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A Challenge to Natural Teeth
Naoki Hayashi, RDT, MDT, MDC

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2023 VOLUME 39 ISSUE 2

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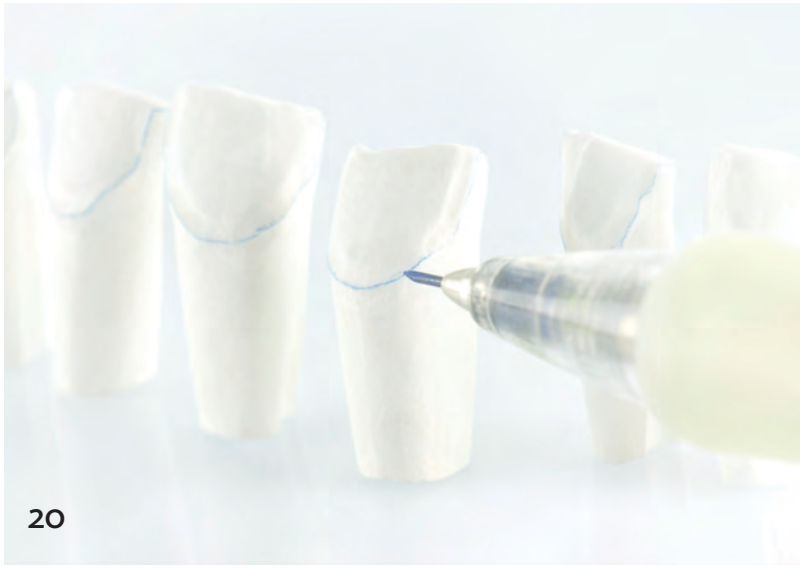

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> "Together, we elevate our education, refine our clinical skills, and sharpen our judgment."

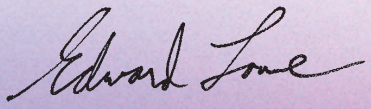
As AACD members, we share a common pursuit—the continual quest for wisdom and growth. Our commitment to expanding and enhancing our knowledge is unwavering, as we understand the importance of mastering new skills while acknowledging the influential figures who have shaped our field and our careers.

In this common pursuit of clinical excellence, I have had the privilege of collaborating with dedicated, like-minded colleagues. Together, we elevate our education, refine our clinical skills, and sharpen our judgment. The power of networking and empowering others is truly inspiring. While formal coursework undoubtedly provides valuable insights, the accumulation of hands-on experience, the lessons learned from trial and error, and the determination with which we problem-solve set us apart. Our journey begins with the fundamentals and involves an ongoing process of attaining knowledge and adopting innovative techniques and treatments. Our choices in the topics and paths we choose to explore are pivotal.

For example, for those who are new to esthetics, consider joining the AACD's New Esthetic Skills Studio hybrid study club. This group offers four modules featuring live online webinars led by esthetics industry experts, personal access to an AACD Accredited Coach, and a discussion forum with your peers. After each live lecture, your coach will lead your small group in discussions exploring topics such as photography, smile design, composites, and veneers.

As always, I am grateful to our authors, whose contributions inspire and propel us toward limitless growth within our dental practices and laboratories. This issue of the *jCD* highlights the scientific and clinical aspects of shade and color, provides remarkable examples of complex interdisciplinary reconstructions, captivating photography, and shares novel approaches using digital technology for direct and indirect composite restorations as well as digitally planned orthodontic treatment.

Our commitment, however, extends beyond technical excellence; it also embraces the creation of a safe, valued, and interconnected environment for our patients and employees. Leading by example and surrounding ourselves with positivity are key to fueling our passions. By empowering and mentoring others, we invest in their growth and, in turn, help to secure our own long-term success. I encourage you to walk this path of enlightenment as you cultivate your wisdom.



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ACHIEVING EXCELLENCE *with a* MINIMALLY INVASIVE INTERDISCIPLINARY APPROACH

Megan A. Shelton, DMD

Abstract

The restoration of one or two teeth in the anterior dentition is one of the most challenging procedures a dentist can perform. This article discusses the use of tooth alignment in conjunction with thorough laboratory communication to produce a conservative and esthetic outcome with two porcelain veneers. Using digitally planned orthodontic treatment modalities to create the ideal amount of space around teeth allows for symmetrical restorative options that involve less removal of tooth structure.

Key Words: ortho-restorative, laboratory communication, veneers, minimally invasive dentistry

Introduction

Some of the most demanding cases in cosmetic dentistry require a skilled practitioner to match a single anterior restoration that harmonizes with the patient's existing smile. Biological "imperfections" and characterizations are often observed in natural dentition and must be replicated. Fortunately, technological advances in materials and digital photography allow us to communicate the unique characterizations that are necessary for designing and fabricating a successful single-unit anterior restoration. Incorporating subtle, yet essential, characterizations into an esthetically challenging case is the hallmark of a superior laboratory technician. This case demonstrates such talents.

Case Presentation

Chief Complaint

The patient presented to the practice dissatisfied with the shape and appearance of her teeth. She had no history of orthodontia or esthetic dental treatment and wanted to explore options for improving her smile. Additional complaints included thinning incisal edges of her maxillary incisors, mild rotations with uneven incisal edges in her mandibular incisors, and diastemas present on the upper and lower arches **(Fig 1)**. Finances were of concern to the patient, and she expressed interest in a conservative approach with respect to any potential removal of her natural tooth structure.

Dental and Medical History

The patient's systemic health was good. Periodontally, she was stable, with minimal inflammation and good home care. Biomechanically, she had a history of routine restorative care including resins, and a recently removed mandibular molar due to an infection. The patient had a normal range of motion, and no crepitus was noted on examination of her temporomandibular joints. There was no muscle tenderness and no pain upon opening or during lateral movement. The patient reported no signs or symptoms of temporomandibular disorders. Upon closer examination, it was noted that she had limited overjet, as well as evidence of functional wear. This was likely a contributing factor to the thin appearance of her maxillary and mandibular incisors.

Figure 1: Pretreatment full-face smile view (1:10).

Figure 2: Preorthodontic full-smile frontal view (1:2) revealing the collapsed buccal corridor and diastemas.

Diagnosis and Treatment Plan

It was very important to the patient that her treatment be conservative. She was emphatic that she did not want to undergo any more restorative dentistry than necessary and preferred a more "natural" appearance. To achieve the patient's esthetic goals and remain conservative, it was decided that the modality of choice would be indirect, minimal preparation veneers for teeth #8 and #9. The treatment would be completed in two phases as follows:

Phase I: Orthodontic therapy to correct tooth position, eliminate the diastemas within the patient's mandibular arch, redistribute the maxillary diastemas, increase the overjet, correct the crossbite (which would result in improved arch form with increased buccal corridor smile display), and level both arches utilizing clear aligner therapy **(Fig 2)**.

Phase II: Restorative treatment would allow for fabrication of indirect veneers on #8 and #9 that would not only be beautiful but would also withstand functional movements, and correct the patient's concerns. A Bolton analysis determined that #8 and #9 did not exhibit proper dimensions for arch relationships.[1] The other significant challenge in this case was making the veneers look natural, rather than "perfect."

Treatment

Clear aligner therapy: This first treatment step required data collection consisting of photos, radiographs, and digital scans. The American Academy of Cosmetic Dentistry's (AACD) required series of 12 Accreditation photographs was taken with a 5D EOS camera and 100-mm macro lens with a ring flash (Canon; Melville, NY).[2] A cone beam computed tomography scan was obtained and converted to a panoramic image for submission to the orthodontic laboratory (Align Technology; Tempe, AZ). Periapical radiographs of #8 and #9 were made with a digital sensor (Dexis; Quakertown, PA). Both radiographs were fully analyzed and did not reveal any pathology or contraindications for treatment. A scanner (iTero, Align) was utilized to capture digital impressions and a bite record. A digital visualization tool (ClinCheck, Align) was reviewed and modifications were made prior to manufacturing the clear aligners. After the orthodontic lab sent a full set of clear aligners to the dental office, the patient completed the prescribed treatment to achieve the desired functional and preoperative esthetic results **(Figs 3a & 3b)**.

Diagnostic wax-up and whitening: Upon completion of orthodontic therapy, the restorative phase of treatment was

Figure 3a: Preoperative full-smile frontal view (1:2) showing the corrected crossbite and the planned residual diastema.

Figure 3b: Preoperative retracted frontal view (1:2) displaying the corrected crossbite and closed mandibular diastemas.

Figure 4: Preoperative retracted frontal view (1:2) demonstrating how to position multiple shade tabs with neutral lighting.

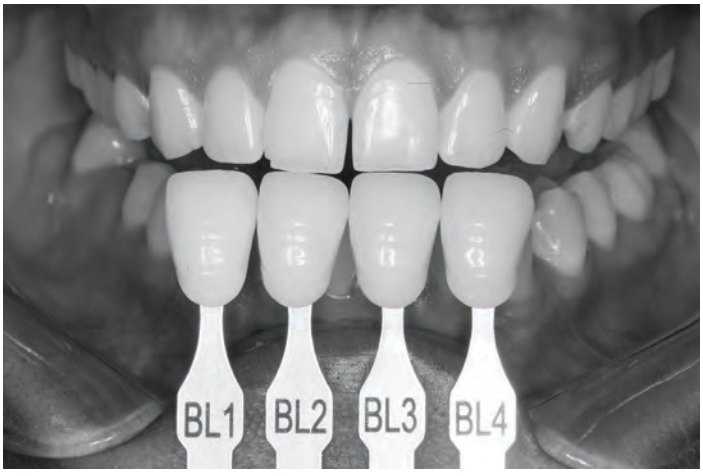

Figure 5: Preoperative retracted frontal view (1:2) in monochromatic picture mode for value selection.

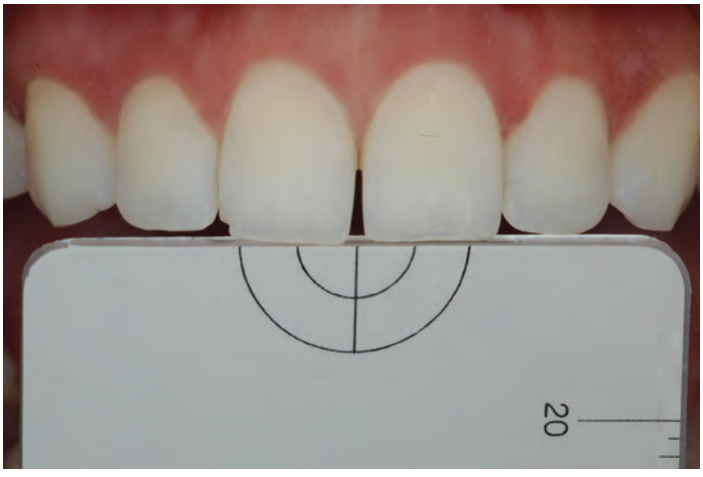

Figure 6: Preoperative retracted frontal view (1:1) utilizing a gray card and polarized lens.

Figure 7: Retracted frontal view (1:2) exhibiting the facial, incisal, and interproximal depth cuts through the provisional material.

initiated. Custom whitening trays were fabricated, and the patient followed a 30-minute regimen daily for 1 week utilizing 35% carbamide peroxide gel (Opalescence, Ultradent Products; South Jordan, UT). An additive diagnostic wax-up was prepared that would enable the veneer preparation design to remain in enamel to achieve the patient's goals of tooth preservation and predictable treatment.[3]

A putty matrix (Ivoclar Virtual XD, Ivoclar Vivadent; Amherst, NY) lined with vinyl polysiloxane (VPS) (Affinity, Clinician's Choice; London, ON) was fabricated on the wax-up model and used to construct a mock-up in the patient's mouth with bis-acrylic (Luxatemp Automix, DMG America; Ridgefield Park, NJ). The patient was happy with and accepted the proposed esthetic outcome.

Photography and shade selection: To avoid inaccurate selection due to enamel dehydration during the tooth preparation appointment, the shade was selected at the beginning of the procedure appointment.[4] A two-week stabilization period was observed after whitening prior to preparing the teeth and taking the patient's final shade-matching photos due to the delayed effects of color stability.[5] Shades were taken using three different techniques for effective communication with the laboratory ceramist. The first technique involved capturing the teeth as they appear to the naked eye by means of multiple shade tabs (VITA 3D, VITA North America; Yorba Linda, CA) with neutral lighting that allowed the ceramist to create a custom shade during the fabrication process **(Fig 4)**. The second technique helped to determine the restoration's value by capturing the shade tabs in monochromatic picture mode **(Fig 5)**. The third technique utilized a white balance gray card (eLAB Prime; Bresigau, Germany). This method focused on the teeth adjacent to those being restored to calculate the shade utilizing artificial intelligence and advanced image processing **(Fig 6)**.

Preparation: Local anesthetic (Septocaine 4%, Septodont USA; Lancaster, PA) was infiltrated to anesthetize the teeth and tissue for patient comfort. The teeth were prepared per the technique pioneered by Gürel for minimum preparation design and to create a uniform space for the restorative material.[6] The putty matrix was filled with bis-acrylic provisional material (Luxatemp Automix), seated over the teeth, and allowed to cure. Upon removal of the stent, the cured set of provisionals could be observed overlaying the unprepared teeth. Preparations were accomplished through the overlaid provisional material using reduction burs (Brasseler USA; Savannah, GA) to ensure the minimal amount of facial, incisal, and interproximal tooth structure was removed to achieve the optimal preparation outcome in the following sequence **(Fig 7)**:

1. A depth-cutting diamond bur (868D.31.030) was used to create 0.5-, 0.7-, and 0.9-mm horizontal depth grooves on the labial surface at each plane, respectively.
2. A pear-shaped carbide bur (BRIOH7.31.008) was used to create 1.6-mm incisal depth cuts and to cut through the mesial interproximal contact of #8 and #9.
3. A tapered round-end coarse diamond bur (KS1L 35005L.31.052) was used to create uniform reduction of the facial surfaces.
4. A tapered round-end chamfer fine diamond bur (8856.31.016) was used to smooth all surfaces and round sharp edges.

The preparation design for closure of the diastema interproximal to #8 and #9 required preparation beyond the mesial proximal surface and extension of the preparation subgingival (without invading the biologic width) in that region for the ceramist to have proper space for emergence form and ideal contacts **(Fig 8)**. A preparation shade (ND1, Ivoclar Vivadent) was selected and captured with neutral lighting to send to the lab along with the preoperative shade photos.

> TECHNOLOGICAL ADVANCES IN MATERIALS AND DIGITAL PHOTOGRAPHY ALLOW US *to communicate* THE UNIQUE CHARACTERIZATIONS THAT ARE NECESSARY *for designing* AND FABRICATING A SUCCESSFUL SINGLE-UNIT ANTERIOR RESTORATION.

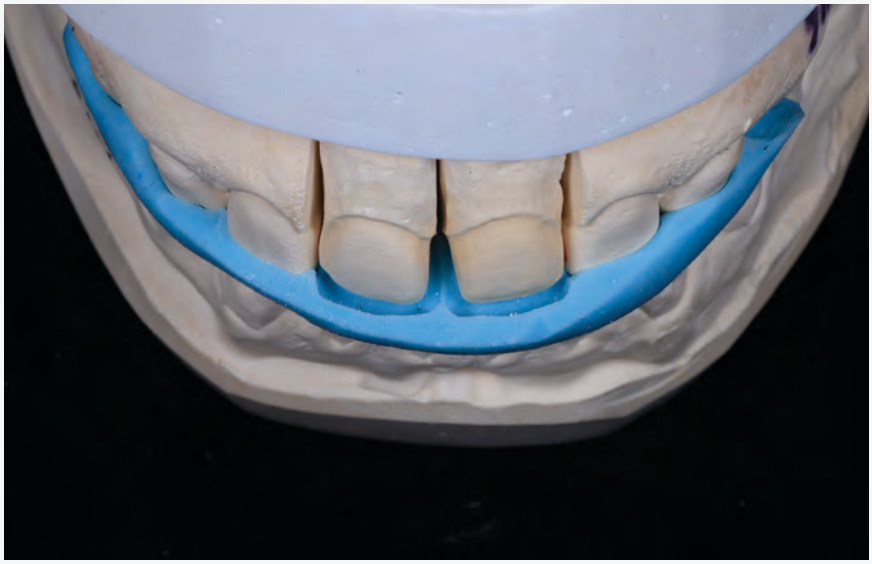

Figure 8: Master cast showing the preparation design and reduction.

Figure 9: Feldspathic porcelain veneers with texture and light properties that mimic nature.

Impressions: Retraction cord (#00 Ultrapak, Ultradent) was placed into the gingival sulcus of the prepared teeth. The teeth were thoroughly rinsed and dried prior to the impression. A full-arch stock lower mandibular tray was used for the final preparations' impression. VPS material (Affinity Fast-set, Light Body) was dispensed onto the preparations and a heavier viscosity VPS material was dispensed into the tray (Affinity Fast-set, Heavy Body) around the preparations. The filled tray was seated over the upper arch and left in place for three minutes per the manufacturer's instructions. The retraction cord was removed from the sulcus when the impression was completed. A lower impression was made with the heavy-body VPS and a bite record was recorded with bite registration material (Quick Bite, Clinician's Choice).

Provisionals: The provisional restorations were fabricated by filling the laboratory-fabricated provisional matrix with bis-acrylic provisional material (Luxatemp Automix B1). After 90 seconds, the matrix and the cured provisional were removed from the patient's mouth. Then the provisional restoration was shaped and contoured extraorally with flexible discs (FlexiDisc, Cosmedent; Chicago, IL). The provisional was secured in place using a spot-etch technique (a small dot of 35% phosphoric acid was applied for 15 seconds, then rinsed), bonding agent (All-Bond Universal, Bisco; Schaumburg, IL) and flowable composite (Tetric EvoFlow Translucent, Ivoclar Vivadent) dots were applied on the facial of #8 and #9, and the provisional was seated over it. A curing light (BluPhase Powercure, Ivoclar Vivadent) was used for 30 seconds with facial and incisal pressure to keep the provisional in place. The patient returned 24 hours later and approved the provisionals' fit and esthetics, after which they were scanned (iTero) and records sent to the lab for duplication of the design for the final restorations. The patient was prescribed doxycycline hyclate 20 mg BID (Periostat, Galderma Laboratories;

Fort Worth, TX) to maintain gingival health. She was instructed to take the Periostat three weeks prior to preparation and to discontinue it one week after cementation.

