected due to the prominent root form seen in **Figure 27**. A full thickness envelope flap was created with intrasulcular and papilla slicing incisions from mandibular canine to canine (##22-27). Once the flap was elevated the prominent roots were visualized outside of the buccal plate and the adjacent concavities in the alveolar bone were noted **(Fig 28)**.

The root surfaces were planed and cleaned and Puros small-particle MCBA was packed into the concavities to create a ramp from the alveolar bone to the root surface as well as a level recipient bed for the donor connective tissue **(Fig 29)**. Adequate donor connective tissue was harvested from the palate and was secured over the recipient bed with interrupted sutures (Vicryl 5.0) through both the graft and the sliced papilla. Once the graft was secured the overlying flap was coronally advanced and secured into place with sling sutures (Vicryl 5-0 P3) reinforced with soft tissue glue (PeriAcryl 90 Oral Tissue Adhesive, GluStich; Delta, BC, Canada) **(Fig 30)**. The patient was seen for regular follow-ups; healing was uneventful and complete root coverage was achieved. A two-year postoperative image is shown in **Figure 31**.

Results and Discussion

It is possible to achieve full coverage of prominent roots using the modified connective tissue grafting technique described above. Postoperative images ranging from four months to five years for a series of 20 cases demonstrating root coverage in areas of recession over prominent roots and malpositioned teeth show the predictability, stability, and results achievable with this surgical technique. Using the clinical cementoenamel junction, height of the adjacent free gingival margin, or height of the gingival margin of the contralateral tooth when indicated, the mean root coverage of the 20 presented cases is 98%. The mean postoperative up time for the 20 cases was 19.5 months and every case achieved full root coverage equal to the height of the adjacent or contralateral gingival margins.

Figure 26: Thin biotype, mild interproximal tissue loss, and recession at #25.

Figure 27: The prominent root form and concavities of the alveolus between #25 and #24 are visible at this angle even through the gingiva.

Figure 28: A full thickness envelope flap was created with intrasulcular and papilla slicing incisions spanning ##22-27. The prominent roots are visible following flap elevation.

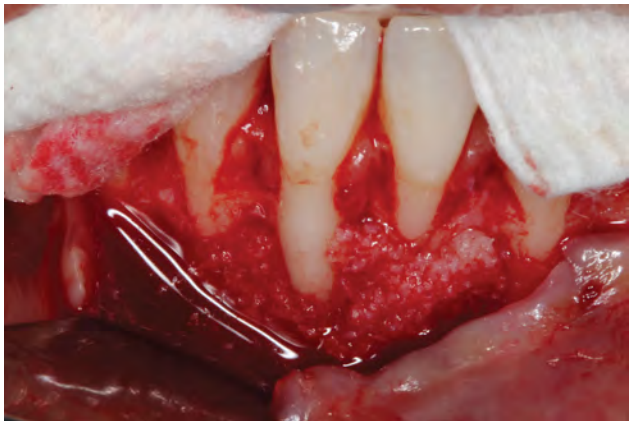


Figure 29: Small-particle MCBA packed into the concavities. Note the graft material turning red from the wicking of the underlying blood supply to the surface.

Figure 30: Adequate donor connective tissue was harvested from the palate and secured over the recipient bed. The overlaying flap was coronally advanced and sutured into place.

Figure 31: Complete and stable root coverage after two years. Gingival margin harmony has been restored and the soft tissue is pink, firm, and healthy, with minimal probing depths.

All of the choices made in the presented surgical procedures were based on wound healing and optimizing the blood supply for the grafted tissue, thus increasing its chance of survival. Increasing the blood supply to the grafted tissue is critical because it is entirely dependent on plasmatic circulation or diffusion of nutrients from the surrounding area during the first few days of healing.[11] Proper stabilization with minimal graft compression through suturing of the graft is also important, as stability is necessary for ingrowth of blood vessels and integration of the donor tissue into the recipient bed.

There are three sources of blood supply to a subepithelial connective tissue graft: the interproximal bone, the PDL, and the supraperiosteal vessels of the overlying flap.[12] A full thickness flap without vertical releasing incisions is used to preserve the supraperiosteal blood vessels and allow the flap to serve as an intact source of blood supply to one side of the underlying graft.[13] The exposure of the alveolar bone with decortication allows blood from the bone marrow to easily permeate the cortical plate and supply the underside of the grafted tissue.[14] Papilla slicing incisions are used to maintain the integrity of the papilla and deepithelialize their surface, allowing for both exposure of the papilla's connective tissue and a stable intact area to suture the graft. Bone graft particulate is placed in the alveolar concavities adjacent to the tooth roots for multiple reasons: to decrease dead space between the alveolus and the donor tissue; to create a level recipient bed; and to wick or absorb blood from the alveolus to the surface of the graft particulate, allowing direct contact between the blood supply of the underlying bone and the donor tissue.

Previous techniques to increase the contact between the interproximal bone and subepithelial grafts in areas of root prominence consisted of mechanical reduction of the root surface. While flattening of a prominent root surface by mechanical means can create more of a level bed for the grafted tissue and increase contact between the graft and alveolar bone, it damages the teeth being treated and the amount of achievable reduction is limited by the pulp chamber. The presented technique of using particulate graft material in the concavities adjacent to prominent roots achieves the goal of increased contact between the graft and blood supply of the alveolar bone without risk to the treated teeth or limitation of pulp chambers.

Summary

Although the authors have had much success using the modified connective tissue grafting technique described here, further long-term studies are needed to compare the results achieved using this technique with conventional means of connective tissue grafting in areas of prominent roots. This technique's capacity to create a stable and predictable esthetic result—and the patient satisfaction that ensues—makes it an excellent addition to any clinician's armamentarium.

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> "Correction of gingival recession in areas of malpositioned teeth and prominent roots, even in cases with little to no interproximal hard or soft tissue loss, can have variable outcomes."

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Turning a Difficult Situation into a Routine Treatment

Treating a Class III Malocclusion with Dentoalveolar Compensation and Ceramic Veneers

Jon Gurrea, DDS
Iñigo Gómez Bollain, DDS

Abstract

Interdisciplinary dentistry can help clinicians to provide less invasive treatments with better outcomes. This case report describes the treatment of a moderate Class III malocclusion with anterior crossbite in an adult patient with dentoalveolar compensation and six bonded porcelain restorations in the anterior segment. The diagnosis of the malocclusion, differentiation between the maximum intercuspation and centric occlusion, use of an orthodontic setup, and finishing of the treatment with bonded porcelain restorations are discussed.

Key Words: interdisciplinary treatment, Class III compensation, comprehensive care, functional diagnosis, veneers

It is, however, a dentist's responsibility to be familiar with what other specialties can offer and to refer when appropriate.

Introduction

Some orthodontists prescribe only orthodontic treatments; some periodontists look only for periodontal pockets and the band of keratinized gingiva; and some restorative dentists and prosthodontists look only for teeth to cap or to "drill and fill." It is, however, a dentist's responsibility to be familiar with what other specialties can offer and to refer when appropriate. In this way, better outcomes sometimes can be achieved with less invasive procedures.[1]

Orthodontics is often the ally restorative dentists need to be able to perform less invasive treatments. It gives the restorative dentist the chance to alter tooth position with no enamel reduction and change occlusal patterns with no crowns, and facilitates restorative dentistry by decreasing the number of teeth involved in future treatment. Orthodontics does have a drawback, however: duration of treatment. We have to motivate our patients to begin with, and then keep them motivated[2] throughout a course of treatment that can take many months and obliges the patient to accept the entire treatment plan to achieve the desired results,[3] especially when orthodontics is restoratively driven.

This case report discusses the treatment of a Class III patient who required an esthetic outcome for his anterior crossbite.

Orthodontics is often the ally restorative dentists need to be able to perform less invasive treatments.

Case Presentation and Treatment Planning

A 35-year-old male with Angle Class III malocclusion without any pain or discomfort required an esthetic solution for his smile **(Figs 1 & 2)**. He presented with an anterior crossbite in maximum intercuspation (MI) and diastemata in the mandibular incisors and canines.

A Lucia jig was used to deprogram the patient[4] during the functional evaluation[5] (a Kois deprogrammer also can be used).[6] The purpose was to determine whether this case of MI with anterior crossbite might be a result of searching for more contacts while having an interference in the envelope of function. In centric relation, the patient was in fact setting his teeth in an edge-to-edge position with a posterior open bite; because of this, the centric occlusion (CO) contact was at the central incisors. As a result the patient developed an avoidance pattern, expanding his envelope of function **(Figs 3a-4b)**.

Figures 1 & 2: Preoperative images.

Figure 3a: Maximum intercuspation, frontal view.

Figure 3b: Centric occlusion, frontal view.

Figure 4a: Maximum intercuspation, right lateral view.

Figure 4b: Centric occlusion, right lateral view.

Due to the presence of diastemata in the lower arch, closing spaces retroclining the mandibular incisors and opening spaces by proclining the maxillary incisors to compensate for the moderate Class III[7] was an option. These anterior gaps would be closed restoratively after orthodontic treatment. This treatment plan avoided the need for orthognathic surgery while providing a stable occlusal scheme **(Fig 5)**.

After examination by the orthodontist and the restorative dentist an orthodontic setup was done to establish the movement that was required. Orthodontic setups can be very useful in determining treatment needs and possible outcomes in many situations.[8,9] This particular setup was intended to determine whether dentoalveolar compensation could provide a satisfactory outcome before starting to move teeth. The orthodontic movement was "restoratively driven" because the treatment could not be concluded without the restorative phase. Different from many orthodontic camouflage cases,[10,11] no extractions were necessary as spaces already existed.

The orthodontic movement was "restoratively driven" because the treatment could not be concluded without the restorative phase.

Figure 5: Preoperative cephalometric and radiographic analyses. *(Illustrations by Dr. Gómez Bollain)*

Interdisciplinary Treatment

Orthodontic Phase

Once the setup was approved the orthodontic treatment began with occlusal stops in the lower posterior teeth and brackets in the upper arch. After three months the anterior crossbite was almost corrected and brackets were placed in the lower arch. From that moment on, the treatment was aimed at correcting the posterior open bite and providing adequate spacing for the restorative phase.

