Achieving Aesthetic and Functional Success

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INTRODUCTION

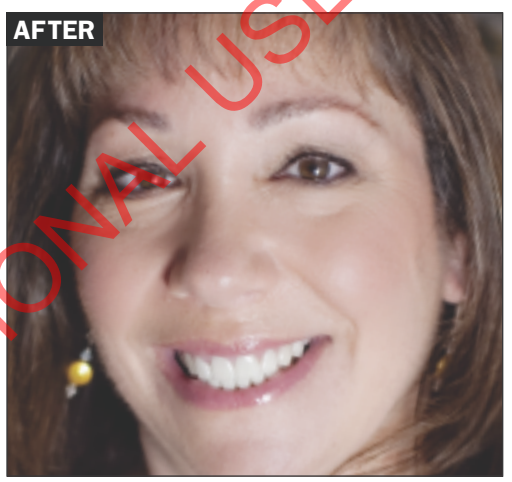
Vital to the protection and integrity of the masticatory system, dentists have the responsibility of developing proper form and function when undertaking any restorative case.[1] The key to long-term stability, correct anterior guidance, or the direction of forces applied to the anterior dentition, can have a significant affect on the success or failure of restorations.[1]

Occlusion

Often overlooked, *occlusion* plays an important role in not only function, but also in aesthetics.[1] To achieve predictable results, it is necessary for dentists and ceramists to completely understand the masticatory forces that will be placed on the restorations, including a patient's parafunctional habits.[1]

Dentists typically work with a patient's occlusal relationship as it exists.[2] However, this often proves detrimental to the stability of the masticatory system and can cause early failure of restorations.[2] Manifesting as muscular pain, joint problems, wear, chipping, tooth mobility, sensitivity, an uncomfortable bite, and a variety of other symptoms, malocclusion can be a cause of many problems for patients.[2] If left unaddressed during the aesthetic and functional restorative process, porcelain fractures, cement fatigue, and washout of bonding agents (leading to secondary caries) can be expected.[2,3]

Before Image. Preoperative portrait of the patient's eyebrow to chin area.



After Image. The final results are best seen in this photo—an absolutely elegant look.

Anterior Guidance

Provided by the lingual contours of the 6 maxillary anterior teeth as they contact the facial aspect of the 8 mandibular teeth in centric occlusion and protrusive and extrusive movements, anterior guidance protects the posterior teeth from excessive lateral force.[4] Leading to fracture and excessive wear, lateral forces must be directed toward the anterior teeth.[4] As a result of root length and the position regarding the temporomandibular joint (TMJ), canines provide the greatest amount of force-reduction to the posterior dentition because they direct a vertical masticatory pattern.[4] Canine-protected occlusion minimizes the patient's risk for developing temporomandibular disorder problems, since there is a reduction in lateral and interfering tooth contacts.[4]

To achieve aesthetic restorative success, dentists and their dental laboratory team must control the forces applied to the teeth.[4] In the natural dentition, the anterior teeth disclude (separate) the posterior teeth in all movements of the mandible to prevent destructive horizontal and lateral forces on the posterior teeth.[4] Overall, creating harmony within the lingual contours of the maxillary anterior teeth and the masticatory system is the single most important factor in the health and stability of the patient's occlusion and restorative treatment.[4]

Often overlooked, occlusion *plays an important role in not only function, but also in aesthetics.*

Vertical Dimension

Occlusal vertical dimension (OVD) (also known as the vertical dimension of occlusion) is the distance between any point on the maxilla and any point on the mandible where the teeth are in maximum intercuspation. It is established during the growth and development of the teeth.[5] In the clinical setting, OVD is often modified to correct tooth and gingival display issues, improve occlusal relationships, and gain space when restoring short or worn teeth.[6] Caution is necessary, however, when selecting a new OVD, since negative effects to the TMJ, speech, and stability can result.[6] Typically determined through trial and error on the articulator, the ideal OVD should be selected based on the aesthetics of the maxillary and mandibular incisor incisal edge position, the restorative needs of the anterior and posterior dentition, and the functional needs of the overbite and overjet.[6]