Final restorations: The lab was provided a complete set of records and instructions including a prescription for the fabrication of the restorations, a maxillary master impression, a mandibular impression, a bite registration, the patient-approved diagnostic wax-up, the AACD's 12-photograph Accreditation series, shade photos, and photos of the preparation shade. It was important to communicate the proper interproximal contact point position to the laboratory technician to avoid black triangles. The lab was instructed to position the apical aspect of the contact no more than 4 mm from the crest of bone.[7]

Feldspathic porcelain (IPS Style, Ivoclar Vivadent) on platinum foil was layered to fabricate the veneers for excellent esthetic outcomes to mimic natural dentition. The master ceramist used underlying high-luminosity dentin, building it into the shape of the tooth, again employing dentin with bleach to make the restoration appear bright; B1 dentin was used to make it appear less bright. Internal lateral segmental layering of various opal enamel porcelains was added. The final skin layer was OE1 and OE3; the mid skin layer was OE3 and neutral. The ceramist developed the shape and contour in the skin layer **(Fig 9)**. Due to the patient's correction of her functional problems by alignment of the bite, the strength of the material that was chosen was not a concern.

Cementation: Local anesthetic (Septocaine 4%) was infiltrated to anesthetize the teeth and tissue for patient comfort on the day of insertion. A pear-shaped carbide bur (BRIOH7.31.008) was used to create a slot on the facial aspect and separate the provisional with a flat-ended hand instrument. The teeth were air-abraded (PrepStart, Zest Dental Solutions; Danville, CA) to remove residual bonding material prior to try-in to reduce the risk of porcelain fracture or incomplete seating. The final veneers were inserted temporarily with translucent try-in gel (NX3 Try-In Gel, Kerr Dental; Brea, CA), checked for fit and esthetics, and approved by the patient and dentist.

A thick rubber dam was placed for isolation from tooth #5 to tooth #12 (Nic Tone; Bucharest, Romania). Two W2 clamps were used to anchor the dam on the premolars and two B4 clamps were used to retract it on the prepared teeth **(Fig 10)**. The veneers had previously been etched with 9% hydrofluoric acid (Ivoclar Vivadent) by the ceramist. The veneers' bonding surfaces were cleaned (Ivoclean, Ivoclar Vivadent) for 20 seconds, then thoroughly rinsed and dried to remove any contamination that occurred during the try-in. The veneers were then silanated (Monobond Plus, Ivoclar Vivadent) for three minutes.

The teeth were cleaned with 27-µm aluminum oxide at 40 psi with air abrasion (PrepStart), after which they were etched with 35% phosphoric acid for 30 seconds and rinsed. The teeth were dried, and the bonding agent (Adhese, Ivoclar Vivadent) was applied and agitated on the surface for 20 seconds and then light-cured for 20 seconds (BluPhase Powercure). A thin layer of translucent resin cement (Variolink Esthetic, Ivoclar Vivadent) was applied to the inside surface of the restorations. Each restoration was placed individually with light finger pressure and excess cement was cleaned with a gingival stimulator. The restorations were tacked into place under finger pressure with a three-second light cure. Flossing was performed interproximally and a Nevi scaler (Hu-Friedy; Chicago, IL) was used to remove excess cement around the margins. The restorations were then thoroughly light-cured for 30 seconds **(Fig 11)**.

After the rubber dam and clamps were removed, the patient's occlusion and functional movements were evaluated using 21-µm articulating paper (AccuFilm II, Parkell; Edgewood, NY), and 200-µm occlusal paper (Bausch; Nashua, NH) was used with the patient seated upright and making chewing movements to confirm no pathway interferences existed. A #12 scalpel blade (Hu-Friedy) was used to remove any residual cement. A post-cementation smile photo was taken and shown to the patient to demonstrate the effects of dehydration and inform her that she would need to return in three weeks for final records **(Fig 12)**.[4] Lastly, a periapical radiograph was taken to confirm well-sealed margins.

Follow-up: As directed, the patient returned three weeks later for the final series of AACD Accreditation photographs. The photos showed a successful esthetic outcome and healthy gingiva.

Figure 10: Rubber dam clamp placement and air-abraded and etched preparations.

Figure 11: The veneers were cemented under rubber dam isolation.

Figure 12: Postoperative full-smile frontal view (1:2) revealing the effect of immediate isolation.

Figure 13: Postoperative full-face smile view (1:10) of a very happy patient.

Figure 14a: Postoperative full-smile frontal view (1:2) exhibiting how the final restorations enhance the patient's natural smile.

Figure 14b: Postoperative view (1:1) showing the value, hue, chroma, shape, and texture mimicking the natural dentition to achieve the patient's desired outcome.

> REDISTRIBUTING THE SPACE AND LEAVING THE MESIAL DIASTEMAS ALLOWED FOR *successful esthetics* AND FUNCTION WHILE PRESERVING NATURAL TOOTH STRUCTURE.

Summary

The patient was delighted with the results **(Fig 13)**. If the size discrepancy between teeth #8 and #9 had not been identified prior to treatment, the case would have required more extensive tooth removal to provide an acceptable prosthetic result and might have resulted in a poor smile design outcome. Redistributing the space and leaving the mesial diastemas allowed for successful esthetics and function while preserving natural tooth structure. This case demonstrates how clear aligner therapy, in conjunction with excellent planning and information, enables a master ceramist to create veneers that mimic natural teeth and enhance the patient's smile **(Figs 14a & 14b)**.

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Dr. Shelton is a restorative and cosmetic dentist and dental practice consultant in Carlsbad, California.

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Examiners' Commentary

Interdisciplinary Planning for Excellence

William J. Rowe, Jr., DDS, AAACD

Accreditation Case Type II focuses on a dentist's ability to match the natural dentition. A candidate may choose to perform either one or two indirect restorations on maxillary incisors while the adjacent dentition remains untreated, but, regardless of the choice, integration into the natural dentition is critical for case success. Given the requirements necessary to achieve a result that falls within the zone of excellence defined by Accreditation standards, judicious case selection, interdisciplinary consideration, and collaboration with a skilled laboratory technician are important aspects as well.[1]

Utilizing thorough interdisciplinary planning and communication with both the orthodontic and restorative laboratory technicians, Dr. Shelton was able to exceed her patient's expectations and achieve Accreditation-level success with conservative restoration of the patient's maxillary central incisors. Dr. Shelton employed orthodontic movement to improve positioning for appropriate restoration of teeth #8 and #9.[2] Clear aligner therapy was used to develop proper spacing to allow for appropriate restorative proportions and minimal need for tooth preparation. Well-planned preparation and execution of the restorative procedure, including provision of precise records to the ceramist, resulted in the delivery of the successful definitive restorations (Figs 1-4).

No case is perfect, however, and the examiners provided the following observations:

- **Criterion #87:** *Are contralateral teeth in harmony in terms of size, shape, and position?* Slight asymmetry in size and shape were noted in #8 and #9.
- **Criterion #89:** *Are the cervical embrasures proper? No dark triangles?* Blunting of the papilla led to a slight black triangle between #9 and #10.

Examiners appreciate the attention and dedication Accreditation candidates like Dr. Shelton expend to achieve excellent results with a challenging case type such as this one. Dr. Shelton carefully chose the right patient, employed a well-thought-out interdisciplinary plan, focused on communicating effectively with the laboratory technicians to obtain an ideal result, and took the necessary steps to utilize proper clinical techniques.

> *Well-planned preparation and execution of the restorative procedure...resulted in the delivery of the successful definitive restorations.*

Figure 1: Preoperative frontal retracted view (1:2).

Figure 2: Postoperative frontal retracted view (1:2); note the slight asymmetry in size and shape at #8 and #9.

Figure 3: Preoperative left lateral retracted view (1:1).

Figure 4: Postoperative left lateral retracted view (1:1); a small black triangle is present between #9 and #10.

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dear BEAUTÉ:

A challenge to Natural Teeth

Naoki Hayashi, RDT, MDT, MDC

Introduction

A restorative prosthodontic treatment that fails to achieve excellent esthetics is not acceptable. As we perform esthetic restorative treatments, some patients desire "shiny, white, and beautiful teeth," while others want "teeth that suit me best and make me look good." Every person has unique lip dynamics, circumstances, preferences, and values. One thing, however, is certain: We always want to look attractive and be liked by others. The functional and esthetic prostheses that laboratory technicians are responsible for fabricating must satisfy patients' requirements when they smile.

To take maximum advantage of today's dental materials, both dentists and technicians must be willing to acquire a thorough knowledge and understanding of those materials and their possible applications. All-ceramic restorations enable us to produce highly biocompatible, functional, and esthetic prostheses, and the use of feldspathic ceramic, zirconia, and lithium disilicate in anterior cases is now widely accepted. Whatever the material or system, our goal remains unchanged—to achieve attractive, even captivating results for the patient through a carefully planned process.

Modern advances and innovations in various systems related to all-ceramic prostheses have allowed us to emulate natural teeth more closely. As technicians, it is our task to observe and analyze the patient's actual biological teeth to reflect and realize those innate qualities in the materials and systems that we use to fabricate the prostheses. In this process, the morphology, surface texture, position, and tooth color become just as significant as occlusion, functionality, and limbal sealing. Also critical is selecting the appropriate system and fabrication technique for each unique case.

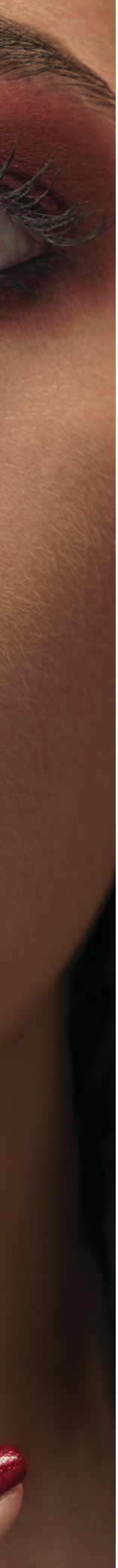
In addition to widening the scope of applications and techniques, all-ceramic systems have expanded the potential for accurate color reproduction and simplified fabrication methods. Along with such advances, however, patient demands have also increased dramatically. Such friction between progress and demand has become a driving force in the industry. I welcome this synergy as it propels me to achieve esthetic and functional excellence. As further technological progress continues to bring forth improved materials and new demands, there will surely be no end to our acquisition of techniques and knowledge. Through experience, we cultivate our techniques, and with knowledge, we complement our artistry.

CASE 1

Single Central Laminate Veneer

Upon observing the patient's postoperative portrait view, it is evident that the veneer procedure has produced a remarkable transformation. The build-up mapping frame that follows provides a detailed understanding of the thorough planning and execution that went into the process. The precisely inserted central veneer exemplifies the attention to detail required for such procedures. A polarization filter further accentuates the ultimate success of the definitive laminate veneer. The artistic nuances of fluorescence highlight the exquisite artistry required for esthetics. The patient's eagerness for transformation and satisfaction are evidenced by her radiance and self-assured expression.

Postoperative *portrait* view of the patient.



Buildup mapping.

CERAMIC LAYERING

BUILDUP 1

- NW0.5B
- E1
- LT Super Luster
- LT Coral
- LT Super Luster (90%) + LT Royal Blue (10%)
- Incisal Aureola (30%) + Creamy Enamel (70%)

BUILDUP 2

- OB White (75%) + White (25%)
- NW0.5B
- E1
- LT Super Luster
- Incisal Aureola (30%) + Creamy Enamel (70%)
- LT Coral
- Clear (50%) + LTo (50%)
- TX

INTERNAL STAIN

- Bright (Dilution) (75%) + Mamelon Orange 2 (5%) + White (20%)
- A+

Partial insertion for a single central veneer case.

After delivery, the definitive laminate veneer.

Postoperative image taken with a polarization filter.

Fluorescent artistry.

The patient's *beautiful* smile and *confident* expression.

CASE 2

Full-Mouth Reconstruction

Upon initial consultation, the patient expressed deep regret regarding her existing restorative veneers, stating, "I should not have done that." The primary objective was to have beautiful and natural-looking teeth. During examination, it was observed that both the patient's maxillary and mandibular crown lengths were notably short. To facilitate the achievement of a more natural-looking esthetic restoration, the patient underwent esthetic crown lengthening. Regrettably, tooth #7 could not be preserved and was replaced with a cantilever bridge for #6 and #7. The pontic bottom and shape were critical in the procedure, so esthetic pontic shaping was performed to create her tissue scallop from the provisional restoration stages.

The preoperative assessment revealed that the patient's teeth had a relatively small morphology. Prior to the restorative treatment, the patient underwent esthetic crown lengthening to optimize the length-to-width ratios.

The *preoperative view* revealed the need for full-mouth rehabilitation to achieve a beautiful and harmonious smile. This case consisted of 22 units. The restorative work was a combination of crowns, veneers, and a cantilever bridge.

The diagnostic wax-up, after crown-lengthening design.

The creation of a cantilever bridge extending from tooth #6 to tooth #7 due to the extraction of tooth #12. Given the significance of the pontic's bottom and site development, we meticulously shaped the pontic site with provisional restorations to ensure optimal outcomes.

Postoperative views This case details a 22-unit combination of crowns, veneers, and a bridge. Crowns: ##3-5, 12-14, 20-21, 28-29 (layered ceramics on zirconia structure). Veneers: ##8-11, 22-27 (feldspathic veneer with refractory technique). Cantilever bridge: #6 and #7 (#6 is a crown and #7 is a pontic).

CASE 3

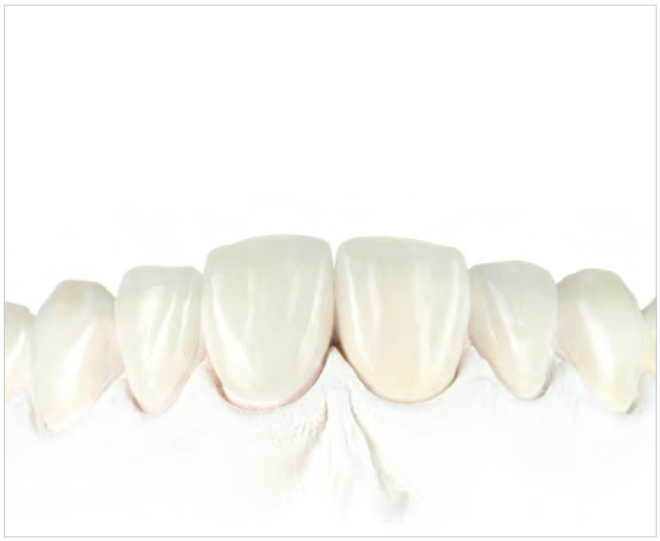
Enhanced Laminate Veneer in the Esthetic Zone

Preoperative condition The patient's chief complaint was the unesthetic maxillary anterior area. She requested esthetic prosthetic treatment with no orthodontics. The treatment plan called for improvement of the position/morphology of the teeth and crown lengthening. The six anterior teeth were slightly protruded and required lingual inclination of both canines. The incisal edge of the central incisors did not touch the lower lip, so improvement of the incisal edge position would be addressed as well. Porcelain laminate veneers were planned for the six anterior teeth. The patient's preference of a rounded shape for the right central incisor was considered for the final prosthesis. Success in this type of case heavily relies on the preparation design, which requires sound and open communication between the dentist and technician. To achieve a successful result, the final prosthesis must be considered during the preparation design phase.

Preoperative condition.

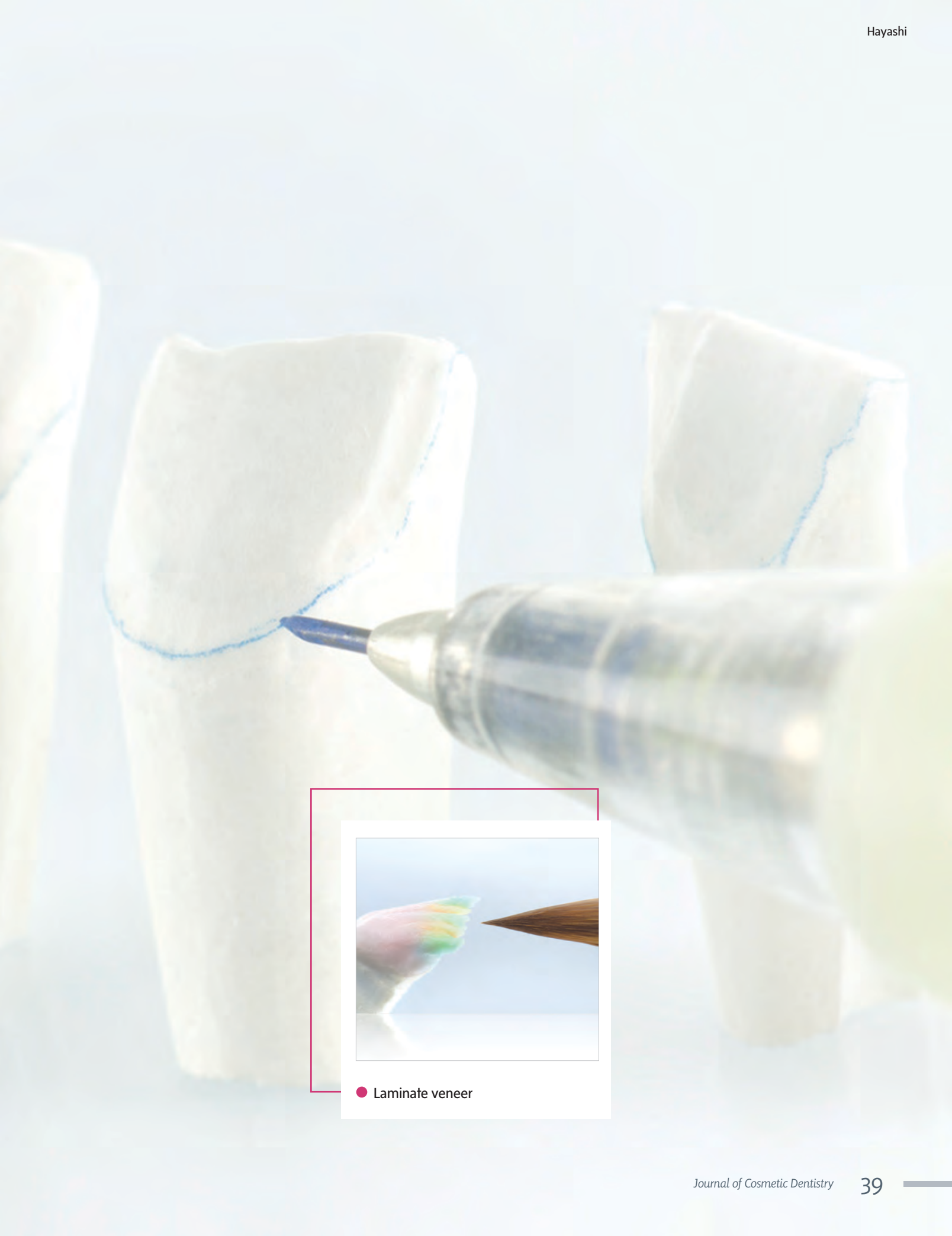
Simulation of crown lengthening of anterior teeth on the cast
The exact scallop position was measured in the mouth from the lip position and reflected on the cast. Using this procedure, the crown length and gingival zenith were determined. A surgical guide was fabricated for the esthetic gingivectomy procedure.