During the final five months of treatment, creating even spaces was the most important part of the orthodontic treatment **(Fig 6)**.

The restorative dentist must emphasize tooth position to the orthodontist. Accurate tooth position will ensure that once the teeth are restored an adequate tooth shape and gingival architecture will emerge. Closing the diastemata between the centrals and laterals will make laterals and canines too big.

Restorative Phase

Respecting tooth size and proportion[12,13] is the key to restorative success. Also, by having even spaces we can ensure the accurate position of the gingival zenith.[14,15] Gingival zenith has to be displaced toward the distal of the tooth axis in lateral incisors and central incisors; if there are no spaces between central incisors (as many orthodontists prefer) the zenith will be in the middle or mesial to the tooth axis. Having a diastema in the midline will provide a more natural tooth shape when the restorations are placed.

Wax-up and Mock-up

Once tooth position was ideal, the restorative dentist approved removal of the brackets. A removable orthodontic retainer was fabricated for the upper arch and fixed retention was placed for the lower arch **(Figs 7a-7e)**. A wax-up and mock-up were done to provide better information to the patient, clinician, and technician.[16-18] In the wax-up, both the length and width of the anterior teeth were augmented to keep an adequate proportion ratio (85% for centrals, 79% for laterals, 76% for canines).[13] The mock-up was done to facilitate the patient's approval and to check speech and teeth exposure during smiling and repose. The additive wax-up[19,20] also served as a guide for a more conservative preparation.[21-23]

Preparation

Teeth ##6-11 were prepared almost completely within the enamel thickness, with special care taken in the cervical area.[24] The preparations were slightly subgingival, being deeper in the interproximal area, to change the emergence profile of the teeth to close the diastemata with no black triangles.[25]

After the preparations were finished, a two-step impression with double cord (#000 and #1 Ultrapack, Ultradent Products; South Jordan, UT) was taken[26] **(Figs 8-10)**. Direct provisionals were made with a bis-acryl resin (Telio CS C&B, Ivoclar Vivadent; Amherst, NY) and polished with goat hair discs and polishing paste (Pasta Grigia I, Anaxdent; Stuttgart, Germany) **(Figs 11a & 11b)**.

Final Restorations

Six porcelain restorations were fabricated with IPS d.Sign ceramic (Ivoclar Vivadent AG; Schaan, Liechtenstein). Having a model that clearly shows the first millimeter of root helps the technician to create restorations that follow the tooth's emergence profile so the restorations will blend in better with the gingiva **(Fig 12)**. The restorations covered the tooth interproximally up to the top of the papilla to close the diastemas properly **(Fig 13)**.

The restorations were bonded under complete rubber dam isolation following the Magne and Belser protocol[27] with a resin-based luting composite (Variolink Esthetic, Ivoclar Vivadent AG) **(Figs 14-15b)**. After bonding, the patient was given a new orthodontic retainer and his lower teeth were whitened.

After 18 months the results were stable and the patient was comfortable with his new occlusal scheme **(Figs 16a-16d)**. The risk with cases like this is a constricted envelope of function, which would break or debond the restorations. Careful planning is needed to avoid this complication **(Figs 17-20b)**.

Orthodontic setups can be very useful in determining treatment needs and possible outcomes in many situations.

Initial

2 months

3 months

5 months

Figure 6: Orthodontic treatment.

8 months

10 months

12 months

18 months

Figures 7a-7e: Final images after bracket removal.

Figure 8: Tooth preparation with double cord.

Figure 9: The cord is carefully removed.

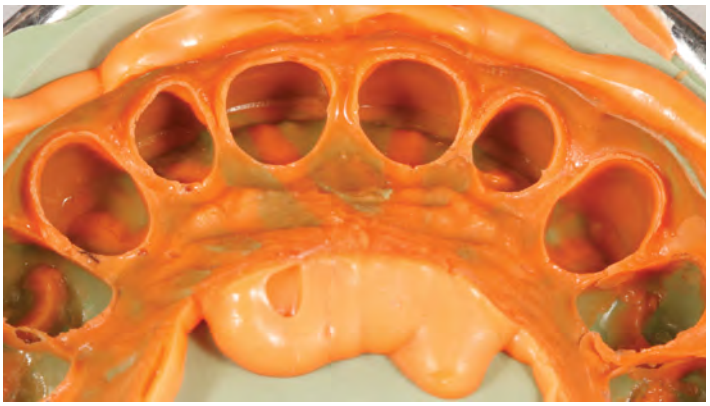


Figure 10: The two-step technique can provide very accurate impressions.

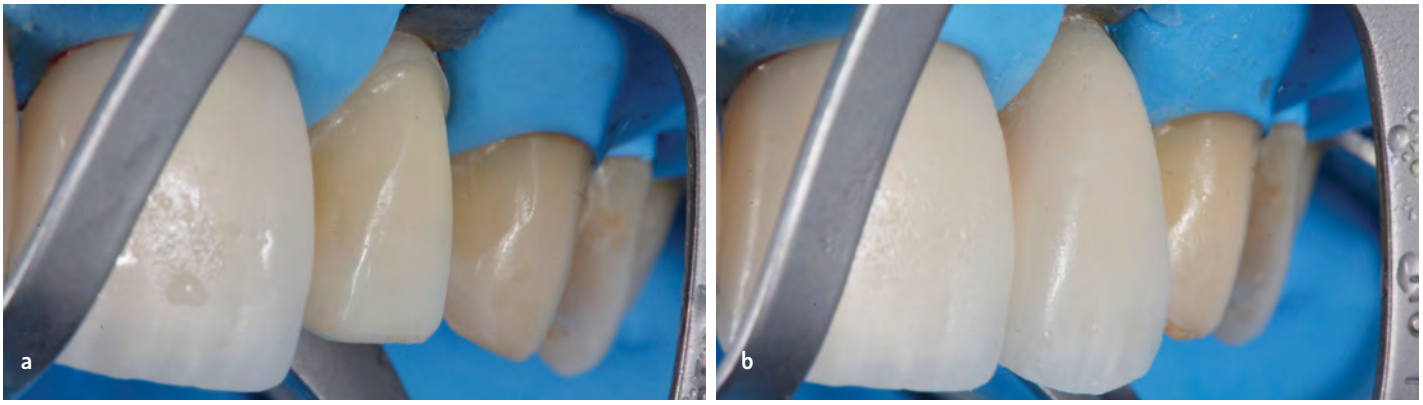
Figures 11a & 11b: Direct provisional with bis-acryl resin.

Figure 12: Porcelain restorations in the solid cast.

Figure 13: Porcelain restorations, palatal view.

Respecting tooth size and proportion is the key to restorative success.

Figure 14: Bonding performed under total isolation.



Figures 15a & 15b: Bonding a lateral incisor restoration. Note the retraction done with a 212 clamp.

Figures 16a-16d: Postoperative intraoral images after 18 months.

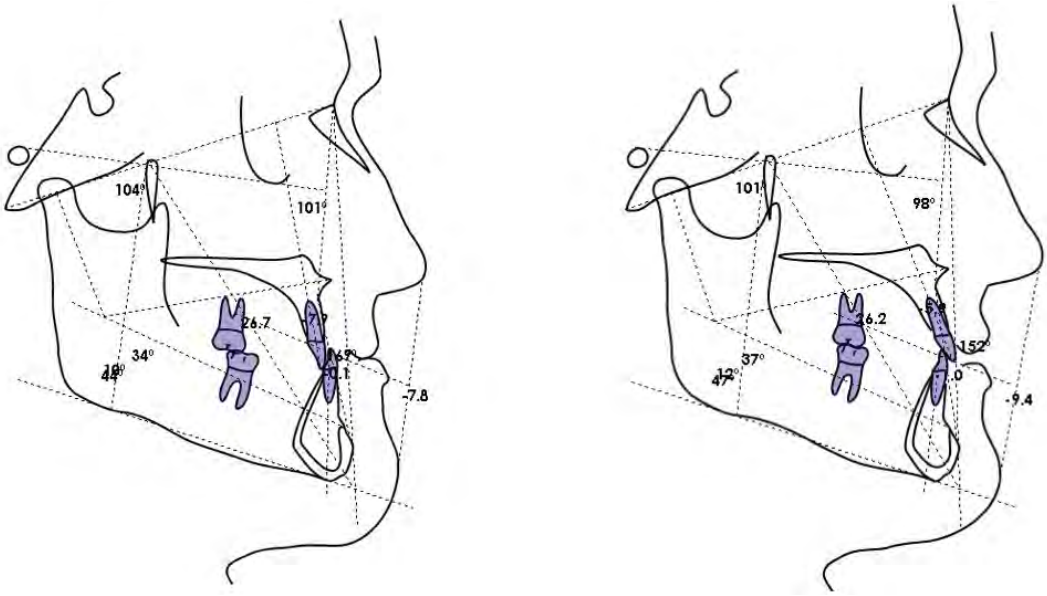


Figure 17: Before and after Ricketts cephalometric analysis. *(Illustrations by Dr. Gómez Bollain)*

