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THIRD EDITION

Porcelain Veneers

Educational Objectives

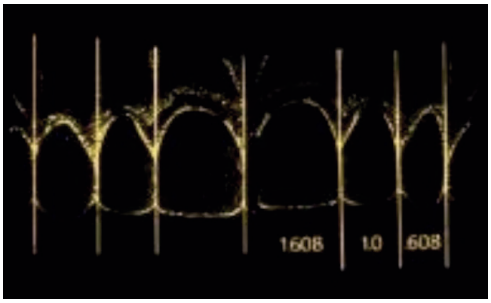
Following this unit of instruction, the practitioner should be able to:

1. Identify appropriate clinical situations where porcelain veneers will provide the optimal restorative result.
2. Prepare the teeth with ideal reductions on the facial, incisal, and proximal surfaces to achieve the esthetic objectives of the patient and the dentist.
3. Engineer tooth preparation designs that account for the presence of various defects, including previous restorations, while optimizing the stress distribution and esthetic outcomes of the veneer.
4. Prescribe the most appropriate porcelain material to achieve the desired esthetic outcome for the veneer(s) in terms of opacity and translucency.
5. Place comfortable and esthetic provisional restorations that protect the teeth and allow the patient to maintain excellent gingival health.
6. Implement a luting regimen that includes all appropriate bonding steps to the porcelain and the tooth structure; provides adequate gingival isolation to prevent contamination during luting; ensures the best fit of the porcelain veneer.
7. Finish the porcelain veneer margins by atraumatic methods that enhance the longevity of the esthetic restoration.
8. Describe potential risks and outcomes for patients.

Introduction

This guide will discuss the indications and contraindications of porcelain veneers and describe various situations in which porcelain veneers can be used to restore the color, contour or alignment of teeth. The guide will describe appropriate tooth preparation designs and the research supporting the proposed designs. Several methods of temporization are described as well as the luting and finishing of porcelain veneers. Differences between porcelain materials are enumerated. Clinical outcomes are described along with best practices to insure success.

Figure 9



The Golden Proportion

Case Selection: Use of Veneers

Porcelain veneers are most commonly used to alter the color of teeth (Figures 1 and 6); repair chipping (Figure 2); repair damage created by acids (Figure 3); correct tooth alignment or spacing (Figure 4); improve tooth shape (Figure 6) and close diastemas (Figures 7 and 8)). Occasionally porcelain veneers can also be used to alter anterior guidance in cases of attrition (Figures 5 & 8). When changing tooth shape it is especially important to consider the appropriate proportionality of tooth size in the smile (Figure 9). Porcelain veneers may be placed on endodontically treated teeth in lieu of a crown in cases where crown preparation will substantially weaken the tooth.

Author Acknowledgements

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The following commentary highlights fundamental and commonly accepted practices on the subject matter. The information is intended as a general overview and is for educational purposes only. This information does not constitute legal advice, which can only be provided by an attorney.

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Figure 1



Mild tetracycline staining

Figure 2



Chipping, discoloration

Figure 3



Bulimia

Figure 4



Space and alignment, tooth shape

Figure 5



Color correction, chipping, attrition and guidance

Figure 6



Color correction, shape and embrasures

Case Selection: Limitations of Veneers

Porcelain veneers may be unable to mask the very darkest tetracycline stains if patients want very white teeth. These teeth may require an all porcelain crown or PFM to completely mask discoloration. Heavily restored teeth may require a complete crown for strength and /or to minimize exposed margins.

Porcelain veneers are subject to fracture and dislodgement when placed on the teeth of patients who brux. While porcelain veneers can be successfully used to align slightly mal-posed teeth, they should not be used in cases where teeth need to be reduced to expose a substantial amount of dentin prior to placing veneers. When porcelain veneers are bonded predominately to dentin, long-term retention of the veneer is not predictable, since research shows that resin-to-dentin bonding under stress, diminishes over time. This fact also contradicts veneers for bulimic patients who have lost all their lingual enamel. When biting forces are applied to the veneer margins that are placed in lingual dentin, eventual de-bonding of the veneer is highly likely.

Pretreatment Tooth Bleaching

In some cases of tooth discoloration, a more favorable result may be achieved using a pretreatment bleaching protocol. If the clinician wishes to do that, realize that the bond strength is lessened significantly to bleached tooth structure.[1,2] When teeth are bleached using peroxide, the peroxide will release oxygen which infuses the dentinal tubules. Oxygen will prevent complete resin polymerization. Studies of bonding strength after bleaching demonstrate that it is best to wait at least two weeks after bleaching before bonding, to regain bonding strength and allow all of the oxygen to dissipate from the dentin.[3]

Figure 7



Tooth fracture, diastemas

Tooth Preparation

Facial Reduction

Several styles of tooth preparation for facial veneers have been advocated since porcelain veneers were introduced in the early 1980's. These vary from the most conservative, where the tooth is not reduced at all, to fairly aggressive preparations that have been described as reverse three-quarter crowns.

