Exploring Minimally Invasive Options

Managing Demands, Expectations, and Outcomes

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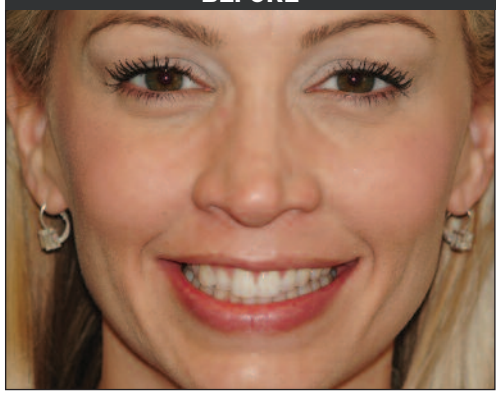
INRODUCTION

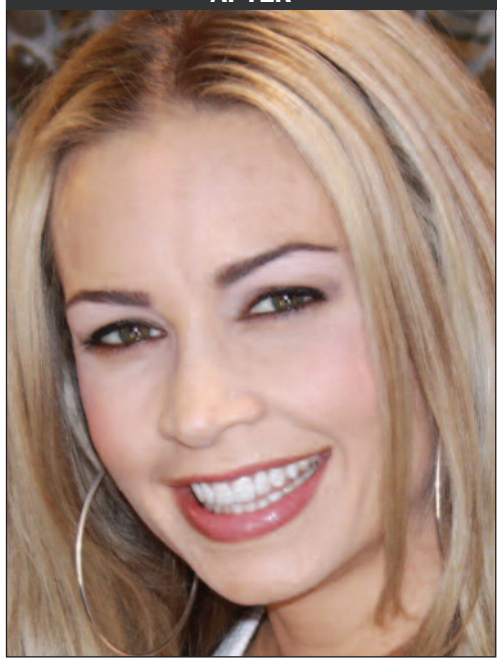
Directly related to increased focus on "the smile makeover" in the media, patients no longer visit their dentist simply for preventative cleanings or required treatments. Whether they require treatment or not, patients are now demanding the ideal "Hollywood smile" through elective cosmetic treatments. Following the concept that "the best dentistry can sometimes be no (or less) dentistry," dentists must carefully manage patient expectations and demands to prevent doing harm.

In the dental industry, a smile with no existing restorations, caries, or discoloration is considered a healthy smile. However, dentists often encounter patients whose cosmetic goals are not considered essential for their oral health. In these cases, dentists often look for the most difficult or most dramatic solution to the patient's problem when considering treatment options. Although dramatic treatment is required in some cases, many patients simply want to improve the appearance of their smile. Consequently, orthodontics or other conservative approaches should be the first recommendation when no pathology is present.

Although important to patients, there are many factors involved when restoring teeth. Alignment, shape and contour, surface morphology, opposing functional surfaces and incisal edge positions all need be taken into consideration prior to any aesthetic work.[1] However, when concerned with only aesthetics, minimally invasive (MI) procedures may be accomplished through the utilization of an additive dentistry model.[2] Requiring excessive removal of sound tooth structure in many instances, the subtractive model was highly invasive and often resulted in over-preparation of the dentition.[2] Less invasive, the additive model used by many dentists today focuses on the preservation of sound tooth structure to improve the patient's oral health and provide long-term results.[2] For example, rather than preparing all anterior teeth and placing conventional veneers to improve crowding, orthodontic treatment to move or shift the position of the teeth is now considered the treatment of choice. Demonstrating the shift in treatment philosophies, modern dentists now improve smiles without pathology through MI dentistry.



Before Image. A preoperative photograph of the patient's maxillary anterior dentition, showing room for aesthetic improvements.



After Image. Postoperative portrait of the patient with her new lithium dilsilicate (e.max Press [Ivoclar Vivadent]) veneers.

Abilities to Provide Minimally Invasive Techniques Has Advanced

Aiding dentists in these types of treatment, a variety of viable and advanced materials now provide an even greater ability to fabricate aesthetic restorations, while still following the concept of nonmaleficence. Although conventionally an invasive procedure, placing veneers has become a MI treatment option that requires no to minimal preparation of tooth structure. Vastly improved from traditional porcelain materials, dentists now have the ability to provide strong and aesthetic all-ceramic veneers, without damaging or removing excessive amounts of tooth structure.

