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CLINICAL ARTICLE

Composite veneers: The direct–indirect technique revisited

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Abstract

Objective: This article provides an update on the direct–indirect composite veneer technique.

Clinical considerations: Composite veneers have long been used as a conservative and esthetic treatment option for anterior teeth. While they are generally performed using a direct technique, there has been renewed interest in the direct–indirect composite veneer technique because of its advantages and broad indications for restoration of tooth color and morphology. In the direct–indirect composite veneer technique, the selected composites are initially applied on the tooth using a layering approach, without any bonding agent, sculpted to a primary anatomic form with slight excess, and light-cured. The partially polymerized veneer is then removed from the tooth, heat-tempered, and finished to final anatomy and processed extra-orally before being luted. Advantages of this technique include enhanced physical and mechanical properties afforded by the tempering process, unrivaled marginal adaptation, enhanced finishing and polishing, and the ability to try-in the veneer before luting, enabling a shade verification and modulation process that is not possible with the direct technique. The direct–indirect approach also affords enhanced gingival health and patient comfort.

Conclusion: This article reviews the direct–indirect composite veneer technique, and outlines critical steps and tips for clinical success.

Clinical significance: The direct–indirect technique for composite veneers combines advantages of the direct composite placement technique with those of the indirect veneer technique, including operator control, single-visit fabrication and delivery, increased material properties, and excellent esthetics.

KEYWORDS

bonding, composite layering, composite veneers, esthetic dentistry, operative dentistry

1 | INTRODUCTION

The direct–indirect composite veneer technique was introduced in the 1990s as a means to heat-temper composites in partial and full veneers.[1-4] In the direct–indirect technique, using similar shade selection and layering techniques that are used for the direct technique, the clinician applies a light-cured composite material to the tooth, with or without tooth preparation, *without* any adhesion. The composite is then shaped to a primary anatomic form with slight excess, and then light-cured. After that, the partially polymerized restoration is carefully removed (lifted) from the non-retentive, non-bonded tooth surface, heat-tempered extra-orally chairside, and finished and polished to final macro and micro anatomy. After shade try-in and confirmation of the overall fit and esthetics, the veneer is bonded to the preparation using a resin-based luting agent.[1,2,4-6] Figure 1 illustrates the workflow for direct–indirect restorations.

Based on N Fahl Jr and AV Ritter (eds), Composite Veneers – The Direct–Indirect Technique, 2020 Quintessence Publishing.

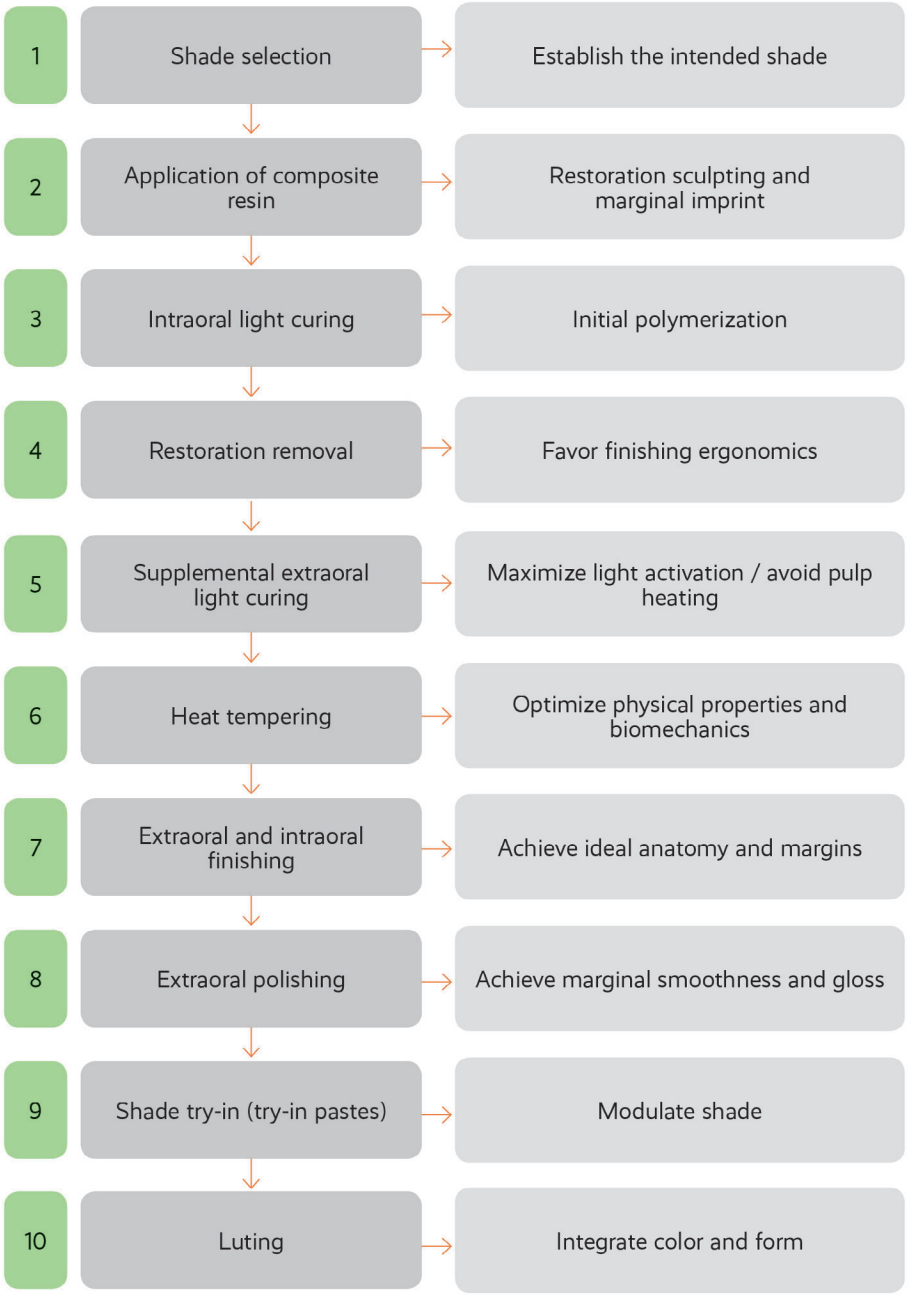

FIGURE 1 Steps for Direct–Indirect Restorations (Reprinted with permission Fahl et al[12])

