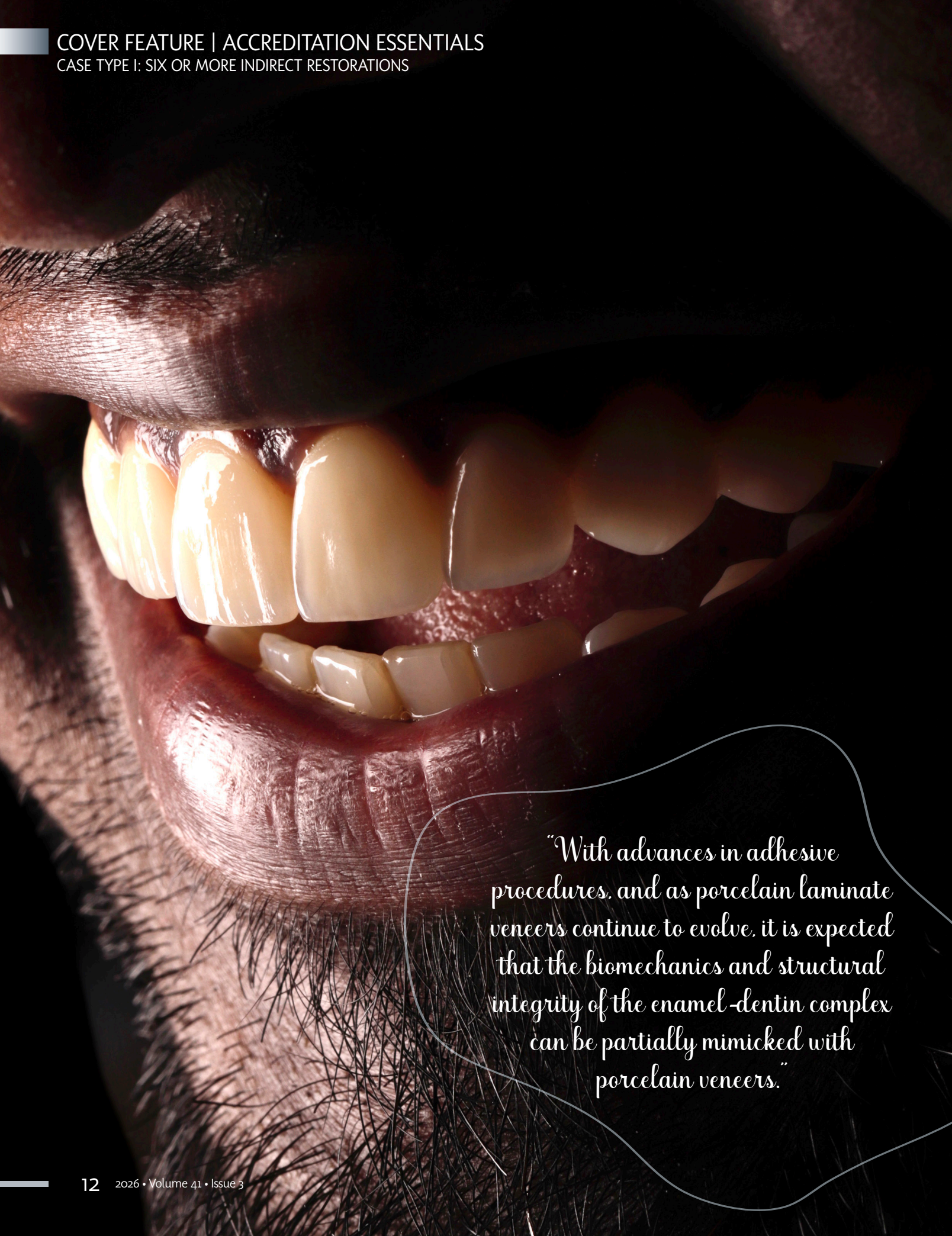


A close-up, high-contrast photograph of a person's mouth, focusing on the upper teeth. The teeth are covered with porcelain veneers, which appear smooth and glossy. The lighting is dramatic, with strong highlights on the teeth and deep shadows in the surrounding areas, including the lips and gums. The person's lips are slightly parted, revealing the teeth. The overall tone is professional and clinical, emphasizing the aesthetic results of the dental procedure.