Although new materials and techniques have simplified MI aesthetic treatments, the dentist must still educate the patient on the potential risks associated with even the most MI treatments. The patient must be presented the available options, assisted in the decision process, and educated on the outcome of the decisions by the dentist, who is both a provider and advisor to the patient. After a decision has been made, the dentist should always attempt to provide the most MI and sound dentistry possible in any given situation.

The following case report demonstrates an example of a patient who had initially presented to the office seeking arguably invasive and excessive treatment with conventional veneers for her otherwise healthy anterior maxillary dentition, in order to obtain a more aesthetic and proportional smile.

CASE REPORT

Diagnosis and Treatment Planning

In 2007, a 35-year-old female patient presented to our office with cosmetic concerns about her anterior maxillary dentition (Before Image, Figures 1 and 2). Specifically, she wanted her teeth to be whiter, longer, completely symmetrical, and in perfect alignment. Basing her treatment demands on the fact that "all of my friends have veneers," the patient was demanding inva-

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sive veneers on teeth Nos. 5 to 12. Although a possible and viable treatment option, it was noted that the patient did not present with tooth decay, periodontal issues, or occlusal pathology. As a clinician, I was uncomfortable with the idea of providing veneers for only cosmetic reasons, so repositioning the teeth with removable aligner tray therapy (Invisalign [Align Technology]) and whitening to correct discolorations was the suggested course of treatment. Displeased and unenthused with the MI treatment plan, the patient declined treatment. However, she did remain a patient in our practice and continued her schedule of regular hygiene appointments for more than 4 years.

In 2011, we revisited the patient's concerns regarding the aesthetics of her smile. Allowing for a more conservative treatment plan and MI preparation, some new and reliable restorative materials had since become available. Therefore, it was decided that the patient would be able to safely and predictably undergo a cosmetic restoration of the maxillary anterior teeth.

During patient consultation, digital photographs were taken and evaluated to determine the best treatment plan. During this appointment, the patient's goals for her smile were also discussed. From these discussions and observations, a treatment plan was decided upon, which included whitening of the lower arch, laser recontouring of the gingiva as needed, and restorations on teeth Nos. 5 to 12, and tooth No. 22, utilizing thin lithium disilicate veneers.

Selected as the material of choice for this case, pressable lithium disilicate ceramic (IPS e.max Press [Ivoclar Vivadent]) provides the fit, form, and function of traditional pressable ceramics, but with greater strength.[3-6] In addition, this lithium disilicate material exhibits the optical properties necessary to create aesthetic and naturally appearing restorations.[3-6]

Prior to any restorative work, the patient's oral heath was evaluated for dysfunction or pathology. Initially, a joint vibration analysis (BioResearch Associates) was completed to assess the health and function of the temporomandibular joints. A full range of digital radiographs (Schick Technologies) and digital photographs (S2 Pro [Fuji]) were then taken, along with an earless face-bow (Kois Dento-Facial Analyzer [Panadent]) (Figure 3).

Figure 1. The preoperative smile photograph demonstrated the need for longer, whiter, and straighter teeth.

Figure 2. The retracted photograph of the patient's smile demonstrated the need for whitening and gingival recontouring of the mandibular anterior dentition.

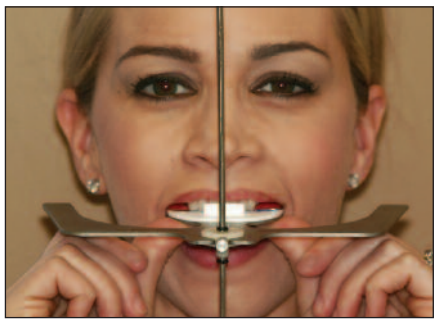

Figure 3. To ensure the laboratory technician had all diagnostic information needed, a Kois earless face-bow (Panadent) record was taken.

Figure 4. A preoperative model was created to aid the dentist in the fabrication and placement of provisional restorations.

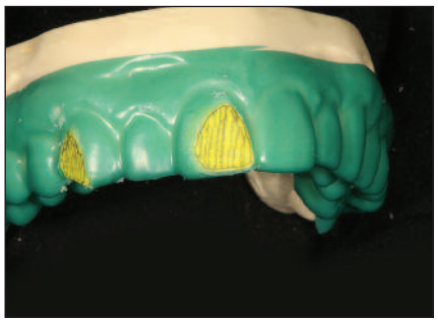

Figure 5. Prior to depth cutting, the areas that remained out of the arch form were trimmed.

Figure 6. An additive/reductive model was created to accurately plan the preparation of the dentition.