When porcelain veneers were first introduced to the profession (and again recently) proponents advocated bonding them directly to etched enamel of unprepared teeth. The outcome of this approach may be esthetically pleasing in some cases, but in all cases, the veneered teeth will appear larger and squarer. Over time, stain may appear at the perimeter of the veneers, depending on the quality of the fit and finish of the veneer.

When direct composite veneers or very thin porcelain veneers are being done no preparation to minimal (0.5-0.75mm depth reduction) tooth preparation, contained primarily in enamel has become most popular.[4,5,6,7] This technique is modified depending on the amount and type of discoloration with gray to purple tetracycline stains requiring the greatest reductions. Diastema closures typically require no tooth preparation for restoration with composite resins and minimal reduction for porcelain veneers.

However, the most satisfactory results usually occur with some type of metered facial preparation design removing less enamel at the facio-gingival margin (0.5-0.75mm) and more at the facio-incisal (1-1.2mm).[8,9] (Figures 10 and 11) This will permit restoration of a tooth with a veneer reliably bonded primarily to enamel, and allows latitude for shaping the restored tooth. Generally, the thicker the porcelain and the thicker the enamel, the loads needed to fracture and cause catastrophic fracture rise substantially when tested in vitro.

Figure 8

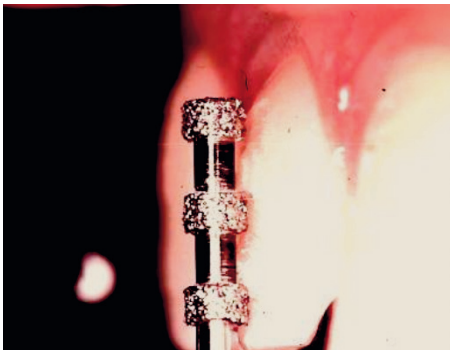


Attrition, color, diastemas, guidance

Veneer preparations should have a chamfered margin gingivally and interproximally.[10,11] This permits sufficient thickness for the veneer to mask underlying discoloration. A well-defined finish line permits accurate positioning and smooth marginal finishing of the veneers. Unless discoloration would cause a need to do otherwise, the gingival margin should be placed at the crest of the gingival margin of tissue. The most favorable response from the gingiva is achieved with the margins at the crest of the gingival tissue.[10,11] If dark discoloration must be covered, then the margin design may extend about 0.5-1.0 mm subgingival. This will assure a favorable periodontal response.

For many years after porcelain veneers were first introduced, it was recommended that all veneer margins end on enamel, because dentin bonding at the time was not predictable.[10,11] With dramatic improvements in dentin bonding over the past twenty years, there is greater acceptance of preparation designs that place margins in dentin or cementum. However, the clinician should realize that, over time, some margins ending on dentin or cementum will leak and could affect the longevity of the restoration, even when the best materials and techniques are used. The greater the percent of the preparation is on dentin, the greater the risk for fracture.[11,12,13,14,15,16]

Figure 10



Metered tooth reduction

Figure 11



Completed porcelain veneer preparation

Incisal Design

Suggestions for the design of the incisal margin of the tooth preparation has varied over time, but today there is general consensus that preparation of the incisal margin for porcelain veneers is required, but it should permit no more than 2mm of free-standing porcelain. It is generally agreed that extending porcelain more than 2mm beyond the incisal edge of the tooth significantly increases the likelihood of fracture. Suggestions for the design of the linguo-incisal margin has varied over time but the best incisal design identified by research is a 1-2mm incisal reduction with a butt joint (i,e, no lingual chamfer). This design will minimize incisal chipping, and will make the fitting, bonding and fabrication of the porcelain veneer easier.[17] Newer research is beginning to support the idea of two designs to the incisal. For worn and chipped incisal enamel, a butt joint is recommended; whereas for healthy normal teeth an incisal overlap, i.e. a palatal chamfer is preferred.[18,19,20,21] The butt joint design handles stress better in worn teeth and concentrates stress less in unworn teeth and have proven over a 7-year clinical trail to be reliable.