"With advances in adhesive procedures, and as porcelain laminate veneers continue to evolve, it is expected that the biomechanics and structural integrity of the enamel-dentin complex can be partially mimicked with porcelain veneers."

CRAFTING SMILES WITH CERAMIC LAMINATES UTILIZING BIOESTHETIC PRINCIPLES OF SMILE DESIGN

Neeta Doss Mariadoss, MDS, AAACD

Abstract

Because smile design involves crafting a smile that enhances the patient's facial features and reflects their personality, the design begins with a facial analysis, then focuses on the smile and the teeth themselves.¹ Proper preparation design and adhesive technique, accuracy of the restoration, choice of the right material, and isolation of the adhesive field are essential for veneer predictability and a reliable outcome.

Key Words: smile design, minimally invasive approach, veneers, enamel-dentin complex, Case Type I

Introduction

The art and science of dentistry, coupled with advances in ceramic technology, enable dental professionals to create lifelike restorations that are virtually imperceptible and long-lasting. A minimally invasive approach was employed in this case to provide a more esthetic and biologically compatible restoration. With advances in adhesive procedures, and as porcelain laminate veneers continue to evolve, it is expected that the biomechanics and structural integrity of the enamel-dentin complex can be partially mimicked with porcelain veneers.²



Figure 1: Preoperative full-face view (1:10).



Figures 2a & 2b: Preoperative smile views (1:2). (a) Frontal and (b) right lateral.

Case Presentation

Patient Complaint and History

A 30-year-old male patient presented seeking a smile makeover (Fig 1). His maxillary left central incisor (#9) had been fractured several years earlier and had been restored. One week before his initial appointment at the author's clinic, the restoration had fractured, causing sensitivity and gingival inflammation. The patient wanted a more permanent and natural-looking restoration. He was in good health, had no significant medical history, and had seen a dentist regularly since childhood.

Evaluation, Diagnosis, and Treatment Plan

Clinical examination revealed a fractured and discolored restoration at tooth #9. There were also minor fractures on the incisal aspects of teeth #7 and #10, contributing to a lack of symmetry in the smile and tooth proportions. The buccal corridors were

deficient, and the patient's smile line did not follow the curvature of his lower lip (Figs 2a-3). Inflammation of the soft tissue was observed in the maxillary teeth (Figs 4a-4c). Findings from radiographic and oral examinations were within normal limits. The radiographic assessment of #9 revealed a fracture line that did not involve the pulp. Pulp vitality testing showed a normal response.

The treatment goal was to enhance the patient's smile by addressing gingival inflammation and achieving harmonious tooth proportions. Once the gingiva stabilized and appeared healthy, the plan was to transform his smile with ceramic laminates on teeth ##4-13. After determining the strategy for the maxillary arch, the mandibular arch was evaluated; the anterior teeth showed no visible signs of wear. Additionally, there were no indications of functional or parafunctional bite problems.

Treatment

Oral prophylaxis: Because gingiva serves as the framework for the teeth and significantly influences a case's overall esthetic outcome, gingival health is critical. As the patient had gingival inflammation with inharmonious tissue, oral prophylaxis was performed to ensure the tissues were in optimal health and shape before commencing treatment, and the patient was advised on home care.

Record-taking and mockup: Once the tissues had settled and healed, intraoral scans and a complete set of AACD Accreditation photographs³ were taken before the teeth became dehydrated, to determine the appropriate shade for the final restoration. In addition to the required AACD views, a full-face photograph with lips retracted, "12 o'clock" images, and a dynamic video necessary for smile design were sent to the laboratory.

Digital smile design and parameters: The treatment's primary goal was to provide restorations that looked natural, with the patient's smile line following the lower lip border.⁴ The outcome was planned and discussed with the patient, and digital smile design was performed (DentalCAD 3.2 Elefsina, exocad America; Wakefield, MA). Examining the patient's facial features and relating them to the smile and teeth is essential for smile design. Therefore, an esthetic evaluation comprising facial, smile, and detogingival analyses was initially done with photographs (Fig 5).