From a dental materials standpoint, the main advantage of this approach over a directly placed composite veneer is the enhanced physical and mechanical properties afforded by the extra-oral chairside tempering process due to increased monomer conversion.[7-10] From an operator standpoint, the technique affords greater operator control over the final marginal adaptation, surface finishing and polishing, and anatomy of the restoration, given that these elements are created outside of the patient's mouth.[5] Finally, the direct–indirect technique is more comfortable to patients, since many of the restorative steps involving rotary instrumentation, particularly margin finishing, occur extra-orally.[5] When compared to ceramic veneers, the direct–indirect composite veneer affords the clinician more control over the entire procedure, including composite shade selection and modulation, the ability to re-do a restoration immediately if the initial shade(s) selected were not correct, the possibility of doing the veneer in a single appointment, and is potentially less costly.

This article summarizes the clinical technique for direct–indirect composite resin veneers with and without preparation. A clinical case is used to illustrate the technique step-by-step.

2 | NO-PREP VENEERS

No-prep Veneers are thin composite veneers with a thickness of more than 0.5 mm, used to change the color and/or shape of teeth when no tooth preparation is required. Unlike *contact lenses* (veneers that

are 0.5 mm or less in thickness, not discussed in this article), no-prep veneers are normally layered with dentin and enamel shades in varying degrees of opacity / translucency.

No-prep veneers are indicated for minor morphological discrepancies that compromise the proportion, size, and volume of the natural dentition. While no-prep veneers are most commonly used in teeth with no discoloration, they *can* be used when such teeth are lingually positioned or undersized, as in the case that illustrates this article. In these situations, the esthetic improvement is achieved by enhancing only the shape of the teeth through *composite resin addition* (hence the no-prep concept) to achieve the desired tooth morphology. Examples of indications for no-prep veneers include heteromorphism, mal-alignment particularly for lingually-positioned teeth, and enamel abrasion/erosion. Figures 2-4 show an example of an indication for a no-prep veneer. Notice in Figure 3 (incisal view) how the discolored tooth is slightly lingually-positioned.

From a clinical standpoint, it is strategic to classify no-prep veneers based on the thickness, number or layers, and incisal edge involvement (Figure 5):

FIGURE 2 Pre-op smile of patient with discolored tooth #8

FIGURE 3 Pre-op occlusal/incisal view of tooth #8, notice slight lingual position of the tooth, which allows a direct–indirect veneer without preparation to be accomplished

- A *Type 1 No-prep Veneer* is used when the facial anatomy must be restored with composite resins with thicknesses in excess of 0.5 mm and the incisal edge must be augmented to reestablish esthetics and function. No-prep veneers Type 1 require a Body Enamel (V1A), Value Enamel (V1B), or both (V1C), *and* a Dentin layer, a Milky-White-Semi-Translucent (MWST) enamel as a lingual shell.
- A *Type 2 No-prep Veneer* differs from a no-prep Veneer Type 1 in the level of internal characterization of the incisal third, and translucency in particular. Trans Enamel resins with a high degree of translucency, iridescence and opalescence are included as a sublayer to create such effects and render the incisal third more polychromatic (V2A, V2B and V2C).

3 | VENEERS WITH PREPARATION

Veneers with preparation are required when it is necessary to create space for the composite material, particularly in discolored teeth when the composite needs to mask the discoloration. Whenever possible, veneer preparations should be intra-enamel to promote high bond strengths and decrease the likelihood of adhesive failure.[11] However, the extent of the tooth preparation is based primarily on the degree of discoloration (if present) and the position of the tooth relative to the ideal location of the final facial contour of the veneer.

Various veneer preparation designs have been recommended, with focus on two main designs according to the involvement of the incisal edge: overlap or no-overlap (Figure 6):

- A *Type 1 Veneer with Preparation* preserves the incisal edge and is totally confined within the facial aspect, hence the term "window prep". Clinical indications include extremely dark tetracycline staining, calcific metamorphosis and congenital erythropoietic porphyria, among others, in patients with a normal overbite. The amount of axial reduction will depend on the degree of

