ABSTRACT

The ultimate goal for an esthetic rehabilitation is the restoration of health, beauty, and function to the patient. This article illustrates a predictable system to guide the clinician with tooth preparations for porcelain veneer restorations based upon the additive diagnostic wax-up. This system promotes a preparation technique using a series of guides that direct the clinician to reduce only the enamel necessary to create enough volume for the ceramist to produce a conservative porcelain veneer restoration.

Research has shown that porcelain veneer preparations remove significantly less volume of tooth structure by weight than full-crown preparations.

INTRODUCTION

STUDIES IN THE LITERATURE

When the patient’s desire is to have an esthetic rehabilitation, it is important to consider options in the treatment-planning stage that will promote the most conservative approach. Research has shown that porcelain veneer preparations remove significantly less volume of tooth structure by weight than full-crown preparations. This study found that a full-crown preparation reduced the weight of the clinical crown by 63% to 72% and a porcelain veneer preparation only reduced 3% to 30% of the total unprepared crown weight.

It is important to consider and select the most conservative restorations that will provide the patient with the desired esthetic, biomechanical, and functional results. Porcelain veneers often are the restoration of choice to provide the patient with a conservative outcome. In many cases, the patient would also benefit from an interdisciplinary approach that would include orthodontics when treatment planning the case. This is especially true if the existing teeth have moderate crowding or rotations that would require ex-
cessive preparation of healthy tooth structure and cause mutilation of the teeth or even endodontic problems for the patient. In these cases, the patient is best served by completing the orthodontic treatment prior to the restorative phase of therapy.

The traditional approach for a porcelain veneer preparation is to use a depth-cutting diamond on the existing tooth surface and remove a fixed amount of tooth structure. This technique leads to an excessive removal of sound enamel with unnecessary dentin exposure, especially for patients who already have wear or thinning of the enamel surface. A number of retrospective studies that look at porcelain veneer longevity have also found that patients will have more predictable long-term success if the restoration is bonded primarily to enamel. This is especially true at the facial-axial region of the tooth preparations; care should be taken not to remove excessive enamel at this critical region. The traditional veneer preparation method has been replaced by newer techniques that attempt to relate the diagnostic wax-up to the tooth preparations. This article demonstrates a simplified technique to prepare teeth for porcelain veneers with the aid of three different guides created from the diagnostic wax-up.

**CASE PRESENTATION**

**FINDINGS**

The patient, a 30-year-old male, presented with moderate anterior crowding and a central diastema that had previously been restored with composite resin bonding (Figs 1-3). The patient was not happy with the crowding or the triangular tooth shape, or with the open gingival embrasure between the central incisors. The initial examination revealed that he had moderate mandibular anterior crowding and a labially positioned lateral incisor. The occlusal examination revealed no temporomandibular disease, muscle pain, or tooth mobility, and the periodontal examination revealed a healthy periodontal condition.

**TREATMENT PLAN**

The treatment plan consisted of Invisalign orthodontic therapy (Align Technology; Santa Clara, CA) to correct the mandibular crowding and position of the lateral incisor; followed by four feldspathic porcelain veneers on the maxillary incisors to lengthen the teeth, alter the tooth shape, and create a more pleasing smile. Invisalign therapy was considered an essential part of the treatment plan because the lateral incisor (#7) would have required excessive preparation and dentin exposure to bring it into alignment with the other incisors. The lower incisors would also have presented a challenge and needed excessive reshaping to create a smooth anterior guidance with the new veneer restorations if the patient did not include orthodontics as part of the treatment plan. When presented with these facts, the patient undertook the orthodontic recommendation as an essential initial phase of an optimal treatment plan for his case.