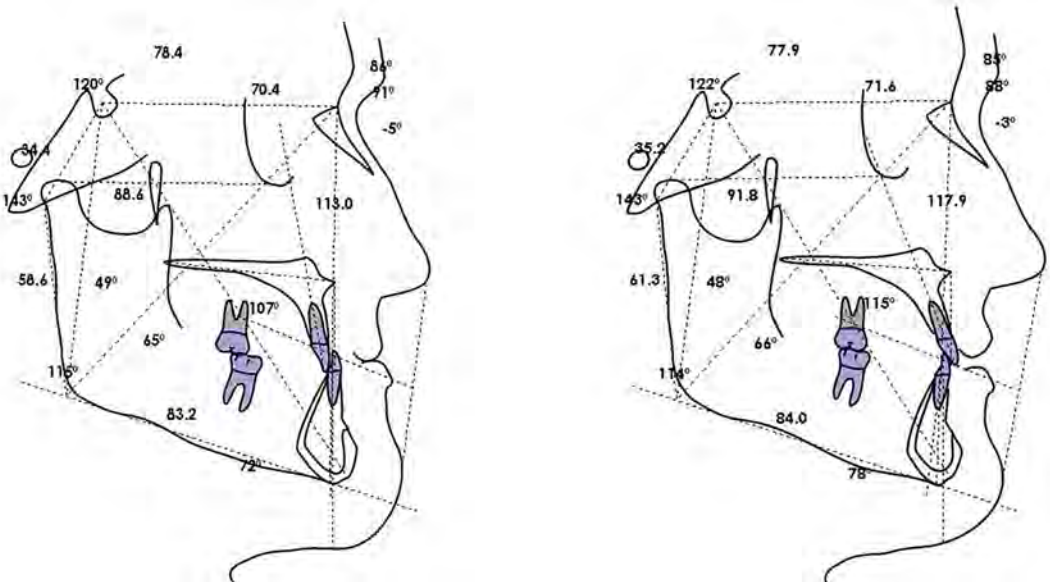


Figure 18: Before and after Björk-Jarabak cephalometric analysis. *(Illustrations by Dr. Gómez Bollain)*

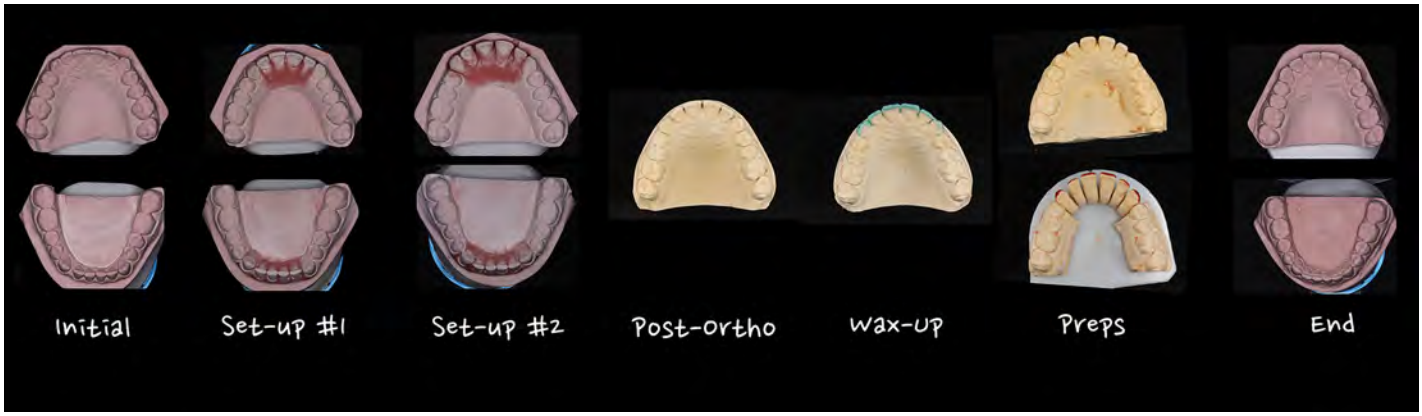


Figure 19: Careful planning leads to success. A first setup was done, but it was not satisfactory and a second setup had to be made.

Figures 20a & 20b: Postoperative images.

Summary

Treating a Class III malocclusion is not difficult in mild or moderate cases where orthognathic surgery is not needed. Compensation only via restorative work would be overtreatment in many cases in which orthodontics is the answer. On the other hand, the orthodontist alone cannot provide an ideal result in most of these cases. This is where interdisciplinary synergy improves treatment outcomes. Interdisciplinary treatments require vision, the importance of which is summed up in the Maori proverb, "The person with a narrow vision sees a narrow horizon. The person with a wide vision sees a wide horizon."[28]

Acknowledgment

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> With many jurisdictions now including use of BoNT/A injections within the scope of practice of general dentistry it is possible to complete the esthetic treatment of the entire smile.

Improving Lip Symmetry

Using Botulinum Toxin Type A to Enhance a Smile Makeover

Janet M. Roberts, DMD, BSc
Warren P. Roberts, DMD

Dr. Janet Roberts and Dr. Warren Roberts will be presenters at AACD Las Vegas 2017, which will take place April 18-21. Their two courses, about the uses of botulinum toxin in dentistry, will address issues including parafunctional habits, endodontics, TMD/myofascial pain, trigeminal neuralgia, anxiety and depression, and smile design.

Abstract

Cosmetic dental restoration often is not optimal due to extraoral soft tissue conditions that traditionally have been out of the general dentist's control. Until recently dentists have been confined mainly to intraoral treatment alone. With recent regulatory changes in some jurisdictions it is now possible to use Botulinum Toxin Type A (BoNT/A) to enhance cosmetic dental outcomes. Although the primary cosmetic use of BoNT/A is to treat rhytids around the eyes (crow's feet) and glabellar frown lines, it is also useful in relaxing other facial muscles to improve symmetry and balance.[1] This article discusses smile design utilizing ceramic restorations and BoNT/A.

Key Words: smile design, Botulinum Toxin Type A, ceramic restorations, photography, communication

Introduction

A beautiful smile comprises more than just the teeth. The various elements, comprising individual teeth, the teeth collectively, the gingiva, lips, and the face must work together harmoniously for the result to be optimal. "The patient will exhibit a pleasing smile only when the quality and health of the gingiva and dental elements, together with the relation between teeth and lips, are harmoniously adapted to the face."[2]

As dentists we have the opportunity to influence many of the smile's components, but for many years general dentists have been limited to making changes inside the mouth only (oral soft tissues and teeth). However, with regulations being modified in many jurisdictions, we are now able to effect change to the soft tissue outside the mouth, enhancing the esthetic changes we make intraorally. Recognizing that the lips frame the teeth and gingiva, and the face frames the entire smile, adjunctive esthetic procedures utilizing such modalities as BoNT/A injections allow us to influence the shape of the mouth. With many jurisdictions now including use of BoNT/A injections within the scope of practice of general dentistry it is possible to complete the esthetic treatment of the entire smile. These treatments are a natural adjunct to esthetic dentistry and their use can have a major impact on the esthetic outcome of smile makeovers and comprehensive restorative treatment through their effect on tooth display and the draping of the soft tissue around the mouth (not to mention through muscle relaxation and its effect on temperomandibular dysfunction, headaches,[3-6] and implant success). Even dentists who may not be inclined to provide these complementary treatments themselves should understand how BoNT/A could influence the dental treatment they provide and refer to a colleague well trained in its use.

The following case report illustrates how the use of BoNT/A in conjunction with cosmetic dental procedures effected a better outcome than traditional cosmetic dental treatment alone.

> "This lip asymmetry made it impossible to achieve one of the major principles of smile design, namely parallelism between the incisal arc of the upper teeth and the curvature of the lower lip."

Case Report

Evaluation and Findings

A healthy 38-year-old female presented for treatment desiring a fuller, whiter, and brighter smile, one that was more uniform in appearance without discolored and chipped teeth. Furthermore, she was bothered by the fact that her lower lip "drooped" on the right side when she smiled. Examination revealed aspects of her smile that were less than optimal, including a dental midline that was canted and displaced to the left side. The dental asymmetry was compounded by facial asymmetry; her nose was canted slightly to the right and although her lips were attractive and pleasantly full, the lower lip was also decidedly asymmetrical, dropping much lower on the right side than the left **(Figs 1-4)**. This lip asymmetry made it impossible to achieve one of the major principles of smile design, namely parallelism between the incisal arc of the upper teeth and the curvature of the lower lip.[7] The drooping of the lower lip when smiling also accentuated the visibility of black triangles between the lower incisors. Dentally, other concerns included stained and chipped teeth, failing composite bonding that was contributing to gingival inflammation, and gingival recession.[8,9] The primary canine was retained in the position of #11 and the upper left permanent canine was congenitally missing. Previous dental history included orthodontic treatment with orthognathic surgery and composite bonding to close spaces.

A thorough examination was performed and detailed records obtained, including a series of facial rejuvenation photographs **(Figs 5-8)**. This series aids in the diagnosis and treatment planning of facial and dental rejuvenation and also provides an important medical-legal record. It allows the patient to view themself from angles they are unaccustomed to seeing, at rest and with various muscles activated; and helps the dentist to critically analyze the face and demonstrates how the muscles of facial expression affect the smile design.[10]

Figure 1: Patient before treatment.

Figures 2-4: Frontal, right, and left smile views before treatment.

> This series aids in the diagnosis and treatment planning of facial and dental rejuvenation and also provides an important medical-legal record. It allows the patient to view themself from angles they are unaccustomed to seeing, at rest and with various muscles activated; and helps the dentist to critically analyze the face and demonstrates how the muscles of facial expression affect the smile design.

Figure 5: Facial rejuvenation series, relaxed and contracted full-face views.