FIGURE 4 Intraoral view of teeth 6–11

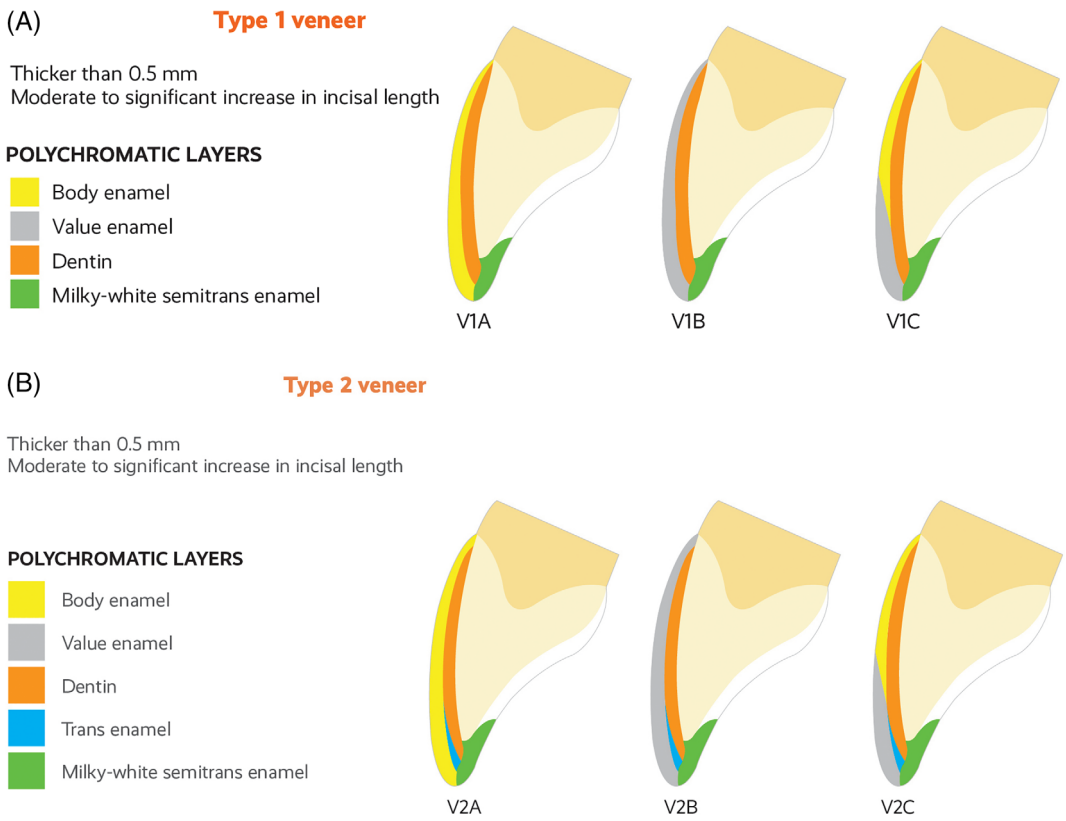

FIGURE 5 (A) and (B) Veneer without Preparation Classification. (Reprinted with permission Fahl et al[12])

discoloration, typically varying from 1–1.5 mm. Just as in the no-prep veneer, here a Body Enamel and a Value Enamel will be used, but because the veneer with preparation typically requires masking of a discolored background, a Dentin and an Opaquer are also used. As homogeneity of thickness for the layering of composite resins and opaquer is crucial to achieve an even color distribution, the window preparation must be evenly carried out throughout the facial aspect and particularly over lower value areas. The preparation must follow the intended facial morphology, while allowing enough room for the amount of composite needed for layering. Depending on the degree of translucency and mamelon effect desired, the incisal third may be thinned out to remove practically all of the dentin while leaving a translucent palatal shell of natural enamel.

- A *Type 2 Veneer with Preparation* requires an incisal overlap and is recommended when incisal lengthening or anatomic modification of the incisal edge is desired. The veneer preparation Type 2 follows the facial reduction guidelines of Type 1 but requires space for an additional incisal build-up to create natural color and optical characteristics of dentin and enamel. Type 2 veneers with preparation require the same composites used for Types 1A, 1B, and 1C, namely Body Enamel, Value Enamel, Dentin, and Opaquer; however, to achieve an optimal esthetic result at the incisal reduction aspect, a MWSE is used as the lingual shell and a Trans Enamel is used to enhance the opalescence and intensify mamelon characteristics. The ideal amount of space necessary for the incisal layering is at least 2 mm. For short teeth that need to be lengthened by 2 mm or more, no further incisal reduction is necessary. In cases of normal occlusion, a 30° - 45° strong bevel is enough to create macro- and micro-mechanical interlock and achieve adequate strength. A shallow chamfer is otherwise indicated when restoring the incisal edge of teeth that will be under stress during function.

4 | SHADE SELECTION

It is beyond the scope of this article to present all of the necessary information related to material and shade selection for composite veneers. Direct–indirect veneers can be fabricated with either the *Polychromatic Concept*, or the *Natural Layering Concept*, or with a combination of both concepts, depending on the tooth shape and color modifications that may be required by the clinical case at hand. The selection of one technique over another will depend on the clinician's own preference and on the available composite resin systems. Nevertheless, it is important that the composite resins used in the fabrication of these restorations provide the necessary optical and mechanical properties to accommodate the different layering concepts that may require the use of materials of varying opacities and strength. Figure 7 (A),(B) illustrate the clinical process for dentin and enamel shade selection for a no-prep veneer where only one dentin and one value enamel shades are used, in combination with various tints.