- **Preparation guide and wax-up—communication between dentist and technician**
  A wax mock-up was completed on the initial incision model to establish the final morphology. The preparation guide was fabricated on the model. The preparation guide was duplicated for use on the diagnostic wax-up. The preparation guide is a highly effective communication tool between the dentist and the technician to determine the appropriate preparation design, achieving the planned prosthesis according to the diagnostic wax-up.



● **Feldspathic ceramic on refractory die**
Laminate veneer
(Super Porcelain EX-3, Kuraray Noritake; New York, NY).

● Postoperative retracted images.



● Laminate veneer

Postoperative—**a smile design with** *personality*

The portrait of the patient six months post-treatment displays intentionally slightly misaligned anterior teeth. Although this might cause concern to some readers, I believe the teeth's overall appearance seems natural and healthy, and their size and position are well harmonized with the patient's face.

What is your perception of the image? While "perfect" tooth symmetry, size, and position are often the patient's desired outcomes of esthetic treatment, perfection can sometimes appear somewhat artificial. Although it depends on each patient, I believe there is no one formula for esthetic prosthodontic treatment. Therefore, it is crucial not to be bound by stereotypes and instead determine the most appropriate design for each patient before producing and delivering it.

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Mr. Hayashi is the president of a private dental laboratory in Irvine, California.

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ENHANCING ESTHETICS *and* DURABILITY:

MULTI-LAYERED ZIRCONIA FACIAL CUT-BACK DESIGNS

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Abstract

This article examines the use of minimal facial cut-back design techniques to achieve optimal esthetic results in anterior zirconia cases. Despite advances in digital dental technology and the development of multi-layered zirconia, layering techniques remain necessary to effectively match the appearance of natural anterior teeth. The implementation of two different facial cut-back designs, the use of a digital shade-matching system, and the importance of luster in achieving optimal anterior cases are discussed. Also addressed is the significance of proper tissue management, which may involve surgical procedures such as bone scalloping, coronally advancing the flap, connective tissue grafting, and bone grafting.

Key Words: facial cut-back design, anterior matching, internal stain technique, minimal layering technique, tissue management

Introduction

Despite advances in digital dental technology, the development of multi-layered zirconia, and continuing improvements in staining and glazing techniques, achieving optimal esthetic results for anterior cases can still prove challenging. In many such cases, effective anterior matching requires layering on facial cut-backs. This article explores two types of minimal facial cut-back designs that retain full incisal lingual support for structural strength **(Fig 1)**. Additionally, it discusses which specific cut-back design is most indicated in individual cases to achieve lifelike characterizations that match the adjacent natural teeth.

Types of Facial Cut-Back Designs

The two types of facial cut-back designs discussed here are as follows:

- Type I features no vertical reduction, allowing the restoration to be fully retained by zirconia. Since it increases the restoration's resistance to chipping at the incisal edge, it is particularly beneficial for patients with bruxism and heavy occlusion. However, Type I designs require the use of artificial stains to achieve the desired translucency.
- Type II cut-back design incorporates a slight vertical reduction of the incisal edge, providing additional space for porcelain application. This subtle change considerably improves the likelihood of achieving accurate color matching.

The three case presentations that follow illustrate how, with the use of multi-layered zirconia and staining and glazing techniques, one of these two cut-back designs can be used on different types of anterior cases to achieve esthetic, lifelike restorations that also offer added protection for and durability of the incisal edge.

case 1

Case Reports

Case 1: Type I Cut-Back Design to Address Occlusion Concerns with No Reduction

Examination and diagnosis: A 54-year-old male presented with the chief complaint of unsatisfactory gingival and color esthetics around his anterior maxillary teeth. Clinical examination revealed a defective fixed partial denture (FPD) from #7 to #9 (#8 being the edentulous area), gingival recession at #9, and a localized anterior crossbite on #10 **(Fig 2)**. Radiographic examination showed no evidence of caries or periapical pathology.

Treatment plan: Before the defective crowns were replaced, different treatment options—including orthodontics and implant therapy—were discussed. The patient elected to replace the existing porcelain-fused-to-metal (PFM) FPD with an all-ceramic FPD and a porcelain veneer on #10 to add volume and compensate for the crossbite. Facial and intraoral photographs were taken and a smile design including all four maxillary incisors was completed. A wax-up replica was transferred to the patient's mouth. The patient was satisfied with and agreed to the new shape.

Fabrication of temporaries, tissue/pontic site evaluation, and surgical treatment planning: The defective FPD was removed, the teeth were prepared following the principles of minimally invasive dentistry, and impressions were taken. Temporary restorations were fabricated chairside with poly(methyl) methacrylate (PMMA) (Protemp, 3M; St. Paul, MN). A shell made from the final shape (pontic and teeth) was fabricated for the surgical team as a guide for surgical therapy in the edentulous areas of #8 and #9. The periodontal tissues and pontic site were clinically evaluated via periodontal probing, bone sounding, and measurements (e.g., width of existing keratinized gingiva and extent of gingival recession), as well as through cone beam

Figure 1: Types of facial cut-back design: A Type I design features no vertical reduction, allowing the restoration to be fully retained by zirconia. It is beneficial for patients with bruxism and heavy occlusion, as it increases the restoration's resistance to chipping at the incisal edge. However, Type I designs require the use of artificial stains to achieve the desired translucency. A Type II design incorporates a slight vertical reduction of the incisal edge, providing additional space for porcelain application. This subtle change considerably increases the likelihood of achieving accurate color matching.

Figure 2: Preoperative view.

Figure 3: Bone scalloping was performed at the pontic site.

"TYPE I CUT-BACK DESIGN FEATURES NO VERTICAL REDUCTION, ALLOWING THE RESTORATION TO BE FULLY RETAINED BY ZIRCONIA."

Figure 4: The coronally advanced flap technique helped to ensure adequate root coverage and optimal esthetics.

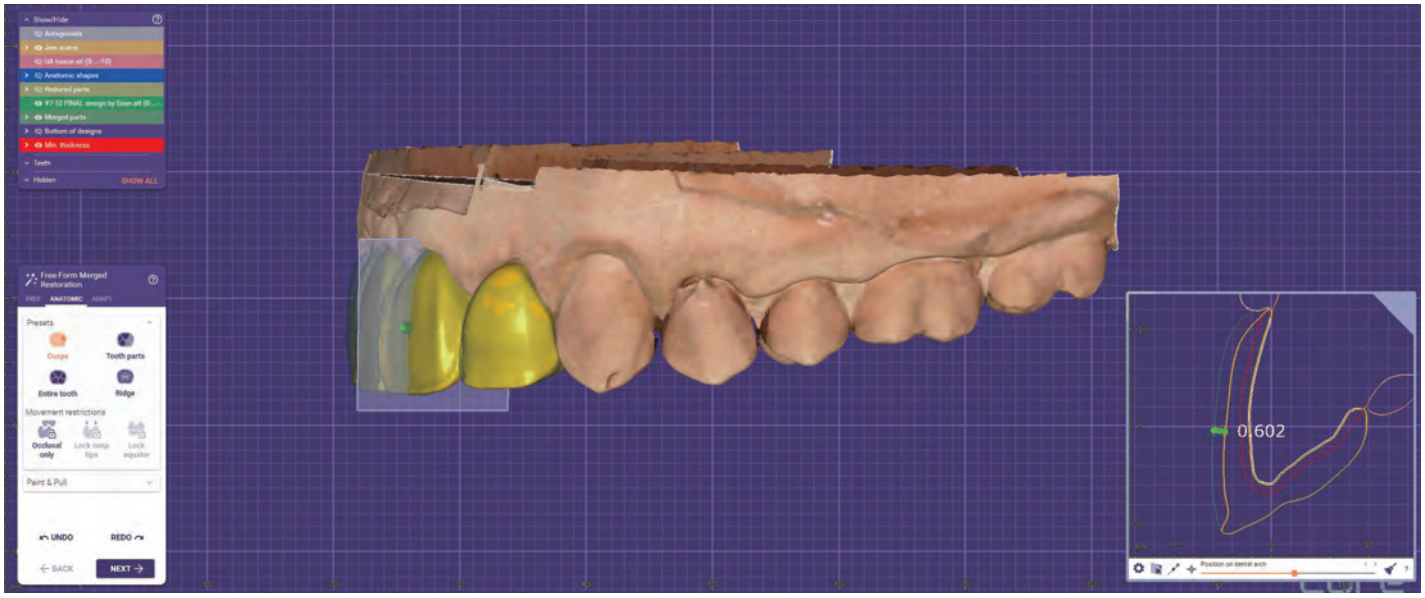

Figure 5: The bridge was designed with a facial cut-back of approximately 0.6 mm, while the veneer had minimal facial cut-back only on the incisal third, with the rest of the restoration remaining as full monolithic lithium disilicate.

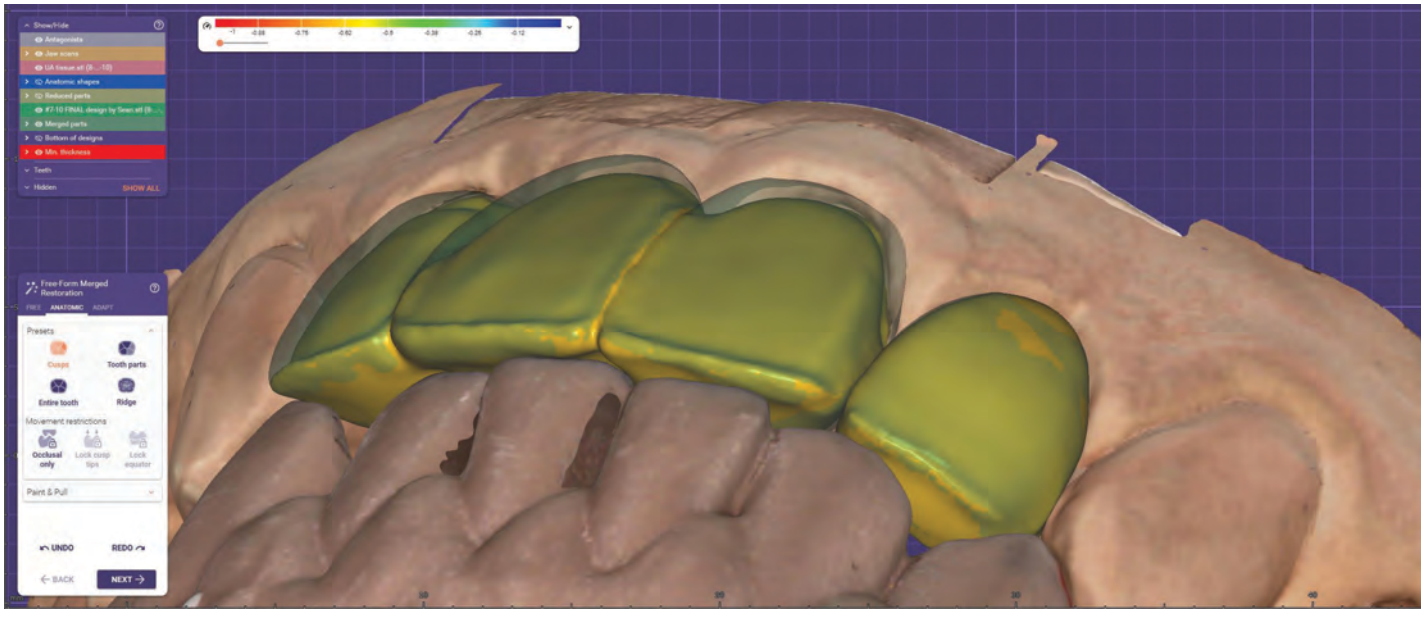

Figure 6: The mandibular anterior teeth were found to occlude very closely to the lingual incisal third of the maxillary teeth, and #10 was initially diagnosed as crossbite.

computed tomography. This examination revealed approximately 3 mm of gingival recession in the area of #9. It was also noted that, based on the provisional prosthesis, there would be invasion of the biologic width and inadequate space for biologic shaping of the tissue in the pontic site area.[1] All of these factors were incorporated into the prosthesis design and surgical treatment planning.

Surgery: During the surgical procedure, the temporary prosthesis was used to help guide the scalloping of the bone[2] at the pontic site to allow for the "prosthetic biologic width," which Pozzi and colleagues described as the thickness necessary between the pontic and the alveolar bone (i.e., approximately 2.26 + 0.6 mm).[3] Gargiulo and colleagues evaluated the average distance from the base of the sulcus to the alveolar bone and found it to be approximately 2 mm **(Fig 3)**.[4] Violating this prosthetic biologic width can result in discomfort, edema, erythema, and epithelial recession. The interproximal heights of bone were also taken into careful consideration to ensure there was no alteration in the height of existing papilla. Tarnow and colleagues found that when the measurement from the contact point to the bone crest was 5 mm or less, the papilla was present almost 100% of the time.[5] In regard to the gingival recession at site #9, the existing keratinized gingiva was found to be of a thick gingival phenotype (>0.8 mm).[6] Therefore, the dental team opted to coronally advance the flap to obtain adequate root coverage and optimal esthetics **(Fig 4)**. A series of milled PMMA temporaries (3DBioCad; Renton, WA) was used to condition the tissue around the new pontic shape. After 12 weeks of healing time,

Figure 7: Internal stains were used to create translucency.

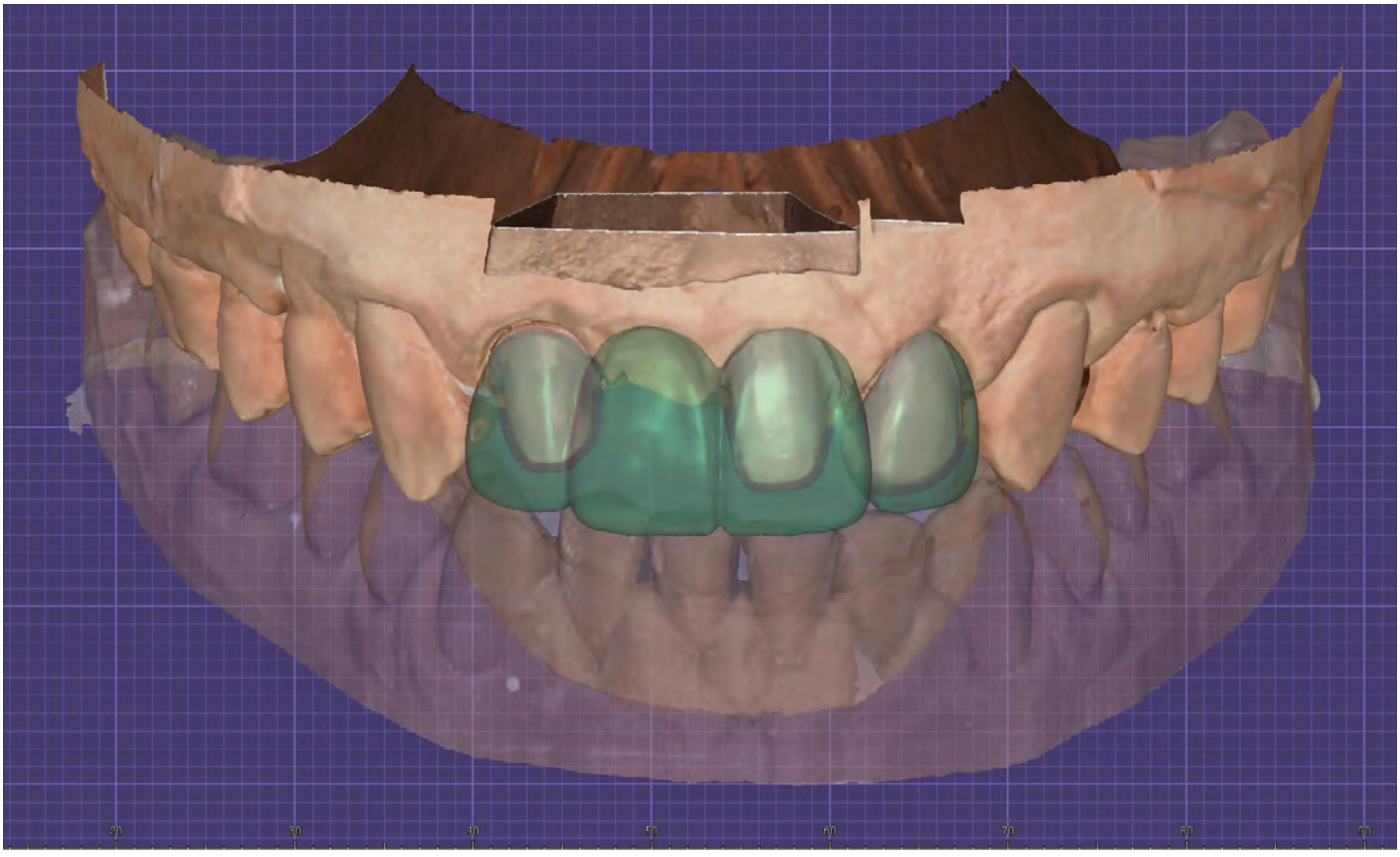

Figure 8: Tooth #7 was angled toward the pontic area, which affected the contouring of the proximal contact area. Since #9 was located mesially, #8 had to be overlapped with #9 to achieve proper proportion, making it challenging to create a straight midline. Tooth #10 was situated far lingually; despite limitations, it had to be brought out.

Tips

case 1

To create translucency using a Type I facial cut-back design, it is recommended to select multi-layered zirconia. Additionally, choosing a more intense hue of bluish or grayish stains can help to achieve proper translucency while minimizing staining.

case 2

Before bonding the titanium base abutment and zirconia restoration, it is recommended to sandblast both surfaces with 50-µm aluminum oxide at an appropriate pressure (between 20-30 psi). Furthermore, it is important to follow the cement manufacturer's instructions to ensure the restoration's longevity and bonding strength.

case 3

When applying the green stage white opaque liquid to block out the dark stump shade, it is essential to apply a thin, even coat. Be sure to check the thickness of the restoration and control the amount of liquid during application to prevent it from "bleeding" through the external surface of the zirconia.

Figure 9: Prior to the bake, the restorations were tried in digitally.

the FPD preparations were refined and a minimally invasive veneer preparation was performed on #10, followed by impression-taking and placement of temporary crowns. A polarized filter with a gray card (eLab, Emulation S.Hein; Freiburg, Germany) was used to capture the shade.

Digital design planning and material selection: The case was initially designed using digital dental software (Exocad; Woburn, MA) and a Type I facial cut-back design was implemented to protect the incisal edges from chipping **(Fig 5)**, a concern due to the patient's almost edge-to-edge occlusion **(Fig 6)**.[7] Providing 1150 MPa and 45% light transmittance, the zirconia chosen for the bridge was selected due to its strength and durability (Katana HTML Plus shade NW, Kuraray Noritake; New York, NY). Additionally, a lithium disilicate providing up to 450 MPa (Amber Mill shade block W3, Hass Bio America; Fairfax, VA) was selected for veneer #10 to ensure proper bonding.

