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Minimally invasive porcelain veneers: Indications for a conservative esthetic dentistry treatment modality

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Patients have many restorative options for changing the appearance of their teeth. The most conservative restorative treatments for changing the appearance of teeth include tooth bleaching, direct composite resin veneers, and porcelain veneers. Patients seeking esthetic treatment should undergo a comprehensive clinical examination that includes an esthetic evaluation. When selecting a conservative treatment modality, the use of minimally invasive or no-preparation porcelain veneers should be considered. As with any treatment decision, the indications and contraindications must be considered before a definitive treatment plan is made. Long-term research has demonstrated a 94% survival rate for minimally invasive porcelain veneers. While conservation of tooth structure is important, so is selecting the right treatment modality for each patient based on clinical findings.

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Today, many patients seek to change their appearance by changing their smiles through esthetic dentistry. Many choices are available for changing the appearance of teeth and smiles. When teeth are misaligned, an orthodontic consultation and treatment is the therapy of choice. Bleaching offers a conservative treatment modality for patients who seek whiter teeth. Unfortunately, there are clinical cases for which tooth alignment or tooth whitening are not sufficient to meet a patient's expectations.

For cases with non-carious enamel or dentin defects that affect color (for example, enamel hypoplasia, enamel hypocalcifications, teeth discolored due to endodontic staining, teeth with localized enamel malformations, flourosis with enamel mottling, teeth with chipping and fractures, undersized teeth, misshapen teeth, tooth spacing that cannot be esthetically corrected with orthodontic treatment, and minor tooth misalignments where the patient has made the decision to not seek orthodontic treatment), a restorative approach to change and enhance that patient's smile must be considered. Esthetic dentistry is elective dentistry; patients seek out dentists for advice on the condition that they diagnose the reason for the patient's dissatisfaction with their teeth and smile.

In most cases, a conservative approach using restorative materials adhesively bonded to enamel can achieve an acceptable esthetic result. These restorative options can utilize either direct bonded composite resins or porcelain veneers.[1-6]

The earliest reports concerning the use of porcelain to change the appearance of teeth involved removable thin porcelain facings that were fabricated and baked on platinum foil. These early veneers were used in the motion picture industry during the 1930s to change the appearance of teeth when actors and actresses were filming movies; they were held in place with denture adhesive.[7] In the early 1980s, Calamia and Simonsen described treating porcelain with hydrofluoric acid and silane to create an adhesive interface with composite resins.[8,9] Early clinical reports that used this adhesive technology for etched porcelain to place bonded porcelain veneers to change the appearance of anterior teeth reported success.[10-13] This research and the early clinical reports helped to transform treatment options for esthetic dentistry by providing a treatment modality that not only used porcelain (considered by most clinicians as the restorative material of choice due to its optimal esthetics and durability) but also offered an alternative to tooth preparations that removed all of the enamel from the tooth crown and left only dentin.

Porcelain veneers are considered the ultimate option for conservative esthetic treatment because they leave nearly all of the enamel intact before the veneer is placed.[14] During the past two decades, there has been a divergence in terms of the concept of tooth preparation for porcelain veneers. Most of the initial articles about tooth modifications and preparations for porcelain veneers described either

minimally invasive tooth preparations or conventional porcelain veneer preparations that required removing one-half the thickness of enamel.[10-13] In all cases, these preparations remained in enamel.

In recent years, the idea of conservative tooth preparations that maintain enamel as the primary tooth substrate for bonding has been challenged, as the literature has described tooth preparations for porcelain veneers that require a reverse three-quarter crown preparation with a preparation depth that leaves much of the veneer preparation in dentin.[15-17]

Crispin reported that the thickness of enamel at the gingival margin of all anterior teeth is less than 0.3 mm.[18] Based on these findings, veneer preparations would need to be 0.15 mm or less to maintain enamel for adhesive bonding. In a 15-year retrospective study evaluating porcelain veneers, Friedman reported that adhesive fractures were rarely observed in the veneer that was bonded to enamel but noted that most failures related to cervical fracture and microleakage occurred when dentin was the bonded tooth substrate.[19] Research on the durability of dentin bonding has demonstrated a bond strength dropoff after two years.[20-22] Friedman maintained that a veneer preparation should remain in enamel, reporting that there is an increased risk for veneer fracture when a veneer that is not supported by natural tooth structure lengthens a tooth or closes a diastema with the porcelain extending more than 1.0 mm.[19]