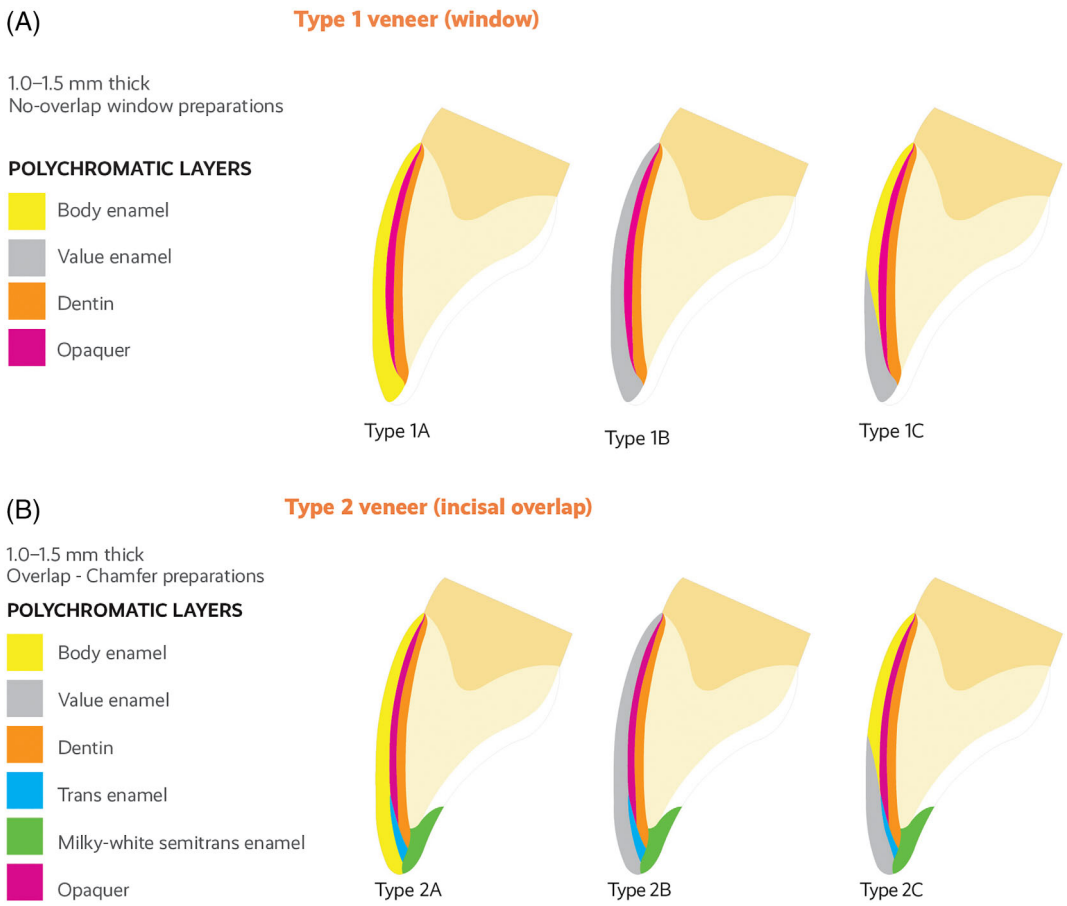

FIGURE 6 (A) and (B)Veneer with Preparation Classification. (Reprinted with permission Fahl et al[12])

5 | COMPOSITE RESIN APPLICATION - LAYERING

In a direct–indirect veneer, the order with which each of the selected composite resins is used is the same as in the direct veneer, *except* when opaquer and tints are needed, in which case the dentin is the first layer followed by the opaquer/tints, to optimize bond strengths (Figures 8 and 9). This is because air-borne particle abrasion and silane treatment cannot be optimally performed on opaquers/tints due to their chemical composition and relatively thin film thickness. Furthermore, the composition and structural arrangement of the resin matrix (organic phase) and fillers (inorganic phase) of restorative resins provide higher bond strengths, making them the material of choice to be used as the first layer. If used, tints and opaquers are applied between the dentin and the enamel layers (Figure 10).

As a general rule, the last layer (Body Enamel, Value Enamel, or both) should be applied with a slight excess (Figure 11). This makes it easier to remove the veneer prior to extra-oral finishing and polishing, avoiding breakage especially with thin no-prep veneers.

Another important recommendation, particularly for veneers with preparation, is that the tooth preparation must be properly finished and polished to facilitate veneer removal after initial curing and before extra-oral processing. This step is especially important if composite restorations remain on the preparation, in which case a surface lubricant should be sparingly applied to isolate the resin from the preparation and thinned out in order to prevent contamination between layers.

6 | VENEER REMOVAL

Once the veneer is completed and light cured intra-orally, flashes of composite that might cause locking and prevent cracking or breaking the restoration upon removal should be eliminated. Course finishing discs and #12 scalpel blades can be used to remove gross lingual excess resin, especially around the incisal and lingual embrasures. Next, the veneer should be engaged at the faciogingival embrasure level with an excavator and gentle yet firm pressure should be placed through a leverage motion on both mesial and distal aspects until the veneer is carefully removed (Figure 12).

7 | CONTOURING, FINISHING AND POLISHING

The step by step protocol for contouring, finishing, and polishing of the direct–indirect veneer will be summarized here; for a more

FIGURE 7 (A) Dentin shade selection. (B) Value enamel shade selection

FIGURE 8 An appropriately-sized dry retraction cord is carefully packed to allow gingival displacement and moisture control

complete description please refer to Fahl and Ritter, 2020.[12] Once the restoration is removed from the tooth, the imprinted margins should be outlined with a red pencil (Figure 13). Aluminum oxide discs are used sequentially to remove the gross excess, and to finish and polish the margins to ideal contour, smoothness, and gloss. The veneer is

FIGURE 9 The dentin-shaded composite is applied and light-cured

subsequently positioned back on the tooth and checked for precision of fit and stability (Figure 14). The incisal one third is flattened until the facioincisal line angle is in proper alignment both in facial volume and incisal length. Next the emergence profile and facial planes are established while the restoration is seated (prior to bonding). Course discs are again used to anatomically blend the cervical and incisal thirds thereby establishing the correct facial contours. The veneer should then be in full facial alignment with the adjacent teeth. With the veneer still in place, the facioproximal transitional line angles are outlined with a pencil to match their ideal position. The veneer is removed and the facial embrasures are finished to proper morphology. Finally, finishing and polishing is accomplished with discs of varying grits until the primary anatomy of the veneer is achieved (Figure 15). Secondary anatomy is not carried out preferably until the veneer is bonded because it is easier to mimic micro and macro texture through direct comparison with the natural dentition.