Translucency/characterization techniques and considerations: Once the bonding layer was applied, the restorations were seated on the tissue stump cast, which was created using a light-curing stump material (IPS Natural Die Material, Ivoclar Vivadent; Amherst, NY) and pink wax to simulate the patient's gum tissue. A polarized photo was taken with an eLab gray card to analyze the initial shade matching.[8] Once the analysis was completed, internal staining was performed to achieve the desired shade match. Since the Type I cut-back design displays minimal light transmittance of the incisal third, creating artificial translucency and incisal characterization was critical (Cerabien ZR [CZR] internal stains Incisal Blue 1 and Gray, and Mamelon Orange 1 and 2, respectively, Kuraray Noritake) **(Fig 7)**. Before applying the dentin and enamel layers, the internal stained area of the restorations was measured as the stump shade using eLab software. This measurement was crucial for generating a more precise porcelain formulation. The eLab software was specifically set to "veneer mode," leveraging the measurements to generate the appropriate porcelain formulation for the restoration. The porcelains were selected for the zirconia bridge and the veneer (CZR and CZR LF respectively); the latter was chosen due to the Amber Mill block's high-temperature resistance.

Figure 10: The final fabricated restorations.

Figure 11: The temporary restoration was removed.

Digital try-in, external staining, and glazing: The position of the teeth presented significant contouring challenges **(Fig 8)**. Before performing external staining, the case was tried-in digitally using eLab software **(Fig 9)**. The entire facial layered areas were naturally glazed, while the remaining surfaces were glazed with a surface stain (FC Paste Stain Clear Glaze, Kuraray Noritake) **(Fig 10)**.

Patient try-in/approval, final steps, and follow-up: On the day of delivery, the temporary restoration was removed to reveal that the conditioned tissue was in a good state **(Fig 11)**. The FPD and veneer were tried in and the patient approved them. The FPD was bonded with Variolink DC and the veneer with Variolink LC (Ivoclar Vivadent); a light shade was applied to both resin cements according to manufacturer's instructions. Enamel contouring was performed on the lower incisors and a protective occlusal guard was delivered. Four weeks after delivery, photographs were taken to demonstrate the final case integration and development of facial harmony **(Figs 12-15)**.

Figures 12-15: Images of the final delivered case.

"FOR SHADE-MATCHING CASES, THE TYPE II DESIGN IS PREFERABLE TO THE TYPE I DESIGN SINCE THE FORMER ALLOWS FOR SLIGHTLY MORE PORCELAIN SPACE, ENABLING THE CERAMIST TO BETTER CONTROL THE TRANSLUCENCY LEVEL."

case 2

Case 2: Type II Cut-Back Design for Optimal Characterization with Minimal Reduction

Examination and diagnosis: A 33-year-old female patient presented with the chief complaint of unsatisfactory gingival esthetics around her maxillary anterior teeth. The patient had previously undergone implant treatment on teeth #9 and #10 with a two-unit splinted temporary restoration supported by only the #9 implant due to improper implant positions. However, the "pink" soft tissue esthetics were inadequate, compromising the ability to develop an optimal "white" crown form. Upon examination, a lack of papilla growth around implant #9 was noted **(Fig 16)**.

Treatment plan: As indicated in a 2003 study, adjacent implants in the esthetic zone are high risk and, in most cases, can only achieve a papillary tissue height of 3.5 mm **(Fig 17)**.[9] Therefore, to increase the likelihood of an esthetic outcome in this case, it was decided to utilize the existing implant in site #10 with a cantilever bridge-type restoration, while implant #9 was submerged to create a pontic site.

Soft tissue treatment: The existing prosthesis was removed and cover screws were replaced over the implants to allow for soft tissue centripetal ingrowth over the cover screws. After approximately four weeks, significant soft tissue grafting and augmentation was performed **(Fig 18)**. After four months of healing, implant #10 was uncovered employing a rolled pedicle technique;[10,11] an additional tuberosity graft was done to further improve the volume of the pontic recipient site over the submerged implant #9 **(Fig 19)**.

Fabrication and modifications: After three months of healing, soft tissue modeling was performed and the first PMMA provisional was delivered. To fully shape the augmented tissue, a series of milled PMMA temporaries was fabricated and the tissue was gradually modified[12] and completed over a two-year period **(Fig 20)**. The old composite filling on the mesial aspect of tooth #8 was removed and re-treated with the composite material and the final impression was taken. Despite the tissue conditioning achieved through the use of the PMMAs, there was still room for improvement. Specifically, the gingival height and contouring required further attention and the gingiva at #10 needed to be narrowed to match the other gingival side **(Fig 21)**. The soft tissue information was transferred onto the working cast, which was then contoured as desired. The case was milled using a multi-layered zirconia that provides up to 1100 MPa and 49% transmittance (Katana YML shade NW). A Type II facial cut-back design was performed (facial reduction was approximately 0.6 mm).

Figure 16: Preoperative view.

Class	Restorative Environment	Proximity Limitations (mm)	Vertical Soft Tissue Limitations (mm)
1	Tooth-Tooth	1.0	5.0
2	Tooth-Pontic	n/a	6.5
3	Pontic-Pontic	n/a	6.0
4	Tooth-Implant	1.5	4.5
5	Implant-Pontic	n/a	5.5
6	Implant-Implant	3.0	3.5

Figure 17: Classification of predicted height of interdental papillae.

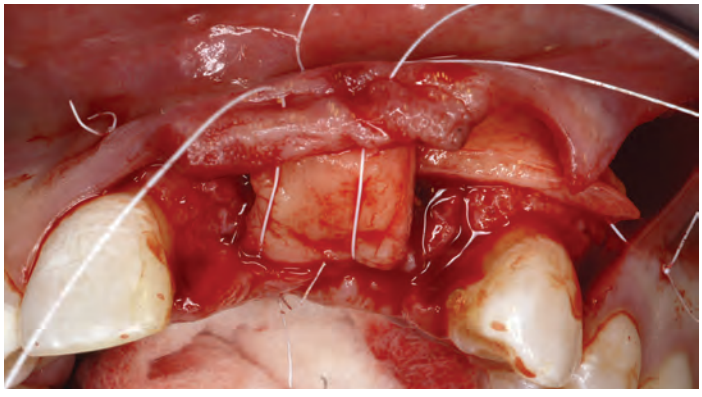

Figure 18: Using the patient's palatal and tuberosity tissue, soft tissue grafting was performed to enhance the gingival contour.

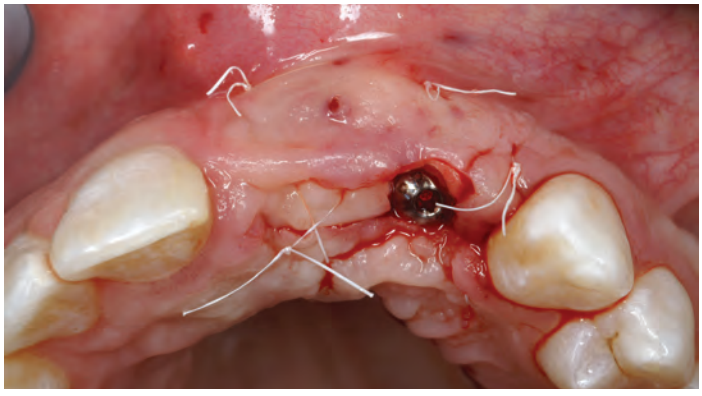

Figure 19: The rolled pedicle technique was employed to uncover implant #10; a tuberosity graft improved the volume of the pontic recipient site over submerged implant #9.

Figure 20: The final PMMA provisional.

Figure 21: The images of the #7 and #8 areas were copied, pasted, and flipped onto the #9 and #10 areas, allowing access to and facilitating a better understanding of the existing gingival esthetics.

Figure 22: Internal characterization, desired shade, and translucency were achieved using the internal stain technique.

Figure 23: The yellow area represents clear glaze, the blue areas indicate polishing with a blue rubber wheel to create a matte luster, and the pink area signifies polishing with a pink rubber wheel to create a glossy luster.

Figure 24: The final fabricated case.

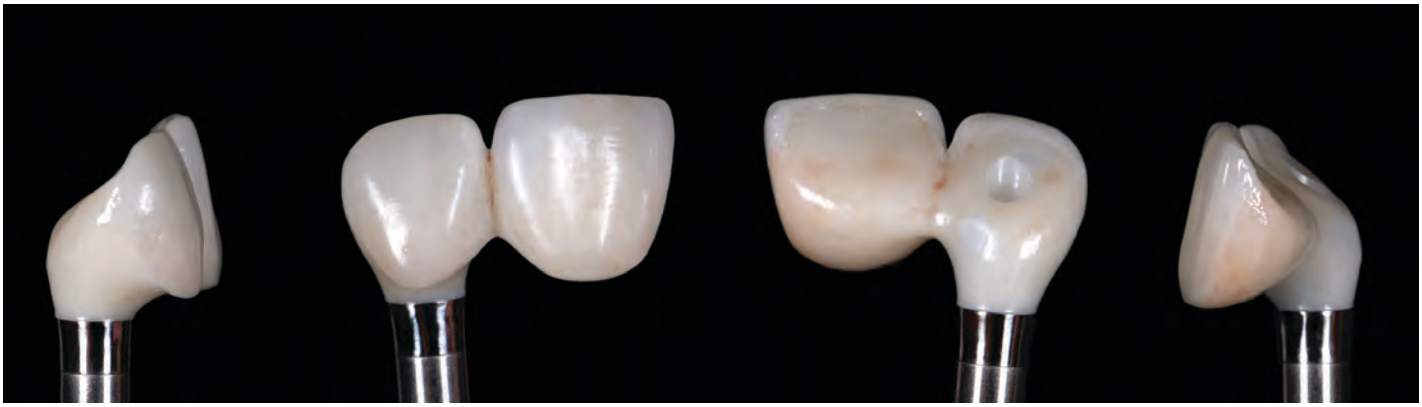

Figure 25: The final cemented implant cantilever bridge.

Figure 26: The PMMA implant was removed.

Characterization techniques and considerations: Performing a Type II cut-back design was crucial in copying the incisal characterization of the adjacent central and lateral incisors. For shade-matching cases, the Type II design is preferable to the Type I design since the former allows for slightly more porcelain space, enabling the ceramist to better control the translucency level. The initial layering was performed using body and enamel porcelain (CZR); the layering was built up approximately halfway to create space for the internal staining technique. Following the bake, internal stain (CZR) was applied to achieve the desired shade and characterization of the restoration **(Fig 22)**. After applying the enamel layer and contouring, the luster of the adjacent teeth, which had both matte and glossy surfaces, was closely observed before performing the glaze. To achieve a similar luster, the #9 glossy mesial area was glazed (CZR FC Paste Stain Clear Glaze), while the rest of the area was natural-glazed and polished **(Figs 23 & 24)**.

Final steps and follow-up: The restoration was cemented to a titanium base with a dentin bonding material (Panavia V5 white, Kuraray Noritake) according to manufacturer's instructions **(Fig 25)**. The temporary PMMA implant was removed prior to delivery **(Fig 26)**, and the final implant cantilever bridge was placed. Additional photographs were taken six months after delivery to follow up on the final outcome **(Figs 27-30)**.

Figures 27-30: Final images 6 months after delivery.

"THE SOFTWARE'S FACIAL CUT-BACK FEATURE ENABLES DESIGNERS TO ACCURATELY MANAGE THE REDUCTION OF THE FACIAL SURFACE. UTILIZING THESE TOOLS ENSURES THAT RESTORATIONS PRESERVE THEIR STRUCTURAL INTEGRITY WHILE DELIVERING OPTIMAL ESTHETICS."

case 3

Case 3: Type II Cut-Back Design to Address Masking Issues and Adjacent Color/Translucency Matching

Examination and diagnosis: A 50-year-old female presented with the chief complaint of unesthetic crowns on teeth #8 and #9. PFM crowns had been placed 30 years earlier and the metal margins were showing due to gingival recession **(Fig 31)**. The patient also showed signs of generalized malocclusion, enamel abrasion, and erosion. Radiographic examination showed no evidence of caries or periapical pathology.

Treatment plan: Comprehensive treatment options included orthodontics, restoring abraded/eroded areas, and replacing defective crowns and restorations. The patient declined orthodontic treatment. Alternative treatment options included a complete smile design with full-mouth restorations to address generalized discoloration and shape. The patient also was presented with a more conservative approach, which included teeth whitening, facial/buccal conservative composite restorations, and replacement of defective crowns on #8 and #9. The patient selected the less invasive, more conservative approach.

Treatment protocol: The teeth were first whitened, then composite resin restorations were placed on the maxillary anterior teeth (Estelite Omega, Tokuyama; Encinitas, CA) **(Fig 32)**. Defective PFM crowns were removed, preparations were refined following the principles of minimally invasive dentistry, impressions were taken, and PMMA temporary restorations were placed.

Fabrication process and key considerations: The case was designed with digital dental software (Exocad). This software's tools give designers the essential ability to evaluate the thickness of restorations after completing the design and before executing cut-back. The software's facial cut-back feature enables designers to accurately manage the reduction of the facial surface. Utilizing these tools ensures that restorations preserve their structural integrity while delivering optimal esthetics.

For the best possible outcomes, both in terms of strength and esthetics, it is crucial to determine the right balance between the minimum zirconia thickness and the desired porcelain space. In this case, a Type II cut-back design was selected for its exceptional ability to replicate the bluish translucency of the incisal third.[13] After the facial cut-back, the restorations were left with a thickness of 0.6 mm, which is an important factor to consider **(Fig 32)**.

Characterization techniques, special considerations, and adaptive alternatives: The stump shade was evaluated with a shade guide (IPS Natural Die), which revealed ND8 for #9 and a notably reddish-brown chroma for the cervical area of #8

Figure 31: Preoperative view.

Figure 32: The composite filling procedure added volume to the abraded/eroded areas while also masking any underlying discoloration.

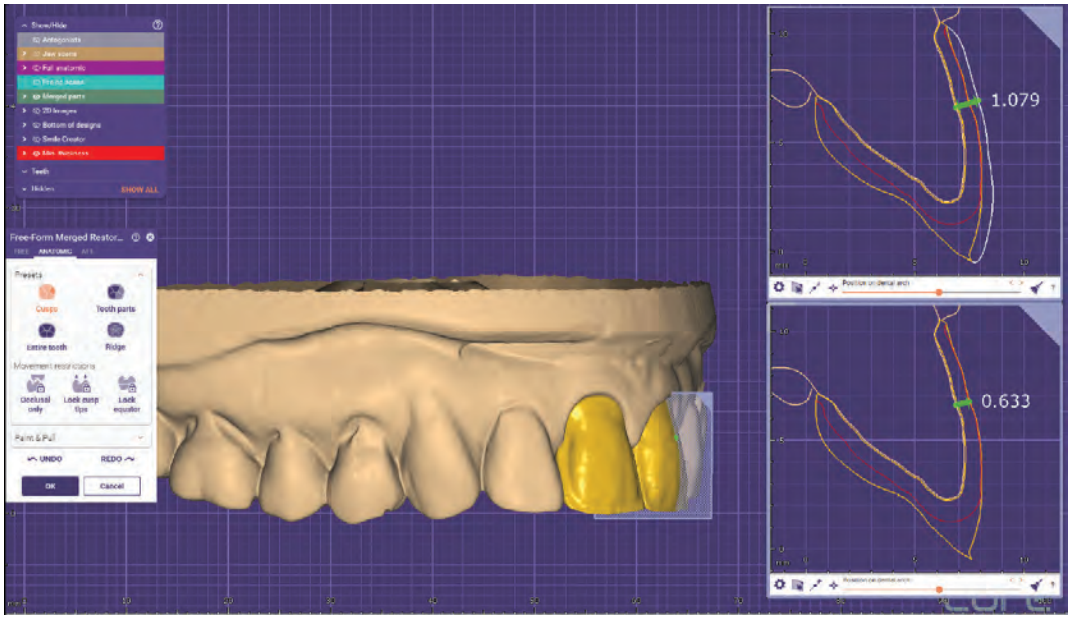

Figure 33: A Type II facial cut-back design was implemented, resulting in a reduction of approximately 0.4 mm.

Figure 34: Emphasizing the necessity of thorough masking, the presence of dark stumps complicated the process of achieving the desired final shade.

Figure 35: Post-sintering, successful masking resulted in uniform crown colors.

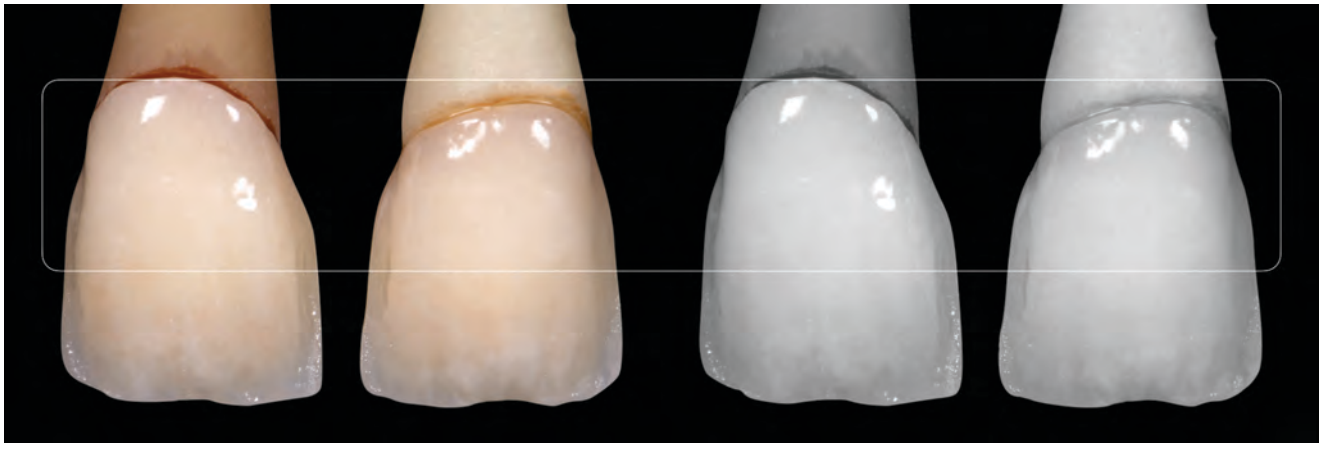

Figure 36: CZR Opacious Body porcelain was applied cervically to increase the value and create mamelon characterization on the incisal.

(Fig 33). To address this challenge, a multi-layered zirconia disc (YML shade A2) was selected for its high translucency and durability. A small amount of white plus liquid (IDS CAD; Centreville, VA) was applied to the zirconia's interior before sintering to create an opaque effect able to mask the dark shade.[14] After sintering, the expected masking was successfully achieved, resulting in a visually appealing and consistent color for both crowns **(Fig 34)**.