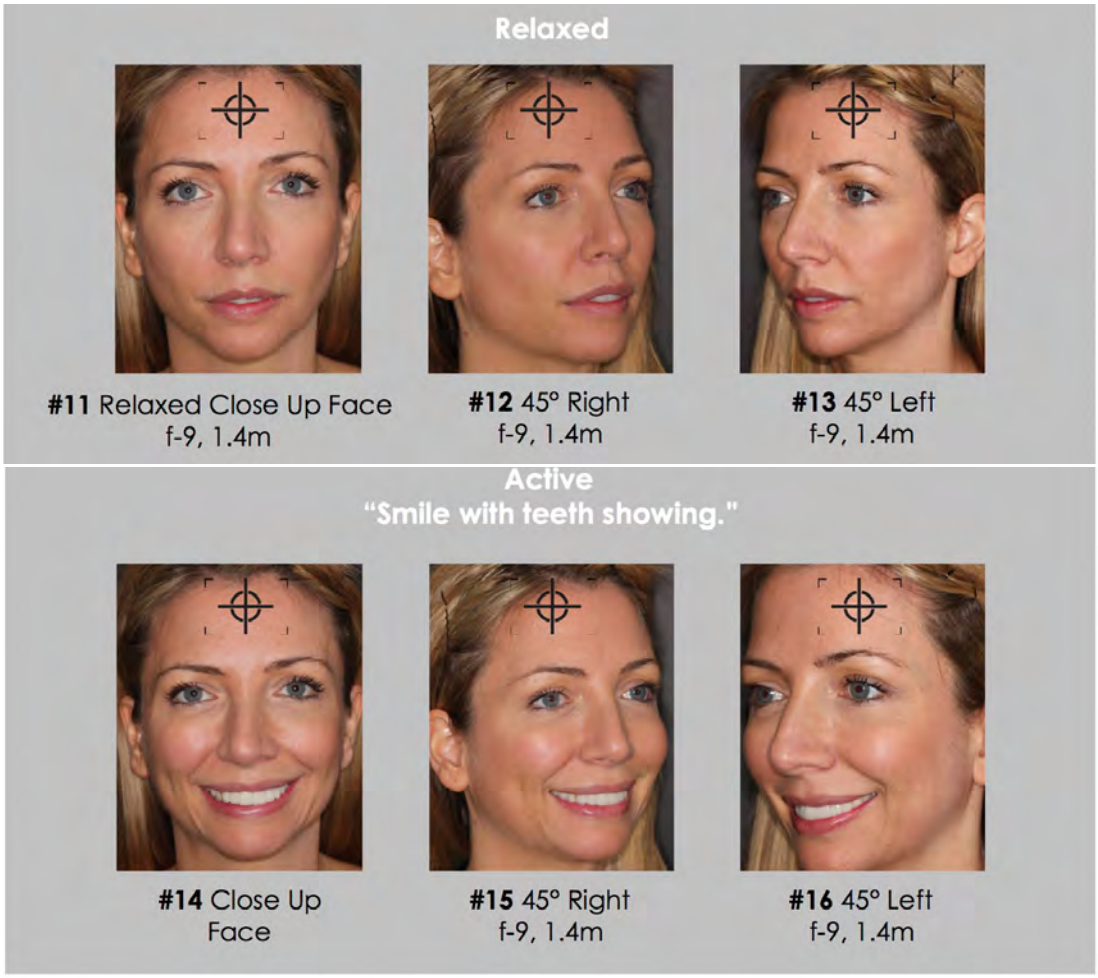

Figure 6: Facial rejuvenation series, close-up relaxed and smile full-face views.

Figure 7: Facial rejuvenation series, upper face with various expressions to evaluate for treatment plan.

Figure 8: Facial rejuvenation series, various views at rest and with muscles activated to analyze for smile design.

Treatment Plan

Various options were discussed with the patient, including further orthodontic treatment, porcelain veneers and crowns, implant placement, and cosmetic bonding.[11,12] BoNT/A was offered as a means to improve lip symmetry. Eventually a treatment plan was devised[13] that addressed both the patient's esthetic dental concerns and the soft tissue asymmetry of her lips. By addressing both issues it would be possible to obtain attractive teeth with a beautiful frame. It was decided that 10 porcelain veneers and crowns would be placed on teeth ##4-13 (upper right second bicuspid to upper left second bicuspid) and Botox Cosmetic (Allergan; Irvine, CA) used to relax the downward-pulling muscles that were exerting too great a force on the right side of the lower lip. During the provisional dental phase, the lip position would again be analyzed to determine whether any adjustment to the original treatment plan was required prior to final porcelain fabrication.

Treatment

The smile design was developed in conjunction with the patient, using multiple photographs, diagnostic models, and a diagnostic wax-up.[14,15] The patient was very clear about the result she wanted: very white, even, rectangular teeth with small incisal embrasures. The first clinical step involved refining the existing composite bonding on the anterior teeth to promote better gingival health prior to preparing the teeth for veneers. A few weeks later the teeth were prepared for 10 Empress veneers and crowns (Ivoclar Vivadent; Amherst, NY). At the start of this appointment a diode laser was used to raise some of the gingival heights and achieve better gingival symmetry. Care was taken to avoid encroaching on the biologic width.[16-18]

Following preparation of the teeth, impression taking, and obtaining necessary records, the teeth were provisionalized. The provisionals allow the patient to preview the final result and the dentist to work out occlusal details. The patient wanted several changes made to the shape and final shade of the teeth; initially the corners were too round and the incisal embrasures too open. The provisional stage is a critical step in the communication process between the patient and the dentist, and the dentist and the ceramist. The desired changes were made to the provisionals and the

details were relayed to the laboratory using photographs, models, and written instructions.[19-21] It was apparent at this stage that the lower lip position was still going to detract from the final result.

Several weeks later the finished veneers were checked on the models, tried in the mouth, and carefully assessed for fit and esthetics. The patient gave her consent and the veneers and crowns were bonded into place. After a follow-up appointment for slight occlusal adjustment and checking to ensure no resin tags remained on any margins, the patient was rescheduled to address the lower lip asymmetry. The lips' appearance following ceramic restoration placement had improved the smile, but the frame around the teeth was still less than ideal. In addition, the black triangles between the lower incisors were still visible, detracting from the overall result **(Figs 9 & 10)**.

The rejuvenation photograph series was again obtained to detail the treatment plan for Botox Cosmetic therapy. The series of photographs and the clinical presentation revealed that hypercontraction of the right depressor labii inferioris, right depressor anguli oris, and right platysma muscles were responsible for the excessive downward pull of the lower lip on the right **(Fig 11)**. Each individual has different muscle recruitment for every facial expression and the recruitment changes with age. If one is performing a true smile design then it is imperative to view the patient in all their various facial expressions. Although in repose the patient's lips appeared normal, when the muscles were activated it was apparent that all three of the aforementioned muscles were overactive on the right **(Figs 12-17)**. The full sagittal views revealed the greater bulk and activity of the right platysma muscle compared to the left side **(Figs 16 & 17)**. Photographing the muscles in repose and activation allowed for precise marking and placement of injections and, therefore, precise results.

Two units of Botox were injected into the right depressor labii inferioris, two units into the right depressor anguli oris, two units into five sites on the right side of platysma just below the inferior border of the mandible, and two units into eight sites on the right lateral band of platysma **(Figs 18 & 19)**. The patient understood that this treatment would need to be repeated every three to four months until subconscious activation of the muscles unilaterally gradually diminished.

After two weeks (the time required for full results to be expressed with Botox) the patient was rescheduled and the results assessed. Sometimes it is necessary to fine-tune the results with several additional units of the neuromodulator. However, in this case no modication was necessary; the lips were now symmetrical. The smile arc and curvature of the lower lip were coincident and the black triangles between the lower incisors were no longer visible. The draping of the soft tissue harmonized with the teeth to create a smile design incorporating macro, mini, and micro esthetics.[22] The final photographs reveal how the use of BoNT/A together with 10 ceramic restorations resulted in a more harmonious smile design than could have been achieved with dental treatment alone **(Figs 20-23)**.

“The lips' appearance following ceramic restoration placement had improved the smile, but the frame around the teeth was still less than ideal.”

Figure 9: Full-face view.

> “Each individual has different muscle recruitment for every facial expression and the recruitment changes with age.”

Figure 10: Smile after veneers only.

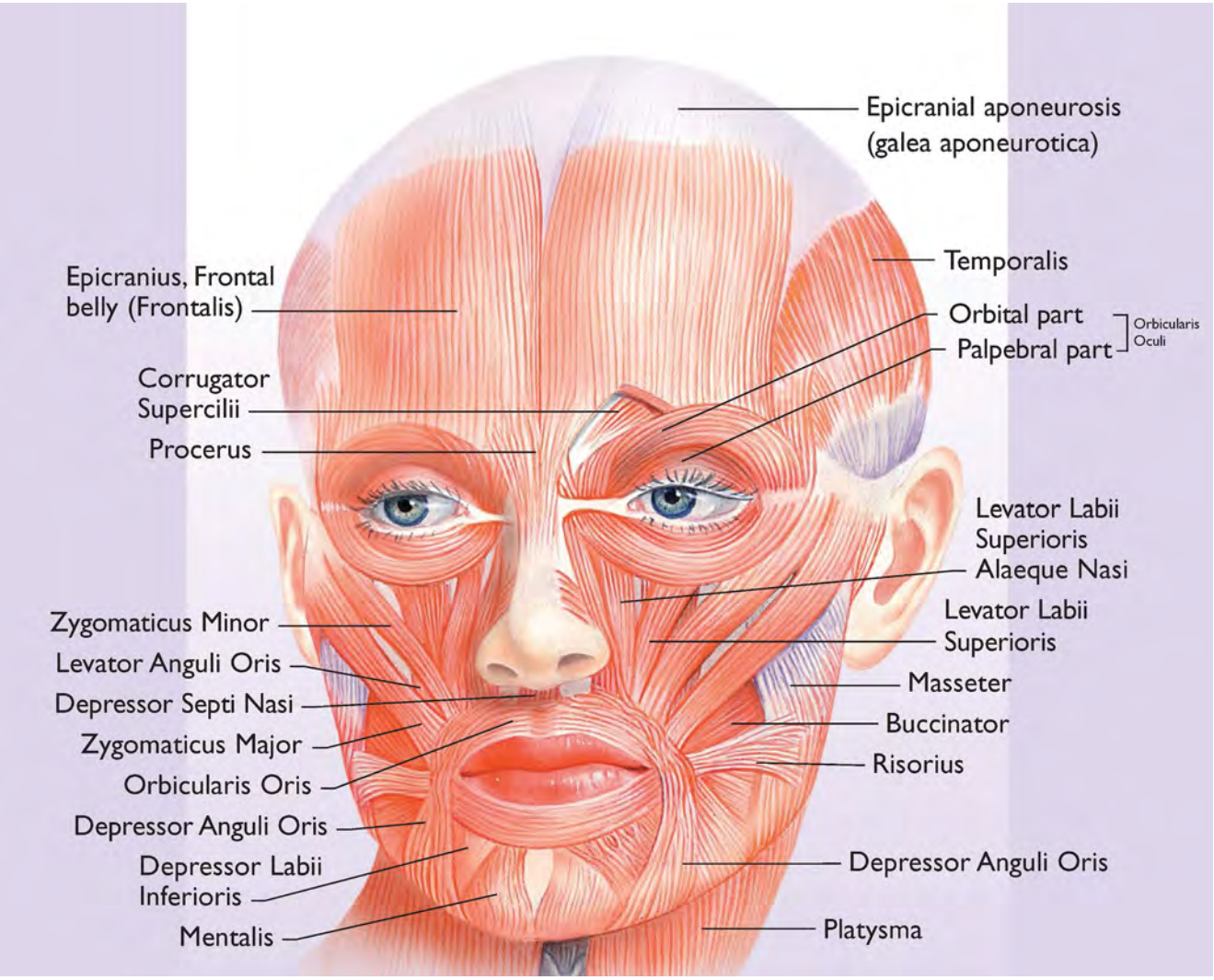

Figure 11: Platysma, depressor anguli oris, and depressor labii inferioris, frontal view. (Reprinted with permission of Allergan, Plc.)