8 | SUPPLEMENTAL LIGHT-CURING AND HEAT TEMPERING

The finished veneer is then submitted to supplemental extra-oral light-curing and heat tempering, which optimizes monomer conversion while avoiding deleterious pulp overheating. This can be accomplished with a high-power chairside light curing unit, or with a number of other heat-tempering methods.[12]

9 | SHADE TRY-IN AND LUTING AGENT SELECTION

One the greatest benefits of the direct–indirect technique is that minor color changes can be realized through the use of luting resins of varying shades and degrees of opacity. This is very beneficial especially when trying to match a single veneer to adjacent, untreated

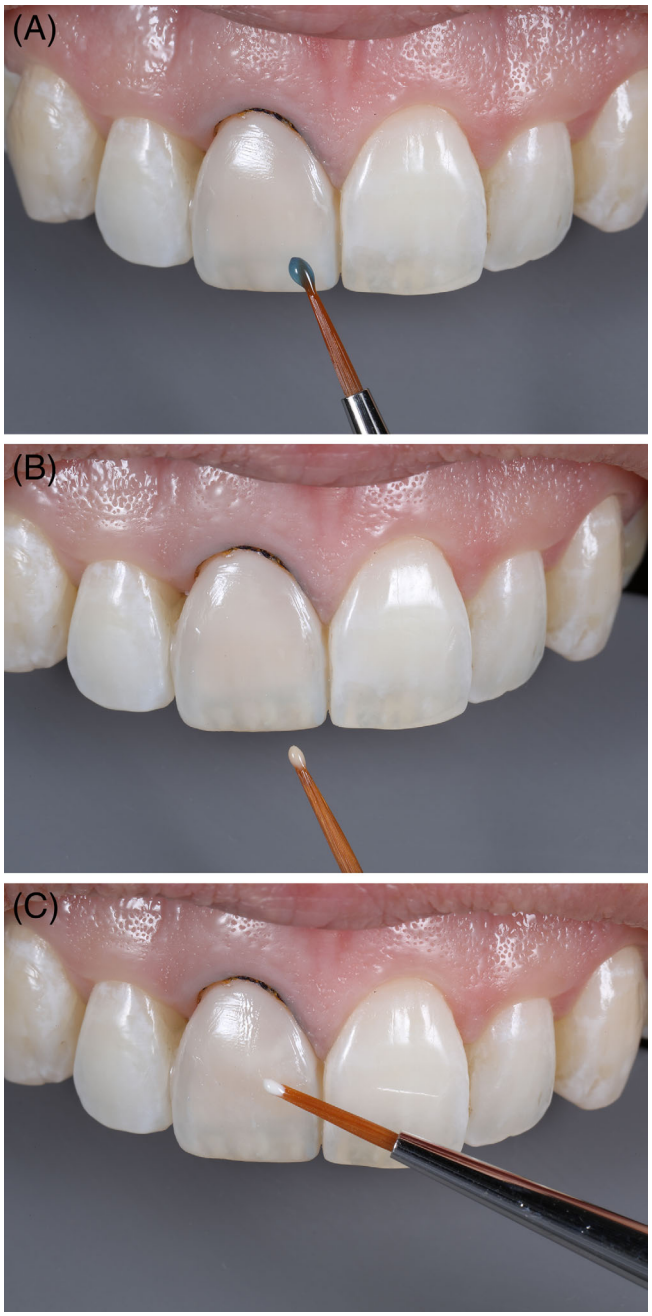

FIGURE 10 (A-C). Given the need to accomplish a high degree of characterization in a relatively thin veneer, tints were used to enhance these effects. (A) A blue tint is applied; (B) A mamelon tint is applied; and (C) a white tint is applied

teeth, and when doing multiple units and the patient's input is needed to determine the color matching alternative that best pleases her or him. How much color change can be achieved under such thin restorations depends on the thickness, color and opacity level of the veneer and the luting resin. Understanding the parameters that guide the modulation of hue, chroma and value will allow the clinician to modify a set color by mixing different shades in varying proportions until the desired color is finally achieved.

FIGURE 11 The value enamel is applied and light-cured. Note the value enamel is applied in excess, so as to allow removal and handling of the veneer without breaking

FIGURE 12 This image shows the veneer being removed prior to extra oral light curing and heat tempering

9.1 | Luting resin systems and try-in pastes

There are several systems specifically designed for veneer cementation. Light-cured luting systems (resin cements) that provide try-in pastes are ideal, as they allow for a previsualization of the final color prior to seating of the restoration. Try-in pastes are also beneficial because they are hydro soluble and can be used and rinsed quickly, which expedites the shade try-in stage. Although the actual luting resin can be used for the try-in, having to clean the veneer with alcohol after try-in(s), or breaking it upon removal, or even the possibility of the ambient light setting the resin, are inconveniences that make this approach less than desirable.