It is important to maintain enamel and healthy tooth structure for porcelain bonding. While there are indications for conventional preparations of porcelain veneers (for example, tooth alignment and the masking of darkly discolored teeth), the use of a minimally invasive or no-preparation technique can achieve a highly esthetic result.[14,23-25]

The indications for a no-preparation or minimally invasive porcelain veneer include a size and anatomic shape of the natural teeth that is acceptable to the patient, diastema closure, minor tooth alignment, color changes, restoring localized enamel malformations, fluorosis with enamel mottling, teeth with minor chipping and fractures, undersized teeth, and misshapen teeth. Prominent cervical contours must be flattened with tooth preparation to avoid overcontouring the completed veneers. This type of porcelain veneer offers a number of advantages: no need for local anesthesia, elimination of postoperative sensitivity, no need for provisional restorations, a more durable restoration due to the enamel bonding, and the potential to reverse the procedure (if necessary) by removing the veneer.[4,14,19,26]

In the author's experience, many patients have resisted the idea of porcelain veneers based on what they have read or seen in the media. In lay publications and some television makeover shows, the clinician performing the treatment demonstrates the administration of local anesthesia (involving intravenous sedation or nitrous oxide analgesia combined with highly invasive tooth preparations) before fabricating the veneers. In some cases, the patients are in pain during the procedure. The author has found that for those clinical situations where "no-preparation" minimally invasive porcelain veneers are indicated, providing the patient with photographic examples of these veneers for clinical situations that are similar to their own needs leads to very high patient acceptance.

The evidence supports the concept of "no-preparation" veneers or slight tooth modification for porcelain veneers by using high-strength porcelains.[10-13] While the earliest porcelain veneers were fabricated from a fired, stacked porcelain (Cerinate) whose unique physical properties contributed to that success, newer pressed porcelains also can be used to fabricate thin veneers (0.3–0.5 mm).[27-29]

Table 1. Indications for minimally invasive and no-preparation porcelain veneers.

Minor color changes
Masking mild to moderate tooth discolorations
Masking existing Class 3, 4, and 5 restorations
Closing diastemas
Restoring chipped incisal edges
Reshaping peg-shaped and undersized teeth
Correcting minor misalignments and rotations of anterior teeth
Recontouring facial surfaces of teeth
Resurface existing porcelain and porcelain-metal restorations

Clinical indications for minimally invasive porcelain veneers

Since most esthetic dentistry is elective, it is the patient who provides the primary indication for porcelain veneers; it is the patient's wish and self-perceived need to change the appearance of his or her smile. Table 1 lists indications for minimally invasive porcelain veneers. For all patients, clinicians must perform a comprehensive clinical examination that evaluates the soft and hard dental tissues. Periodontal health is an important criteria for clinical success. An esthetic examination also should be performed

Fig. 1. A preoperative view of the patient, showing anterior spacing and misalignment.

Fig. 2. After bleaching and minor laser gingivectomy, the teeth were prepared for the minimally invasive porcelain veneers.

to determine an understanding of a patient's expectations, tooth position relative to the smile and lip line, incisal edge position of maxillary and mandibular incisors, midline position, tooth shape, spacing, occlusion, presence or absence of fremitus and mobility, tooth color, and other esthetic considerations.

Porcelain veneer can refer to a minimally invasive or no-preparation veneer with a thickness of 0.3–0.5 mm; it also can refer to a more conventional porcelain veneer (fabricated to a thickness of 0.5–0.7 mm) in which the preparation remains in the enamel (with a gingival preparation of less than 0.3 mm).[30] Clinical situations that can be considered appropriate for minimally invasive porcelain veneers include changing basic tooth shades, masking minor to moderate tooth discolorations (tetracycline staining, endodontic staining, and fluorosis), and overlaying existing composite resin restorations, which can be combined with restoring interproximal, cervical, and incisal edge caries with composite resin to ensure an esthetic restoration. Minimally invasive porcelain veneers also can be used to close diastemas between anterior teeth; reshape undersized teeth and peg-shaped incisors; reshape tooth contours and incisal edges of anterior teeth; restore worn, chipped, and/or fractured teeth; and correct minor misalignments of anterior teeth. Porcelain veneers also have been used to change color and repair existing porcelain and porcelain-fused-to-metal restorations through resurfacing.[24,31]