Bruxing

Of the many parafunctional habits with which patients may present, bruxing is commonly a cause of severe wear and pain.[1] Typically viewed as a dysfunction of the TMJ, bruxing is actually a result of a neurological dysfunction and may also be a stress-releasing function.[1] No matter the case, the dentist and dental laboratory team must make careful considerations when treating patients with bruxism.[1] Materials prone to chipping and fracture should not be used, since the patient's bruxing habit will likely continue even after restorative treatment.[1-3] In cases requiring all-ceramic restorations, a system that is wear and fracture resistant is required to meet the needs of the bruxer patient and to avoid the need for protective mouth guards.[1-3]

Historically, conventional all-ceramic systems have provided dental professionals with predictable and efficient treatments for highly aesthetic cases.[7] Most aesthetic materials, however, often fail when placed under the stress of typical parafunctional

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habits.[7] The choice of dentists and dental technicians for many years, metal-based ceramic restorations, solved some of the fracture and chipping issues associated with conventional porcelain systems.[3,7] Although these systems could withstand the stresses of function, they often lacked the aesthetics of all-ceramics, and some chipping still occurred.[3,7] Utilizing a monolithic technique, lithium disilicate pressable ceramic systems (such as IPS e.max Press and IPS e.max CAD [Ivoclar Vivadent]) help to solve some of these historical problems, while exhibiting the physical and optical characteristics desired by even the most demanding of patients and dental professionals.[7-10]

Delivering the fit, form, and function of conventional pressable ceramics, lithium disilicate glass ceramic also demonstrates enhanced strength and optimized optical properties.[7-10] Indicated for thin veneers, veneers, partial crowns, posterior and anterior crowns, inlays, onlays, 3-unit anterior bridges, 3-unit premolar bridges, telescope primary crowns, and implant superstructures, lithium disilicate offers solutions for many different clinical needs.[8-10] Lithium disilicate can be used in settings requiring either conventional cementation (when adequate resistance and retention form is possible in the preparation design) or adhesive resin bonding, and the aesthetic and physical properties of this material allow dentists and ceramists to address functional and aesthetic concerns in a predictable manner.

Figure 1. Preoperative photograph of the patient's smile showing aesthetic issues.

Figure 2. Preoperative retracted view of the patient's dentition.

Figure 3. After the gingivectomy, a diamond bur was used on the facial surfaces of the teeth to ensure the matrix would fully seat and the mock-up of the provisionals would stay in place during the initial preparations.

Figure 4. Using a 0.7-mm depth-cutting bur (KOMET USA), the clinician prepared into the mock-up, which helped preserve as much facial tooth structure as possible.

Figure 5. After the preparations, impressions, and occlusal records were made, a stump shade photograph was taken to communicate the desired overall shade to the laboratory team.

Figure 6. A photograph was taken of the patient in the provisionals, without the effects of anesthetic, which is a very important and often overlooked photograph for the laboratory team.

Figure 7. Retracted view of the provisionals in place.

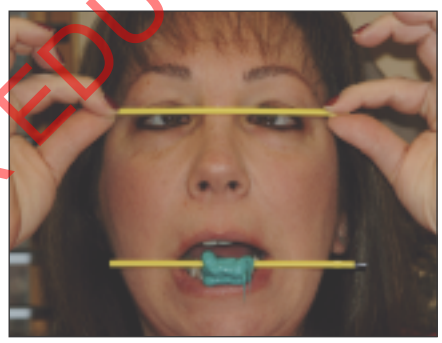

Figure 8. Photograph of the horizontal plane guide reference. The patient can hold a stick across the bridge of the nose horizontally, providing a reference to parallel the guide stick while the bite registration material sets.

Figure 9. A face-bow record (Kois Earless Facebow [Panadent]) was also taken to mount the models on the articulator.

CASE REPORT

Diagnosis and Treatment Planning

A 52-year-old female presented with concerns about her bite, grinding habits, gingival display, and the overall lack of aesthetics in her dentition. Upon consultation with the patient, it was discovered that as she had aged, she noticed that her teeth were gradually looking worse. She stated that she had never really liked the appearance of her teeth, and that her current situation negatively affected her self-confidence. She wanted to wear lipstick, something that she had never done for fear of drawing attention to her smile. As a mother and active member of her community, she wanted a better smile.

Upon clinical examination, severe wear caused by bruxing was observed. This parafunctional habit led to issues with tooth proportion, length, contour, color, and function. In addition, the patient's gingival levels were uneven, and there was excessive gingival display (Before Image and Figures 1 and 2).