> “Various options were discussed with the patient, including further orthodontic treatment, porcelain veneers and crowns, implant placement, and cosmetic bonding.”

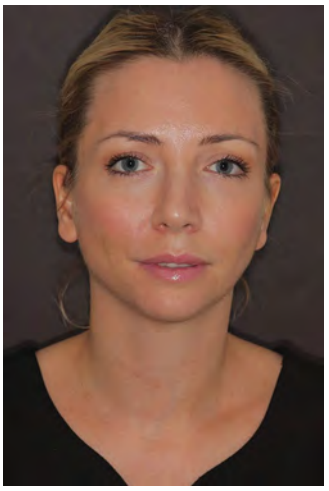

Figure 12: Muscles relaxed, frontal view.

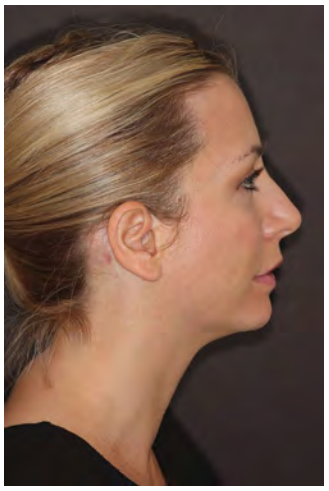

Figure 13: Muscles relaxed, right.

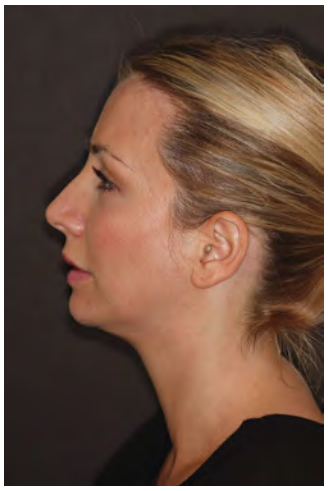

Figure 14: Muscles relaxed, left.

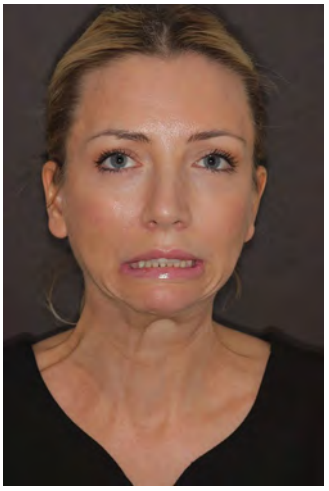

Figure 15: Muscles activated, frontal view.

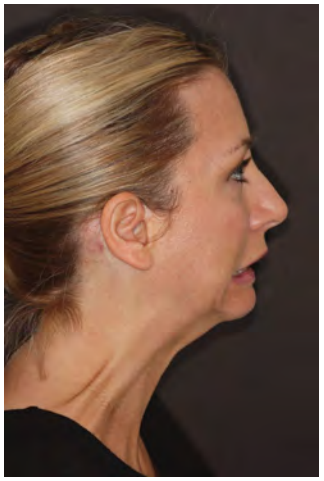

Figure 16: Muscles activated, right.

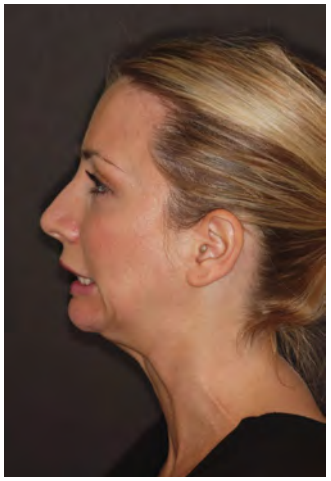

Figure 17: Muscles activated, left.

Figure 18: Markings of injection sites, relaxed.

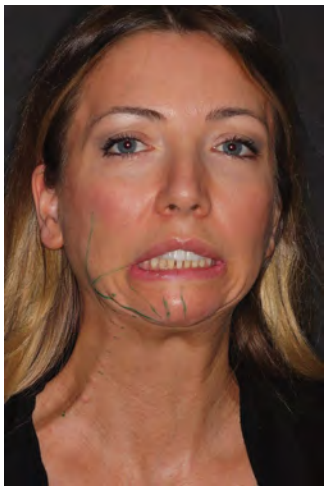

Figure 19: Markings of injection sites, activated.

Figures 20-22: Frontal, right, and left smile views after treatment with Botox.

Figure 23: Full-face image after treatment with Botox.

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Repairing Dental Erosion with **Minimal-Preparation Dentistry**

Validation of Biological and Functional Esthetics in a Full-Mouth Rehabilitation

Cyril Gaillard, DDS
Florin Cofar, DDS
Ioana Popp, CDT
Jérôme Bellamy, CDT
Christophe Hue, CDT

Abstract

Dental erosion is being seen more and more frequently in dental offices today. Its treatment must be biological, esthetic, and functional. The creation of a treatment plan is critical to therapeutic success. First, it is necessary to determine a new mandibular position, then to redesign the esthetics. Next, the occlusal concept and the new smile must be tested using a mock-up. This allows the validation of function and esthetics so that the dental tissues can be prepared only minimally—or not at all—and maximum enamel is preserved to guarantee the quality of bonding. Finally, digital dentistry enables us to more precisely copy the shapes of mock-ups and therefore the occlusal concept.

Key Words: digital dentistry, full-mouth rehabilitation, adhesive dentistry, worn teeth, minimal preparation

CE CREDIT

Learning Objectives

After reading this article, the participant should be able to:

1. Follow a conservative, systematic protocol for correcting dental erosion.
2. Understand the three treatment components needed to treat dental erosion.
3. Appreciate a predictable method for opening a patient's vertical dimension of occlusion.

Disclosures: The authors did not report any disclosures.

Introduction

The prevalence of patients with severe dental wear has increased over the past few years.[1,2] This erosion often causes not only esthetic damage but also serious functional problems for many patients.[3] The etiology can be either mechanical (bruxism) or chemical (acid from ingesting soft drinks or from gastroesophageal reflux). Adhesive dentistry enables us to treat these patients with a very low biological impact by avoiding dental mutilation, especially if we manage to keep the maximum amount of enamel on the tooth, which greatly increases the quality and longevity of the bonding.

The goals of a full-mouth treatment must be to:

- be biological, not iatrogenic, destroying as little natural dentition as possible, with periodontics and occlusion (muscular and articular) also being taken into account
- maintain long-term health and ease of hygiene
- reestablish effective function (mastication) as well as create esthetics that please the patient.

This article presents the rehabilitation of a patient with severe dental erosion, integrating the concept of minimally invasive dentistry with adhesive dentistry and, most importantly, functional dentistry, by knowing the patient's precise occlusal concept and mandibular position.

Case Presentation

Examination and Findings

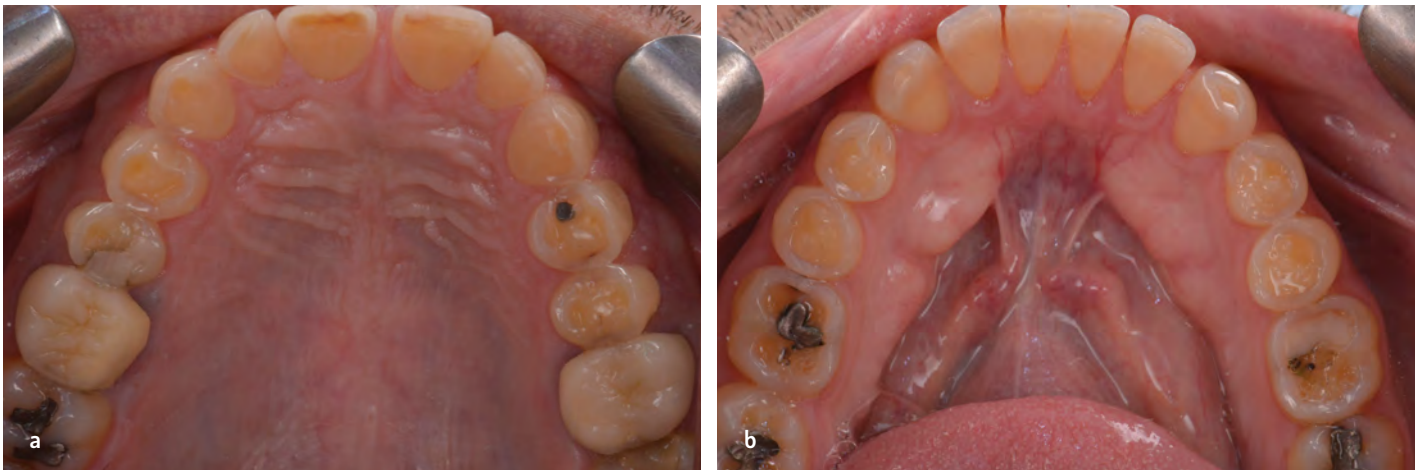
A 40-year-old male patient came to the office for his annual check-up **(Fig 1)**. During initial examination, we brought up his severe dental wear and the fact that it would worsen further due to the absence of enamel on the occlusal surfaces **(Figs 2a & 2b)**.