**STENT FABRICATION AND TOOTH PREPARATION**

Three types of stents were used to guide the tooth preparations for this case: The incisal putty stent, the depth gauge stent, and the vertical putty stent. The diagnostic wax-up was developed after the completion...
of the orthodontic treatment using a new set of study models that were mounted with the Kois dento-facial analyzer (Panadent; Grand Terrace, CA) on a Sam 3 articulator (Great Lakes Orthodontics; Tonawanda, NY). The diagnostic wax-up was completed using an additive technique that was designed to preserve the existing enamel and add wax to build up the new tooth form. The additive diagnostic wax-up is a critical step in the biomimetic approach for the preservation of enamel and the clinician must be able to accurately relate this to the final tooth preparations.9

**Incisal Reduction**

Placing the incisal putty stent on the teeth and evaluating the position of the pretreatment incisal edge compared to the desired incisal edge initiated the preparations (Fig 4). The palatal stent was created on the diagnostic wax-up by placing the putty material over the palatal surfaces and extending it to the facial incisal edge of the teeth to be restored. In this case, the patient wanted his teeth lengthened slightly, so the putty stent reflected these changes. The incisal edge of the preparations should be reduced, 1.5 mm to 2.0 mm, based upon the desired final incisal edge, not the existing incisal edge of the teeth. The preparations were initiated with the KS7 diamond (Axis Dental; Coppell, TX), which reduces the incisal edge and creates the butt joint finish line that is desirable for porcelain veneers. Studies have demonstrated that a concentration of tensile stresses are found on the palatal concavity of incisors and a chamfer finish line in the palatal incisal area is not as strong as the butt joint design.10,11

**Preparation Design**

With the completion of the incisal reduction, the facial prepara-
tion was then initiated and guided by the depth gauge stent (Fig 5). In this case, the depth gauge stent was created from a duplicate die stone model of the diagnostic wax-up using a 1.5-mm Copyplast material and a Biostar vacuum-forming machine (both Great Lakes Orthodontics). This stent was designed with depth holes drilled into specific locations on the facial and incisal areas that map out the preparation surface at the incisal, body, and cervical zones in the middle and line angles of each tooth. I prefer a preparation design that leaves the interdental contact areas intact and finalizes the preparations just short of the contact (Figs 6 & 7). I believe that this design leads to a more simplified preparation technique and a preservation of healthy tooth structure.

With this patient, the contact areas were left intact everywhere except between the central incisors, which had a pre-existing diastema, and an open gingival embrasure that the patient wished to have closed. It is important, when completing the preparation design and margin placement in cases that have a diastema, to locate the interdental margin slightly subgingivally so that the ceramist has the opportunity to fully close the gingival embrasure and push slightly on the gingival tissue from below to create the desirable triangular tissue shape (Fig 8). The preparations are quickly developed by creating approximately 0.3 mm to 0.5 mm of space, using the depth gauge stent to approximate the final dimensions and design of the porcelain veneers.

**SECTIONING THE PUTTY**

The preparations were then finalized with the vertical putty stent to help ensure that the ceramist had the appropriate amount of space for

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**Figure 6: Lateral view of the tooth preparations after the removal of the provisional restorations. Note the healthy gingival tissue.**

**Figure 7: Lateral view of the tooth preparations after the removal of the provisional restorations.**

**Figure 8: The final veneer preparations with the retraction cords in place**

**Figure 9: The vertical putty stent in place intra-orally to evaluate the veneer preparation depth.**
the porcelain (Fig 9). The vertical putty stent was created by carefully molding the silicone putty over the diagnostic wax-up model to cover the entire surface of the teeth to be prepared, including three teeth on either side (Fig 10). The putty could then be sectioned prior to the preparation appointment.

The putty was sectioned by cutting the two most distal teeth to be prepared on one side midfacially with a 12b scalpel blade. The small piece of putty between these two teeth was then discarded and the two large sections were used to evaluate the preparations (Fig 11). In this case, teeth #7 and #8 were evaluated initially with these vertically sectioned putty guides, and any areas where the tooth preparations were too close to the putty surface (which represents the final porcelain veneer surface) were reduced to create a more ideal veneer thickness. With the evaluation of #7 and #8 completed, the putty guide could be sectioned midfacially on tooth #9 and the large section of putty could be used to evaluate the preparation depth of this tooth (Fig 12). Once this was completed and the preparation space was confirmed to be correct, the putty could be sectioned a final time in the midfacial of tooth #10, and the larger remaining section could be used to evaluate the preparation depth of this tooth (Fig 13).