In a situation where a significant portion of the incisal length or incisal angle is missing, it is recommended to build the incisal angle up using composite resin prior to covering the restored defect with a porcelain veneer. Research has shown that replacing missing tooth structure with a bonded composite will improve the outcome in terms of fracture resistance; as compared to not building up the fractured tooth and ending up with too great a thickness of porcelain.[22,23] Other studies show that bonding to previously placed composites affect the bond strength and can increase incidence of chipping, or fracture.[19, 20] The theory underlining this finding relates to the water sorption of composite resins and its effect on free monomer. This water sorption will reduce the availability of free monomer to which resins subsequently bond. Generally, the older the composite, the weaker is the bond to it. The best practice is to replace any composite material contained within the porcelain veneer preparation outline, if the existing composite age is greater than about 2-3 years. Repair strength studies show bond strengths after that time begin to fall below 50% of the tensile strength of the material being studied.[24,25] Research also directs us to apply silane to any pre-existing composite material under a porcelain veneer before luting the porcelain veneer. Placing a thin film of a bonding resin after the silane has been applied and dried significantly improves the bond strength of new resin to old composite.[26,27]

Bonding to existing composite resins compared to tooth structure causes no significant microleakage or fracture load differences.[28] In a clinical trail of of 3.5 years, porcelain veneers bonded to existing composites of good quality untreated and treated with silane and Cojet (a silica coating) showed no significant difference in outcomes.[29]

Design to Prevent Chipping & Fractures

How do you minimize chipping and fractures of porcelain veneers? All veneers depend on adequate support to minimize chipping. Bonding to tooth structure provides some of the support. Making sure there is no more than 2mm of free-standing porcelain will also minimize fractures, especially for diastema closures. There should be adequate anterior guidance in protrusive and lateral movements in order to prevent excessive stresses on the veneers. Group function may place too much stress on veneers and can increase the incidence of chipping. Inadequate bonding can also cause chipping of the porcelain.[6] Make sure each bonding step is followed carefully and without error or contamination. Fracture can also occur if the preparation design includes sharp angles rather than rounded angles. Research is quite conclusive in demonstrating the concentration of forces in areas of the preparation that are sharp.[6,7,8]

Interproximal Extension

Where should the interproximal margins end? Some clinicians will favor not breaking the contact with the adjacent anterior tooth, thereby placing interproximal margins slightly labial to - or right at the proximal contact.[6] Margins placed labial to the proximal contact may reveal stain over time. Proximal margins are extended lingually when closing diastemas; including old restorations that extend lingually past the proximal line angle; and when a tooth is being repositioned by veneering to alter either the inciso-apical tilt, the incisal edge placement, or the mesio-distal alignment of the facial and proximal surfaces. In all cases, clinicians are urged to prepare the tooth especially near the gingival margin interproximally, so that the original tooth structure does not show. (Figure 12; note the areas at the arrows)

Porcelain technicians prefer preparations either not through proximal contact or generously through proximal contact to make it possible for them to finish a sound porcelain margin. Placing proximal margins lingual to the proximal contact improves bond strength by increasing surface area and provides greater fracture resistance. The esthetic outcome may be better by placing margins where they are more easily finished. Lingually placed proximal margins also will not make marginal staining as evident to the patient. Veneers placed distal to the canine should have the proximal margins end facial to or at the broader proximal contacts of posterior teeth.

Veneer preparation for diastema closure should be extended lingually near the cingulum in order to contour the veneer for correct proximal contact placement. (Figures 13, 14, 15)

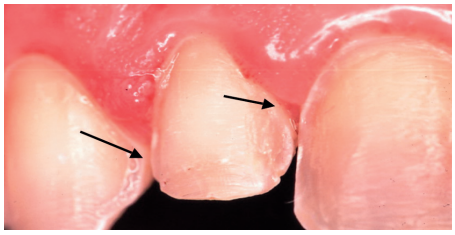
Thickness

What is the optimal thickness of veneering material? Thickness of porcelain in part is determined by a need to cover discoloration. Technicians can incorporate very thin layers of opaque or opacious porcelain into veneers, permitting good masking of dark teeth with relatively thin veneers. Alternatively, pressed and milled veneers can be made from more opaque blocks of porcelain, cut back and overlaid with feldspathic porcelain of variable translucency. Although research indicates that the least interfacial stresses are obtained when the porcelain veneer is uniformly thick,[30,31] it may be difficult to maintain such uniformity, particularly when veneers are used to re-align teeth.

Temporization

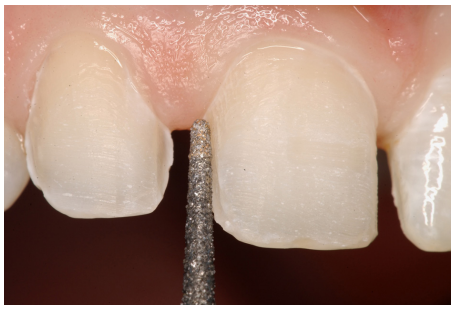
Most patients approach esthetic veneer dental treatment with high expectations. High quality provisional veneers that preview the final restorations are important to the success of the porcelain veneer treatments. Provisional veneers that closely match the final shape, spacing and contour permit the patient to assess and adjust to esthetic, functional and phonetic changes that the final porcelain veneers will make. Provisional veneers should be hygienic and bonded securely enough that they do not dislodge unexpectedly, while being easily removable by the dentist.

Figure 12



Arrows indicate areas of inadequate tooth reduction.