9.2 | Shade try-in technique

The shade try-in protocol will only work if the actual color of the veneer is correct in the first place, as no major color changes are

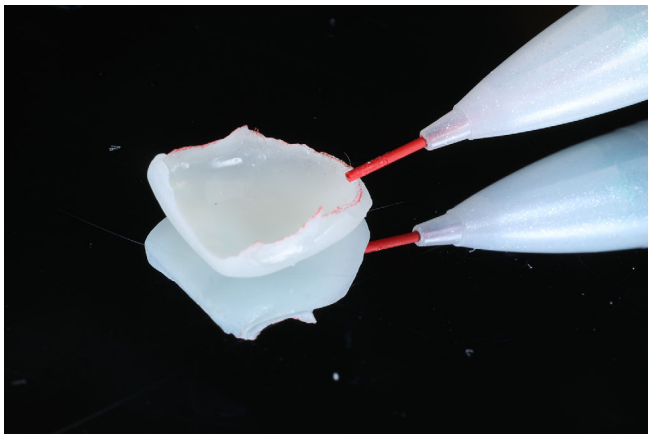

FIGURE 13 The veneer margins are outlined prior to finishing and polishing

FIGURE 14 The veneer is tried on and primary anatomy developed

FIGURE 15 Finished direct–indirect veneer

possible if the shades of the selected composites are totally wrong and the mismatch is significant. The most important feature of a luting resin is to modulate the value and the chroma, in that order. After the

FIGURE 16 The path of insertion is verified before adhesive procedures

path of insertion is confirmed (Figure 16), the veneer is tried in dry, wet, and, when additional opacity is needed, with opaque try-in pastes (Figure 17).

10 | BONDING

10.1 | Veneer treatment

The treatment of the veneer intaglio surface involves airborne particle abrasion[13] and application of 35%–40% phosphoric acid for 10 s (Figures 18 and 19). Next, silane is applied (Figure 20) followed by a hydrophobic adhesive resin (Figure 21), and air-thinned. The restoration is set aside under a light-protective shield until it is luted. If more than one veneer is being completed, they should be organized in the sequence according to which they will be bonded.

10.2 | Tooth surface treatment

The tooth surface treatment will vary depending on the type of substrate involved. Unprepared enamel should be lightly "roughened" with a fine grit flame shaped finishing diamond bur or air abrasion with 27–50 μm aluminum oxide particles. For intra-enamel veneers, these steps are not necessary. Veneers with preparation will almost invariably expose a large dentin surface area, particularly for discolored teeth, and therefore the bonding protocol will be considerably more complex (Figure 22). For a no-prep veneer, the tooth is etched with phosphoric acid (Figure 23), rinsed, then the adhesive is applied (Figure 24).

10.3 | Choice of adhesive

A 3-step etch-and-rinse adhesive is preferred for bonding no-prep veneers because phosphoric acid etching of enamel is very effective

FIGURE 17 Dry (A) and wet (B) try-in. (C) Try-in with opaque try-in paste

and predictable for enamel bonding. For veneers with preparation where dentin and/or composite resin is exposed, the choice of adhesive is far more complex and should be matched to the type of restoration and substrate. Because the longevity of the tooth-restoration complex is highly dependent on the quality of the adhesive interface, the choice of adhesive application strategy is critical. It is not in the scope of this article to describe the adhesion protocol in detail; the reader is encouraged to read Fahl & Ritter, 2020.[12] In the direct–indirect technique, the adhesive should *never* be light-cured prior to seating the finished restoration because it may pool if not thinned out properly, thereby creating a thicker layer that prevents precise fitting of the veneer.

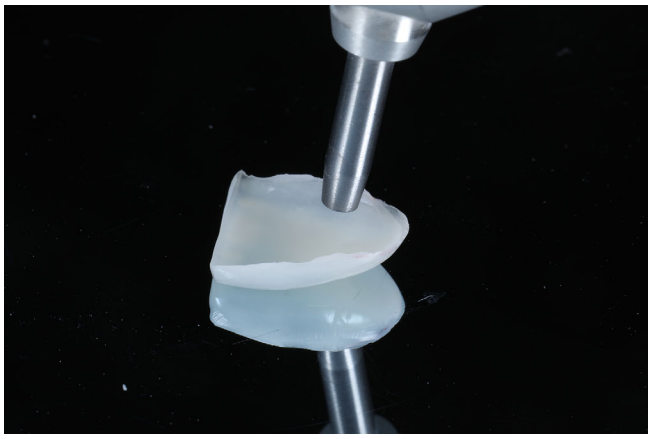

FIGURE 18 Using sandblasting on the intaglio veneer surface

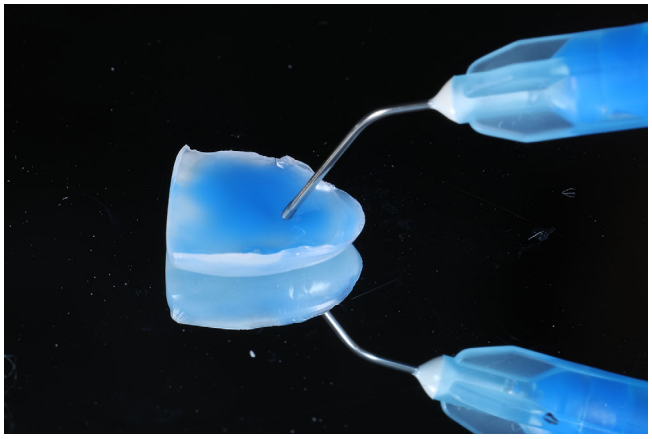

FIGURE 19 The intaglio surface is etched with phosphoric acid

Once the adhesive has been applied to both the veneer and the tooth, the veneer is loaded with the resin cement and seated (Figures 25 and 26).

