The Evolution of the Porcelain Laminate Veneer

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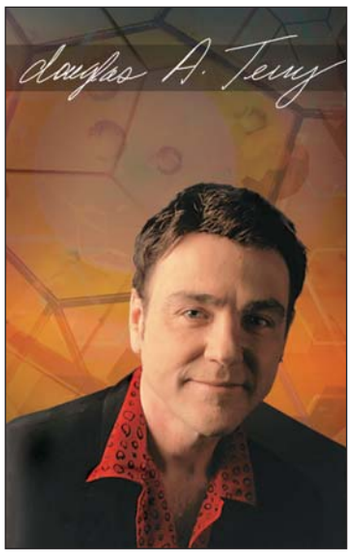
The catalyst behind the development of veneer restorations involved the combination of two innovative processes: mechanical and chemical bonding. The introduction of surface treatment to enamel[1] and porcelain,[2] followed by the development of the first composite resin system,[3] were responsible for the evolution of bonding technology that led to the laminate veneer. During its inception, this concept of placing custom-formed thin shells of plastic or ceramic over the tooth structure was considered a departure from the conventional treatment methods and considered highly suspicious by the dental profession.[4]



Historical Perspective

The veneer concept was developed in 1938 by Pincus, who described a technique for masking defects and improving the appearance of actors' teeth by utilizing a thin plastic or porcelain veneer that was retained by a denture adhesive. The early 1970s brought the introduction of a composite catalyzed by ultraviolet light, which allowed adequate working time for developing direct veneers. These restorations, however, had significant limitations that included poor resistance to abrasion, limited shade selection, increased susceptibility to staining, lack of color stability, and questionable durability of polish.[5]

In the late 1970s, a prefabricated acrylic veneer (ie, chemically bonded to etched tooth structure with a thin layer of self-curing composite resin) was advocated by Faunce.[6] While this technique increased stain resistance and the durability of polish, its use was discontinued because of adhesive failure at the laminate-composite interface and negative gingival responses.[5]

The 1980s saw the introduction of the fabrication and the placement of the porcelain veneer. While the fabrication and cementation procedures were described by Horn,[7] the studies of Calamia and Simonsen outlined the surface preparation time and procedure (eg, hydrofluoric acid etching, silanation) for improved retention.[2,8] This technique, along with advancements in adhesive formulations and resin cements over the past 20 years, have expanded the conservative treatment possibilities that simplify the clinical application of aesthetic techniques and ultimately improve the level of patient oral healthcare.

Indications and Contraindications

Veneers can now be fabricated out of two different materials: composite resin (via either direct or indirect methods) and porcelain. Although not a panacea to all restorative challenges, the veneer can offer alternatives to various clinical situations without compromising the natural tooth or periodontium. These clinical situations include the management of carious lesions, fractured or discolored teeth, worn anterior dentition, and other noncarious enamel defects.[9] Accepted clinical applications for these restorations include masking discolorations, improving anterior guidance, modifying occlusal relationships, and altering tooth size, shape, alignment, and color along with other well-documented indications. Contraindications for these biomaterials include patients with poor oral hygiene,

bruxism, teeth with only dentin present or minimal enamel, teeth that exhibit severe crowding, and teeth in severe labial version.[10]

Porcelain Laminate Veneers (PLVs)

Indirect porcelain veneers provide several advantages to direct resin veneers. With PLVs, discolorations and underlying irregularities can be more easily controlled and monitored using ceramic opaquers and modifiers. In addition, porcelain systems are unsurpassed in color stability, gloss, and wear resistance, and the gingival response to them is excellent since porcelain retains less plaque than other restorative materials.[11] Plaque can also be removed more rapidly from the surface of porcelain.[12] Furthermore, when properly fabricated and bonded, these restorations require minimal finishing. Their disadvantages include the fact that porcelain modifications (eg, contacts, fractured margins) are time-consuming chairside tasks, the bonding protocol for porcelain to composite requires attention to detail, the need for multiple patient visits, and the potential need for provisionalization. The indirect method requires close communication between the technician and clinician for optimal aesthetic results.