The incisal edge's position determined its actual shape and was the best place to start the design. The next parameter was the midline symmetry, which established where the centrals should be located. The gingival margin became the third parameter: The gingival zeniths of the canines and centrals were plotted on the same plane and those of the laterals were kept 1 mm shorter.¹ Since the patient had a broader smile that prominently displayed the bicuspid, the design was planned so that these teeth would fill the buccal corridors. All the parameters were conveyed to the lab, keeping in mind the bioesthetic principles of smile design. Soft tissue features (gingiva, lips, facial lines) and their relationship to other components were evaluated by grouping and superimposing them on the facial photograph.⁵

A 3D-printed model of the design was made, and the mockup was transferred to the patient and analyzed for the new incisal edge position, facial contours, smile line, midline symmetry, and the reach of the smile in the corners. The digital smile design also helped determine the appropriate material, tooth preparation, and provisionalization designs. After a detailed discussion with the laboratory technician, lithium disilicate (IPS e.max Press MT, Ivoclar; Amherst, NY) was decided upon as the material of choice. Once the patient approved the temporaries, a new set of scans and AACD photos was taken and sent to the lab, and the minor changes needed were communicated in detail. Pre-visualization of the final result was used as a motivational tool, not only to initiate treatment but also to keep the patient involved throughout the process.



Figure 3: Preoperative retracted view (1:2).

“IT WAS EXTREMELY IMPORTANT TO MAINTAIN THE PREPARATION WITHIN ENAMEL, BECAUSE BETTER ADHESION BETWEEN THE VENEER AND THE PREPARED TOOTH WOULD ALLOW FOR MORE EFFECTIVE STRESS DISTRIBUTION IN THE ENAMEL-COMPOSITE-CERAMIC SYSTEM.”



Figures 4a-4c: Retracted views (1:1). (a) Frontal, (b) right lateral, and (c) left lateral, showing gingival inflammation.

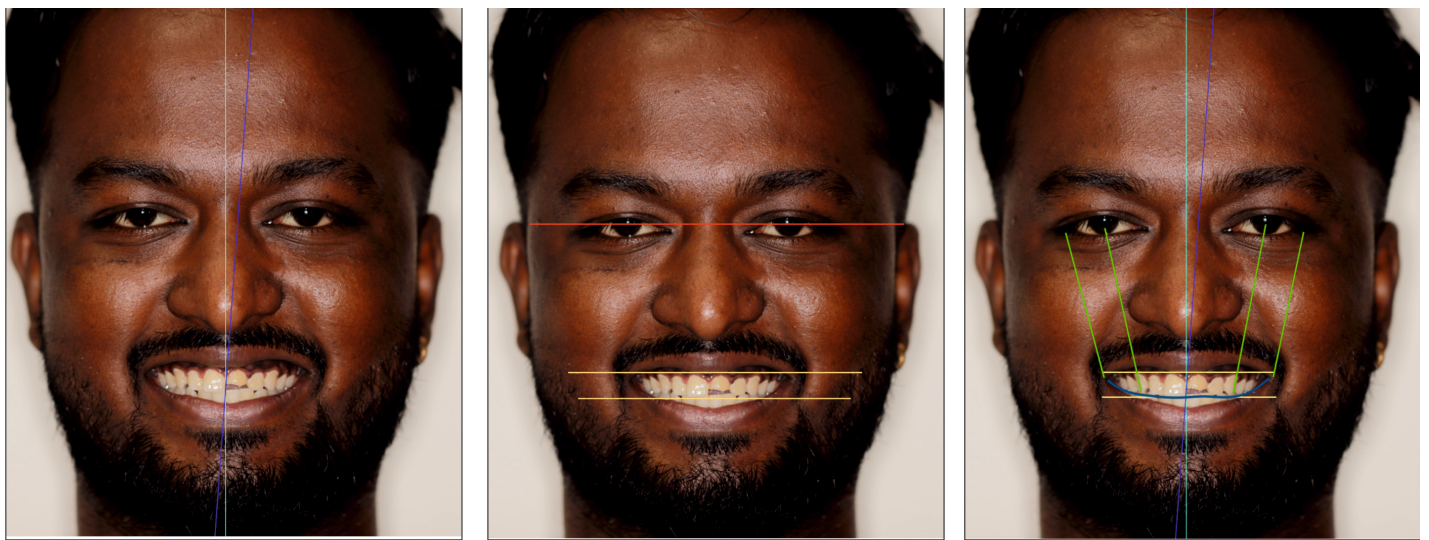


Figure 5: Esthetic analysis images with lines assessing parallelism and synergy in the various components of the face as they relate to the smile.