An internal stain was applied to establish the base chroma. However, unique circumstances required an alternative approach. Due to the presence of an indirect composite filling, the cervical third displayed a higher value and lower chroma, which is uncommon in natural teeth **(Fig 35)**. One specific area required a close match to the adjacent shade (i.e., the strong bluish enamel color on the incisal edge); this was achieved with a translucent porcelain (CZR Luster LT Royal Blue). To further optimize esthetics and a seamless match with adjacent teeth, the restorations were hand-polished after glazing **(Figs 36 & 37)**.

Final steps: The final all-ceramic crowns were tried in **(Fig 38)**, approved by the patient, and cemented with glass ionomer cement (Fuji Plus, GC America; Alsip, IL) according to manufacturer's instructions. The final results exhibited considerably improved smile esthetics **(Fig 39)**.

Figure 37: The final fabricated crowns.

Figure 38: The case during the try-in procedure.

Figure 39: The final delivered case.

"FOR THE BEST POSSIBLE OUTCOMES, BOTH IN TERMS OF STRENGTH AND ESTHETICS, IT IS CRUCIAL TO DETERMINE THE RIGHT BALANCE BETWEEN THE MINIMUM ZIRCONIA THICKNESS AND THE DESIRED PORCELAIN SPACE."

Summary

Selection of the most case-appropriate facial cut-back design (i.e., Type I or Type II) is a significant factor in achieving optimal esthetics; correctly choosing which type to use will also greatly minimize the need for layering while helping to maintain restorative strength. The technique involves the use of advanced dental materials and internal staining techniques to create attractive, natural-looking dental restorations that also protect and enhance the durability of the incisal edge. It should be noted that these designs may not be suitable for all cases, and that each patient's individual needs and preferences must be considered when planning a design. However, when applicable, the appropriate case-specific cut-back design—in combination with proper digital design planning, material selection, and characterization techniques—can produce dental restorations that demonstrate optimal esthetics and seamless harmony with the surrounding natural teeth.

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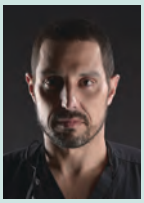

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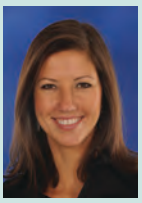

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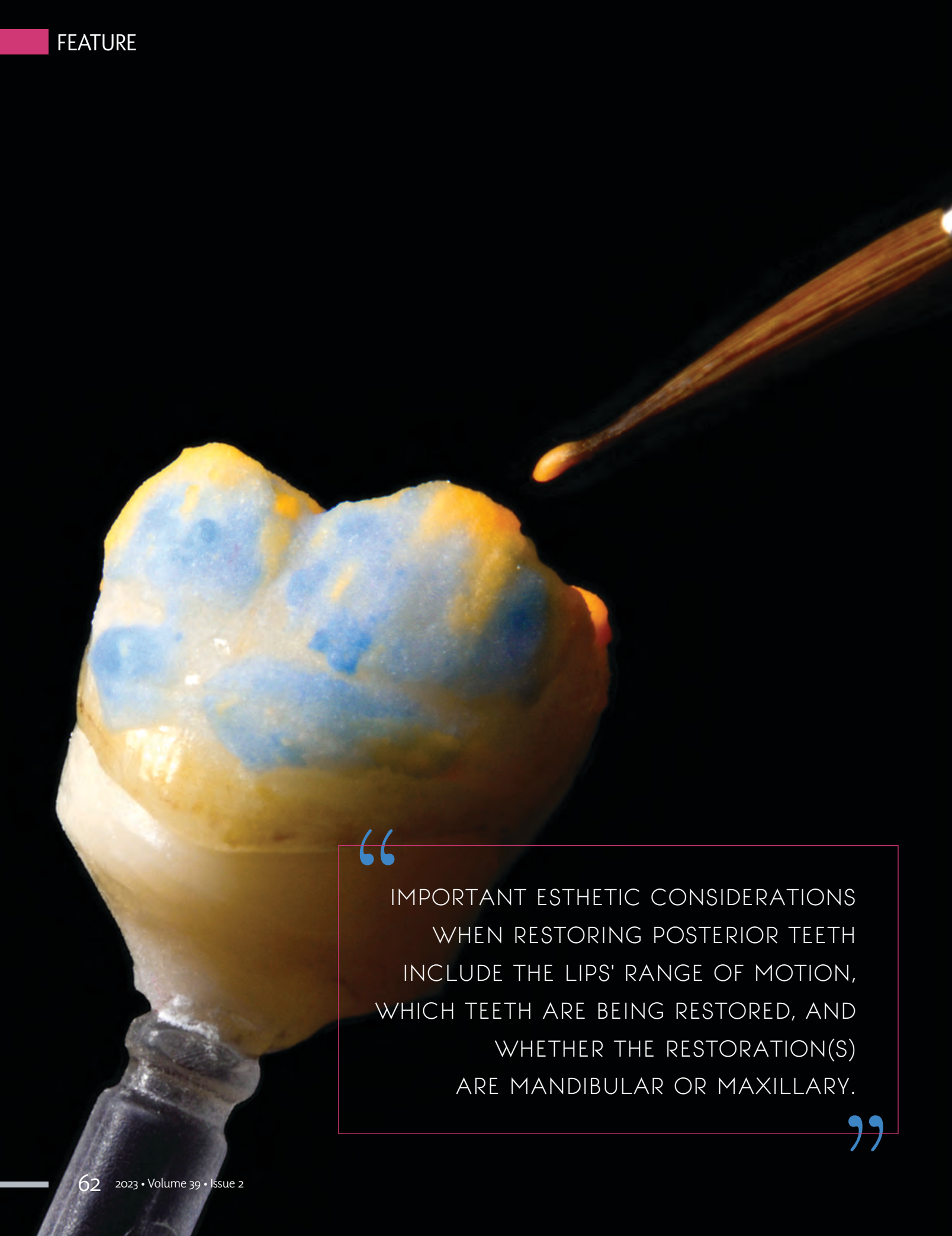

> IMPORTANT ESTHETIC CONSIDERATIONS WHEN RESTORING POSTERIOR TEETH INCLUDE THE LIPS' RANGE OF MOTION, WHICH TEETH ARE BEING RESTORED, AND WHETHER THE RESTORATION(S) ARE MANDIBULAR OR MAXILLARY.

THE SUBTLE ELEGANCE of POSTERIOR RESTORATIONS:

A RATIONAL APPROACH WITH PRESSED MATERIALS

Hernán Lázaro Villa, MDC, CDT, TSPD

Abstract

There are important esthetic considerations when restoring posterior teeth, and the more visible aspects of posterior areas require more harmoniously blended and imperceptible restorations. Unfortunately, despite their necessity to the esthetic restorative process, precise shade analysis, color matching, and subsequent replication of the dentition's unique characteristics are often difficult undertakings. However, knowledge-based collaboration between the dentist and laboratory ceramist greatly enhances success when evaluating, analyzing, communicating, and then replicating tooth shade/color in the final restorations. This article provides a quick, basic review of tooth color and optical properties; outlines an approach for shade analysis and laboratory communication; and describes the use of custom ingot guides, light-cured stump shade dies, and sample restorations to increase esthetic accuracy.

Key Words: posterior restorations, indirect restorations, shade matching, monolithic press technique

Figure 1: A patient's display of the occlusal aspect of their mandibular posterior teeth while showing a Duchenne smile underscores the need for meticulous attention to esthetic detail when restoring these dentition.

Introduction

Among the many goals of indirect restorative dentistry is the esthetic integration of restorations alongside natural dentition and/or existing restorations in the most harmonious and seamless manner possible, regardless of whether anterior or posterior treatment is involved. For anterior cases, achieving this objective may primarily—although not exclusively—result from detailed examination and analysis of orofacial esthetics, golden proportions, and collective and individual tooth/teeth balance within the smile zone.[1] Similarly, successful posterior restorations may be achieved primarily from (and again, not exclusively by) focusing on occlusal schemes and restoration shape and function.[2]

In fact, there are important esthetic considerations when restoring posterior teeth that include—among other things—the lips' range of motion, which teeth are being restored, and whether the restoration(s) are mandibular or maxillary.[3] A large mesiodistal range of lip motion (i.e., wide smile) reveals more of the posterior quadrants, thereby requiring esthetic harmony of the facial aspects of visible posterior restorations in order to achieve the best possible seamless integration with adjacent teeth.[4] Likewise, although occlusal aspects of maxillary posterior teeth are rarely visible in everyday or social contexts, the occlusal aspects of mandibular restorations may be easily revealed during social interactions (e.g., laughing, talking).[3,4] These far more visible posterior areas require more harmoniously blended and imperceptible restorations **(Fig 1)**.

However, regardless of where a single restoration or multiple units are placed, precise shade analysis, color matching, and subsequent replication of the dentition's unique characteristics are essential yet often difficult undertakings for ensuring an overall esthetic treatment outcome.[5] This is particularly the case when shade matching a single restoration as opposed to multiple units or a full smile design. Therefore, esthetically integrating posterior restorations among natural dentition and/or existing restorations requires a comprehensive approach to evaluating, analyzing, communicating, and then replicating tooth shade/color, an approach that is predicated on knowledge-based collaboration between the dentist and laboratory ceramist.

To help contribute to such collaboration, this article provides a brief, very basic review of the dimensions of color and optical properties that must be examined in natural teeth and incorporated into esthetic restorations. Additionally, it outlines the author's preferred dual approach to shade analysis and laboratory communication. Finally, it describes the use of custom ingot guides, light-cured stump shade dies, and sample restorations to help decrease the likelihood of remakes and increase esthetic accuracy.

Light Dynamics in Shade Perception

The complex light dynamics within and between enamel and dentin[6] contribute to the difficulties associated with integrating posterior restorations among natural dentition and/or existing restorations. Although the scientific and dental literature has extensively described the three dimensions of color (i.e., value, hue, and chroma),[7] the interplay of translucency, opalescence **(Fig 2)**, and fluorescence within natural dental structures also significantly affects their vital appearance and unique characteristics. Dental materials and the restorations created from them must therefore replicate not only a tooth's color and physical properties, but also corresponding optical properties observed in enamel and dentin layers in order for treatment outcomes to be truly imperceptible **(Table 1)**.[8]

Table 1. Optical Property Considerations for Imperceptible Restorations

Characteristics in Natural Teeth	Considerations & Visual Effects in Dental Materials
Hue/Chroma	• Can be modified with external stains to match the desired final shade.
Value/ Brightness	• If the value is not matched, the restorations may appear "gray" intraorally or too bright. • The more opacious the ingot, the more light-reflective the restoration will be. • Esthetic discrepancy is easily observed with single-unit restorations, but less so among multiple restorations fabricated for complete smile makeover cases.
Translucency/ Opacity	• Level of translucency/opacity is ingot-dependent. • High-, medium-, and low-translucency ingots are available. • High- and medium-opacity ingots are available.
Fluorescence/ Opalescence	• Both occur naturally in dental structures. • Very little, if any, opalescence is perceived when natural molars or premolars are visible.[9] • Teeth exposed to unfiltered ultraviolet (UV) wavelength sunlight will appear to "glow," although it is almost imperceptible to the naked eye.[10] • Must be inherent in the restorative material itself. • Restorations lacking fluorescence may appear dull, gray, and lifeless.[6] • Fluorescent optical properties impart a natural appearance to restorations for better visual integration. • Fluorescence is extremely noticeable under black light or UVA light.

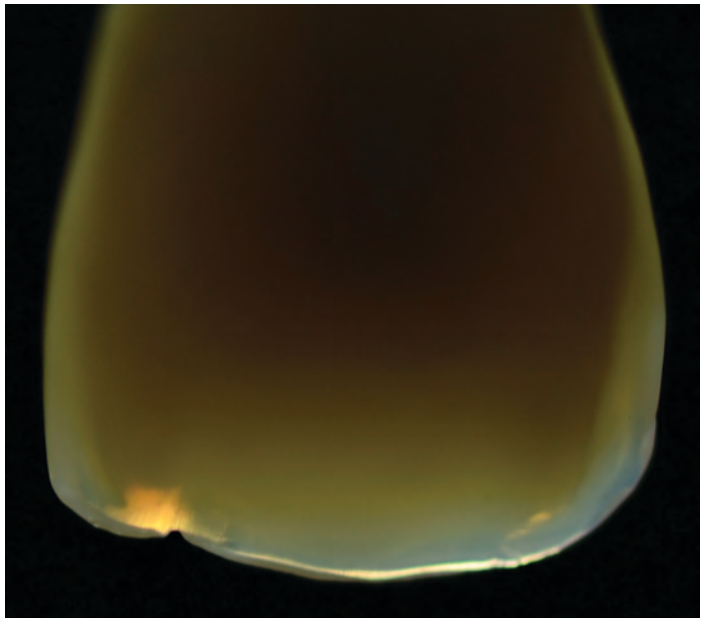

Figure 2: As illustrated here, restorations fabricated with some all-ceramic materials (e.g., zirconia-reinforced pressed lithium disilicate) can demonstrate opalescent optical properties.

> "MORE VISIBLE POSTERIOR AREAS REQUIRE MORE HARMONIOUSLY BLENDED AND IMPERCEPTIBLE RESTORATIONS."

Figure 3: Custom-made pressable ingot shade tabs after pressing and divesting.

Figure 4: The custom ingot shade tab setup.

Figure 5: A gray card tab is photographed adjacent to the tooth to be restored for color calibration.

Figures 6 & 7: Commercially available shade tabs are placed for shade selection photography protocol.

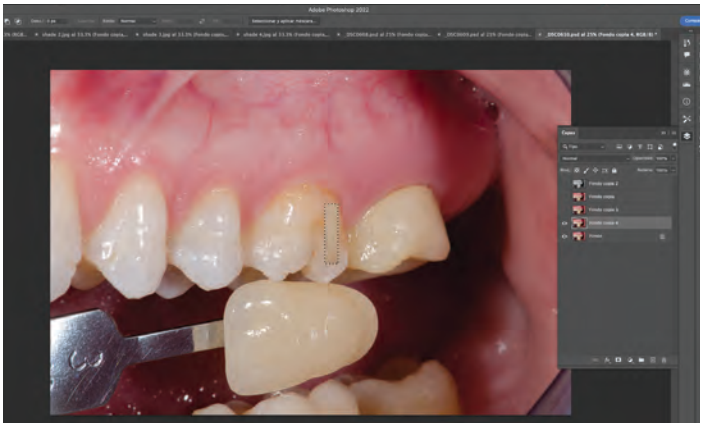

Figure 8: After calibrating the photograph and opening it in photo-editing software, the rectangular frame tool can be used to cut and drag a piece of the shade tab onto the adjacent tooth.

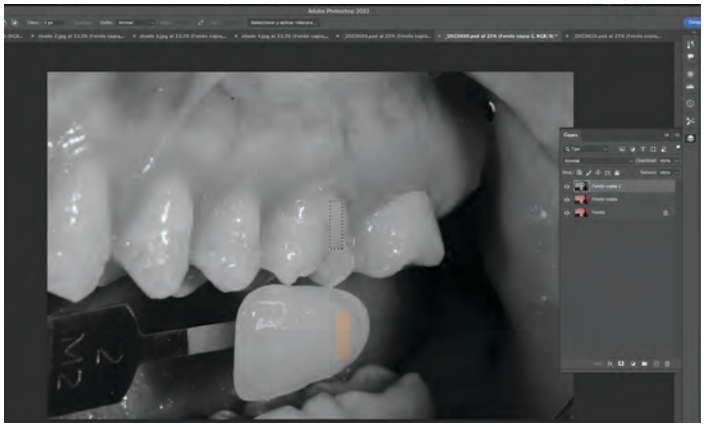

Figure 9: The same can be done to evaluate value after the photograph is converted into black and white.

Photography for Shade Analysis and Communication

Unfortunately, inherent challenges associated with "naked eye" visual color assessment, inconsistent lighting conditions,[7] and variations among dental material shade guides all complicate shade matching and dentist/laboratory ceramist communication processes. In fact, shade communication continues to be one of the most challenging endeavors in clinician/technician interactions. For this reason, the author advocates a dual approach to shade analysis, one that combines perceptual/naked eye shade determination with digital/photographic software evaluation using specific armamentaria according to the following technique.[11,12]

step 1

Step 1. Analyze the tooth shade using standard shade tabs (e.g., Classical shade guide, VITA North America; Yorba Linda, CA), which identify the tooth shade/color based on naked eye perception. After visual analysis is performed, verify the selected shade using a handheld spectrophotometer.[13]

step 2

Step 2. Based on this visual assessment, select the ingot value with either an ingot selection chart or ingot shade tab guide. Most pressable all-ceramic systems offer an ingot selection guide, the use of which significantly increases the accuracy of the planned restoration's selected value and translucency when it is compared to adjacent natural teeth and/or existing restorations.[12] Alternatively, laboratory-fabricated custom-made ingot guides can be used.

Although custom-made ingot tabs can be used for shade matching any type of restoration, their utility is best suited to full-coverage crowns since their thickness will be closer to the color change threshold of the material. Bear in mind that most dental material manufacturers recommend preparation depths ranging from 1 mm to 2 mm for full-coverage restorations, depending on the aspect of the tooth/restoration.[14] Veneer onlays (i.e., vonlays)[15] and three-quarter crowns will also benefit from this technique but will be more dependent on facial tooth reduction. Therefore, when fabricating custom ingot shade guide tabs, this thickness requirement should be considered (a wedge-shaped form is probably most suitable) **(Figs 3 & 4)**.

step 3

Step 3. Take a test photograph to adjust the camera settings and establish the proper exposure (always check the histogram). Then, photograph a portion of a gray card placed as close as possible to the tooth adjacent to the one being restored **(Fig 5)**; this will help with calibrating (i.e., creating a key by gray-card balancing) the digital photographs that will subsequently be used in shade communication.[11,12]

step 4

Step 4. Replace the gray card with a tab from the desired shade guide that most closely matches the perceived tooth shade, taking care to maintain the tab in the same position as the gray card. Take a photograph without changing the focal length, flash position, or flash output; repeat, using as many shade tabs as needed **(Figs 6 & 7)**.

Keep in mind that manual photography is necessary for this step, so having an assistant replace the shade tabs is highly recommended. Additionally, having the patient assist by holding the cheek retractors is also beneficial.[11,12]

step 5

Step 5. Once all photographic data have been collected, the images can be opened in a photo-editing software program (e.g., Photoshop, Adobe; San Jose, CA); exposure-corrected using the key picture (i.e., the one that has been gray card-balanced); and the values copied and pasted onto the remainder of the photographic series.[11,12]

If using Photoshop, its assorted tools will allow a piece of the tooth image to be cut and placed onto the shade tab image, thereby enabling a direct shade comparison between the shade tab and the tooth **(Fig 8)**. Then, turn the images into grayscale, which allows the value to be gauged without any influence from hue and/or chroma **(Fig 9)**.[11,12]

Tips

BEGINNER

» Ensure that the teeth have been cleaned prior to shade matching, yet remain hydrated.