Case report

A 26-year-old woman had spacing of the maxillary anterior teeth. Examination revealed a lack of contour heights on the mesial and distal surfaces of the maxillary central incisors, a width discrepancy between the maxillary central incisors, a lingually positioned maxillary right canine, a slightly misaligned maxillary right lateral incisor, and slight misalignment of the maxillary left lateral incisor (Fig. 1). When the patient was presented with the option of an orthodontic consult, she said that she did not desire "braces." Her chief esthetic interest was to align the maxillary anterior teeth and to close the anterior spaces. She also wanted to show more of the incisal edges of her teeth when she smiled. An impression was made of the maxillary arch and a diagnostic wax-up was made to demonstrate the esthetic changes that could be made.

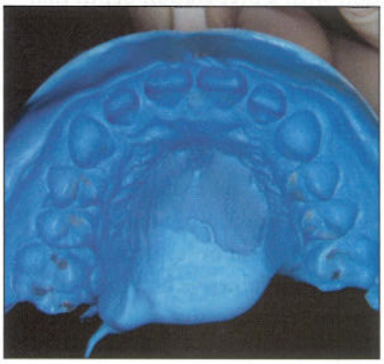

Fig. 3. A monophase (regular bodied) VPS impression material in a bite impression tray is used to make an impression of the teeth to be veneered.

After discussing treatment alternatives (including bleaching, direct composite resin bonding, and minimally invasive porcelain veneers), the patient selected the most conservative treatment for achieving an esthetic result. As part of the treatment plan, the patient whitened her teeth by applying a 15% carbamide peroxide gel (Opalescence, Ultradent Products, Inc., South Jordan, UT; 800.552.5512) to the mandibular incisors for four weeks. During the esthetic evaluation, a

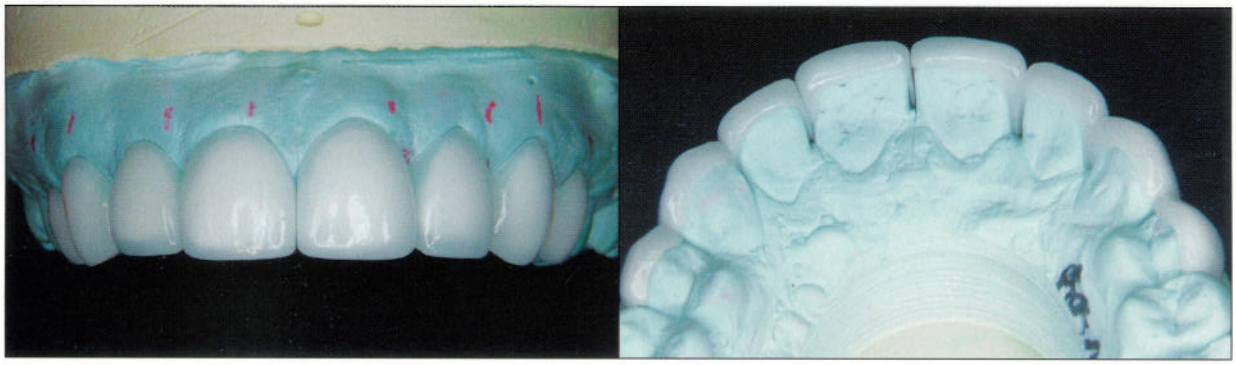

Fig. 4. Facial and lingual views of porcelain veneers tried on the cast.

discrepancy in the gingival height of the maxillary central incisors was noted. The patient was referred to a periodontist for gingival recontouring of the maxillary right central incisor using a soft tissue laser (Odyssey, Ivoclar Vivadent, Amherst, NY; 800.533.6825). Six weeks after the laser recontouring, the patient returned for tooth modification and impressions.