Figures 6a & 6b: Gingivectomy to align pink and white esthetics. (a) Floss stretched over the gingiva to evaluate the tissue height balance. (b) Minimally invasive laser gingivectomy from #4 to #13.

Gingivectomy: A week after the smile design was performed, bone sounding and radiographic evaluations were done. The smile design had helped to determine appropriate tooth lengths. Minimally invasive laser gingivectomy was performed to enhance the shape and symmetry of the gingiva while respecting the biological widths of teeth ##4-13 (Figs 6a & 6b). The osseous level was deemed appropriate. The improvement in gingival health enhanced the patient's appearance and self-confidence.⁶ After the gingiva stabilized, a new set of photographs and digital scans was obtained with an intraoral scanner (Trios 3, 3Shape; Copenhagen, Denmark) to refine the design with smile design software (DentalCAD 3.2 Elefsina) (Fig 7). Spending more time on the diagnosis and treatment-planning phases improved treatment predictability and efficacy.⁷

Preparation: The teeth were anesthetized (4% Articaine with 1:100k epinephrine, Septodont; New Castle, DE) and prepared with diamond burs (imP.R.E.S Blueprint Bur Block, Brasseler USA; Savannah, GA). The ultimate goals regarding the position, color, and shape of the restorations served as the primary guide for the extent of tooth reduction. As patients with small or lingually positioned teeth are ideal candidates for techniques involving minimal or no preparation, a minimally invasive approach was employed to provide a more esthetic and biologically compatible restoration.⁸

After removing the existing restored #9, adequate palatal tooth structure was evident, and a composite build-up was done. Preparation was done through the mockup. Depth orientation grooves were made with a pencil on the mockup using the Aesthetic Pre-Evaluative Temporary (APT) technique with a depth-cutter bur (WDLCONV, Brasseler USA) (Figs 8a & 8b). This approach took the final volume of the restoration into account, serving as a guide for preparation through the final result.⁹ The mockup was removed, and the pencil marks were evaluated. They clearly indicated the areas that needed additional tooth reduction. Labial preparations were done with a diamond bur (KS1 012, Brasseler). The contacts were broken only in the mesial and distal of #9, making sure to preserve the tooth's cingulum. Once the preparation was studied from all angles, the mockup was placed and checked again until an adequate reduction was achieved. A labial and incisal reduction guide made from the mockup model also helped in evaluating the reduction. Margins were kept equigingival to allow the restoration to visually blend with the gingiva. All preparations were accomplished with an electric handpiece (NSK America; Hoffman Estates, IL).

The preliminary set of intraoral scans and photographs was sent to the lab to confirm that the tooth reductions were sufficient to achieve the desired functional and esthetic results. Once the ceramist approved the records, the preparations' sharp edges were smoothed with a white stone bur (645 420, Brasseler). Size



Figure 7: Full-face image showing the 3D smile design.



Figures 8a & 8b: APT technique. (a) Depth orientation grooves were made over the mockup with a pencil. (b) The pencil marks gave a clear indication of the areas that needed additional reduction.



Figure 9: Scanned image of the prepared tooth with retraction cord in place.



Figures 10a & 10b: Views (1:2) of the patient with temporary bis-acryl provisionals. (a) Smile and (b) retracted.

1 retraction cord (Ultrapak, Ultradent; South Jordan, UT) was placed in the sulcus. The margins were refined with a fine-grit diamond bur (KS0F 010, Brasseler) without water under high magnification, creating a chamfer finish line. After complete isolation, intraoral scans were performed (Trios 3), making sure the margins were retracted and clearly visible (**Fig 9**). It was extremely important to maintain the preparation within enamel, because better adhesion between the veneer and the prepared tooth would allow for more effective stress distribution in the enamel-composite-ceramic system.¹⁰ A new set of photographs of the prepared teeth was then taken in several views.

Laboratory communication: Advances in digital technology have made lab communication much easier and more effective.¹¹ Communication included the following:

- preoperative digital photos and videos, including monochromatic images
- cross-polarized images
- preoperative photos with shade guides
- photos of the prepared teeth with shade guides
- intraoral scans of the prepared tooth and of the provisional restoration.
- photos with a facebow in place
- esthetic analysis photos.