Figure 13



Placement of the margin lingually for diastema closures.

Figure 14



Finishing the lingual margin for a veneer to close a diastema.

Figure 15



Incisal view of completed porcelain veneer preparation for diastema closures.

Several methods may be used to temporize porcelain veneer preparations. Individual prepared teeth can be temporized directly by spot etching an area of 2-3 mm in diameter near the incisal aspect of the facial surface, applying bonding resin over the entire prepared surface, and then placing and shaping the appropriate color of composite resin on the tooth, followed by light-curing. The veneer should be polished with all gingival margins finished flush with the unprepared tooth.

Alternatively, composite resin can be placed on un-etched tooth, shaped to the approximate dimensions and light-cured. It is then removed from the tooth for further shaping and polishing with rotary discs before being bonded with unfilled resin or flowable composite to the spot-etched tooth. This method reduces the risk of tissue injury during the fabrication process. When spot etching retains individual temporary veneers, it is best to inform the patient that the veneers cannot withstand forceful biting.

Multiple temporary veneers can be fabricated directly in the mouth or indirectly on casts of the prepared teeth using a vacuum formed or PVS template made from a cast of the unprepared teeth or from a diagnostic wax up of the finished veneers. The provisionals can be made from either bis-acryl provisional resins, or MMA crown and bridge resins. MMA crown and bridge resin provisionals are best fabricated on casts rather than in the mouth. Splinted provisionals are then luted using non-eugenol temporary cement or bonded to spot etched teeth with light-cured resin. Dycal has also been suggested as a temporary cementing media.[32] Although splinted provisional veneers may be more retentive than individual provisional veneers, they complicate hygiene care. Care should be taken to ensure that the marginal fit, embrasure form and surface smoothness of the provisional is sufficient to maintain excellent gingival health.

Porcelain Properties and Choice of Porcelains

Porcelain veneers usually exhibit a low rate of chipping and fracture. Repairs of porcelain chips and fractures can be accomplished with composite resins, but usually the best result is achieved by replacing the

fractured veneer.[33,34] Porcelain veneers will not change color appreciably over time.[35] The luting cements may change color over time and become more opaque, though the thickness of the cement may not cause a color change to be noticeable. However, if the technician has placed porcelain stains on the outside of the porcelain veneer, rather than build the color variations into the porcelain buildup, the patient may see a change in color due to wear of the "softer" layer of glazed porcelain stains, especially vulnerable to acids.[37] Intrinsic staining and distribution of color within the porcelain buildup provides a superior esthetic outcome and diminishes the need to use surface stains or colored luting agents to achieve an acceptable shade match.[38,39]

Different types of porcelain can be used to fabricate a porcelain veneer. Feldspathic porcelains can be stacked and baked on refractory dies or on stone dies swaged with platinum foil. By stacking the veneering porcelains, some opacity and translucency can be built into very thin veneers. The thinness of most veneers limits their ability to mask the darkest colors however.[40,41] Veneers baked directly on refractory dies have the potential for the most accurate fit. Whether baked on a refractory die or press fitted, the fit of porcelain veneers are comparable.[42]

Pressed or cast leucite-reinforced porcelains such as Empress I™ (Vivadent) are available in varying opacities and can also mask darker stains while still providing life-like reproductions of teeth. By altering the makeup of the porcelain by adding either mica or lithium disilicate, Dicor™ and Empress II™ (Vivadent) can provide even greater opacity. Clinical outcomes measured in a meta-analyis of clinical trials after five years show Empress porcelain veneers survive at 92.4%; and from 66% to 94% after ten years.[43] An *in vitro* testing of the contrast ratio (translucency/opacity) of various porcelains has ranked the IPS e-max (Ivoclar Vivadent) as the most opaque followed by Vita VM7 (VITA Zahnfabrik), then Nobel Rondo Press (Nobel Biocare).[44]

IPS e-max Press (IPS, Ivoclar Vivadent) has been tested for shear bond strength after pretreatment of the intaglio surface and bonding. The e-max Press veneer showed micro-retentive features when viewed with SEM.[45]

Zirconia and alumina-core porcelains (*e.g.* Lava™-3M, Procera™-Nobel, Cercon™-Dentsply, Y-Z™-Vita Zahnfabrik) are very opaque and cannot be etched. These porcelains should not be used for veneers.

Pulpal and Periodontal Considerations

The conservative preparations for veneer design are unlikely to lead to significant pulpal problems. However the materials and clinical procedures used for bonding the veneers can lead to sensitivity and other pulpal responses, if the proper bonding protocol is not followed.