» If the patient is wearing bright-colored clothing, it should be covered during shade matching.

» If you have trouble selecting the value, squint slightly, which helps with value perception.

» Rest your eyes on the gray portion of the shade guide in between shots, which helps to "clear" the eyes' photoreceptors when analyzing color.

INTERMEDIATE

» Shoot images manually using the same settings and light schemes for all the photographs.

» Choose the lens magnification, then slowly move back and forth until the correct focus is achieved.

» Ensure that shade tabs are placed parallel to the tooth being matched, and not behind—which makes it appear lower in value, or in front—which makes it appear higher in value.

» After the preliminary shade is selected in natural light, it is recommended to confirm the selected shade using an intraoral spectrophotometer.

ADVANCED

» When placing the gray card, choose hard tissue landmarks as reference points (e.g., premolar tips), which increases the efficiency and accuracy of placing the shade tabs and capturing images.

» Match the white balance of your camera to your flash's color temperature in Kelvin, or to the closest value your camera allows.

» If a "perfect" match cannot be found, select the lighter shade tab.

» View the patient and the teeth at eye level so the line of sight is perpendicular to the tooth's surface.

The Role of Stump Shade, Preparations & Provisionalization

Keep in mind, however, that the stump shade should also be considered when choosing the ingot shade. This is because, depending on the preparation design, material thickness that can be accommodated, and the translucency of the selected restorative material, the stump shade could influence the appearance and esthetics of the final restorations.[5,16] However, the dentist should first and foremost design his or her preparations to be as minimally invasive as possible, use reduction guides accordingly, and base preparation depths on the desired treatment outcome.

Fortunately, most of today's pressable ceramic systems have a stump shade guide in addition to complementary light-curing stump/custom die materials **(Fig 10)**. The purpose of these tools is two-fold. First, they allow the stump shade to be recorded (i.e., photographed) after tooth preparation, along with the translucency and shade of the adjacent teeth, using shade tabs and an ingot sample. Second, they enable the laboratory to create a custom die that replicates the stump shade's color features, thereby enhancing the ceramist's ability to recreate lifelike characterizations in the restoration **(Fig 11)**. Alternatively, an actual stained and characterized pressed restoration can be used instead of an ingot shade tab to evaluate the appearance of chroma and value intraorally **(Fig 12)**. Either approach greatly increases the likelihood of a successful outcome, reduces the need for remakes, and saves both bench and chair time.

Then, once direct or indirect provisionals are placed, the temporaries serve as prototypes of the final restorations, allowing the patient to "test drive" the treatment and the entire team to evaluate its design (i.e., form, function, fit, anticipated esthetics) without compromising the final result. Although most valuable when multiple teeth are being treated so that the occlusion can be refined intraorally (e.g., quadrant or nonconsecutive teeth), experienced practitioners know that regardless of how many occlusal records have been taken and how carefully the articulation and occlusal analysis have been performed, the mouth itself is the ultimate "evaluator."

The provisionalization phase also provides the laboratory technician with invaluable shade information. Although the temporary material will not demonstrate the same optical properties as the definitive restorative material, it will allow the discerning observer to evaluate how the final restoration shade may be influenced by the substrate, as well as whether the reduction depth is sufficient.

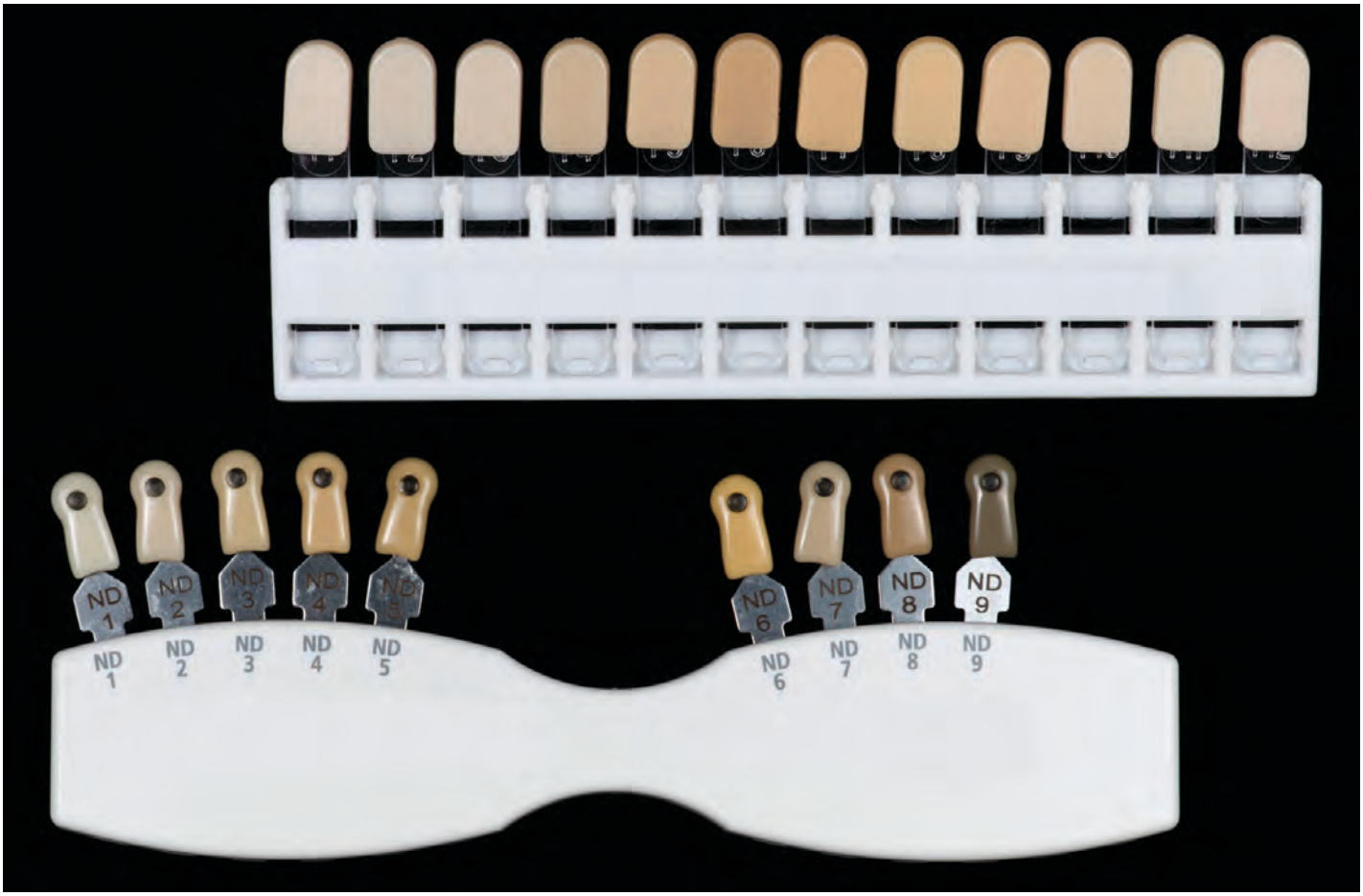

Figure 10: Commercially available stump shade tabs.

Figure 11: A completed pressed restoration demonstrating lifelike characterization staining, made possible by visualization on a custom die fabricated from light-curing material.

Figure 12: To evaluate hue and value, the pressed restoration could also be used, rather than an ingot shade tab.

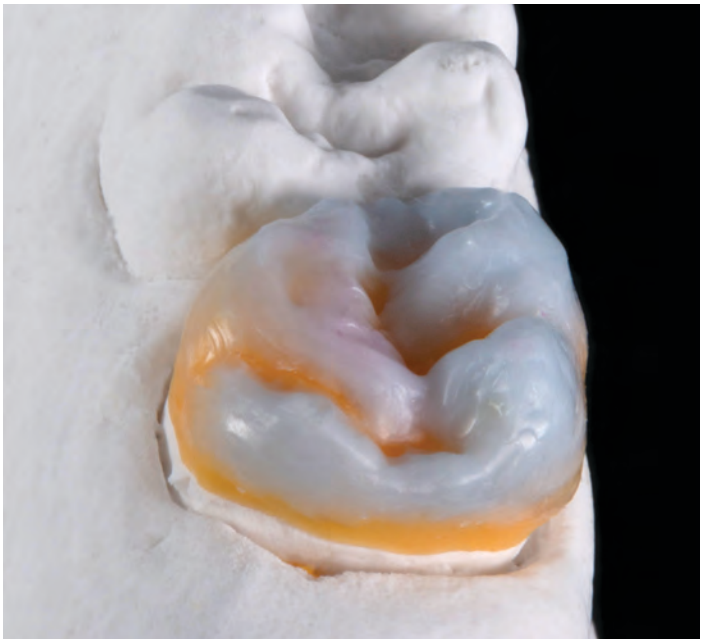

Figure 13: Wax pattern on a solid model.

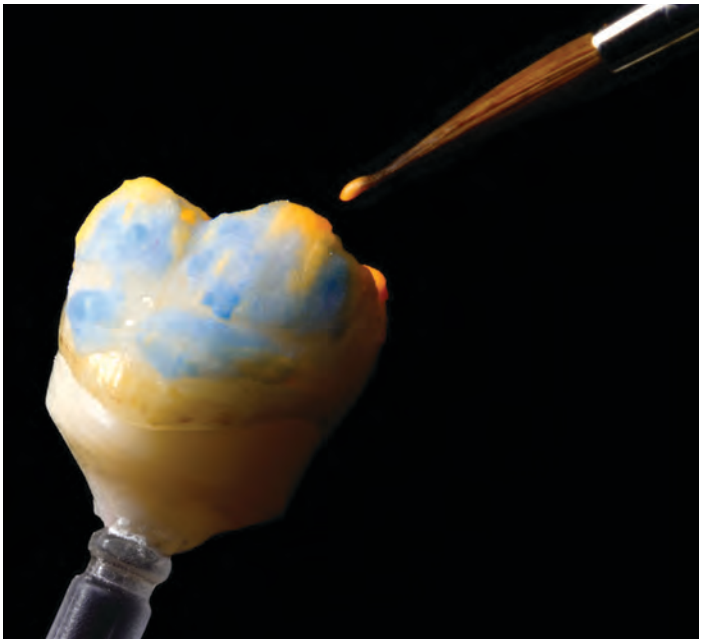

Figure 14: Detailing porcelain is applied to the restoration to enhance its texture and shape. Tints have also been added to the porcelain mix to facilitate visualization.

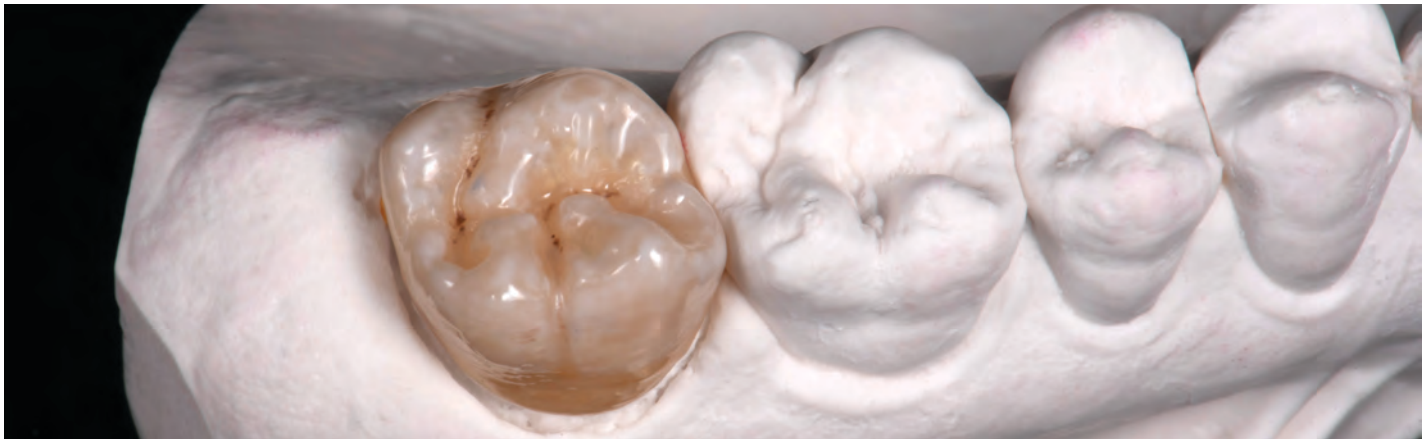

Figure 15: The completed definitive crown restoration is returned to the solid model.

Figures 16 & 17: Custom staining of a sample restoration is completed with the patient present to reduce the likelihood of remakes and frustration. In this case, several restorations were planned and placed in the patient's mouth. Note that polishing the margins potentially removes surface staining/characterization in those areas, so patients should be informed of this beforehand to prevent disappointment.

Replicating Nature in the Dental Laboratory

Since their introduction in the 1980s, materials capable of being processed according to press/lost wax and/or CAD/CAM techniques have become the gold standard for esthetic monolithic restorations. Although newer materials offering different solutions, as well as more advanced technologies, have subsequently been developed to accommodate a faster, cleaner, and more efficient workflow, the basic collaboration, communication, and esthetic principles guiding their use remain the same.[14]

For example, when restoring highly chromatic teeth or undertaking a significant shade change, the more information the ceramist receives, the better. In fact, the success of the treatment—whether in terms of esthetics or function—depends upon the amount and quality of information the laboratory receives, and then upon the technician's skills at interpreting and transferring that information to the restorations. In many cases, the technician does not have the benefit of direct access to the patient, so most case- and shade-related information will be communicated via photographs.

Once the laboratory has received all this information and the appropriate ingot(s) has been selected for the restoration(s) (i.e., based on the identified value, hue, chroma, and opacity), the laboratory can proceed. The following summarizes the author's technique for replicating nature in pressed monolithic posterior restorations.

step 1 **Step 1.** Wax up the restoration on the dies **(Fig 13)**, then press according to the manufacturer's recommendations for the specific system used.

step 2 **Step 2.** Divest and clean the pressed monolithic restorations.

step 3 **Step 3.** Polish and prepare the restorations for finishing with silicone wheels. Note that the press technique produces restorations with a slightly higher flexural strength and fracture toughness than their milled counterparts. However, it has no effect on the restoration's polishing, staining, or finishing.[17]

step 4 **Step 4.** Apply a first coat of fluorescent glaze paste, which serves as both a surface sealer and primer, onto which stains can be painted; it also optically enhances the restoration's fluorescence.

step 5 **Step 5.** Fire the primer, then run a series of stain bakes to impart the appropriate shade and chroma to the restoration.

step 6 **Step 6.** Create anatomical details by adding either correction, low-fusing, or standard ceramic. Note that since the advent of newer liquid ceramics, such anatomic detailing can be achieved with mixes specifically designed for texturizing restorations **(Fig 14)**.

step 7 **Step 7.** Fire/bake the restoration.*Note that several factors associated with this process (e.g., gradient and final temperatures, restoration height in the furnace, distance from the heating element, whether a vacuum is used) affect the restoration's final appearance **(Fig 15)**. Therefore, the author always places restorations in the same area of the furnace, at the same distance from the heating element, and at the same height in order to obtain consistent results when firing glass ceramic or other porcelain.

Additionally, when firing more than six units, a common trick to prevent underfired porcelain or stains due to the increased mass in the firing chamber is to raise the final temperature. However, because each oven fires slightly differently, this compensation must be customized, and using small increments (e.g., five degrees) is the safest way to find an oven's "sweet spot." Further, calibrating the oven and running a test fire with clear porcelain provides most of the necessary information about the oven's performance and what custom modifications may be needed.[17]

*Alternatively, to decrease the number of patient office visits for restoration try-ins, as well as the potential for remakes, a sample restoration can be fired with the patient present and used as a guide for customizing all other restorations based on photographs that can be taken subsequently **(Figs 16 & 17)**. It may also help the laboratory to minimize possible flaws and potential visual discrepancies resulting from nonmatching restorations.

Summary

Despite their commonplace nature, posterior restorations continue to challenge dentists and laboratory technicians, particularly in terms of ensuring that their more visible aspects blend harmoniously and seamlessly with adjacent natural dentition and/or other restorations. Fortunately, the likelihood of success in this regard can be increased through knowledge-based collaboration between the dentist and laboratory ceramist when evaluating, analyzing, communicating, and then replicating tooth shade/color in the final restorations. Such collaboration, combined with the considerations and techniques presented in this article, can ultimately contribute to patient satisfaction and overall treatment success **(Figs 18-23)**.

Acknowledgment

The author thanks Dr. Augusto Robles (Birmingham, AL) for his exceptional clinical work and partnership.

Figures 18-23: Intraoral images showing the successful integration of the restorations in the posterior areas. In this case, the base ingot was a medium-translucency glass ceramic (Celtra Press shade D3, Dentsply Sirona; Charlotte, NC) that was characterized with Celtra universal stains and glaze. Since no additional ceramic was needed, the restorations were fully monolithic.

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DIGITALLY GUIDED DIRECT and INDIRECT COMPOSITE LAYERING TECHNIQUE: a Case Report

Learning Objectives

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

1. Develop a method for conservative dentistry using modern materials.
2. Learn how to apply digital technology to ensure a predictable outcome.
3. Incorporate silicone indexes to streamline the process for bonding.

Disclosures: *The authors did not report any disclosures.*

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Abstract

Digitization and planning are key to achieving predictability with dental veneer treatment. However, when working with composite resin, only a palatal guide is typically generated from a wax-up to establish length, and layering is performed freehand. This article discusses how to make the most of digital tools such as intraoral and facial scanning for planning and design when increasing vertical dimension of occlusion, as well as how to generate "stamping" guides that provide an exact likeness in comparison to the previously established design in order to transfer the planned anatomy and details with direct composite veneers and tabletops without deviating from the initial design.

Key Words: esthetic, planning, composite, stamp, digital, function

Figure 1: Preoperative portrait.

Figure 2: Portrait of the patient with a wide smile, showing slight facial asymmetry and a canted maxillary plane.

Introduction

The success of any esthetic treatment is based on several factors, one of the most important being correct occlusal function. Therefore, when patients wish to improve the appearance of their smile, the first step should be a proper evaluation of occlusion.[1] Ideally, the second step should be to thoroughly plan all the subsequent steps so as to significantly decrease the incidence of errors and to help guarantee treatment stability over time. Digital tools are extremely valuable in achieving predictability and precision during this process.[2]

While there are guides for composite layering and injection, they are neither very useful when executing a precise final layer, nor for obtaining a clean marginal finish prior to polymerization. This article presents a more detailed view of how to obtain correct marginal adaptation and how to easily achieve precision when it comes to reproducing the details, texture, and thickness previously established in digital planning.