A periodontal probe (Hu-Friedy; Chicago, IL) was used to assess bone height. This information was also communicated to the laboratory to accurately position the contact point in relation to the gingival margin, thereby preventing the formation of a black triangle in the gingival embrasure while achieving a 50% contact ratio between the central incisors.¹²

Provisionals: Once all records were taken, the patient's teeth were temporized. Each prepared tooth was spot-etched (Total Etch, Ivoclar), and a bonding agent (Clearfil SE Bond 2, Kuraray Noritake Dental; New York, NY) was applied with a disposable brush and light-cured (Bluephase G4, Ivoclar) for 20 seconds. The matrix was filled with bis-acryl provisional composite (Inspire shade B1, Clinician's Choice; Lompoc, CA) and placed over the prepared teeth for three minutes (**Figs 10a & 10b**). Excess material was removed with wet gauze, and a small carbide bur (ET 3 008, imP.R.E.S Blueprint) was used to remove the excess material interproximally to allow adequate room for the gingiva to heal. The provisionals were smoothed with a medium-coarse disc (3M Oral Care; St. Paul, MN), and any occlusal discrepancies were corrected. Final polishing was performed with alumi-

num oxide polishing paste (Enamelize, Cosmedent; Chicago, IL) applied with a flexible felt disc (FlexiBuff, Cosmedent). Intraoral scans of the provisional restorations and photographs were taken for lab communication.

The provisionals significantly improved the patient's smile. As we had increased tooth lengths, he was instructed to observe any changes in his pronunciation of words and was scheduled to return a week later to make any modifications if required.

Adjustments and lab processing: The patient was comfortable with his speech and function and said that his provisional smile made him feel more confident. However, a few modifications to the lengths and widths of #8 and #9 were made to enhance his smile line. Once the lab had made the final prescribed corrections, separate files of the designed veneer were milled in poly(methyl methacrylate) (PMMA) (Sagemax; Federal Way, WA) to verify the design. The PMMA temporaries were tried in individually to check each veneer's marginal fit, shape, contacts, and esthetics before fabrication of the final restorations (**Figs 11a-11c**). To maintain the precision of the digital workflow, the design was converted to an STL file format, and the pattern was milled in burnout wax (ProArt CAD Wax yellow, Ivoclar). The milled patterns were then invested and pressed (IPS e.max Press). Lastly, they underwent a cutback process and were prepared for layering (IPS e.max Ceram).

Try-in: The patient returned two weeks later for the veneer try-in. A regular-sized retractor (Optragate, Ivoclar) was placed for isolation. The provisionals were then carefully sectioned with a bur and removed. After the ceramics had been evaluated and verified for fit and position on the master model, the individual restorations were placed intraorally to confirm marginal fit (**Fig 12**). They were then tried in two at a time to check for proximal fit and interproximal contacts.

After the marginal adaptation and fit of each restoration was confirmed to be satisfactory, all restorations were placed onto the respective preparations with a neutral try-in paste (Variolink Esthetic, Ivoclar) to carefully assess shade from every aspect. Photographs were taken to evaluate the smile's alignment and for lab communication. The occlusion was analyzed to ensure there were no discrepancies. The pressed lithium disilicate veneers fabricated from milled wax patterns exhibited a superior fit and marginal accuracy. The entire dental team examined them under both office and natural lighting and determined that the restorations met the case's esthetic criteria. The patient was happy with the veneers' fit, shade, and the smile's esthetics.



Figures 11a-11c: (a) Final approved design. (b & c) PMMA provisionals made to check the marginal fit, shape, and contacts before fabrication of the final veneers.



Figure 12:
Fabricated veneers
on the model.

“THE PMMA TEMPORARIES
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Figures 13a-13c: Relative isolation and cementation of veneers.



Figure 14: Postoperative full-face view (1:10).



Figures 15a & 15b: Smile views (1:2) showing a more balanced and harmonious smile. (a) Frontal and (b) right lateral.