There should be no adverse periodontal response to veneers if the gingival margin does not extend more than 1mm below the crest of the gingival tissue, and if the tissue is not damaged during preparation, temporization, bonding and finishing of the veneers. Lesser amounts of plaque with qualitatively healthier tissue can be found against ceramic surfaces compared to other materials.[46,47]

Bonding Porcelain Veneers

The veneer itself will not change color over time and is impervious to stains. The cement margin is susceptible to staining from ingested liquids and foodstuffs (tea, coffee, cola, red wines, fruits, berries, etc.). Marginal adaptation and surface smoothness play a large role in the extent and timing of marginal staining of porcelain veneers, as does patient hygiene. The better the fit of the porcelain, the less marginal staining is likely to occur.

It also is critical to maintain an even thickness of luting resin when bonding the porcelain to tooth structure. The thicker the luting agent, the more likely thermal changes will create cracking of the porcelain.[6,9,22]

An *in vitro* study of cementation of porcelain veneers showed that the cement thickness usually was 1/3 the thickness of porcelain or less depending on the luting agent used. In this study the dual cure Variolink II formed the thinnest layer of luting resin.[48] A dual cure resin-luting agent will have a higher modulus of elasticity, higher Vickers hardness, lowest creep values and elastic/plastic deformation compared to only light cured resin-luting agents.[49] In one *in vitro* study the color of the luting cement did not affect the color of the cemented porcelain veneer regardless of its opacity. In this study the porcelain used was from a milled block of IPS Empress CAD using multi-chromatic, high translucency and low translucency blocks. The greatest influence on the color appeared to be from the background color of the resin block unto which the porcelain was cemented.[50] In another *in vitro* study using four shades of porcelain IPS Empress Esthetic (Ivoclar Vivadent) and a total of 13 shades of luting materials from two manufacturers, the authors found significant shade differences with any of the shades of the Empress after cementation regardless of whether the porcelain was 0.5 or 1.0 mm thick. Empress porcelains are fairly translucent materials, which provides a caution, the more translucent the porcelain, the more likely the cement color will affect the color outcome.[51]

When bonding veneers, it is critical to maintain a clean dry field that is free from contamination from sulcular fluids, saliva and debris. Various methods of isolation can be utilized depending upon the health of the tissue. If the tissue is healthy and the preparation margins are either equi- or supra-gingival, it may be possible to lute with no special gingival isolation or retraction. (Figure 18) More commonly, some form of gingival retraction and auxiliary isolation is required. Retraction cords, Mylar strips, chemical management of the tissue, or rubber dam can be used. Ferric sulfate astringents should not be used because of the possibility of marginal or substrate tooth discoloration caused by the precipitation of the iron. A Contour Strip™ (Vivadent) can also be used to isolate a single tooth for veneer luting. (Figure 19) This has the advantage of curing the resin luting material against a celluloid strip with a very smooth surface, while allowing an excess of luting resin at the margin. Using this method of isolation, excess luting material normally can be stripped from the veneer exterior with some application of force, requiring little marginal finishing. The author has used this method of isolation for thirty years and has found it produces superior gingival margins for direct composite resin or porcelain veneers.

After the provisional veneers have been removed from the teeth, all remaining bonding resin and or/ temporary cement must be removed from the tooth surfaces before trying in the veneers. If necessary, a light wet flour of pumice can clean the area to be bonded. Typically, the porcelain veneer(s) are initially tried in using water first to optically connect the veneer to the underlying tooth and assess the color match. Water-soluble try-in pastes can also be helpful. The veneers should all fit passively, with no binding interproximally. Proximal contacts can be adjusted if necessary with rotary porcelain polishing wheels. After try-in, the veneers should be cleaned with some organic solvent such as alcohol, acetone or chloroform to ensure that all contaminants (e,g, oils, try-in pastes etc.) have been removed.

It is essential that the intaglio surface of the porcelain veneer is etched with a hydrofluoric acid before bonding. Hydrofluoric acid gel (6-9.5%) is applied to the clean internal surface of the veneer for 1-2 minutes, and then rinsed with water. The etched surface should be scrubbed with a piece of wet cotton to remove salts created by the etching acid. After rinsing off the salts, the veneer is dried and a silane solution is applied to the etched surface. (Figure 16) The silane is left on the inside of the porcelain veneer for one minute. Then it is dried with compressed air to remove all solvents. (Figure 17)

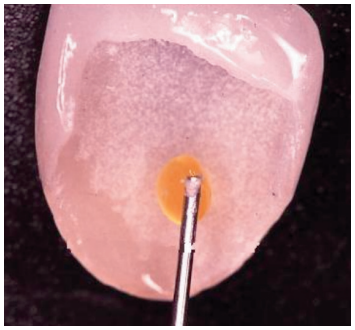
After the tooth is isolated for bonding, the prepared tooth surface is etched with phosphoric acid gel for 10-20 seconds. (Figure 18) The etchant is rinsed off. If the prepared tooth substrate is enamel only, the tooth may be completely dried until the surface appears frosty. An unfilled bonding resin is applied and blown thin but **not** cured. Curing the bonding resin at this point would interfere with the fit of the veneer. If the prepared tooth substrate is both enamel and dentin, the etched surface should be left damp, while a dentin-bonding agent is applied. All dentin bonding agents contain solvents that interfere with the polymerization of the resin, and therefore solvents **must** be evaporated from the surface with compressed air prior to light curing. (Figure 19) The best bonding systems will utilize a separate etchant, to ensure adequate etching of the enamel.[53,54]