The extraoral exam revealed a largely reduced lower facial zone. The intraoral exam showed significant dental erosion but also extremely developed exostoses on the maxillary and mandible, consequences of very strong occlusal pressure **(Figs 3a-4)**. Exostoses and tori are not necessarily the result of occlusal pressure and can sometimes be solely genetic in nature, but with this patient the cause appears to have been occlusal pressure. We also noted the presence of crowns at teeth #26 and #16, and amalgams on the molars.

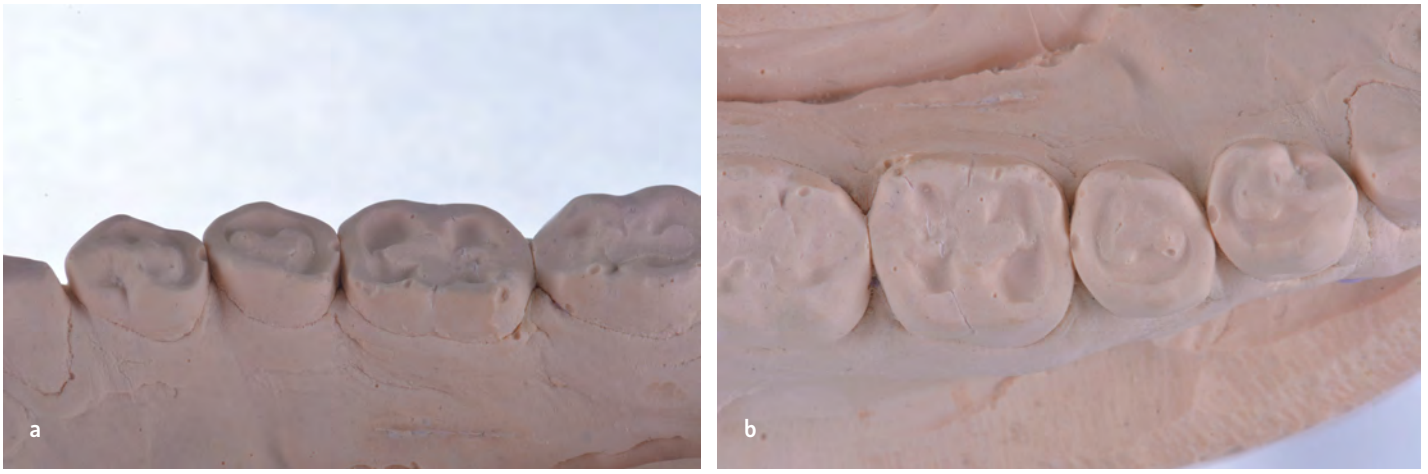
The patient stated that he had neither muscle spasms nor articular pain but did have increasing discomfort during mastication and constantly tried to find a comfortable mandible position (he was unable to do so because of faulty proprioceptive feedback due to the severe tooth erosion).

Figure 1: Initial full-face image.

The extraoral exam revealed a largely reduced lower facial zone.



Figures 2a & 2b: Initial upper and lower occlusal views showing severe erosion.



Figures 3a & 3b: Study models showing the severe wear.

Figure 4: Initial intraoral image.

Treatment Plan

In creating a treatment plan, we followed these steps:

- Talk with the patient to learn his wishes, desires, and possible limitations in terms of treatment.
- Seek the appropriate mandibular position during occlusal planning to determine how much dental tissue will have to be destroyed.
- Utilize digital tools in esthetic planning.

Treatment would proceed as follows:

- Clean all the teeth.
- Complete a mock-up (excluding vestibular faces of ##14-24).
- Complete a shell mock-up on the vestibular faces of ##14-24.
- Leave the first mock-up in the patient's mouth for two months to validate the new occlusion.
- Utilize computer-aided design/computer-aided manufacturing (CAD/CAM) technology to create the definitive prosthesis, integrating the concept of minimally invasive dentistry.[4-6]

Defining a New Occlusion

Clinical Phase

A transcutaneous electrical nerve stimulation (TENS) session was scheduled to determine the new occlusion.[7,8] Because the patient's vertical dimension of occlusion (VDO) was deficient, it was necessary to increase it to reconstruct the teeth, not only vertically but also anterior-posteriorly and transversally. It also was necessary to disrupt the patient's faulty proprioception so that the muscles could return to their original, relaxed position. TENS relaxes the muscles and rids them of built-up lactic acid while introducing oxygen and adenosine triphosphate (ATP), thus interrupting the former anaerobic cycle and recreating an aerobic cycle.[9]

The TENS unit (Bisco; Lançon de Provence, France) was applied to the patient's cranial nerves V, VII, and XI for one hour to relax the paracervical muscles and muscles of mastication. The new occlusion was recorded vertically, anterior-posteriorly, and transversally with a K7 evaluation system (Myotronics; Kent, WA). This system comprises two parts: electromyography to evaluate muscle activity and jaw tracking to see the precise position of the mandible at any given moment.

To record the patient's bite, a magnet was placed on the buccal surface of the lower incisors and we registered the physiologic movement of the jaw, including the rest position, the habitual occlusion, and the trajectory of opening and closing.

We determined the new VDO in function of the trajectory of opening and closing and in function of the rest position and the wear of the teeth. To determine the new occlusion we visualized on a software-generated graph the resting position of the patient's mandible after one hour of relaxation with the TENS unit. This position was stable. Starting from this position, when the TENS sends an electrical pulse that contracts the muscles, we can see on the computer screen a line that corresponds to the beginning of the patient's closure. We know that the new occlusion must be found along this trajectory because this trajectory corresponds to the most natural muscular contraction possible. The brain does not intervene to correct this trajectory as it could if there were interferences. So for the occlusion we want to be on the trajectory at approximately 2 mm above the point representing the mandible at rest to create free space. Once the recording was done, we confirmed the position of the temporomandibular joints with a cone beam computed tomograph. For the bite recording, we asked the patient to sit, back straight, eyes closed; he opened his mouth and we injected the silicone without touching him, then guided him into the chosen position using the screen and jaw tracking. Bite registration **(Fig 5)** was done using Regidur (Bisco) and polyvinyl siloxane (PVS) impressions were taken, then given to the laboratory to create plaster models and a wax-up.

Laboratory Phase

Plaster models (FujiRock EP, GC, Tokyo, Japan) were made from the PVS impressions in the laboratory, which served as a base for the creation of a maxillary and mandibular wax-up integrating esthetic (incisal edge) and function (palatal and occlusal surfaces). The technician created the wax-up with GEO Snow White L wax (Renfert; Hilzingen, Germany), integrating the occlusal surfaces of the premolars and molars as well as the palatal and lingual surfaces of the incisors and canines, and a lengthening of the incisal edge. Silicone was used on the wax-up to produce a template for the intraoral mock-up **(Fig 6)**.

Performing the Mock-Up

Before performing the mock-up, the teeth were cleaned and spots were etched on the surfaces with phosphoric acid, then the teeth were rinsed and dried. The teeth were not prepared in any way. The resin was injected into the maxillary silicone key and the key was pressed onto the maxillary arch. Once the resin had set, the key was gently removed, the excess was eliminated with dental tweezers, and the surfaces were polished. The same process was followed with the mandibular silicone key.

Testing the Occlusion

Once the mock-up had been placed in the patient's mouth **(Fig 7)**, it was necessary to test the new occlusion and adjust if needed. Another one-hour TENS session was conducted so that the facial muscles could once again relax into their proper position, newly supported by the mock-up.

Figure 5: Recording the new bite.

Figure 6: Preparing the mock-up.

Figure 7: Functional mock-up.

The occlusion was tested in static and dynamic position using articulating paper. Static position was verified by the patient biting on the mock-up to check the contact points between the upper and lower cuspid fossa. Once the static position was verified, the dynamic position (i.e., mastication) was tested: The patient chewed on the right side of his mouth and the clinician verified the surface guidance on the molars, premolars, and canines. If the surface guidance is not equal, adjustments must be made. If guidance is present only on the canines, for example, the clinician has two possible courses for adjustment: Composite can be removed from the canines to match the premolars and molars, or composite can be added to the premolars and molars to create equal guidance with the canines.

The same verification process as described above was conducted on the patient's left side. Surface guidance was confirmed to be equal on all occlusal surfaces. Finally, the patient was asked to move his jaw laterally to verify group function, as well as in propulsion to verify guidance on the two central incisors. The authors prefer to work with group rather than canine function because it allows for a more effective mastication cycle. The more effective the mastication cycle, the less the masticator muscles need to work and therefore they become less worn. Everything was confirmed as being in equilibrium. The position of the incisal edge was inspected, videos were made and photographs taken, and the patient was consulted to be sure he was satisfied with the outcome.

Digital Planning and Esthetics

The esthetic study was done digitally (Digital Smile Design [DSD]; São Paulo, Brazil; and the SKYN concept [São Paulo, Brazil]).[10-14] After the occlusal maxillary and mandibular mock-up was performed, we took photographs and made videos that enabled us to complete the esthetic study. Because the patient had, as is common, presented with a slight asymmetry, we decided to use the vertical glabella-philtrum line as a reference line. The DSD protocol was followed and we determined the ideal length, width, and position of the future teeth **(Fig 8)**.[10,11] No gingival retouching was necessary.

Recreating Natural Morphology

The DSD tool supplied the ideal proportions for the future restorations, the surfaces and shapes of which were selected from models of natural teeth. The SKYN concept creates a thin composite shell on natural teeth to copy the form and surface texture, then uses this shell to perform the mock-up **(Fig 9)**.[12-14] Once the mock-up is validated the laboratory can begin to emulate nature. A silicone impression of the model teeth's buccal surfaces was taken. A thin layer of composite was added and photopolymerized in the silicone impression. The composite shell was then carefully removed, positioned in the patient's mouth, and fixed onto the tooth with composite. During the creation of this SKYN mock-up, it was important to pay attention to the emergence profile, incisal edge position, and gingival zenith. After this mock-up was done, a video was made to validate the esthetics of the patient's future smile.