After discussing options with the patient and having her look at her smile, it was decided that there was a need to place veneers from only the maxillary right first premolar to the left first premolar (teeth No. 5 through 12). A profile of the maxillary incisors and alignment revealed the need to make a minor tooth preparation (modification) before taking an impression—specifically, an intraenamel reshaping of the distal of tooth No. 7 and mesial of No. 10 due to alignment considerations. The facial incisal third of the maxillary central incisors also was prepared to eliminate the possibility that the final veneers would have a protrusive appearance. When closing diastemas, it is important to overlay the incisal edge to provide porcelain support. As part of the plan, the maxillary central and lateral incisors were lengthened so that more of the incisors would show when the patient smiled; the diagnostic wax-up also demonstrated that lengthening the incisors would give them a more proportional and esthetic appearance. The maxillary central and lateral incisors were prepared with a lingual finish line (no tooth shortening) that was 0.3 mm in depth within the enamel; the canines and first premolars were reduced by 0.3 mm with a lingual finish line (Fig. 2).

After tooth modifications were complete, a bite impression was made using a fast-setting, monophase (regular body) viscosity, vinylpolysiloxane impression material in a bite impression tray. No retraction cord was used. The laboratory used the free margin of the gingiva as the most cervical part of the veneer. Packing cord can create a major problem during try-in and bonding of the veneer when no gingival finish is used. If gingival retraction is used, the veneer can be overextended and be subgingival. It is difficult to etch and bond reliably to a subgingival margin.

The monophase impression material was syringed directly onto the teeth with the automixing tip. This impression technique provides the laboratory with accurate impressions of the teeth to be restored, the opposing arch, and the bite registration (Fig. 3); it also eliminates guesswork for the laboratory and guarantees accurate cast articulation.[32] The restorations would be fabricated to a thickness of 0.3 mm for a minimally invasive preparation and it was decided that these veneers should be fabricated from a fired feldspathic porcelain (Lumineers by Cerinate, Den-Mat Corporation, Santa Maria, CA; 800.445.0345); a contact lens-thin porcelain veneer also has been fabricated from Cerinate Pressed Porcelain (Den-Mat Corporation).[24,26,33]

A laboratory authorization was completed describing the purpose of the veneers, the desired shade, and the length and surface texture for the facial surface of the veneer; the need for a lingual finish line for the maxillary incisors also was noted. The impression, diagnostic wax-up, and preoperative digital images were sent to the Cerinate Design Studio (Den-Mat Corporation) for fabrication of the restorations. Because the teeth were minimally reshaped, there was no need for any provisional restorations between visits.

The veneers were returned by the laboratory in two weeks (Fig. 4). The teeth and surfaces that were

Fig. 5. The teeth were moistened with water and the veneers were tried in.

Fig. 6. The teeth after etching, rinsing, and drying.

to be bonded were cleaned with a water-pumice paste using a disposable prophylaxis. The interproximal surfaces were cleaned using a safe side-handled diamond strip (Ceri-Sander, Den-Mat Corporation). The teeth were moistened with water and the veneers were tried on to verify fit and esthetic shape. The patient was shown the veneers and approved the esthetic appearance of the restorations (Fig. 5).

Surface treatments

The internal surfaces of all of the porcelain veneers were etched in the laboratory with hydrofluoric acid. At chairside, an acidic porcelain conditioner (Cerinate Prime Porcelain Conditioner, Den-Mat Corporation) was painted on the etched surfaces of the Cerinate porcelain for 20 seconds using a disposable brush. The surface was rinsed with water and dried. The use of an acidic conditioner activates and enhances the chemical treatment of the porcelain with an organo-silane (porcelain chemical coupling agent).

At this point, the conditioned surface was painted with a silane ceramic primer (CerinatePrime, Den-Mat Corporation) for 30 seconds and dried from the surface. A resin adhesive (Tenure S, Den-Mat Corporation) was applied to the internal porcelain surfaces and the dental assistant placed the automixed resin cement (Ultra-Bond Plus, Den-Mat Corporation) into the veneers. The teeth were etched for 15 seconds with a 32% semi-gel phosphoric acid etchant while the veneers were prepared for bonding. The teeth were rinsed for 10 seconds (using an air-water spray) and dried, leaving an etched frosty appearance in the enamel. The resin adhesive was applied with a Benda Brush (Centrix, Shelton, CT; 800.235.5862) to the etched enamel surfaces of all eight teeth (Fig. 6). The teeth and veneers were ready for simultaneous placement of the veneers.