After the bonding agent is placed on the tooth, the light-cured, filled bonding resin cement should be placed on the etched and silane treated surface of the veneer.[55] The veneer should be seated firmly, while viewing the linguo-incisal margin to assess complete seating. An excess of luting agent should be left at the margin while curing the bonding resin in order to compensate for the polymerization shrinkage of the luting resin. Failure to do this can result in a ditched margin that is more susceptible to plaque retention and marginal staining may result. This ditching results from the polymerization shrinkage of the resin luting material. Using a quick 5-10 second cure to gel the composite and then removing excess may result in an inadequate excess of resin to compensate for the polymerization shrinkage. The veneer should be light cured for 60-120 seconds depending on the translucency of the veneer. The most translucent porcelains require the shorter cure time; the most opaque require the longer cure time. Dual cure and light cure resin luting agents have been tested to determine how the opacity/ translucency, porcelain type and exposure times altered the physical properties of the various cements. In this study the more opaque porcelains caused a significantly lower degree of conversion, hardness and modulus of elasticity. That was evened out when the exposure time was increased to 120 seconds.[56]

Then the bulk of the excess luting material can be removed using a scalpel (#12 blade), gold knife, or finishing burs wet. Polishing of the margins can be accomplished using assorted discs wet, such as the Sof-Lex™ (3M) to ensure as smooth a transition from veneer to tooth as possible.[57,58]

The technique used for marginal finishing has much to do with marginal staining. Atraumatic methods that do not cause overheating are essential for the durability of the margins. Superfine diamonds and 12- and 30-fluted carbide finishing instruments can remove gross excess, while polishing with discs wet can provide a smooth finish to the margins with less plaque retention and less staining. Rubber impregnated finishing devices may tend to overheat the resin luting material, and potentially leave rougher surfaces than the ultra fine, wet polishing discs, creating a potential for more rapid discoloration at the margin.[31,59]

Figure 16



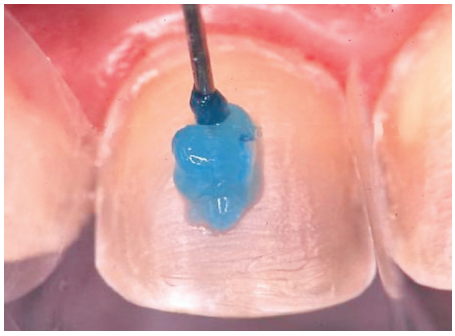
The intalglio surface of the porcelain veneer is being etched with HFl acid.

Figure 17



The intaglio surface of the porcelain veneer has silane applied following etching with HFl acid.

Figure 18



The tooth is etched prior to luting.

Figure 19



Vivadent™ Contour Strip isolates the tooth and bonding agent is applied to the etched tooth surface and cured prior to veneer placement.

Clinical Outcomes

Marginal staining is sometimes amenable to bleaching agents.[60] The larger the gap between the porcelain veneer and the tooth, i.e. the wider the resin luting margin, the more likely it is to stain. Discoloration of the resin-luting agent will be less of a problem if the luting agent used is of optimal thickness and the marginal fit is good.[61,62]

Bulk fracture of all ceramic crowns over a six-year period is reported to be 5-10%, whereas fractures of porcelain fused to metal is 3-4% at ten years and 74% can be in service after 15 years. The majority of the problems with PFM's are reported as being secondary caries, periodontal and endodontic.[63,64,65] Porcelain veneers have been found to have a fracture or loss of retention rate of less than 5% as reviewed in eleven clinical studies of 3-5 years each.[66] In a clinical study spanning ten years, the number of clinically acceptable veneers had decreased from 92% at five years to 64% at ten years. Fractures of porcelain (11%) and large marginal defects (20%) were cited as the main reasons for failure in this clinical study. Most of these restorations were repairable. However, it was noted in this study that many of the marginal defects were found in areas where the porcelain veneer ended on a composite restoration.[67]

Feldpathic porcelain veneers have the longest history and therefore the longest clinical outcome data. Survival rate after seven years of feldpathic porcelain veneers bonded with a light-cured composite was 97.5%. The most notable finding was marginal discoloration. This study had thirty patients with 119 porcelain veneers.[68] In another clinical study with 84 patients and 318 veneers, running up to 20 years, the estimated survival rate was 94.4% after five years; 93.5% at ten years; 82.93% at twenty years. Higher failure risks were non-vital teeth that had 7.7 times greater risk of failure than bruxism. Marginal discoloration was significantly greater in smokers.[69]