Figure 7. After placing the provisional restorations, an oral hygiene technique was demonstrated to the patient to maintain the health of the soft tissues.

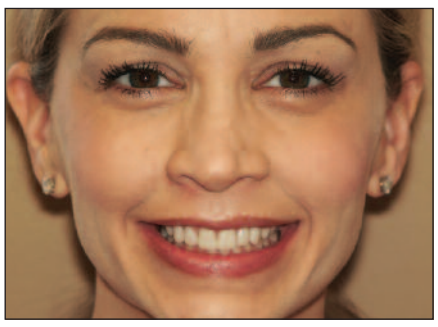

Figure 8. A full-facial photograph of the provisional restorations intraorally.

Figure 9. Corrections were made to the provisional model and a new model was made using a matrix and wax-injector. Wax was then injected on the lubricated dies to create a duplicate model of the modified provisional.

Figure 10. The finalized wax-up was placed on the model to ensure fit and function.

Figure 11. After pressing, the restorations were placed on the model to be cut back and layered.

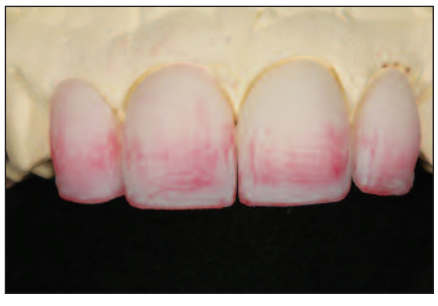

Figure 12. A 0.5-mm facial-incisal bevel reduction was completed, along with an undercut to create a natural halo effect.

After confirming that no underlying conditions were present, diagnostic impressions were made using a vinyl polysiloxane (VPS) impression material (Position Penta Quick [3M ESPE]; Directed Flow Impression Trays [3M ESPE]) to aid in the fabrication of the provisional and definitive restorations. While evaluating the patient's occlusion, it became apparent that a veneer restoration was needed on tooth No. 22 to establish ideal canine guidance. A full periodontal charting was then completed, followed by an oral cancer screening and a close evaluation of all teeth for signs of decay.

Once it was determined that the patient was in good oral health, preparation for MI veneers began.

Clinical Protocol

The patient was anesthetized with 3 carpules of 4% articaine hydrochloride solution with 1:100,000 epinephrine (Septocaine [Septodont]) using a computerized anesthetic injection system (The Wand [CompuDent Inc]). The lips and cheek were then retracted (OptraGate [Ivoclar Vivadent]) to help make our work more efficient and to maximize patient comfort throughout the duration of the procedure. While allowing the anesthetic

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to take effect, a pre-reduction was performed using a diamond bur (KS6SC 025 [Komet USA]) on any areas that were aligned out of the desired arch form. Utilizing the initial diagnostic wax-up and a soft-tissue diode laser (Odyssey Navigator [Ivoclar Vivadent]), areas that indicated the need for recontouring of the gingiva were corrected to provide ideal gingival symmetry, being careful to observe the biologic width.[7]

After both tooth and gingival prerecontouring, a silicone putty matrix (Sil-Tech [Ivoclar Vivadent]) was made from the laboratory wax-up, filled with a bis-acrylic provisional material (Protemp Plus [3M ESPE]), and seated on the unprepared teeth. The silicone putty matrix was allowed to stay in the mouth for 3 minutes until the bis-acryl material was set. Then, the matrix was removed, leaving a mock-up in place intraorally; this would be used as a blueprint for the final proposed restorations and as an ideal guide for the preparations.

Tooth preparation then began with a diamond depth cut bur (828-026 [KOMET USA]), which included facial depth cuts of 0.5 mm in 3 planes and incisal depth cuts of 1.0 mm. To ensure perfect accuracy, and in order to conserve as much tooth as possible during preparation, the bis-acryl provisional shell was prepared into as though it were tooth structure. This meant that some areas were prepared within the provisional material, while others were completed in tooth structure. Each tooth was prepared sequentially with the LD0526 kit (KOMET USA) containing the KS series (KS0 010, KS1SC 012, KS3SC 016, KS6SC 025, and KS5SC 031) burs; for minimal or no preparation and to prevent sharp angles or J-shaped margins.