Although the original concept of the veneer technique had not evidenced the development of improved dentin bonding systems, the conservative preparation and placement of the restoration in enamel has proven to be beneficial for the longevity of the restoration and tooth. A long-term clinical trial suggests that resin-retained porcelain veneer restorations that did not meet enamel ceramic criteria had a greater risk of failure through microleakage, fracture, and debonding.[13]

While various conservative preparation techniques have been advocated, the diagnostic waxup can aid in the management of tooth removal through the development of a silicone matrix guide. This process also provides the patient with a visual image of the anticipated restorative outcome and should occur prior to finalization of the treatment plan to ensure that the patient is satisfied. The following guidelines should be considered to improve patient understanding and to provide optimal long-term clinical results:

Figure 1. Virgin tooth following improper veneer preparation. Notice preparation is not in three planes and depth cutting was extended too far into dentin.

- Inform the patient of other treatment alternatives, beginning with the most conservative options, and then discuss long-term consequences and replacements;
- A diagnostic waxup should be finalized and reviewed by the patient prior to completion of the treatment plan and initiation of restorative treatment;
- Only prepare teeth when the gingival tissue is healthy;
- Keep as much of the preparation in the enamel layer as possible;
- If dentin is exposed during preparation, seal (ie, hybridize) to prevent sensitivity and bacterial invasion;
- All internal line angles should be rounded to prevent stress that can lead to fracture;
- Margins should be placed supragingivally when possible;
- Provisional restorations, fabricated from the diagnostic waxup, should be developed to allow the patient to visualize and function with the prototype;
- Utilize adhesive techniques according to manufacturers' suggestions;
- Individual placement or sequence placement in series of two beginning at midline (ie, central incisors, laterals, canines) and avoid complete placement of numerous veneers at the

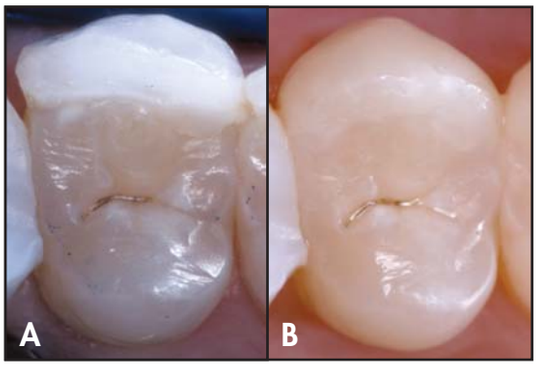


Figure 2A. View of the improper veneer placement on the premolar. 2B. Proper embrasure form and marginal integrity can be seen following veneer replacement.

same time to prevent micromovement and possible microleakage;

- Inspect margins and gingival adaptation, and completely finish and polish; and
- Evaluate occlusion in centric, protrusive, and lateral excursions, adjust as needed and then repolish.

The longevity of a bonded veneer is a direct function to the amount of enamel substrate supporting it.[14] The primary consideration for the success of PLVs is one's knowledge of the enamel thickness and how it varies throughout the given tooth. Unfortunately, many clinicians continue to use preparation guidelines that suggest a standard geometric design, failing to consider the anticipated final restorative dimension or variations in enamel thickness on one tooth to another or from one area of the tooth to another (eg, cervical, body, incisal).[15] This approach of removing predetermined tooth thickness without consideration of anatomic variations and final restorative dimension can result in improper removal of tooth structure and postoperative sensitivity (Figure 1).

Current "makeover" trends promote this more aggressive tooth preparation with less consideration for conservative dental concepts, the needs of the patient, and interdisciplinary diagnosis and treatment planning.[16] Alternatively, the modern restorative concept seeks to minimize the biologic cost of the natural tooth, combining the prevention, preservation, and perpetuation of longevity of the restoration (Figure 2). Clinicians should correct restorative challenges by selecting a progressive treatment concept that begins with the most conservative restorative option and progresses to more invasive procedures only as required.[17] Additionally, the method of informing patients to ensure proper decision-making should be directed toward the long-term biomechanical risks associated with more invasive procedures.

Closing Comments†

Veneers have undergone quite a transformation since their inception as a conservative option was met with skepticism decades ago. Today, however, PLVs are a sound treatment option if conservative preparation designs and precise adhesive techniques are followed. Those clinicians who practice aggressive restorative procedures and improper adhesive protocols leave their colleagues in disbelief and their patients in peril.

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