Case Report

Patient History

A 30-year-old female presented to the authors' clinic with direct composite veneers from maxillary canine to canine (#6 to #11), with fractures in #7 and #11. The patient's initial desire was to change the veneers; however, at the time of her occlusal function evaluation, a deficiency in canine guidance of lateral excursive movements—which may have contributed to the fractures of the existing restorations—and a slight maxillary cant were observed. Therefore, performing the treatment with the original occlusal scheme would lead to failure of the future veneers. This was explained to the patient, and she was given two treatment options: orthodontics to correct the occlusal scheme and then esthetic treatment, or to first increase her vertical dimension of occlusion (VDO) with tabletop overlays to improve occlusal function and protect the future esthetic restorations. The patient declined orthodontics, opting instead for the increase in VDO with tabletops and veneers **(Figs 1 & 2)**.

a

b

c

Figures 3a-3c: Right lateral, frontal, and left lateral views of the patient's smile.

Figure 4: Patient with retractors in place for digital design purposes when correlating and evaluating the dental midline in relation to the facial midline.

"The incorporation of the intraoral scan allowed the patient's mouth to be digitized quickly and directly, thus reducing the discrepancies caused by alginate and plaster casting."

Figures 5a & 5b: Close-up retracted images in centric occlusion and protrusive guidance.

Figures 6a-6c: Close-up retracted images. (a) Tooth #7 showing wear and a deficiency in canine guidance in the right lateral excursive movement; (b) 1:1 view; (c) tooth #10 showing resin fracture on the cusp of #11 and a deficiency in the function of canine guidance.

Diagnosis and Records

The clinical evaluation discovered the presence of direct composite veneer fractures in #7 and #11, wear signs in the mandibular anterior teeth associated with bruxism and occlusal instability, a maxillary plane cant, a midfacial line slightly deviated to the left side, a very pronounced Curve of Spee, and the absence of canine guidance in lateral excursive movements due to tooth position and wear **(Figs 3a-7)**.

Subsequently, a complete photographic protocol, intraoral scanning (Medit; Winnipeg, Canada), and facial scanning (Bellus3D, Bellus; Campbell, CA) were performed to facilitate in-depth analysis and planning of the functional and esthetic rehabilitation. Each record was taken to achieve greater visualization and precision during the digital design. The incorporation of the intraoral scan allowed the patient's mouth to be digitized quickly and directly, thus reducing the discrepancies caused by alginate and plaster casting.[3] The facial scanner was also indispensable since it fulfilled the function of a facebow in the virtual articulator for calculating the ideal increase of VDO and for making the relevant occlusal adjustments as accurate as possible. This method works on the principle of *stereoscopic vision* (three-dimensional vision produced by the fusion of two slightly different angles of a scene on each retina). In general, it makes a compilation of images from different views of the face and superimposes them, adding depth.[4] Both the facial scanner and the photographs simplified the process of the design by guiding the dental proportions facially.

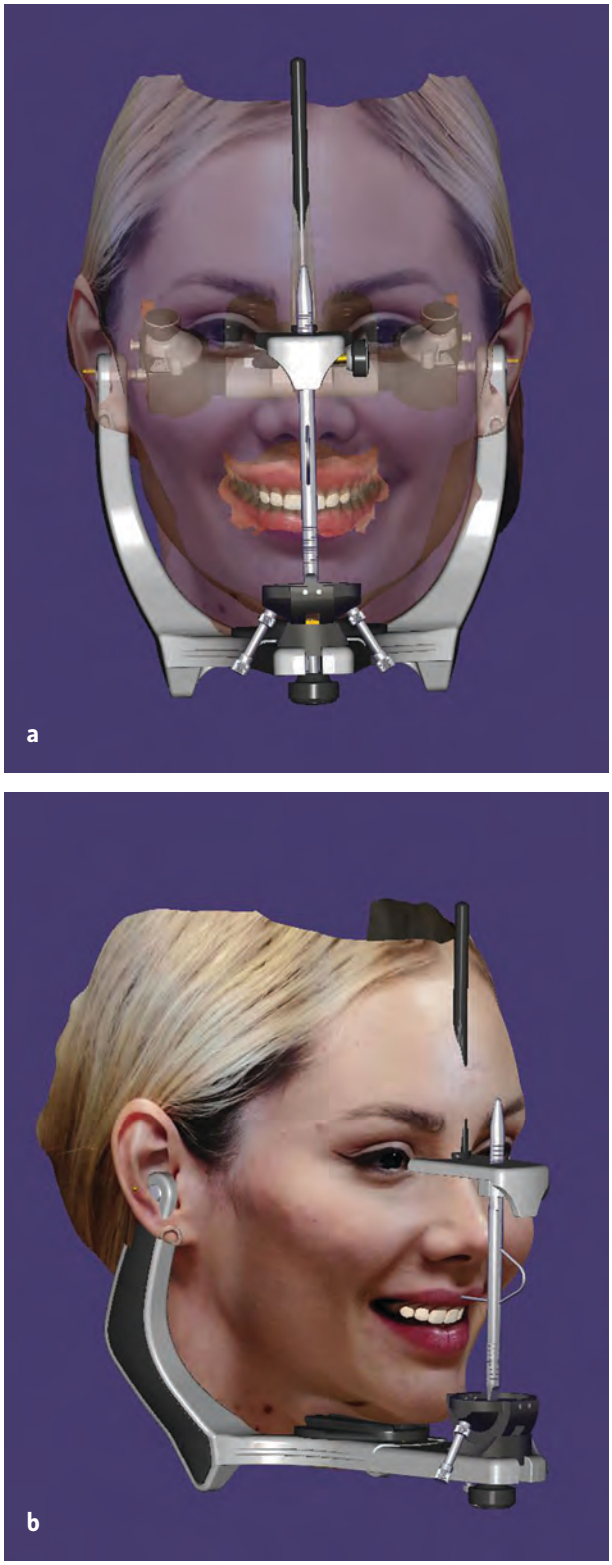
Wax-Up

The patient expressed that she wanted longer and more noticeable central incisors. However, her current occlusal scheme and the relationship of her maxillary plane to her lower lip was an impediment to this. Therefore, it was decided to increase the VDO, as this would allow for alignment of the cant, improve the relationship of the incisal edges to the lower lip, and functionally protect the temporomandibular joints and the esthetic rehabilitation to be performed.

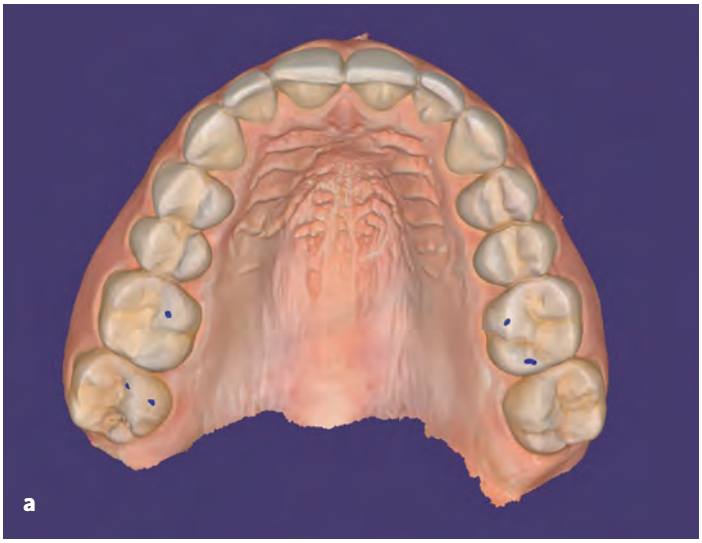
Study of the facial photograph determined that the patient's midfacial line deviated slightly to the left, thus the anterior teeth design was based on the concept of a facial flow. This way, harmony could be achieved even with the presenting facial asymmetries, also considering the slight improvement caused by modifying the VDO and the maxillary plane.[5]

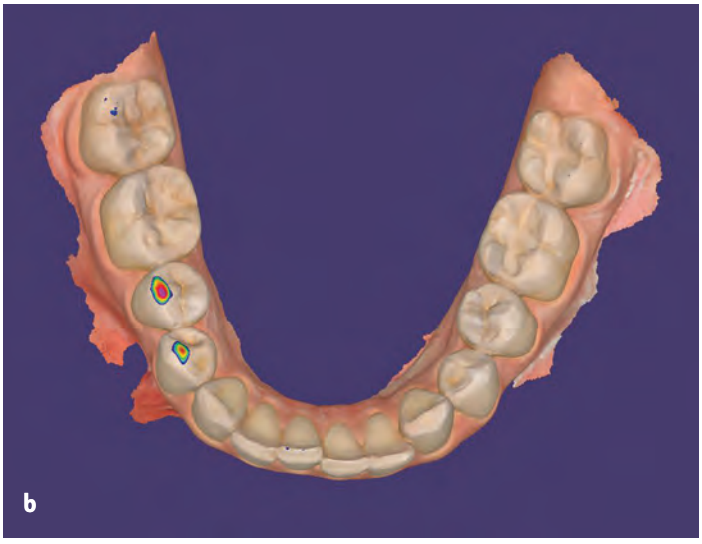
Likewise, the dental proportions were based on the use of the golden proportion because the design had to be oriented according to the initial teeth structures to work without preparation.[6] Correspondingly, the dental anatomy was established based on the similarity to the patient's previous design so as not to generate radical esthetic changes, which might upset her.

The wax-up was designed via CAD software (Exocad; Woburn, MA), which allowed for digital simulation of the facially guided function and esthetic rehabilitation.[7] Initially, models in stereolithography (STL) format were incorporated into the software and correlated with the facial scan. Next, the models were facially articulated in a virtual articulator (Bio-Art; São Paulo,

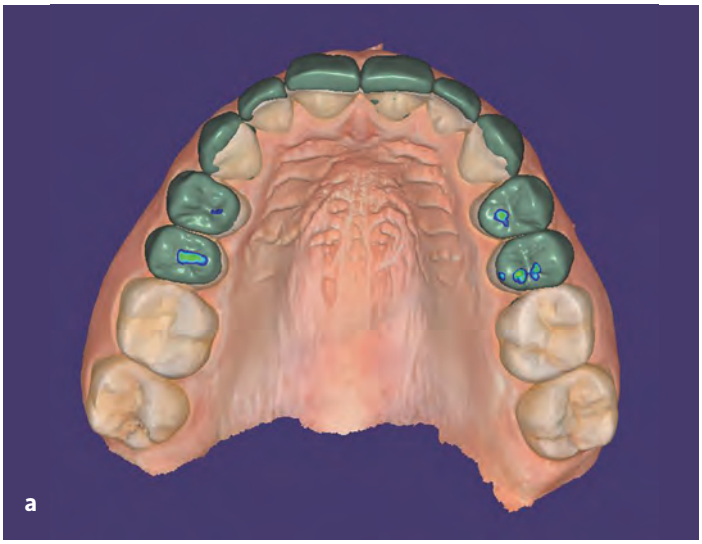


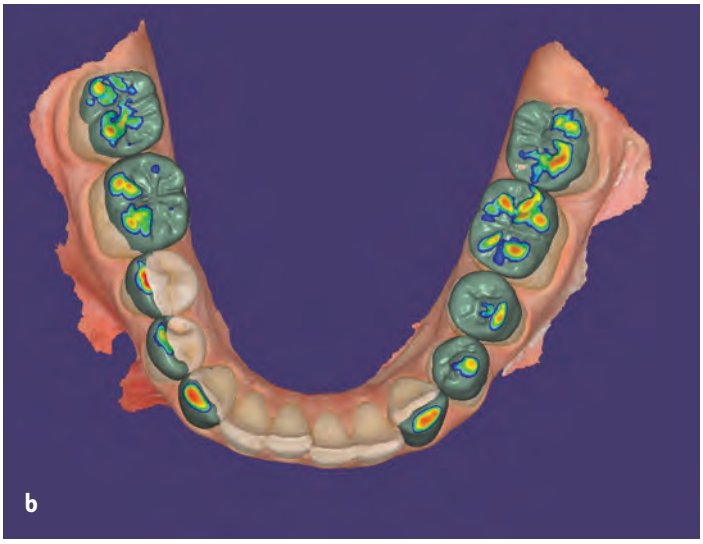
Figures 7a & 7b: (a) Frontal and (b) right lateral view of facial scanner and model on virtual articulator.





Figures 8a & 8b: Digital occlusal views of the (a) maxillary and (b) mandibular initial situation.





Figures 9a & 9b: Digital occlusal views. (a) The maxillary digital wax-up, planned with anterior veneers and tabletops for the premolars. (b) The mandibular digital wax-up, planned with veneers on the canines and tabletops on the molars and premolars.

Brazil) through a point-to-point markup of the same areas on each tooth on both the facial and dental meshes, allowing orientation of the STL model on the facial reference **(Figs 8a-9b)**.

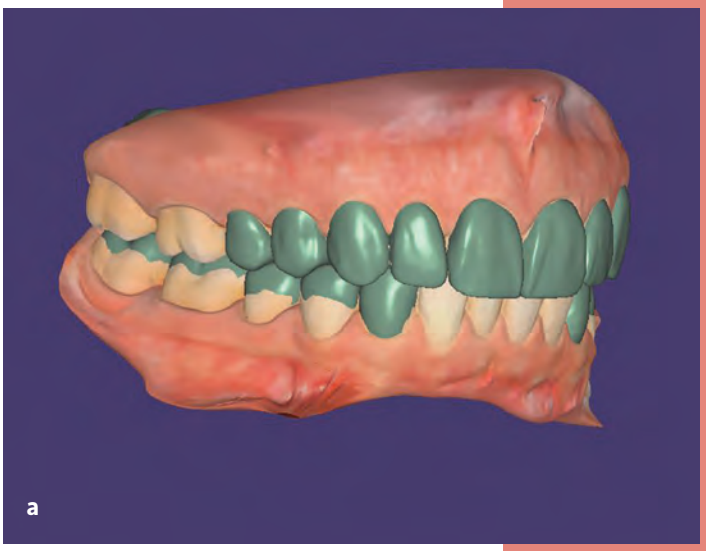
Before virtually increasing the VDO, #6 through #11 were waxed to determine the position and length of the desired incisal edges to be used as a reference for the millimeter increase in bite in the posterior area.[8] The amount of increase performed was 0.5 mm, planning tabletops in the posterior sector while keeping the patient's centric occlusion (CO). This reflected a gain of 1 mm in overbite, which would allow the maxillary incisors to be lengthened successfully, resulting in better canine guidance and a more harmonious smile curve **(Figs 10a-11)**.

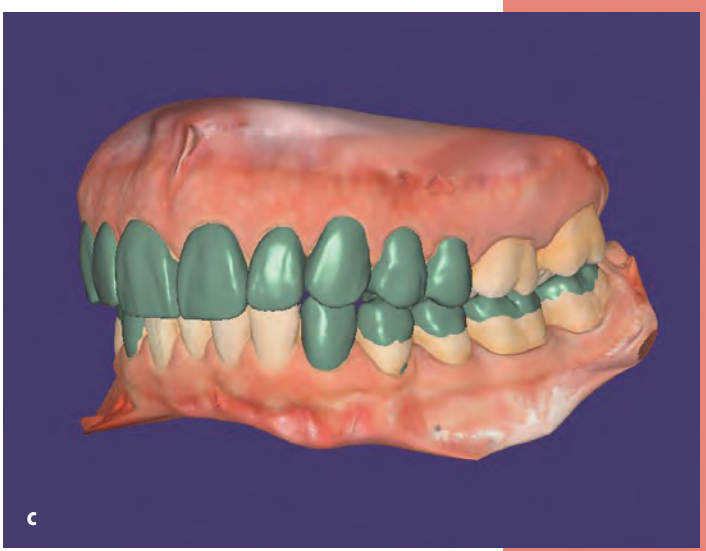
Once the desired result was achieved digitally, 3D-printed models were created to test the planning through a mock-up and to make corrections directly in the mouth if needed.

Material Selection

The choice of restorative material depends on multiple factors. Oral hygiene, intake of colorants, consumption of tobacco, and the regularity of follow-up visits as well as the patient's socioeconomic status are important to consider when selecting a restorative material to best ensure treatment longevity. Treatment invasiveness was also considered, as the patient was unwilling to go through orthodontics or to undergo preparations or permanent changes in her dental enamel.

Although ceramic materials exhibit physical-mechanical properties of flexural strength between 120 and 180 Mpa and resistance to abrasion similar to or somewhat greater than a natural tooth,[9] they tend to be more vulnerable to fracture than composite resin-based materials and lead to greater enamel wear when obtaining a perfect fit.[10] Because of this, it was decided to restore the posterior area with a material that offers the





Figures 10a-10c: (a) Right lateral, (b) frontal, and (c) left lateral views of complete wax-up after increasing the VDO.

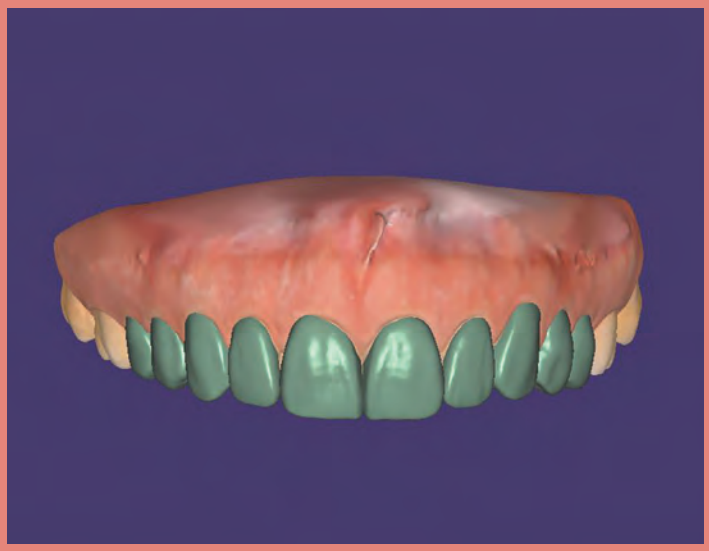


Figure 11: Maxillary plane after wax-up.

"THE DENTAL ANATOMY WAS ESTABLISHED BASED ON THE SIMILARITY TO THE PATIENT'S PREVIOUS DESIGN SO AS NOT TO GENERATE RADICAL ESTHETIC CHANGES, WHICH MIGHT UPSET HER."

Figure 12: Smile with mock-up in place.

advantages of both ceramic and resin, adapted to the needs of this specific case. The zirconium silicate micro ceramic light-curing material selected (Ceramage, Shofu; San Marcos, CA) comprises an organic matrix and 73% by-weight micro fine ceramic particles. This characteristic is designed to enable it to resist significant load during mastication, reduce the risk of fracture and wear of the antagonist surfaces, and make it easier to repair, adapt, and modify.