Definitive Restorations

After the patient had worn the mock-up for the prescribed two months, it was time to fabricate the definitive restorations. CAD/CAM (Cerec, Sirona Dental Systems; Charlotte, NC) was utilized to copy the exact morphology of the teeth. Indeed, one of the laboratory technician's most challenging tasks is to copy the shape of the teeth to conserve anterior guidance and the occlusal morphology when advancing from the temporary to the final restorations. With CAD/CAM, we were able to exactly copy the mock-ups the patient had worn and validated.[14]

The first impression taken was the mock-up. The next step was to prepare the teeth as minimally as possible through the mock-up to eliminate the least amount of dental tissue. The aesthetic pre-evaluative temporary (APT)[15-17] technique was selected for minimal selective reduction **(Fig 10)**. Because the teeth were very abraded, we could have worked with ceramic elements such as crowns, but without preparation of contact points so as to cause the least damage possible and to conserve a maximum of enamel. This would involve connected double veneers where the incisal edge was involved. The amalgams, infiltrated composites, and old crowns in the back of the patient's mouth were removed. Once the preparations were perfectly polished and the immediate dentin sealing performed,[18] digital impressions were taken, along with a conventional PVS impression to create the plaster study model for the final restorations **(Figs 11-13)**.

A transcutaneous electrical nerve stimulation (TENS) session was scheduled to determine the new occlusion.

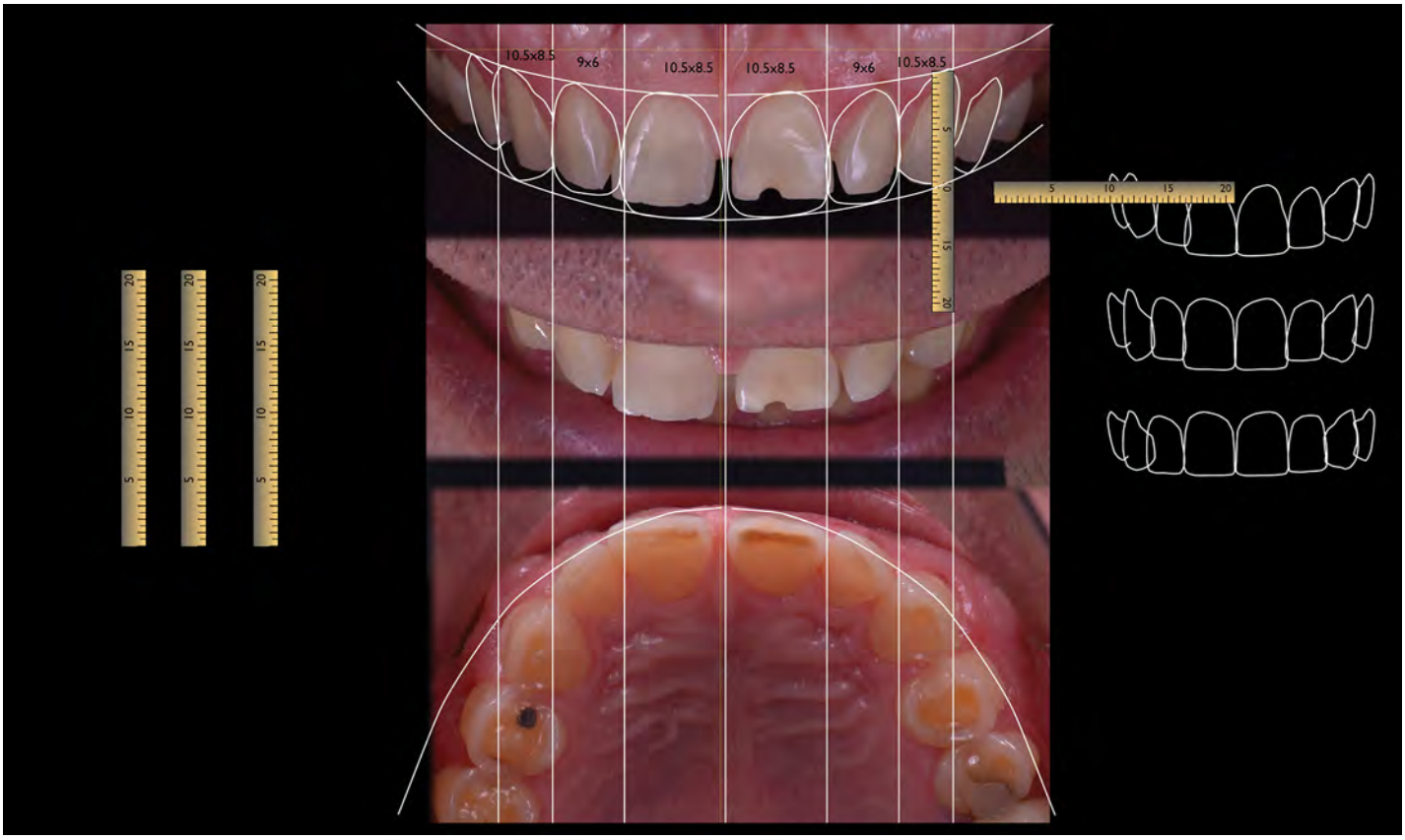


Figure 8: DSD study.

Figure 9: Skyn mock-up.

Figure 10: Preparation with the APT technique.

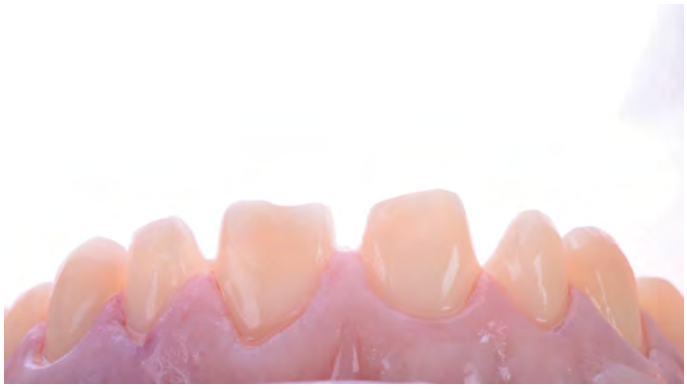


Figure 11: Preparation of the anteriors.

Figure 12: Preparation of the upper jaw.

Figure 13: Preparation of the lower jaw.

Creating the Prosthesis

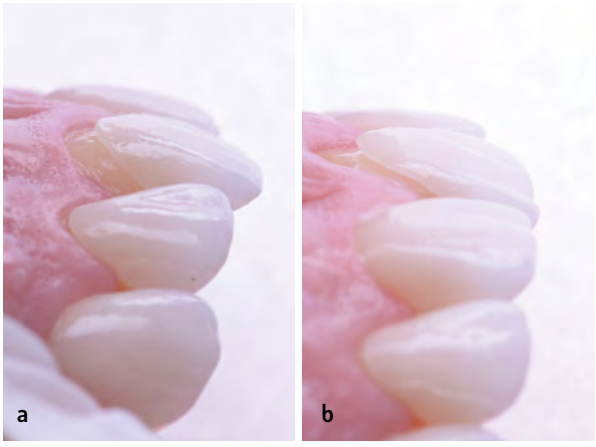
The final restorations were created starting from the two digital impressions. The cervical limits were marked on the impression of the preparations. Next, the Cerec software matched the two impressions by subtraction and indicated the shape of the restorations to be milled. These restorations were an exact morphological copy of the mock-up the patient had worn. If the work is done section by section, the computer can match the impressions more easily. All the restorations were milled using leucite-reinforced glass-ceramic blocks (IPS Empress CAD Multi BL3, Ivoclar Vivadent; Amherst, NY) **(Fig 14)**.[19] Each restoration could then be adjusted on plaster models if necessary. After milling, the restorations were stained using a three-dimensional (3D) staining technique that requires a specific sequence to create 3D optical illusions.

Bonding

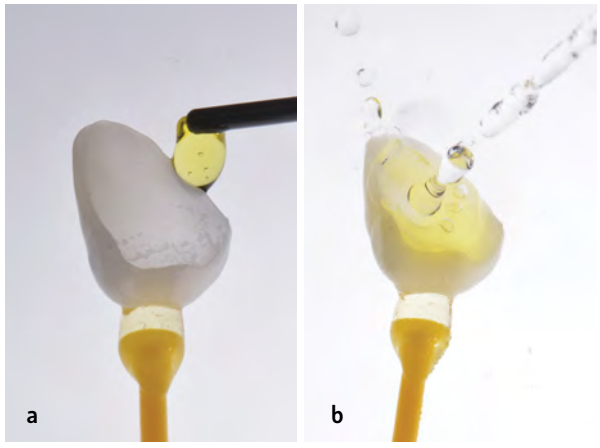
A classic bonding protocol was followed. First, all ceramic elements were tried-in separately for validation and adjustment, then all together to check the contact points **(Figs 15a & 15b)**. The rubber dam was then placed on the maxillary. The intrados of the ceramic elements were prepared with 9.5% hydrofluoric acid for 60 seconds, rinsed well, and dried **(Figs 16a & 16b)**. A layer of saline was applied for 60 seconds then dried and heated.[20]

A solution of 37% phosphoric acid was applied for 30 seconds on the enamel and 10 seconds on the dentin, after which the surfaces were rinsed, dried, and the adhesive was applied **(Fig 17)**. The two central incisors were bonded first with light-cured resin cement. Excess material was eliminated **(Fig 18)** and final photopolymerization was performed with glycerin. Then the lateral incisors, canines, molars, and premolars were bonded. The mandibular restorations were bonded in the same manner. The occlusion was verified in static position with cusp fossa contact, and laterality, propulsion, and mastication were all checked. Final images can be seen in **Figures 19 through 24**.