In a clinical trial over 21 years, porcelain veneers placed by one prosthodontist excluding non-vital teeth, molars and unfavorable periodontal prognosis, seventeen veneers in eight patients failed; 407 veneers in 130 patients survived. Survival rates were 96% at 10 years; 91% at 20 years. In this study group the author estimates at least 80% enamel coverage. He states when accounting for clusters (similar failures in the same patient) the estimated survival rate after 21 years is 96% when porcelain veneers are bonded to enamel.[70]

If a veneer de-bonds and is intact, it can be re-bonded to the tooth achieving the same shear bond strength as the original. The veneer must be tempered in an oven at 850^0 F for ten minutes, below the glass transition temperature of the porcelain in order to carbonize all of the previous bonding materials. It may then be etched and bonded.[71]

Complicated Cases

The following case is illustrative of a "gummy smile", wherein the teeth, stained with moderate tetracycline, have inadequate length. After making the determination that the crowns of the teeth require periodontal surgery prior to veneer placement, the patient is prepared for surgery. (Figure 20; note the crown length is 8mm.) A template is given the surgeon to approximate the length required for a pleasing smile. The surgeon lays a flap and re-contours bone as necessary to achieve a normal biologic width. And the flap is sutured in place. (Figure 21; note crown length is 10mm.) Healing is encouraged for a minimum of six to eight weeks. Longer is better. (Figure 22) Veneers (from first premolar to first premolar) and in this case a porcelain fused to metal crown (the left central) are placed. (Figure 23) The case demonstrates a multidisciplinary approach to improving a moderate tetracycline smile.

Figure 20



Preoperative facial view, moderate tetracycline staining with crown present on left central incisor. Crown length is inadequate (8mm) as a full facial view demonstrates a "gummy" smile. *Surgery by Dr. James Hinrichs.*

Figure 21



After surgical intervention to place the gingival heights at a more esthetic position, crown lenth is established (10mm) and the biologic width reestablished.
Surgery by Dr. James Hinrichs.

Figure 22



After healing is allowed for 6-8 weeks, the teeth are ready to have the pordcelain veneers prepared.

Figure 23



Veneers and a crown on the left central incisor are placed after the gingival surgery to establish color, length and position.

Best Practices

Shade Selection

- Mixing resin and porcelain restorations for esthetic treatment of anterior teeth are inadvisable due to optical property differences between the materials. It is better to either place all composite or all porcelain restorations.
- If possible, use all porcelain crowns rather than PFM crowns to restore anterior teeth when matching veneers. Porcelain fused to metal crown has a layer of opaque porcelain that reflects light much differently than the translucent porcelain of veneers.
- When matching shades of teeth, choose one color for the dentin shade in the gingival 1/3 of the crown; chose a different color for the incisal 1/3. Draw a "color map" to identify variations in the hue, chroma and value. Identify the degree to which the enamel is translucent or opaque. Indicate the presence of white spots or other surface conditions including texture.
- Always select shades before the tooth has begun to dehydrate. If you don't, the value of the shade you have chosen will be too light.
- Always identify the hydrated shade of the prepared tooth when placing veneers. Determine the amount of opacity you think you may need to block discoloration and tell the technician the final outcome shade of the veneered tooth.
- Matching veneers to natural teeth requires you match surface texture and reflectivity of the surfaces. Both will affect the perception of tooth color. Describe the desired surface texture in your laboratory prescription.

Tooth Preparation

- Whenever possible, keep gingival preparation margins even with the crest of the gingival tissue. This will improve gingival health, minimize marginal staining and make finishing easier.
- All internal line angles for porcelain preparations must be rounded to prevent concentration of stress leading to fracture.
- Whenever possible on anterior teeth, place proximal margins lingual to the contact. For posterior teeth, place the proximal margins slightly buccal to proximal contact.
- Form the incisal margin as a butt joint against lingual enamel, reducing the incisal edge no more than 2mm.
- Keep as much of the preparation as possible in enamel.

Temporization

- Diagnostic wax ups can be useful for treatment planning and for fabricating provisional restorations for veneers.
- Temporary veneers must fit well, be contoured and finished so they are hygienic, and promote good gingival health.
- Temporization of porcelain veneer preparations is essential for assessing the outcome of treatment and patient comfort. Temporization can be accomplished using either a directly placed composite material or by indirectly forming the provisional using a template developed either with a diagnostic wax up or directly in the mouth.

Bonding

- The best procedure for luting porcelain will enable the operator to isolate the tooth preparation from any crevicular fluid or blood during the luting process. It also permits excess material to be present at the porcelain/tooth interface when polymerizing the luting agent to account for the polymerization shrinkage of the luting resin.
- Resin luting materials should be polished with rotary polishers wet to dissipate the heat from polishing, remove the debris without making it airborne, and prevent ditching at margins from overheating.