Etching and cementation: The teeth were isolated using the split dam technique (Figs 13a-13c). Since the material was lithium disilicate ceramic, the internal surfaces of each restoration were etched with hydrofluoric acid (IPS Ceramic Etching Gel) for 20 seconds, according to the manufacturer's instructions. The etchant was then rinsed. To remove residual etchant, the veneers were submerged in an ultrasonic bath (Dentmark; Mumbai, India) for 60 seconds. Following visual inspection of the etching pattern, the veneers were silanated (Monobond Plus, Ivoclar). The teeth were then etched with 37% phosphoric acid (Total Etch, Ivoclar) for 15 seconds, thoroughly rinsed, and the excess water was gently air-dried. Two layers of bonding agent (Tetric N-Bond, Ivoclar) were applied on the teeth, and the excess was gently air-dried and light-cured. The neutral resin cement (Variolink Esthetic) was placed on each veneer, and the veneers were cemented in pairs. They were seated in the following order: #8 and #9, #7 and #10, #6 and #11, #5 and #12, #4 and #13, using inward and upward pressure. The restorations were then tack-

cured to help remove the excess cement. Interproximal excess was cleaned with an interproximal serrated saw (Edenta AG; St. Gallen, Switzerland). Floss (Super Floss, Oral-B; Cincinnati, OH) was used to ensure no excess cement remained.

Finishing and delivery: Glycerin gel (Oxyguard, Ivoclar) was placed along all the margins, and final curing was performed to ensure complete polymerization. Radiographs were taken to check for any excess cement. The margins were finished with an extra-fine diamond finishing bur (Brasseler). The patient's occlusion was checked and found to be ideal, and the restorations needed no adjustment. The laboratory technician's skill and appreciation of esthetic principles and their importance in the visual perception of tooth form, size, and width enabled natural anatomical details to be reproduced (Figs 14-16). When the patient was evaluated one week later, the restorations looked very natural, and the gingiva was in excellent health (Figs 17a-18). The patient and the entire dental team were extremely happy with the result.



Figures 16a & 16b: Postoperative retracted views (1:2) showing the completely blended restoration.



Figures 17a-17c: 1:1 Postoperative retracted views (1:1).



Figure 18:
The "12 o'clock" view shows vestibular projection of the incisal margins in relation to the position of the lower lip.

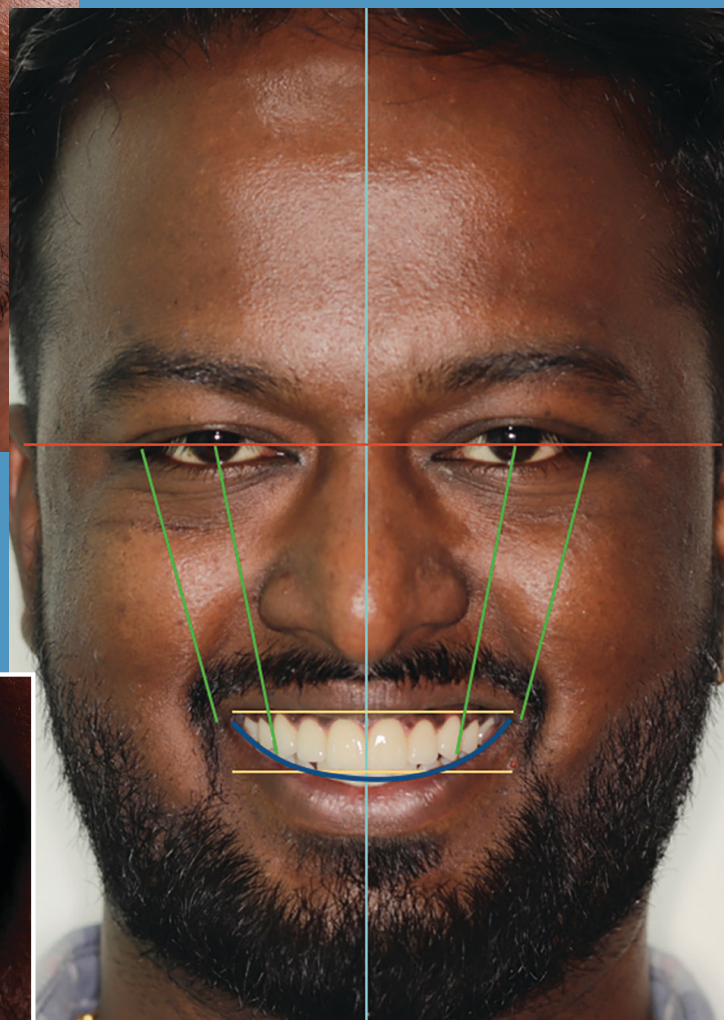


Figure 19:
Postoperative facial analysis showing symmetry and balance of the smile in relation to the face.