After the initial preparations were completed, the interproximal areas were smoothed with a flame-shaped diamond bur (FSD6EF [KOMET USA]). The facial and palatal surfaces were then smoothed with the 8856 021 (KOMET USA) very fine diamond bur, which mimics the KS burs in general shape, but possesses a slightly more tapered contour to eliminate undercuts. Facial reduction was eventually completed at a depth of approximately 0.8 mm from the outer surface of the bisacryl provisional shell. Utilizing an electric handpiece (ELECTROtorque [KaVo]) at a reduced speed of 15, preparation continued to the margins. The margins were made extremely smooth because this is critical to the success of the case; the smoother the preparation the more accurate the impression and the die are, and the easier the seating procedure will go.[8] Once complete, the preparations were polished with a progression of finishing and polishing system discs (Sof-Lex [3M ESPE]). Using water spray, the incisal edges of all the preparations were also rounded.

Following the completion of the preparations, a series of photographs was taken (with and without stump shades) for communication with the laboratory team. A master impression was then taken using a heavy body VPS impression material (Imprint [3M ESPE]) in an impression tray (Directed Flow Trays), and a regular body VPS impression material (Imprint) placed directly on the teeth and margins.

Since all the teeth required veneers, the silicone putty matrix (the same one initially used for the mock-up) was used to lock them in place. The teeth were then coated with an antibacterial desensitizing solution (Telio Desensitizer [Ivoclar Vivadent]) and coated with a fourth-generation primer-only (OptiBond FL [Kerr]) and air-thinned. Lined with bisacryl provisional material (B1 Luxatemp, [DMG America]), the matrix was placed over the preparations. After allowing the provisional material to cure for 3 minutes, the matrix was gently removed and the facial and palatal surfaces were trimmed of excess provisional material with finishing carbide burs (KOMET FS6 014 and 7408 023) intraorally.

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Figure 13. To develop characterization in the restorations, internal powder effects were placed on the cutback surfaces.

Figure 14. The internal powder effects were fired.

Figure 15. Full-contour enamel powders were used to further build the restorations.

Figure 16. The full-contour enamel powders were fired.

Figure 17. A red wax-based pencil was used to mark the height of contour for the interproximal deflection zones, which were then developed with a diamond-based rubber wheel.

Figure 18. Prior to cleaning and glazing, rotary diamonds were utilized to develop the surface lobes and perikymata.

Figure 19. The cleaned and glazed restorations were placed on the master die model.

Figure 20. The restorations were tried-in to confirm fit, function, and marginal integrity.

Figure 21. The central incisors were tried-in individually to verify proper fit, then seated together.

Figure 22. Postoperative retracted view of the definitive restorations demonstrated improved aesthetics.

Figure 23. Postoperative smile of the patient's dentition showed great improvement in color, shape, and spacing.

Figure 24. Postoperative lateral view of the patient's smile demonstrated natural optical qualities that mimicked the surrounding dentition.

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The gingival embrasures were then opened to eliminate compression of the gingival tissue and the formation of black triangles on seating day. Occlusion was verified and the provisionals were polished using a series of polishing cups and points (Astropol [Ivoclar Vivadent]). Finally, a very light coating of a low-viscosity polish/sealant was placed on the facial surfaces of the temporary restorations (BisCover LV [BISCO Dental Products]).

After completion of the provisional restorations, the patient was instructed to make the clinician aware of any aesthetic or functional changes that were required prior to fabrication of the definitive restorations (Figures 4 and 5). Any required changes were then communicated to the laboratory and all corrections were made to the initial model (Figure 6). Essential to the success of provisionalization stage, proper hygiene technique was demonstrated to the patient (Figure 7).

Dental Laboratory Protocol

All diagnostic information and records, including clinical photographs and the Kois earless face-bow transfer plate, were sent to the dental laboratory team to assist in the fabrication of the wax-up and the silicone putty matrix, which were used to fabricate the both the provisional and definitive restorations (Figure 8). A matrix of the modified provisional model was then created and a jeweler's wax injector was used to create an exact duplicate on the lubricated master dies (Figures 9 and 10). Prior to sealing the margins for investing, form and function were developed in the wax-up.

After spruing and investing, the wax restorations were ready to be burnt out and pressed using a high performance press furnace (Programat EP 5000/G2 [Ivoclar Vivadent]). The restorations would be fabricated from a pressable lithium disilicate restorative material (IPS e.max Impulse [Ivoclar Vivadent]), in Value 3 ingots, with a core shade of Chromoscope Bleach 030.

After pressing, the restorations were divested, the sprues were removed, and the pressings were fitted to the master dies (Figure 11). Since the restorations were waxed and pressed to full contour, it was then necessary to systematically cut back the incisal-facial surfaces of the pressings. This would allow the ceramist to layer internal mamelons that would then be covered by enamel layers (IPS e.max Ceram [Ivoclar Vivadent]), mimicking the color and optical qualities found in the surrounding natural dentition.