11 | POST-LUTING PROCEDURES

11.1 | Primary anatomy refinement

Anatomical elements that may require additional finessing usually include transitional line angles, point angles, and incisal and facial embrasures. To assist in the visualization of these landmarks, extra-fine silver powder or glitter is brushed over the veneer. Flash photography will identify the light-reflecting and light-deflecting areas that were amplified by the silver powder and provide an enhanced visual perception of the anatomical details that need to be incorporated. These symmetry-related modifications are carried out with finishing

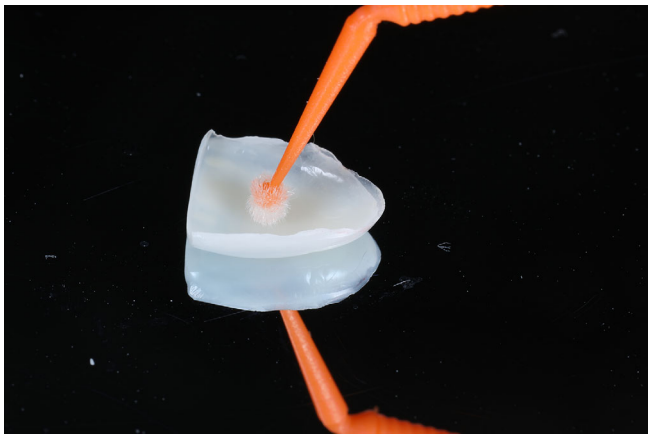

FIGURE 20 Silane is applied to the intaglio surface

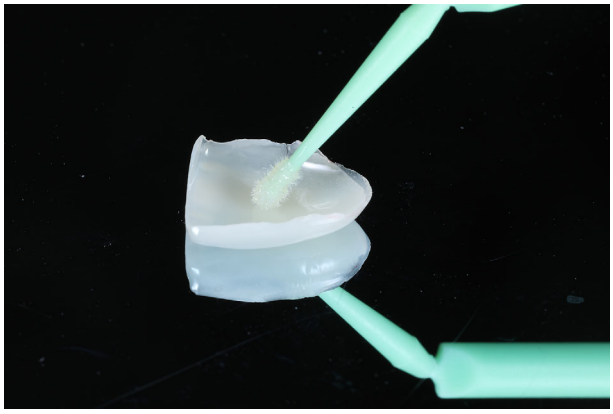

FIGURE 21 Adhesive is applied to the veneer

discs. At this step, composite resin flashes that overlap the incisal edge of the tooth are finished and occlusion adjustment is performed.

11.2 | Secondary and tertiary anatomy

Once the veneer is bonded at the primary anatomy stage, it becomes easier for the clinician to create secondary and tertiary anatomy without having to modify the original contours, as the primary facial and proximal boundaries have been previously determined during the intra- and extra-oral finishing and polishing steps. Anatomic details that compose the tertiary anatomy, such as split lobes, depressions, perikymata, and stippling, can be added according to the desired morphological pattern. Multi-fluted carbide and fine diamond burs are

FIGURE 23 The tooth is sandblasted and etched with phosphoric acid

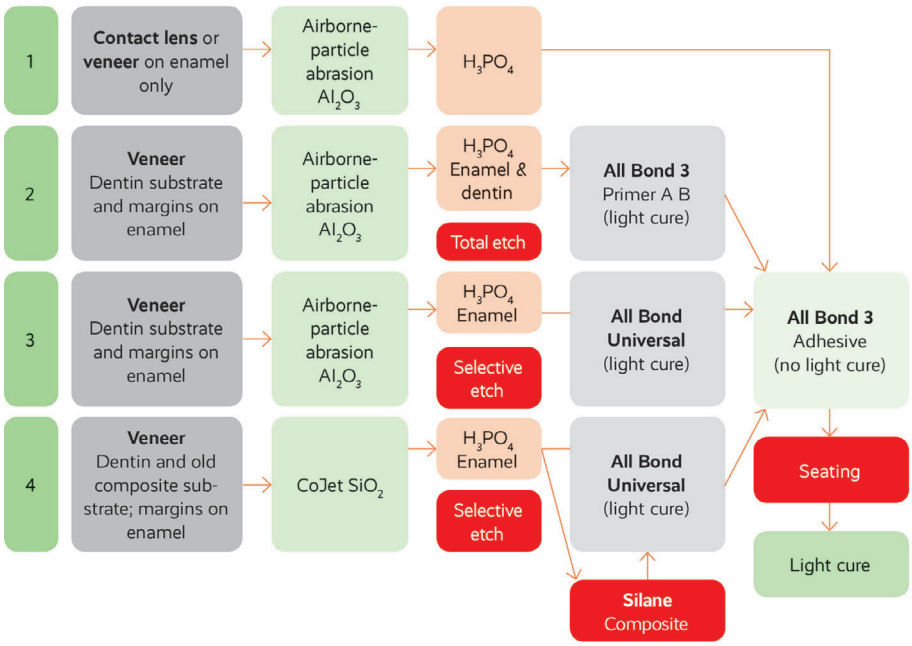

FIGURE 22 Adhesive Protocol for Bonding Direct–Indirect Composite Veneers. (Reprinted with permission Fahl et al[12])