Porcelain veneer placement

The eight veneers were bonded in place using a multiple placement, no-matrix technique that has been described in the literature.[34,35] This technique has greatly simplified the placement of porcelain veneers. Other techniques bond one or two veneers at a time; at that point, the composite resin cement must be finished at the proximal margins before the adjacent veneers can be seated. This can be problematic, as finishing the interproximal margins of porcelain veneers may cause gingival hemorrhage that can interfere with subsequent continued bonding of the adjacent veneers.

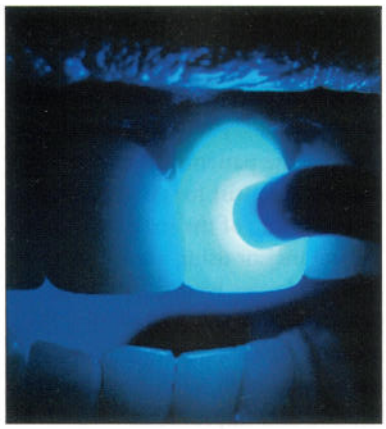

Fig. 7. Veneers were seated and tack-cured with a 3.0 mm light guide.

In the present case, the veneers were placed simultaneously on the teeth. The back end of the disposable brush was used to seat the veneers fully as each one was placed. Because of the viscosity of the resin cement, this seating of the veneers was repeated several times to make certain that the veneers were not lifting up on the teeth. In some cases, the viscosity of the resin cement can cause a hydraulic effect in which the veneers float on the cement, lifting them away from the tooth surfaces.

Fig. 8. For the matrixless simultaneous placement technique, dental floss was passed through the contacts after the veneers were tack-cured.

Fig. 9. A flame-shaped finishing diamond is used to make a margin for the porcelain veneer on the facial surface.

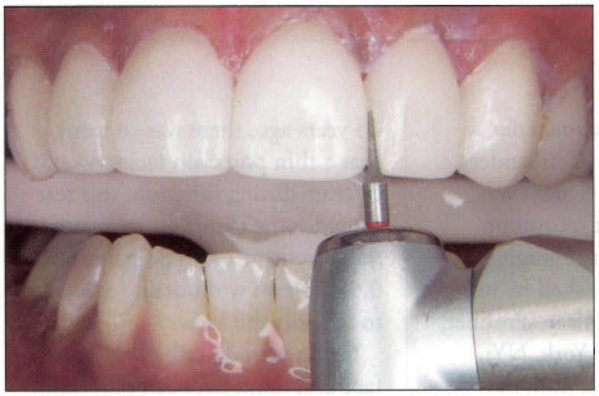

Fig. 10. The facial interproximal surfaces are cleared of excess composite resin.

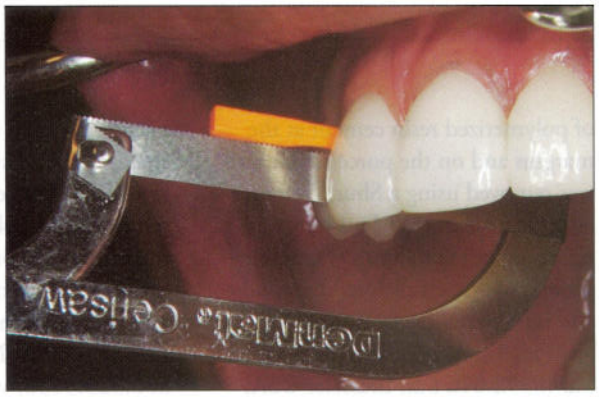

Fig. 11. An interproximal saw is used to remove additional composite resin. Note the placement of the gingival wedge to avoid laceration of the gingival papilla.

When it was verified that all of the veneers were seated fully without any matrix strips, each veneer was tack-cured for five seconds with a quartz halogen curing light (Demetron Optilux 501, Kerr Dental, Orange, CA; 800.537.7123) with a 3.0 mm tacking tip in the middle of the facial surface of each veneer (Fig. 7). A curing time of five seconds allows for additional easy clean-up of excess resin cement from around the veneer margins. In addition, dental floss can be passed gently between the proximal surfaces to allow for easy interproximal clean-up of excess cement (Fig. 8).