To begin the cutback stage, a 0.5 mm facial reduction was completed using a cardibond ceramic diamond (DB-15M [Cardinal Rotary Instruments]) to bevel down approximately one half of the restoration. A red pencil was then utilized to mark the incisal and inter-proximal areas to be troughed-out with a centered diamond disc (9009.220HP [Cardinal Rotary Instruments]), which guaranteed the creation of a proper halo effect (Figure 12). The trough, or undercut, was then colored using high (Vanilla) and low (Gray) value stains (Universal Stains [Ivoclar Vivadent]), to impact the incisal edges. Shade BL2 bleach dentin (Universal Stains), was then applied to emulate internal dentin lobes and/or mamelons (Figure 13).

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Following application, the powders and stains were fired under full vacuum to 750°C at a climbing rate of 60° per minute, with a one minute high temperature hold (Figure 14). Opal clear (OE1) and high value (TI1) enamel powders were then carefully segmented over the internal effects to create an optical filter, which gave the internal effects a natural appearance (Figure 15). The contour of the restorations was then finalized and the restorations were bisque baked (Figure 16).

After bisque baking, a diamond bur (ZDL8842R-018-1 [Cardinal Rotary Instruments]) was used to smooth the surfaces, then to shape and contour the restorations. A red pencil was used to mark the desired heights of the contours to aid in the development of the interproximal deflective zones (Figure 17). The facial lobes and surface textures were then created using the diamond bur (ZDL8842R-018-1) (Figure 18).

A non-fluorescent glaze paste (IPS e.max Ceram Glaze Paste [Ivoclar Vivadent]) was applied to the finalized surfaces of the restorations and fired under full vacuum to 740°C at a rate of climb of 70° per minute, with a one minute high temperature hold. To lessen the brassy appearance caused by the artificial glaze, the flat surface of a knife-edged carborundum filled white rubber wheel (G322 [Cardinal Rotary Instruments]) was used carefully, to ensure the desired number of perikymata were maintained. To finish creating the desired luster, a knife-edge diamond polisher (U6125-250-1 [Cardinal Rotary Instruments]) was used to replicate the surfaces of the natural dentition (Figure 19).

Upon completion, the gingival interproximal spaces were scrutinized against the hard-tissue model to ensure that black triangles were not present (Figure 20). To prepare the restorations for delivery, the internal aspects of the finalized restorations were then carefully cleansed with an aluminum oxide microblaster and etched with 5% hydrofluoric acid etching gel (Ceramic Etching Gel [Ivoclar Vivadent]) for 20 seconds. The lithium disilicate restorations were then delivered to the clinician and patient for final seating.

Delivery Appointment

To guarantee normal lip and facial gingival areas, as well as patient comfort, when fitting the restorations only the left and right palatal areas were anesthetized with three fourths carpule of Septocaine on each side using the Wand. The provisionals were then removed and the preparations cleaned with hydrogen peroxide in a metal-dental infuser tipped syringe (Ultradent Products). To clean the preparations further, a pumice slurry (Consepsis Scrub [Ultradent Products]) and rotary brush (ICB Brushes [Ultradent Products]) were used.

The lithium disilicate veneers for the central incisors were first tried-in separately; and then together to verify fit, contacts, and the overall appearance (Figure 21). Composite based try-in gel (Variolink Veneer [Ivoclar Vivadent]), in shade +2, was used since the patient desired extremely white teeth. The patient then evaluated the restorations for shade, length, and overall aesthetics.

Once it was certain that the cosmetic aspects of the restorations were satisfactory, the veneers were ready to be seated. The restorations were then removed and the internal surfaces cleaned of the try-in gel with water, followed by 35% phosphoric acid etch (Ultra Etch [Ultradent products]), then rerinsed and dried. A prehydrolyzed silane-based primer (RelyX [3M ESPE]) was placed on all internal surfaces of the restorations for 20 seconds and air-thinned.

Immediately following, a fourth-generation adhesive (All Bond 3 [BISCO Dental Products]) was placed on all internal surfaces of the restorations and air-thinned. A fourth-generation adhesive was selected in this case to provide longevity and improved bond strength to the prepared dentin and enamel.[9] Studies have shown that fourth-generation adhesives outperform any other generation of dentin adhesive.[10] A light-cured resin cement (Variolink Veneer) in shade +2 was chosen as the luting agent of choice due in part to good long-term color stability. The cement was loaded into the restorations, and then placed in light-proof containers (Vivapad [Ivoclar Vivadent]) until the teeth were ready for the bonding.