The patient was well aware of her dental issues and that she would need a full-mouth reconstruction to correct them. Because the patient was a severe bruxer, a restorative material that would not fracture or chip easily would be required. First, it would be necessary to address the patient's occlusal plane and anterior guidance challenges, while eliminating the posterior interferences. A diagnostic wax-up was planned to work out a solution and to guide the dental team in correcting aesthetics and occlusal issues. Additionally, a gingivectomy would be used to achieve the proper and aesthetic gingival levels.

Because the patient was missing her first premolars, the 16 anterior teeth were to be restored first, rather than the typical 20. The first and second molars initially would be left out of occlusion. Additionally, it was recommended to the patient that the remaining third molars be extracted at least 2 months prior to initiating treatment. Veneering of all mandibular teeth was preferred, as opposed to using crowns, to avoid lingually preparing the lower incisors since they were already thin.

Veneers for teeth Nos. 6 to 11 and onlay veneers for the upper premolars were also included in the treatment plan. In order to achieve the desired postoperative OVD, the occlusal surfaces of the premolars needed to be fully covered. However, it was not necessary to place the lingual margin of the preparations more than halfway past the palatal wall of the tooth, since the restorations would be adhesively bonded in place.

Material Selection

The patient wanted her restorations to mimic the appearance of natural teeth. In this case, we chose to use a pressed lithium disilicate all-ceramic (IPS e.max Press) to help us meet the patient's stated aesthetic goal. When used as a monolithic material (without the use of layering porcelains), IPS e.max Press is a very strong (400 MPa biaxial flexural strength) all-ceramic material that can be resin-bonded for maximum strength. If desired, it can also be pressed to full contour, and then cut back and layered to create any special effects that may be needed within the aesthetic zone. Demonstrating exceptional strength, along

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with high aesthetic values and optical properties, lithium disilicate is ideal for restorative cases where aesthetics and function must be predictably delivered.

Clinical Diagnostics

A thorough TMJ evaluation was first completed using a Joint Vibration Analysis (Bio-JAV Scan [Bio-RESEARCH Associates]) to assess the function and vibration patterns of the TMJ. All previous periodontal and restorative work was then charted. The patient's dental history was unremarkable, with no major periodontal or dental work. Additionally, her TMJ was found to be stable before treatment.

A full set of diagnostic photographs and radiographs were then taken, and upper and lower impressions were made using a vinyl polysiloxane (VPS) impression material (Imprint 3 [3M ESPE]) to allow for multiple pours for the fabrication of diagnostic models. These impressions also enabled he patient to review both her initial and final restorations on the articulator (Stratos [Ivoclar Vivadent]).

Utilizing an anterior deprogrammer that the patient wore for several days, a centric occlusion bite registration was taken, and her new postrestorative OVD was estimated. By using the deprogrammer, a repeatable condylar position was easily captured during the bite registration process. Additionally, by using upper and lower incisor cementoenamel junction (CEJ) to CEJ measurements using digital calipers (Erskine Dental), the proper vertical dimensions were further established. Simple and accurate, this method provided the dental laboratory team with sufficient information to mount the case in centric relation to the correct (estimated postrestorative) OVD. With clinical photographs, the ceramist was able to wax the case to ideal form and function.

Figure 10. Wax was injected through a matrix made from the modified and approved provisionals onto the master dies.

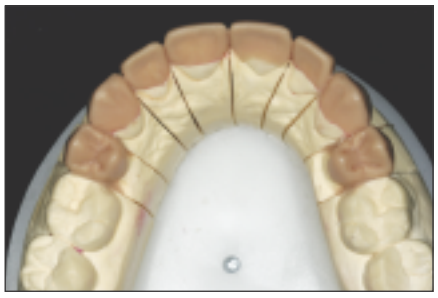

Figure 11. After sealing the margins, form and function were developed in the wax and readied for investing and pressing.

Figure 12. The canines and bicuspids were pressed from lithium disilicate (IPS e.max Press [Ivoclar Vivadent]) and the incisors from (IPS e.max Press).

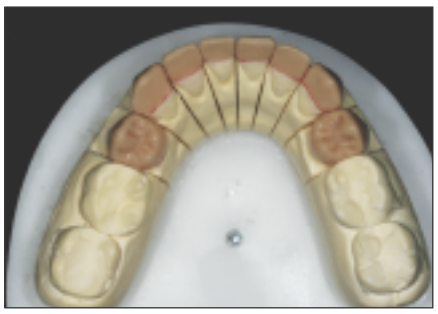

Figure 13. The lower wax-up was also made ready to invest and press.