Excess resin cement was removed using a brush wet with resin adhesive to guarantee that the resin cement would be at the margins of the veneers. The veneers were photocured once more for 20 seconds with a 13 mm curing tip.

Before finishing and polishing the veneers, a topical local anesthetic (Oraqix, Dentsply, York, PA; 800.225.2787) was dispensed using an applicator from a carpule using a canula tip for placement around and into the gingival sulcus. Its unique formulation allows Oraqix to reach onset in 30 seconds and change from a liquid to a gel when it reaches body temperature. In the author's experience, Oraqix allows for subgingival finishing without the need to apply local anesthetic. The patient often displays no discomfort during gingival finishing; in addition, the numbing effect is localized to the gingival tissues and is short-lasting.

Finishing and polishing was accomplished using the accessories in the Lumineers Finishing Kit (Den-Mat Corporation), which included a CerisSaw, CeriSander, Shure 349 orthodontic instrument, finishing diamonds and burs, and a diamond polishing paste. For the present case, the slight excess

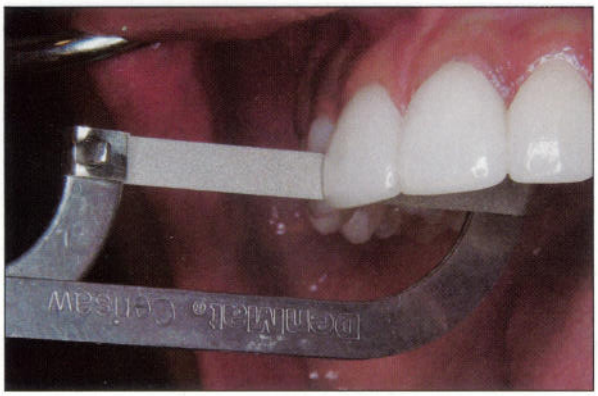

Fig. 12. Finishing the interproxmal surfaces with a handled ultrafine diamond strip.

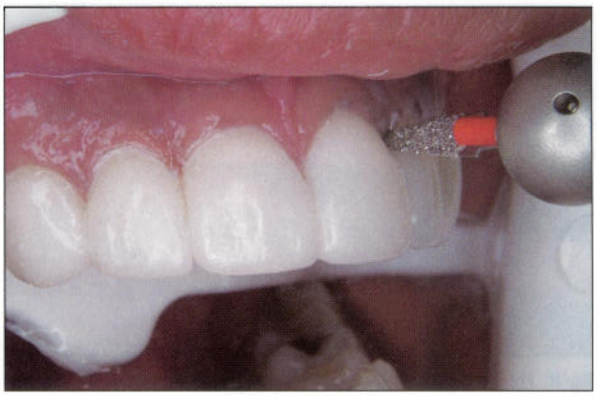

Fig. 13. Final finishing of the gingival interproximal margin.

of polymerized resin cement at the margins and on the porcelain surface was removed using a Shure 349 orthodontic instrument. Finishing and polishing of the margins was accomplished with the finishing diamonds and burs found in the finishing kit (Fig. 9). A mosquito diamond bur (8392-016 bur, Brasseler USA, Savannah, GA; 800.451.4522) was used to clear excess composite resin cement (Fig. 10).

The contacts were opened for access using the Cerisaw, an intraoral dental saw that uses extremely thin (0.05 mm) stainless steel dental saw blades attached to a miniature hacksaw handle (Fig. 11). By attaching the blades to the handle and placing a gingival wedge, the saw is controlled easily to prevent cutting gingival tissues accidentally.[20] It is not necessary to open all contact areas at the placement appointment. The proximal contacts that are more difficult to access can be managed more easily and opened at the follow-up appointment. Tooth movement during function breaks the resin free and loosens tight contacts to allow for easier access at the next appointment.