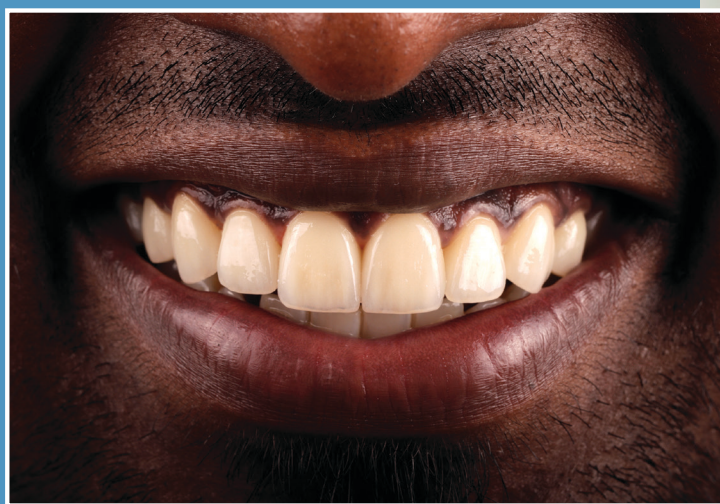


Figure 20:
Smile line that follows the curvature of the lower lip.

Summary

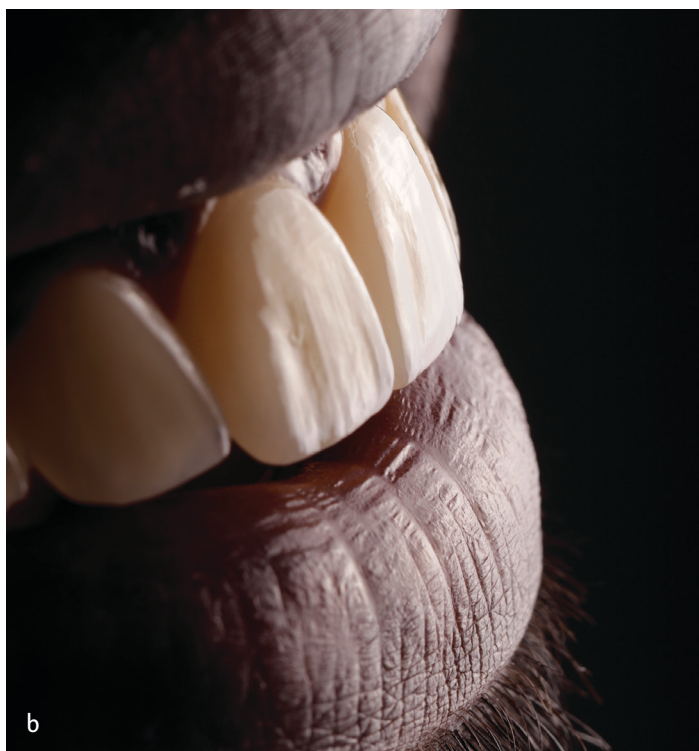
The patient was elated with the esthetics and function of his new smile. Although ceramic laminates have been used for years, the overall behavior of the restoration is most predictable when the case has been thoroughly treatment-planned. When the dentist and technician have a shared vision of esthetic excellence along with knowledge of the materials and exceptional clinical skills, beautiful, long-lasting restorations can be crafted (Figs 19-23).¹³

Acknowledgment

The author thanks ceramist Thanh Cao (HT Dental Art; Ho Chi Minh City, Vietnam) for her committed support and collaboration with this Accreditation case. The author also extends gratitude to Dr. Adamo Notarantonio and Dr. Amanda Seay for their imP.R.E.S. course, which assisted her with this case.



Figure 21: The smile captured under studio lighting shows the seamless integration of the teeth with the gingiva.



Figures 22a & 22b: Images under studio light displaying the texture in detail.



*Figure 23:
The patient's
captivating
new smile.*

“WHEN THE DENTIST AND TECHNICIAN HAVE A SHARED VISION OF ESTHETIC EXCELLENCE ALONG WITH KNOWLEDGE OF THE MATERIALS AND EXCEPTIONAL CLINICAL SKILLS, BEAUTIFUL, LONG-LASTING RESTORATIONS CAN BE CRAFTED.”

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Dr. Mariadoss has a practice focused on cosmetic dentistry, biomimetic restorations, and microscopic endodontics at Vignesh Dental Hospital in Chennai, Tamil Nadu, India.

Disclosure: The author declares no conflicts of interest.