Figure 14. After devesting and fitting, the restorations were scrutinized against the model of the provisionals.

Figure 15. Internal powder effects were added to a high and low value stained 0.5 mm incisal—facial cutback.

Figure 16. View of the internal effects after firing.

Figure 17. 0.5 mm of enamel powders were added to full contour.

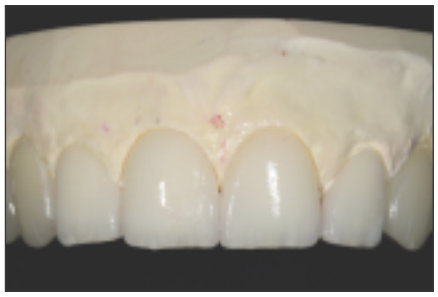

Figure 18. View of the fired enamel with medium glaze to see the internal effects of the ceramics that were ready for final shaping and contouring.

...gingival architecture was also very important to achieving the desired final aesthetics of this case.

As mentioned earlier, gingival architecture was also very important to achieving the desired final aesthetics of this case. Probing of the anterior teeth and bone showed that osseous crown lengthening would not be necessary. Saving time and money for the patient, it was determined that despite the excessive amount of facial gingival tissue that required removal, there was no issue with biological width. Working with the ceramist, the proposed tissue changes for the day of preparation were mapped, and a tissue reduction guide was created.

Clinical Preparation Protocol

The patient was anesthetized with a 4% articaine hydrochloride solution with 1:100,000 epinephrine (Septocaine [Septodont]) using a computerized anesthetic delivery system (The Wand [CompuDent]) to provide a more comfortable injection. While the patient was waiting for the anesthesia to take effect, a hard putty matrix (Sil-Tech [Ivoclar Vivadent]) fabricated from the diagnostic wax-up was filled with a bis-acryl composite provisional material (Luxatemp [DMG America]) and seated over the unprepared teeth. Since the restorative technique was an additive one, very little tooth structure was removed prior to this step. However, to seat the matrix, an initial reduction stent was used (Figure 3). The matrix was then removed and used as a guide to prevent overpreparation of the teeth (Figure 4).

The tissue guide made during the diagnostic stage was used to mark necessary tissue reductions that were to be made prior to any tooth preparation. To perform the gingivectomy, a radiosurgery unit (Ellman International) was utilized according to the reduction stent. The guide was then extracted, and excessive tissue was removed where necessary to establish an even scallop on each tooth.

Tooth preparation was initiated with diamond burs (KOMET USA) and an ELECTROtorque handpiece (KaVo). Utilizing polishing discs (Sof-Lex [3M ESPE]), rough/sharp edges were removed from the preparations, and they were given a final polish. Immediately after, final impressions were made using impression trays (Directed Flow Trays [3M ESPE]) filled with a heavy body VPS impression material (Imprint 3). To ensure successful impressions, the preparations were kept clean and fluid-free throughout the process.

To maintain the correct proposed OVD throughout the treatment process, a "bite-jig" was created from a rigid VPS bite registration material (Mega Bite [Discus Dental]) on the articulated wax-up of the molars. The 2 registrations, right and left, were used throughout treatment for bite verification and to maintain the correct vertical dimension. This "bite jig" also assisted the laboratory ceramist in mounting the upper and lower preparation models to the correct vertical dimension.

Stump shades (Chromoscope Stump Shade Guide [Ivoclar Vivadent]) were then taken, along with a series of digital photographs for communication of case specifics with the dental laboratory team (Figure 5). Once completed, provisional restora-

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tions were created. Telio Desensitizer (Ivoclar Vivadent) was applied to the preparations for 20 seconds each and air thinned prior to the application of OptiBond FL Primer (Kerr) to the preparation margins. This technique, when performed on the preparations prior to provisional fabrication, virtually eliminates sensitivity and substantially minimizes microleakage under the provisionals. The matrix was lined with a provisional material (Luxatemp) and placed over the preparations. Once the provisional material had set, the matrix was removed, and the provisionals were polished with polishing cups and points (Astropol [Ivoclar Vivadent]). A low viscosity liquid polish and sealant (BisCover [BISCO]) to prevent staining was placed over the temporary restorations. (The key is staining and not sensitivity.....the glaze doesn't have a thing to do with sensitivity.)