**Finalizing the Margins**

With the confirmation of the preparation depths, the first retraction cord was placed and the margins were finalized. In this case, the first retraction cord was a black #000 Ultrapack cord (Ultradent Products; South Jordan, UT) that was treated in Hemodent (Premier; Plymouth Meeting, PA). The margins were then finalized using a KS1 diamond bur (Axis Dental) in an electric handpiece at a reduced speed of 80,000 rpm operated dry. This...
margination was completed with 8x to 10x magnification using the PROergo dental microscope (Carl Zeiss Meditec; Dublin, CA). The retraction was then enhanced with a single piece of purple #0 Ultrapack cord that was packed into the four tooth preparations and left for five minutes before the impression procedures (Fig 8). The second cord was removed and the impression was taken with Permadyne impression material (3M ESPE; St. Paul, MN) followed by a Blue Mousse bite registration (Parkell; Edgewood, NY). The preparation shade was recorded and photographed to communicate this information to the ceramist (Fig 14).

**PROVISIONAL RESTORATION**

The provisional restoration was created using a duplicate Copyplast stent of the diagnostic wax-up, with an A1 shade of Protemp3 Garant (3M ESPE). Particular attention was given to the embrasure form, especially in the cervical embrasures, so that a small space was created for the tissue and papillae to rebound after the preparation, retraction, and impression procedures. The provisional was spot-etched and luted into place with Neo-Temp resin cement (Waterpik; Ft. Collins, CO). It was evaluated a few days after the preparation appointment, and a new Kois dento-facial analyzer was created (Fig 15). The upper provisional model was mounted on the Sam 3 articulator, the remaining models were cross-mounted to the upper provisional model, and the case was sent to the dental ceramist.

**LABORATORY COMMUNICATION**

The appropriate shade and surface characterizations of the surrounding natural dentition were photographed with a Nikon D2X camera (Nikon USA; Melville, NY) and sent to the ceramist, along with
Figure 18: Definitive porcelain veneer restorations on the solid cast.

Figure 19: Direct view of the tooth preparations after the removal of the provisional restorations.

Figure 20: Final esthetic and biomimetic rehabilitation for the patient with conservative porcelain veneers.

Figure 21: Macro view of the final restorations. Note the closure of the gingival embrasure between the central incisors.

Figure 22: Lateral view of the final restorations.

Figure 23: Three-year post-treatment smile view.
the provisional model and bite record. The shade tab photographs were also converted to grayscale so that the ceramist could view the value in order to effectively match the porcelain veneers to the adjacent natural teeth (Figs 16 & 17).

Adhesive Luting and Finishing of the Case

The case was received from the ceramist and inspected on the solid and die models (Fig 18). The provisional restorations were removed and the tooth preparations were pumiced and cleaned (Figs 6, 7, & 19). The restorations were tried in individually to inspect the fit and then were tried in collectively to evaluate the contact points. The veneers were tried in with Prevue try-in gel (Cosmedent; Chicago, IL) and the patient approved the esthetics of the case. The veneers were then luted into place two at a time using the standard bonding protocol with Optibond FL adhesive (a fourth-generation, two-step total etch adhesive system) (Kerr; Orange, CA) and Insure resin cement (Cosmedent). The veneers were polished and the occlusion was checked and adjusted using red and black AccuFilm articulating paper (Parkell). I find that the AccuFilm paper marks porcelain the best if a small amount of petroleum jelly is coated over the surface prior to use intra-oraly.

The patient returned a few weeks after the veneers were seated and the margins were carefully inspected at high magnification using the PRO-ergo microscope to confirm complete tissue healing. (Figs 20-24)

Conclusion

The ultimate goals for an esthetic rehabilitation are the biomimetic recovery of the tooth, as well as the esthetic enhancement of the smile. When the original tooth has a thinned-out or a worn enamel surface and is to be restored to its original volume with porcelain veneers, studies have found that the tooth recovers much of its original structural, optical, and biomechanical properties. Following a minimally invasive preparation protocol guided by the various stents created from the diagnostic wax-up can enhance these goals and create a conservative result for the patient. The tooth preparations can also be made more conservative by following an interdisciplinary approach to treatment planning, using orthodontics to correct any crowding or tooth rotations prior to the restorative phase of treatment.

Editor’s Note: For video footage of the case described in this article, log on to www.phelandentalseminars.com

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References