The preparations were rinsed with water and dried, and a final check of the teeth for provisional material or any remaining try-in gel was completed. The teeth were then etched with 35% phosphoric acid (Ultra-Etch [Ultradent Products]) for 20 seconds, rinsed, and dried. To prevent dentinal hypersensitivity, a desensitizing agent (Telio [Ivoclar Vivadent]) was applied for 20 seconds on each tooth and air-thinned with a high-speed evacuation until there was no movement of liquid and the teeth appeared glossy.

An ethanol-based adhesive (All Bond 3) was then applied with a microbrush (Microbrush International) to each tooth for 20 seconds. During adhesive placement, ideal tissue health helps to ensure an optimal bond; if bleeding had occurred, the entire process would have been stopped to control bleeding to prevent microleakage and discoloration of the restorations at the marginal areas.[11,12]

The adhesive was air-thinned with high-speed evacuation until there was absolutely no movement to ensure total evaporation of the solvent for guaranteed bond strength.[13] The teeth were then light-cured with a light emitting diode (LED) curing light (Bluephase [Ivoclar Vivadent]) for 15 seconds. The resin-cement loaded veneers were then carefully and firmly placed on the teeth and held in the proper position. A 2.0 mm

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tacking tip (Ivoclar Vivadent) was then used on the central-facial position of each tooth, to "tack" the veneers into place for 2 seconds each.

After tack curing, a cat's tongue brush (Princeton Art and Brush Company) was used to remove excess cement from the labial and palatal surfaces, as well as the interproximal areas. The goal during excess cement removal was to remove as close to 100% of the extruding cement as possible, without "pulling" the cement from the margins. In the author's opinion, this technique saves time during the polishing and clean-up stages. Additionally, it has proven the most effective way for the author to visualize proper seating of the veneers prior to the final cure.

Teeth Nos. 8 and 9 were seated first to evaluate for canting, improper seating, or other general seating errors. To ensure full surface hardness, the 2 teeth were then coated with an oxygen barrier gel (Liquid Lens [Danville Materials]) and cured fully with the LED curing light (Bluephase [Ivoclar Vivadent]) for 20 seconds each on the facial and palatal surfaces. The veneers for teeth Nos. 5 to 7 were then seated and cured using the same technique. Lastly, teeth Nos. 10 to 12 were seated using the same method.

After all veneers had been seated and light-cured, final finishing and polishing was completed utilizing a sequence of diamond and carbide burs (FSD4F 010, FSD4EF 010, FS4UF 010, 8274, 016, 274EF 016, 8379 023, 379EF 023) from kit LD0531 (KOMET USA), a diamond polishing system (Optrafine [Ivoclar Vivadent]), and a diamond polishing paste (Diashine [VH Technologies]).

Upon completion of the procedure, the veneers demonstrated excellent fit, function, and aesthetics, appearing indistinguishable from the surrounding natural dentition (Figures 22 to 24, After Image).

CLOSING COMMENTS

Combating caries, emergency repairs, and preventative care, are only few of many factors that must be considered before performing any restorative procedure. Although a thorough understanding of materials and techniques is necessary, maintaining open communication with the patient at all times is crucial to ensure the success of any case. By discussing MI options, the effects of treatment on the existing dentition, patient expectations, and realities, the dentist has the opportunity to educate the patient and assist the patient in making the proper treatment choice. Further, an open dialogue among the patient, dentist, and the dental laboratory team will help to ensure that the patient's expectations and goals are met.✦

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Disclosure: Dr. Engleberg reports no disclosures.

Mr. Jones is a Fellow member of the American Academy of Cosmetic Dentistry (AACD), making him one of the only 4 ceramists in the world to hold this honor. He is also an AACD accreditation examiner and recently served 4 years on the AACD Board of Directors. Mr. Jones currently owns and operates a boutique laboratory, Smiles, Inc, in Boise, Idaho, where his exclusive service is smile design including complex, full-mouth reconstruction. Founder and codirector of Total Team Advantage, the semi-annual live patient seminars where dentists and technicians are taught hands-on smile design, Mr. Jones is also an international lecturer, author, and instructor on advanced dental ceramics. He can be reached at (208) 368-0206.

Disclosure: Mr. Jones reports that he receives honoraria from Ivoclar Vivadent for lecturing.