After the provisionals were in place, the patient was encouraged to make note of any possible changes in aesthetics and function that she felt would be necessary to discuss.

Photographs were taken at the post preparation appointment, and models of the provisionals were created (Figures 6 and 7). The patient made some suggestions and underwent another stick bite and a new face-bow to avoid the restorations appearing canted after final seating (Figures 8 and 9). Once the patient was satisfied with the provisionals, all photographs and pertinent diagnostic information was forwarded to the laboratory with a prescription for IPS e.max Press lithium disilicate restorations using the cut-back and layering technique on all teeth.

Laboratory Protocol

After receiving photographs, diagnostic information, and the prescription from the dentist, the ceramist first poured the impressions in stone. Wax then was injected through the matrix of the provisionals onto the master dies (Figure 10). The margins were sealed, and form and function were developed in the wax. Once this was completed, the restorations were ready for investing and pressing with the selected lithium disilicate ingots (Figure 11). The canines and bicuspids were pressed from IPS e.max HTBL2 bleach shade, low value, and the incisors from IPS e.max HTBL1, higher value, for both the uppers and lowers (Figure 12). The lower restorations also were formed through wax injection of the provisional matrix and readied for investing and pressing (Figure 13).

After the restorations had been devested and then fitted on the working model, they were scrutinized against the model of the provisionals (Figure 14). Internal powder effects were added to the stained 0.5-mm incisal facial cutback. Opal white dentin (OE 4) powder was used to create the internal lobes, while light mamelon (MM) created the incisal edge and a natural halo effect (Figures 15 and 16). Segmented low value, high opal (OE1) enamel powders (only 0.5 mm) were added to full contour in the outermost incisal-mesial and incisal-distal, alternating with contrasting high value (TI1) powders to mimic natural optical qualities (Figures 17 and 18).

A wax-based red pencil then was used to draw the desired line angles on the restorations, after which the interproximal deflection zones were developed using the flat surface of a diamond-based rubber wheel (94002C [KOMET USA]) (Figure 19). The facial lobes were developed prior to imparting the perikymata, each of which were established using a diamond bur (842R [KOMET USA]) to finalize the surface for glazing (Figures 20 to 23).

Final Seating

The provisionals were removed and then the preparations cleaned with brushes (ICB Brushes [Ultradent Products]) and a chlorhexidine and hydrogen peroxide antibacterial scrub (Consepsis Scrub [Ultradent Products]) (Figure 24). A retraction barrier (Optragate [Ivoclar Vivadent]) was placed in the patient's mouth to allow easier photography, patient comfort, and to provide a dry operative field.

The final restorations were placed in the mouth with a try-in cement gel (Variolink Veneer [Ivoclar Vivadent]) designed for veneers to verify the contacts, fit, and occlusion. The patient was pleased with the appearance of the restorations after viewing them intraorally in various lighting conditions, including natural sunlight.

The restorations were removed to be deep cleaned: the try-in gel and other possible contaminants were removed from the lithium disilicate restorations using a 35% phosphoric acid etch (Ultra Etch [Ultradent Products]) applied for about 20 seconds, and then rinsed with water. All restorations were primed with a ceramic silane primer (Rely-X [3M ESPE]) before placing and air-dried. A fourth-generation adhesive (ALL BOND 3 [BISCO Dental Products]) was then applied on the internal surfaces of the *restorations*. The restorations were air-dried and set aside in a light-proof container (Vivapad [Ivoclar Vivadent]). It is correct to coat the internal surfaces of the restorations with adhesive.

To ensure proper adhesion, the teeth were completely isolated and etched with a phosphoric acid gel (Ultradent Products]). A desensitizing agent (Systemp.desensitizer [Ivoclar Vivadent]) was then applied for 20 seconds each, using high-speed evacuation to remove the excess (Figure 25). Immediately following, the teeth were coated with the fourth generation adhesive (ALL BOND 3) for 20 sec-

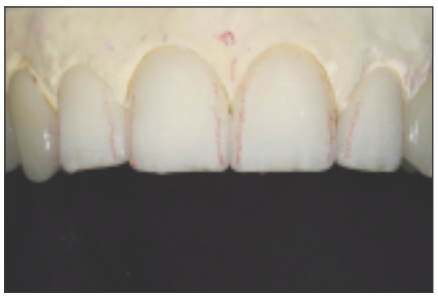

Figure 19. Using a wax-based red pencil, the desired line angles were drawn onto the restorations.