The patient's esthetic requirements were also taken into account. Considering that the buccal surfaces would not be a major problem in terms of receiving vertical masticatory forces if the correct parameters and anatomy were maintained for lateral excursive and protrusive movements, this would free the anterior sector from inappropriate tensions.

A 2021 in vitro study[11] showed that partial laminate veneers can exhibit fracture resistance values similar to direct composite restorations or conventional ceramic laminate veneers, showing fracture resistance values in direct resin veneers of 385 (± 225) versus 266 (± 69) in ceramic laminates.

Given the above criteria and the patient's requirements, treatment with direct composite resin veneers was selected.[11]

Mock-up

The wax-up was performed first using condensation silicone (Zetalabor, Zhermack; Badia Polesine [RO] ITALY) to fabricate a putty model of the 3D-printed models, which was then placed in a pressure pot (Aquapres, Lang Dental; Wheeling, IL) to ensure optimum fit and an accurate copy of the surface details and contours.[9] The putty was filled with a bisacrylic self-curing resin (Acrytemp shade A1, Zhermack) and placed in the patient's mouth. The esthetic parameters and the protrusive and lateral guidance were verified to be optimal, and minimal occlusal adjustments were made until the patient stated that her new bite was comfortable. After making the necessary modifications, the mock-up was scanned to use as a reference for fabrication of the layer guides **(Figs 12-14b)**.

Composite Selection

The choice of composite is one of the most important things to consider when crafting an esthetic restoration; the optical and mechanical properties must be optimal to achieve success, depending on the area to be worked on.[12]

The authors believed that Ceramage was an ideal material to consider for the tabletop restorations. Its properties of resistance to compression and traction are needed in any material to be subjected to occlusal loads, especially in patients with bruxism. This zirconium silicate micro ceramic can also potentially last up to 15 years if placed correctly and is designed to have excellent polishing properties and color stability.[13]

For the veneers, it was decided to use a composite with low viscosity to ease stamping and with optimal visual properties that incorporate colors adapted to the dentin, body, and enamel of the tooth[14] (Filtek Z350, 3M; St. Paul, MN). It is key to emphasize the importance of consistency when performing the stamping technique and to avoid the risk of displacing the composite when removing the guide for marginal adaptation and polymerization.

Figures 13a-13c: Intraoral images in (a) right lateral, (b) frontal, and (c) left lateral excursion after the mock-up test. Improvement in canine guidance can be observed.

Figures 14a & 14b: (a) Maxillary and (b) mandibular views of contacts in CO after the mock-up test.

Figure 15: Composite color selection.

Tips *for Clinicians*

• When planning, always establish a facial orientation, both for design purposes and for vertical dimension increases. Use a facial scanner when possible.

• It is ideal to customize the digital dental galleries to ensure the adaptation of the wax-up to each tooth, and the adjustment to a spatial predisposition that must be respected in minimally invasive treatments.

• Remember that the increase in vertical dimension causes modifications in the positioning of the surrounding tissues such as skin and lips, which will not be completely perceptible in the design software.

• When fabricating the guides, it is essential to use a model with no bubbles or imperfections. If using a 3D-printed model, it should be printed in a minimum of 100 µm.

• The stamping technique works best with composites with a firm consistency, which allows for maintaining the shape once the guide has been used to stamp and is then removed. Low-viscosity composites will make the task much more difficult.

• Apply only a little model separator or resin modeler with a brush on the inside of the guide before stamping the resin; otherwise, the composite will stick to the guide.

• The stamping guide fabricated with condensation silicone provides fewer possibilities to deform or modify the anatomy of the composite at the time of the stamp and removal. If the guide is fabricated with clear silicone, a pressure pot is needed during fabrication to copy all the details and proximal adaptation.

• Precise trimming of the guide is essential with this technique; use a fine diamond disc, carefully sectioning the contact points to avoid adaptation problems and to prevent the loss of the proximal relation of the wax-up.

• At the moment of stamping the final layer of enamel with the aid of the guide, always place the composite directly on the tooth. It is recommended to adapt the margins and clean the excess prior to light curing using a fine brush, a thin spatula, or a matrix band.

Color Selection

To determine the shade of the composite to be used, the existing veneers were first removed, followed by prophylaxis and polishing. The color selection was made at the very beginning of the second appointment to prevent alteration of the actual tooth color due to dehydration. Because the composite shades did not exactly match the VITA Classical guide (VITA North America; Yorba Linda, CA), a small portion was placed along the surface of the tooth and then polymerized to visualize the composite color.[15]

For the anterior teeth, the selected shades were Filtek Z350 A1B for recreating the dentin portion due to the medium level of opacity required for the incisal area; and Filtek Z350 XWE for the final enamel layer due to its optimal level of translucency, which resembles that of a natural tooth. For the posterior teeth, Ceramage universal shade A2 was chosen **(Fig 15)**.

Manufacturing Guides

Initially, a palatal guide from second premolar to second premolar (#4 to #13) was made with condensation silicone, where the palatal layer would be incremented with its new length.

A second guide was later made to stamp the final layer of enamel, replicating the anatomy and macro texture as planned in the initial wax-up. A translucent custom tray was previously fabricated and used to make an impression of the waxed model with clear polyvinyl siloxane (PVS) (Elite Glass, Zhermack), then placed into the pressure pot to achieve an accurate copy of the buccal details and contours.[9] Then, each tooth was sectioned with a diamond disc to limit the proximal margin between each tooth.

For the tabletops, the previously established anatomy and height tested in the patient's mouth were used to make a third guide, starting from a putty of each posterior quadrant of the mouth made and once more placed into the pressure pot for accurate copy of details. Then, with a No. 11 scalpel blade (Swann-Morton; Sheffield, UK), the buccal side of the putty from the teeth to be worked on was carefully cut off just at the level of the buccal cusps, obtaining a guide that allows for stamping a zirconium silicate micro ceramic layer and later eliminating the excess through the guide's buccal window **(Figs 16-23)**.

Tabletops Fabrication

For the fabrication of the tabletops, first, an analog plaster model was obtained from a PVS impression (Virtual silicone, Ivoclar Vivadent; Amherst, NY). Later, the models were prepared along the surfaces of the teeth involved with a spacer to create space for the cement and then brushed with isolation liquid. Preferably, the model should be previously die-cut to work the proximal contact areas more efficiently; however, in this case, since these were thin restorations that did not involve a proximal contact, it was not imperative.

Figure 16: Palatal guide.

Figure 17: Translucent guide on maxillary wax-up.

Figure 18: Each tooth was sectioned with a diamond disc.

Figure 19: Try-in and margin delimitation of the individual translucent guide on the wax-up.

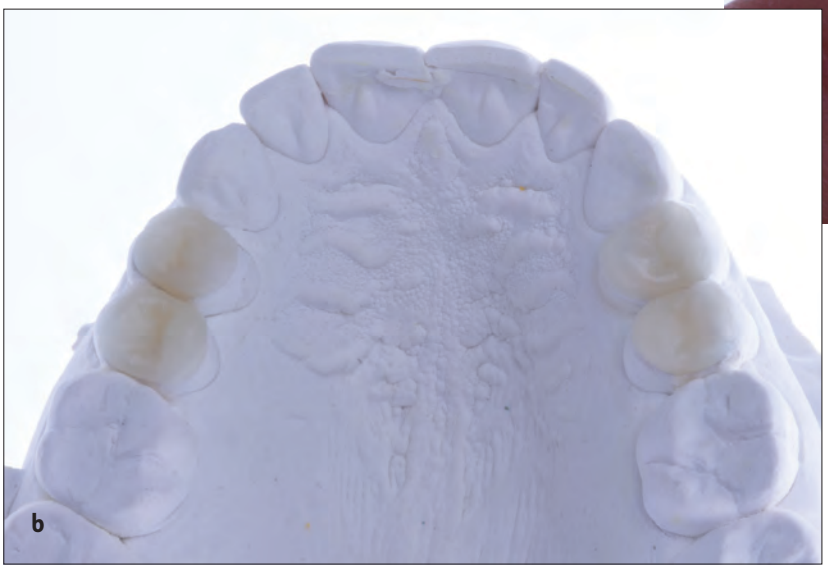
Figure 20: Palatal view of the individual translucent guide on the wax-up.

Figure 21: Fabrication of the occlusal tabletop stamping guide.

Figure 22: Internal view of the occlusal tabletop stamping guide.

Figure 23: Stamping guide for tabletops on working model.

Figure 24: Tabletop restoration with the stamping guide showing elimination of excess from the buccal window.



Figures 25a & 25b: Completed (a) mandibular and (b) maxillary tabletops.

Figure 26: Close-up of completed tabletop.

Figure 27: Try-in of tabletop on #19.

Figure 28: Cemented tabletops.

Figure 29: Anterior teeth in modified isolation prior to layering and stamping.

"The choice of composite is one of the most important things to consider when crafting an esthetic restoration; the optical and mechanical properties must be optimal to achieve success, depending on the area to be worked on."

Figure 30: Palatal and dentin layers in #8 and #9 prior to enamel layer stamp.

Figure 31: Stamped veneers prior to finishing and polishing.

Figure 32: Veneers after finishing and polishing.

After the model was ready, a considerable portion of zirconium silicate micro ceramic was added to the first of the teeth to be worked on, and then a very small amount of isolation liquid was applied inside of the guide with a brush and carefully positioned on the model until it reached its maximum settlement while the excess was eliminated through the buccal window. Subsequently, the guide was removed, resulting in a stamped tabletop that was later marginally adapted and placed in a curing oven (Solidilite V, Shofu) for three minutes to achieve complete polymerization.[16] This process was repeated tooth by tooth, after which a layer of oxygen inhibition gel (Oxybarrier, Shofu) was applied to the tabletops and placed again in the oven for one more minute to remove the oxygen-inhibited layer.[16] Finally, the teeth were finished and polished with an indirect composite kit (DFS Composites; Lee-on-the-Solent, UK) **(Figs 24-26)**.

Tabletops Cementation

First, the teeth to be restored were isolated with a dental dam (Sanctuary; Auckland, New Zealand) using the complete isolation technique[17] and later cleaned with a prophylaxis brush and water. The teeth were then etched with 37% phosphoric acid (Bisco; Schaumburg, IL) and rinsed, and the adhesive (All-Bond Universal, Bisco) was applied according to the manufacturer's instructions. The internal surfaces of the tabletops were also conditioned by sandblasting with 50-µm aluminum oxide at 60 psi, applying adhesive and dual-cured cement (Duo-Link, Bisco), and then seated and cemented onto the corresponding tooth. Finally, the isolation was removed and all teeth were polished to eliminate the excess cement **(Figs 27 & 28)**.

Stamping of Direct Composite Veneers

Once the patient felt comfortable with her new VDO, treatment proceeded with the direct composite veneers, starting with isolation from first premolar to first premolar (#5 to #12) with a dental dam using the modified complete isolation technique[15] and continuing with the cleaning of the teeth with a prophylaxis brush and water. Conditioning was then performed by etching with 37% phosphoric acid followed by rinsing, after which adhesive was applied along the entire surface of the tooth following the manufacturer's instructions.

Next, a thin layer of XWE composite resin was placed in the space of the central incisors on the palatal guide and positioned on the palatal side of the corresponding teeth, and light-cured for 20 seconds. Later, to make the transition between the tooth and the restoration imperceptible, A1B was used for the dentin layer, extending it from the palatal shell toward the incisal edge of the tooth, making sure not to leave any irregularities or excess; this was followed by light-curing for 20 seconds. The XWE was used for the final layer of enamel, placing a considerable portion on the buccal surface of the tooth and then molding it with a spatula until it covered the entire surface.

The translucent guide was then brushed internally with isolation liquid and placed on the tooth to stamp the buccal anatomy (i.e., the micro and macro textures that were previ-

Figure 33: Postoperative portrait.

Figures 34a & 34b: Postoperative close-up views of (a) frontal and (b) right lateral smile.

Figures 35a-35c: Postoperative retracted images. (a) Right lateral, (b) frontal, and (c) left lateral views showing improved lateral excursive movements with right canine guidance.

ously planned). The translucency of the guide allowed the authors to ensure that the entire surface of the tooth was covered by the composite. Excess composite was carefully removed, and the contact points were cleaned using a translucent matrix band (Epitex, GC America; Alsip, IL), followed by light-curing for 40 seconds. This process was repeated on the lateral incisors, canines, and premolars; the buccal cuspids of the premolars were previously sandblasted and conditioned to achieve optimal bonding of the direct veneer with the portion of the zirconium silicate micro ceramic tabletop **(Figs 29-31)**.

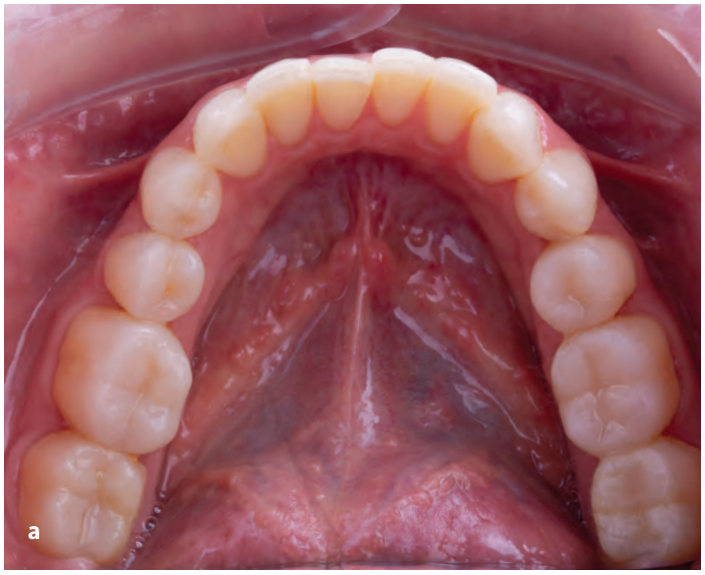
Finishing and Polishing

Once the stamping was completed, a deeper demarcation of the macro anatomy and finishing of the cervical and proximal margins was undertaken, as well as elimination of palatal excess and correction of changes that might have occurred during the stamping technique using carbide burs (Jota; Rüti, Switzerland) and medium-grit discs (Sof-Lex, 3M).

Finally, it is important to emphasize that the success and longevity of a composite veneer depends on many factors, with proper polishing being one of the most important.[18] A polishing system for composite resin (Jiffy, Ultradent; South Jordan, UT) was used following the manufacturer's recommendations **(Figs 32-36b)**.

Digitally Fabricated Night Splint

Because the patient had a bruxism habit and modifications were made to the occlusion, she was advised to use a protective splint overnight after the treatment was completed.[19] It is very easy to make a splint using an intraoral scanner and a virtual articulator, which allow for ideal occlusal stability with greater precision.[20] Exocad software was used to fabricate the splint, which was based on the principle of a Michigan splint to allow inclusion of the canine guide.[20] Finally, the splint was 3D-printed and tried directly in the patient's mouth **(Figs 37 & 38)**.



Figures 36a & 36b: Final result, occlusal view (a) mandibular and (b) maxillary.

Figure 37: Intraoral scan of final result.

Figure 38: 3D design of Michigan occlusal splint prior to 3D printing.

THE APPLICATION OF THESE GUIDES, BOTH DIRECTLY AND INDIRECTLY, ALLOWED FOR GREATER PREDICTABILITY AND PRECISION, AS WELL AS A CONSIDERABLE REDUCTION OF MISTAKES IN THE ANATOMY AND DENTAL SYMMETRY.

Discussion

The stamping technique for direct and indirect composites enabled the desired results, replicating the wax-up as planned. However, the technique did not allow for the clinical time to be reduced as the authors would have wished, as, during the execution, it was not easy to select the correct isolation liquid for the guide to facilitate the removal once stamped.

On the other hand, the application of these guides, both directly and indirectly, allowed for greater predictability and precision, as well as a considerable reduction of mistakes in the anatomy and dental symmetry. This helped to avoid the need for later corrections and achieved an exact replication of the initial wax-up in the mouth in a practical and easy way. However, it is important to consider using a low-viscosity composite to prevent deformation of the stamp during the procedure.

Summary

The stamping technique for direct and indirect composites can achieve good results for both composite resin techniques. Moreover, the digital correlation between the intraoral scan and the facial scan can significantly reduce the incidence of discrepancies and mistakes that can occur when using an analog facebow and articulator, whether the veneer material is composite or ceramic. Finally, the correct composite selection, shade selection, and calibration of each composite layer are all essential to achieve satisfactory, natural-looking results with the final restorations.

Both the patient and the clinicians were very satisfied with the esthetic results achieved in this case. The patient can now smile with complete confidence and is very comfortable with her new bite **(Figs 39 & 40)**.

Figure 39: Close-up right lateral view of marginal adaptation and texture of stamped veneers in composite resin.

Figure 40:
The happy patient.

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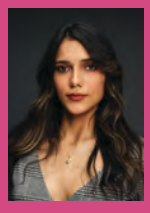

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jCD Self-Instruction

(CE) Exercise No. jCD53 AGD Subject Code: 780 Esthetics/Cosmetic Dentistry

This Continuing Education (CE) self-instruction examination is based on the article *Digitally Guided Direct and Indirect Composite Layering Technique: A Case Report* by Ana Alvarado, DDS, and María E. Pérez, DDS. This article appears on pages 74-97.

The exam is free of charge and available to AACD members only. AACD members must log onto www.aacd.com/jcdce to take the exam. Note that only Questions 1 through 4 appear in the printed and digital versions of the *jCD;* they are for readers' information only. This exercise was developed by members of the AACD's Written Examination Committee and *jCD's* Contributing Editors.

1. What type of guide is used to develop the incisal length?

a. full matrix silicone
b. occlusal silicone
c. palatal silicone
d. cross-cut silicone

2. Facial scanners use which type of principle?

a. stereoscopic vision
b. LED scanning
c. lithographic scanning
d. arch-based vision

3. Which method is used to orient the oral scan with the facial scan?

a. overlay treatment
b. point-to-point reference
c. digital importing
d. Exocad influx

4. Why would a dentist avoid the use of ceramic materials?

a. They require a heavy reduction of tooth structure.
b. The color is unstable over the long term.
c. There is a greater vulnerability to fracture.
d. They require the assistance of a dental technician.

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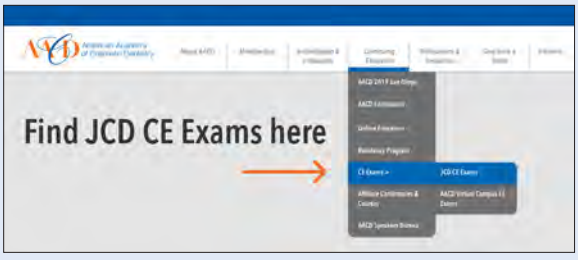

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