Figure 14: Milled restorations.



Figures 15a & 15b: Try-in.



Figures 16a & 16b: Etching and rinsing a portion of the restoration.

Figure 17: Applying adhesive.

Figure 18: Eliminating excess material with a blade.

Figure 19: Final upper jaw.

Figure 20: Final lower jaw.

Figure 21: Palatal face.

Figure 22: Texture.

...one of the laboratory technician's most challenging tasks is to copy the shape of the teeth to conserve anterior guidance and the occlusal morphology when advancing from the temporary to the final restorations.

Figure 23: Adaptation of the veneers.

Figure 24: Final new smile.

Summary

The three most important aspects of a full-mouth rehabilitation are function, esthetics, and patient satisfaction. Treatment that utilizes physiologic occlusion (with muscle relaxation and TENS), a natural morphology, a complete mock-up to validate all elements, a digital impression system, and CAD/CAM appears very promising. Our treatments must be esthetic, functional, and minimally invasive, but also—and most importantly—biologically sound.

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Surface guidance was confirmed to be equal on all occlusal surfaces.

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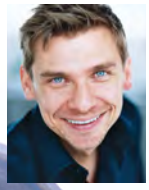

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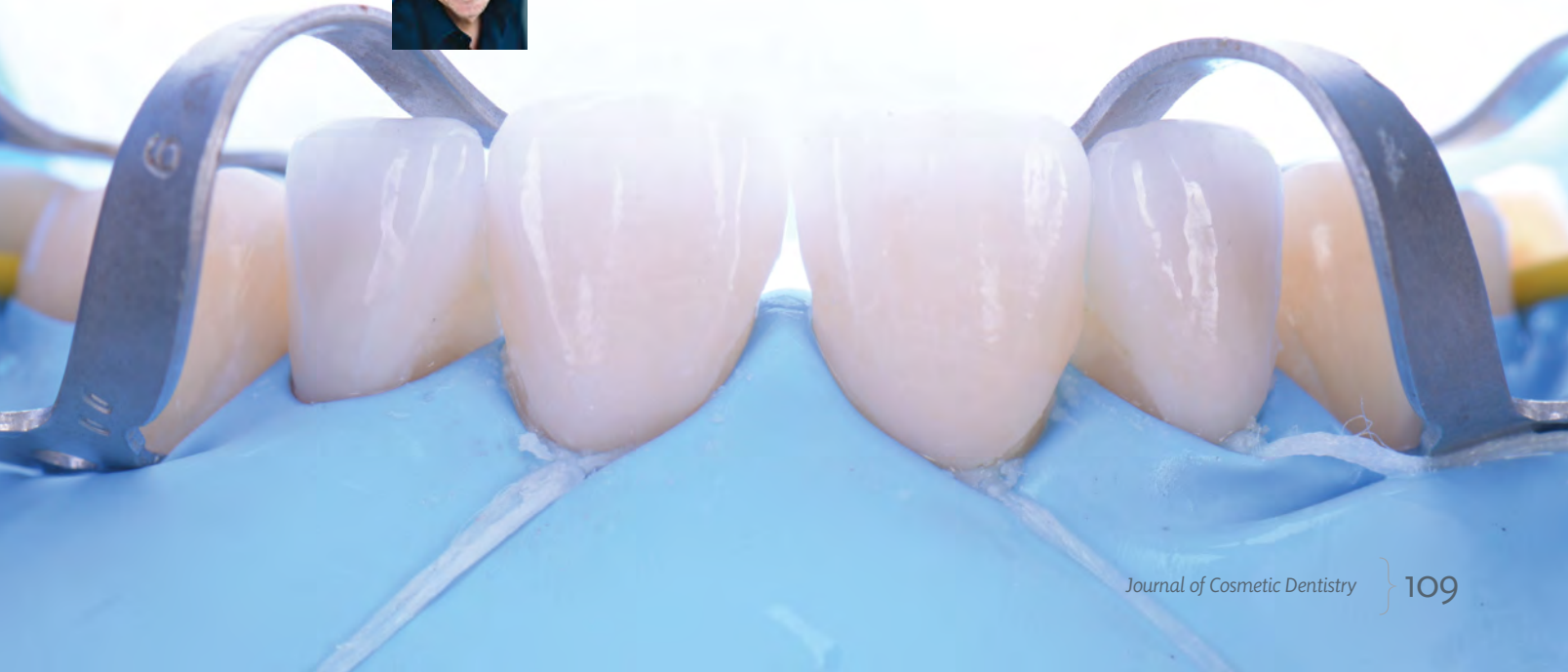

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The 10 multiple-choice questions for this Continuing Education (CE) self-instruction exam are based on the article, *Repairing Dental Erosion with Minimal-Preparation Dentistry* by Dr. Cyril Gaillard, Dr. Florin Cofar, Ms. Ioana Popp, Mr. Jérôme Bellamy, and Mr. Christophe Hue. This article appears on pages 96-109.

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1. Dental erosion is a frequent phenomenon and its treatment must be

a. biological, esthetic, and psychological.
b. esthetic, psychological, and functional.
c. psychological, functional, and biological.
d. functional, biological, and esthetic.

2. The purposes of using a mock-up are to

a. test a new mandibular position and evaluate shade.
b. establish preparation requirements and evaluate the new smile.
c. evaluate shade and surface anatomy for consideration in the definitive restorations.
d. check the desired final shade and the occlusal concept.

3. Causes of dental erosion can be

a. mechanical and psychological.
b. psychological and chemical.
c. esthetic and functional.
d. mechanical and chemical.

4. Rehabilitation of severe dental erosion must incorporate

a. minimally invasive, adhesive, and, most importantly, multidisciplinary dentistry.
b. adhesive, multidisciplinary, and, most importantly, functional dentistry.
c. multidisciplinary, adhesive, and, most importantly, minimally invasive dentistry.
d. minimally invasive, adhesive, and, most importantly, functional dentistry.

5. Intraoral and extraoral examinations of this patient with severe erosion revealed

a. a normal, vertically correct lower facial zone.
b. a history of muscle spasms and articular pain.
c. exostoses that developed as a result of excessive occlusal forces.
d. a comfortable, definable mandibular functional envelope.

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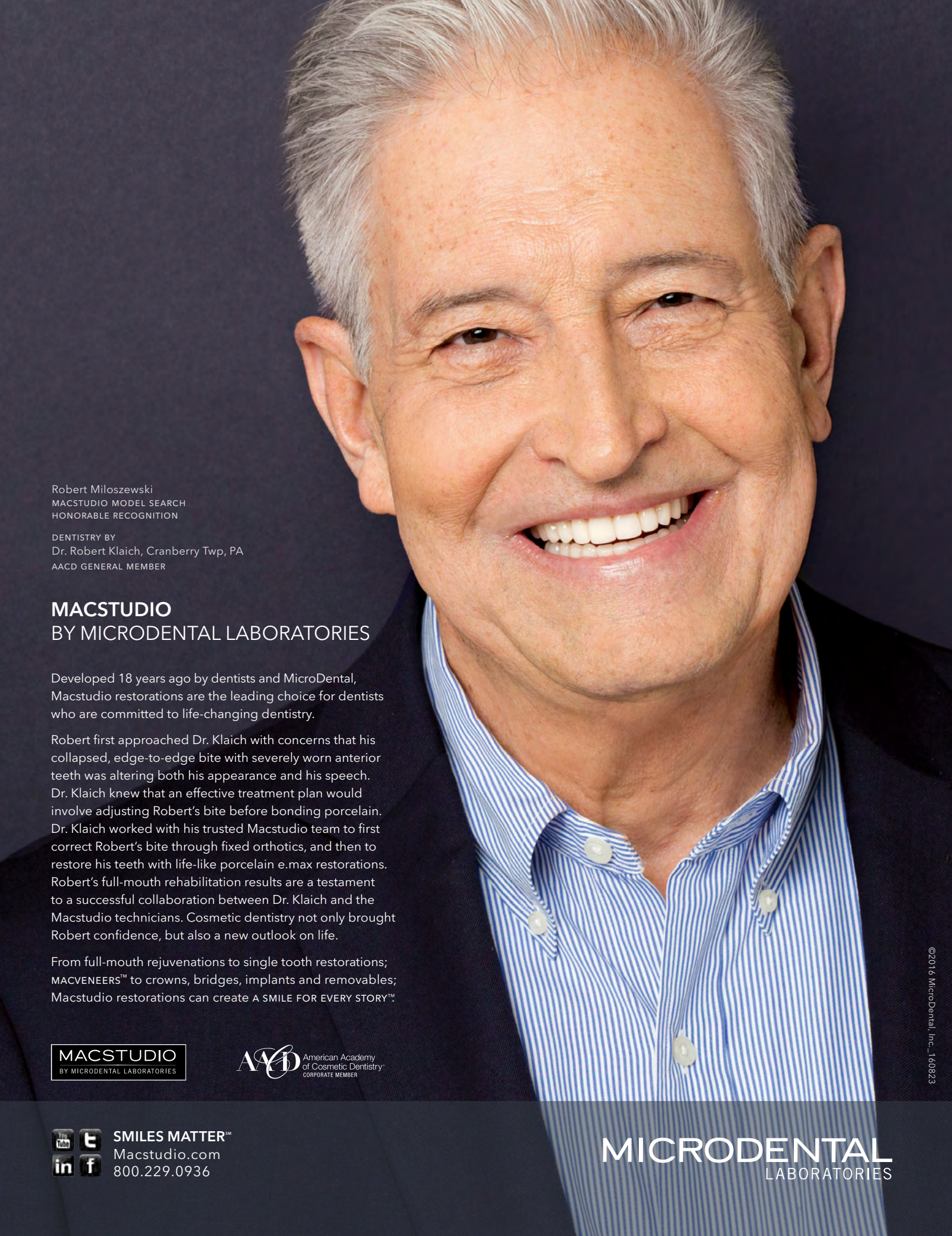

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