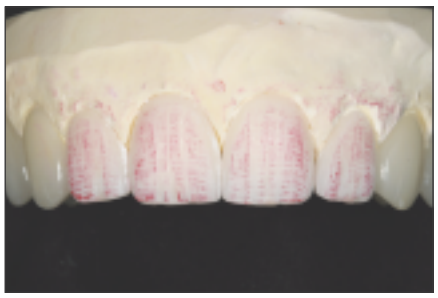

Figure 20. Facial lobes were developed before placing the perikymata, all by using an 842R diamond bur (KOMET USA) to finalize the surface prior to glazing.

Figure 21. View of the lower finished restorations.

Figure 22. View of the upper finished restorations.

Figure 23. Articulated view of the final restorations.

Figure 24. The provisionals were removed, and the preparations were cleansed with a chlorhexidine and hydrogen peroxide antibacterial scrub and pumiced in preparation for bonding.

Figure 25. Prior to bonding, a desensitizing agent was applied to the preparations to minimize postoperative sensitivity.

Figure 26. View of the patient's postoperative smile.

Figure 27. Retracted postoperative view of the patient's smile makeover.

onds each, removing the excess with high speed evacuation until there was no movement of the adhesive on any of the teeth.

A light-cured resin cement (Variolink Veneer [Ivoclar Vivadent]) (shade +1) was then loaded into the restorations and they were seated on the preparations. The restorations were seated together and tacked into place using the tacking tip of the curing light (Blue Phase [Ivoclar Vivadent]). The restorations were cured in wave-like motions, facially and lingually, for 2 seconds each. Excess cement was then easily removed, and the margins were coated with copious amounts of a glycerin gel (Liquid Lens [Danville Materials]) (to prevent an oxygen inhibited layer from forming) and cured for a full 20 seconds on each side.

To give the restorations their final fit and finish, diamond burs (flame-shaped: FSD4F 010, FSD4EF 010, FS4UF 010; pointed-shaped: 8274 016, 274EF 016; and football-shaped: 8379 023, 379EF 023 [KOMET USA]) and a diamond polishing system (Optrafine [Ivoclar Vivadent]) were utilized, followed by the use of a diamond polishing paste (Diashine [VH Technologies]). Separating strips (KOMET USA) were used as needed, and the contacts were rechecked for residual adhesive, cement, and smoothness using dental floss. The occlusion was then fine-tuned to develop perfect anterior guidance, and no posterior interferences were noted on the premolars. (Note: The molars remained out of occlusion, however, because they had not undergone restoration at the time this procedure was completed.)

Upon conclusion of the case, the patient, dentist, and dental laboratory team were very pleased with the aesthetic and functional results of treatment (Figures 26 and 27 and After Image). The patient was even more excited that she could wear lipstick for the first time, and have the self-confidence to do so without worrying that it would draw attention to her previously unaesthetic smile. For the dentist and ceramist, the case was successful beyond merely the predictably planned dentistry, but rather by making a special and dramatic difference in the patient's life.

CONCLUSION

Although aesthetics is the main goal in the anterior region, the most important aspects of any restoration are the function and stability of the masticatory system.[1] To ensure restorative longevity, dentists must consider the forces that will be placed on their restorations and what affect anterior guidance, vertical dimension, and parafunctional habits will have.[1] From there, they can develop a treatment plan to satisfy the patient's collective needs using an appropriately selected material.

While this is important for all restorative cases, the authors note the significance of providing predictable, aesthetic, and durable restorations that will function long-term in particular for this patient. She is a kind, warm, and active woman who never liked her smile and, as a result, never wore lipstick. As dental professionals, there is no greater professional or personal satisfaction than the smile on a patient's face—especially if you are the one who designed it especially for that individual.

By using advanced materials like lithium disilicate to correct functional issues and aesthetics, dentists and ceramists can provide patients with highly functional results—and even more importantly—greater self-confidence through aesthetics.[7] *Patient testimony may be viewed at youtube.com/user/ahsmiles#p/u/5/JRAKnhWDIhc.*✦

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Disclosure: Dr. Engelberg reports no disclosures.

Mr. Jones is a Fellow 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. He is founder and co-director 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 receives honoraria from Ivoclar Vivadent.