The contact areas were finished using a handled ultrafine, safe-sided diamond strip (CeriSander) (Fig. 12). The resin cement was removed and a slight recontouring of the interproxmal gingival surfaces was accomplished by using a reciprocating handpiece (Profinet, Dentatus USA, New York, NY; 800.323.3136) with a thin, flat-bladed, safe-sided diamond Lamineer tip (Fig. 13). A thin diamond bur with a high-speed handpiece is contraindicated in the gingival interproximal areas because one can notch the veneers in these areas and leave an esthetically unsatisfactory restoration.

The restorations were polished using a disposable prophylaxis angle and cup with a diamond-impregnated porcelain laminate polishing paste. Figure 14 shows the completed veneers. A profile view of the completed veneers shows no gingival overcontouring (Fig. 15). Compared to the preoperative smile, the completed veneers provided a highly esthetic result that met the patient's expectations (Fig. 16).

Discussion

When porcelain veneers were introduced as a treatment modality 25 years ago, there was concern that a thin porcelain facing would fracture during function; this fear caused some clinicians to recommend routine tooth preparations of 0.5–1.0 mm without any evidence to support this view.

Nathanson described the interface and bond between porcelain, composite resin, and enamel as strengthening the porcelain and eliminating the propagation of microcracks between the three materials.[36] A 1990 study by Sorensen *et al* evaluated porcelain durability and the resistance to microcracking and microleakage after thermocycling.[37] The study tested four systems and reported that Cerinate porcelain with Ultra-Bond was the only porcelain that resisted microcracking after thermocycling.[37] These findings parallel those observed in long-term clinical trials involving fired, stacked porcelain.[38-43] Nash chose Cerinate Porcelain for those patients who desired minor changes in tooth shade and appearance because he preferred to remove as little tooth structure as possible to accomplish the desired esthetic result and this method removed so

Fig. 14. Facial and lingual views of completed veneers.

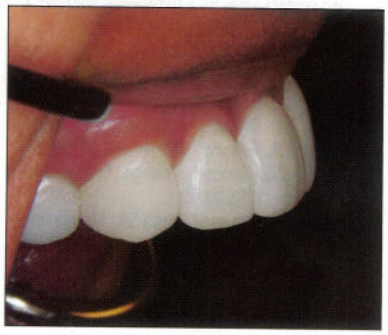

Fig. 15. A profile view of minimally invasive porcelain veneers that demonstrates no overcontouring.

Fig. 16. *Left:* The patient's preoperative smile. *Right:* The patient's smile one week after Lumineer placement.

little enamel that no temporization was necessary.[40]

One major concern for a minimally invasive porcelain veneer is the potential for periodontal problems due to veneer overcontouring. Yu *et al* compared teeth restored with porcelain veneers, both with and without preparation, and reported no difference in terms of periodontal health.[44] Peumanns evaluated porcelain veneers for gingival health after five years and concluded that smooth finished margins were important for maintaining gingival health.[45] When porcelain veneers were still a new treatment modality, two separate studies reported clinical success with minimally invasive and conventional porcelain veneer preparations.[38,39] Other research supports minimally prepared teeth for veneers; a 1994 study by Nordbo *et al* reported that veneers without incisal overlap performed successfully.[46]

Long-term evaluation of minimally invasive porcelain veneers has demonstrated that this treatment modality is very successful.[43] In a 2005 study, porcelain veneers that had been fabricated with Cerinate Porcelain and placed with Ultra-Bond were evaluated for a period ranging from 140 months (11.7 years) to 240 months (20 years), with a mean of 15.2 years. Of the veneers placed, 78% would be considered minimally invasive because there was either no preparation or only very slight tooth reshaping to accommodate misalignments and incisal edge discrepancies. Over the duration of the study, the patients who were able to be recalled displayed 100% retention of the veneers with very little change in color. There were no veneers that were completely debonded over the course of the study. At the last recall, 157 of the 167 veneers (94%) were clinically successful; only 10 veneers needed to be replaced. Replacement usually was needed because of chipping or cracking on stress-bearing surfaces; these fractures usually were cohesive fractures within the porcelain.[43]

Summary

As with most dental treatment, there should not be a "one size fits all" philosophy for veneers. Clinicians need to consider all esthetic options when treatment planning. A thorough clinical examination with esthetic evaluation is important for achieving an acceptable final result. By following the guidelines described in this article and selecting an appropriate treatment, clinicians can expect to achieve a result that will please the patient.

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