FIGURE 24 Adhesive is applied to the tooth

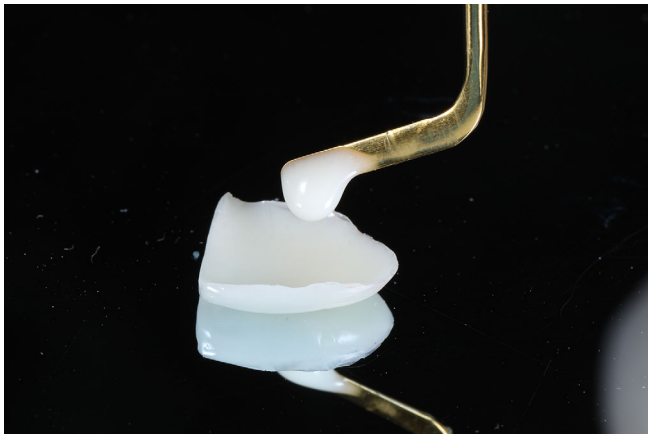

FIGURE 25 Luting resin cement is applied

FIGURE 26 The direct–indirect composite veneer is luted

FIGURE 27 Immediate post-op. Notice slight shade mismatch (lower value) due to dehydration of the adjacent teeth

FIGURE 28 One-month post-op

FIGURE 29 Post-op with lips in repose

ideal for this purpose. These burs should be used with extra care in order not to over-reduce the thin veneer enamel layer, causing undue perforation, especially in extra-thin contact lenses. Also, burs should be kept away from subgingival margins – a sometimes-hard step to remember for the operator who is used to finishing subgingival margins the conventional way with rotary instruments when doing direct composite resin restorations and is not completely familiar with the direct–indirect concept.

Because the margin of the restoration is complete finished and polished extraorally before luting of the veneer, its margins should not

FIGURE 30 Post-op smile

FIGURE 31 Post-op occlusal/incisal view of tooth #8

be touched during this post-luting phase, so as to avoid trauma to the soft tissue and a rough composite margin.

11.3 | Polishing

Polishing should encompass the facial and lingual aspects and promote life-like surface smoothness and gloss. Over-accentuated texture can be softened to match the natural adjacent teeth, in the case of a single unit, or to reach the degree of texture that the dentist and patient have deemed appropriate, in the case of multiple units. Rubber rotaries of varying levels of abrasiveness are used for initial polishing and are followed by brushes, diamond and aluminum oxide polishing pastes, and buffing discs. Again, as mentioned above, the sub-gingival margin should not be touched.

Figures 27-31 show immediate and 1-month post-operative views of the completed case.

12 | DISCUSSION AND CONCLUSION

Recent advances in composite materials, instrumentation, and chairside light-curing have generated renewed interest in the direct–indirect composite veneer technique given its advantages over directly-placed veneers. Modern composites, when correctly used, can achieve esthetics that matches that of ceramics in many cases, including surface texture and shade matching and characterization. Additionally, the new generation of curing lights affords energy that approximates that of laboratory-based composite processing devices. All of these advances make it possible for clinicians to obtain chairside composite veneers that result in an excellent restoration choice for many cases that would otherwise be very challenging to complete using a direct composite technique.

The direct–indirect composite technique undoubtedly represents a different (and perhaps initially challenging) paradigm for the management of certain clinical situations. This approach is not a solution for all problems related to composite resins, and certainly has its limitations, such as when the tooth/teeth present pronounced undercuts in which case a direct restorative technique would allow more tooth conservation. Nevertheless, with practice, determination, and attention to detail the clinician will find that this technique will be a great addition to his/her armamentarium.

As with any evolving clinical technique, further research is necessary to determine optimal adhesive protocols for the direct–indirect composite technique, as well as to more properly compare its marginal adaptation and clinical performance with the more traditional direct composite technique.

CONFLICT OF INTEREST

The authors do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Birnbaum NS. Direct oven-tempered hybrid composite-resin laminate veneers. *Pract Periodontics Aesthet Dent*. 1992;4(5):23-31.
2. Birnbaum NS. Heat-tempered composite resin laminate veneers. *Curr Opin Cosmet Dent*. 1994;52-57.
3. Covey DA. Composite resin inlays. *Va Dent J*. 1992;69(2):30-36.
4. Fahl JN. The direct/indirect composite resin veneers: a case report. *Pract Periodontics Aesthet Dent*. 1996;8(7):627-638.
5. Fahl N Jr. Direct-indirect class V restorations: a novel approach for treating noncarious cervical lesions. *J Esthet Restor Dent*. 2015;27(5):267-284.
6. Dietschi D, Spreafico R. *Adhesive Metal-Free Restorations: Current Concepts for the Esthetic Treatment of Posterior Teeth*. Chicago: Quintessence Publishing; 1997.
7. Covey DA, Tahaney SR, Davenport JM. Mechanical properties of heat-treated composite resin restorative materials. *J Prosthet Dent*. 1992;68(3):458-461.
8. Ferracane JL, Condon JR. Post-cure heat treatments for composites: properties and fractography. *Dent Mater J*. 1992;8(5):290-295.

9. Ferracane JL, Mitchem JC, Condon JR, Todd R. Wear and marginal breakdown of composites with various degrees of cure. *J Dent Res*. 1997;76(8):1508-1516.
10. Wassell RW, McCabe JF, Walls AW. Wear rates of regular and tempered composites. *J Dent*. 1997;25(1):49-52.
11. Friedman MJ. Commentary. Survival rates for porcelain laminate veneers with special reference to the effect of preparation in dentin: a literature review. *J Esthet Restor Dent*. 2012;24(4):266-267.
12. Fahl N Jr, Ritter AV. *Composite Veneers: the Direct-Indirect Technique*. Chicago, IL: Quintessence Publishing Co; 2020.
13. Ritter AV, Sulaiman TA, Altitinchi A, Baratto F, Gonzaga CC, Correr GM. Effect of tribochemical coating on composite repair strength. *Oper Dent*. 2020;45(6):E334-E342.

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