Outcomes

- Inspect that all margins are flush with the tooth, and that no excess bonding resin is present.
- Recheck the patient's occlusion in all movements, especially latero-protrusive to assure that there are no interferences. If necessary, adjust the veneers with rotary diamonds and porcelain polishing wheels.
- Inform the patient that there is about a 5% risk of fracture and that it may require a remake if severe enough; or it may be repairable.
- Inform the patient that eventually the margins where the resin luting material is present may discolor. Discoloration can be removed by bleaching or additional refinishing procedures.
- Inform the patient that slight color changes may occur during the first 24 hours after bonding due to rehydration of the teeth and the bonding resin.

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POST-TEST

Internet Users: This page is intended to assist you in fast and accurate testing when completing the "Online Exam."
We suggest reviewing the questions and then circling your answers on this page prior to completing the online exam.

(1.0 CE Credit Contact Hour) Please circle the correct answer. 70% equals passing grade.

1. Which among the choices given are indications for placing porcelain veneers?

1. Mild to moderate tetracycline staining
2. Diastema closures or mal-alignment of teeth
3. Heavily restored anterior teeth
4. Endodontically treated teeth with discoloration
5. Teeth with dark purple discoloration in the gingival one third of the crown
6. Irregular tooth size and/or mal-alignment

a. 1, 3, 5 and 6 only
b. 3, 4, 5 and 6 only
c. 2, 3 and 4 only
e. 2, 4 and 5 only

2. When preparing a tooth for a porcelain veneer, the gingival margin position that produces the best gingival response is

a. 1.5 mm apical to the free gingival margin.
b. 1.0mm apical to the free gingival margin.
c. 0.5mm apical to the free gingival margin.
d. at the free gingival margin.

3. In order to ensure even distribution of stress on a porcelain veneer, the porcelain thickness should be reasonably uniform and the preparation should have no sharp angles.

a. True b. False

4. The incisal edge of the tooth prepared to receive a porcelain veneer

a. does not need preparation.
b. requires no more than a 1mm reduction.
c. should be reduced no more than 2mm.
d. should have the incisal reduction prepared as a lingual chamfer.

5. Facial reduction of the tooth for a porcelain veneer should vary from 0.5mm-0.75mm at the gingival to 1.0-1.2mm at the incisal and should end as a chamfer margin gingivally and interproximally.

a. True b. False

6. Temporization of porcelain veneer preparations can be accomplished using which of the following methods?

1. Placement of a direct composite while bonding to a small area of enamel near the incisal.
2. Using a bis-acryl acrylic in a preformed matrix, luting with a non-eugenol cement.
3. Using a MMA resin directly in a preformed matrix, luting with a eugenol cement.
4. No temporization is necessary.

a. 1 and 2 only
b. 1 and 3 only
c. 2 and 4 only
d. 3 and 4 only

7. Gingival health can be optimized by what methods during the provisional stage of porcelain veneer restoration?

1. Polish the margins of the provisional material directly on the teeth
2. Do use ferric sulfate to control bleeding
3. Prescribe chlorhexidine for daily use
4. Instruct the patient in appropriate brushing techniques
5. Extend the provisional material 0.5mm apical to the preparation margin

a. 1, 3 and 5 only
b. 2, 4 and 5 only
c. 1, 3 and 4 only
d. 1, 4 and 5 only

8. When luting porcelain veneers, why is gingival isolation required?

1. Gingival seepage of fluid or blood can create improper bonding allowing microleakage
2. Gingival contamination during bonding can cause discoloration under the porcelain veneer
3. Gingival contamination can prevent the set of the resin luting material
4. Gingival seepage can prevent adequate bonding leading to possible fractures of the porcelain or de-bonding

a. 1, 2 and 4 only
b. 1 and 4 only
c. 2 and 4 only
d. 3 and 4 only

9. Gingival response to the presence of porcelain veneers is affected by?

a. Position of the margin relative to the gingival crest.
b. Gap size and configuration of the marginal fit of the veneer.
c. Ditching at the margin associated with polymerization contraction of the resin luting agent
d. Ability of the patient to cleanse the area by brushing and flossing.
e. All of the above

10. Finishing procedures for porcelain veneers after luting should be atraumatic to the porcelain and the resin luting agent. Identify some of the methods that should be used.

1. Polish margins wet to avoid overheating
2. Polish using high-speed carbide finishing burs dry
3. Polish using rubber impregnated polishing points and wheels dry
4. Polish using garnet and cuttle finishing discs dry
5. Polish using high speed ultra fine diamonds wet

a. 1 and 3 only
b. 1 and 5 only
c. 2, 4 and 5 only
d. 3 and 5 only

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8. The level to which your personal objectives were satisfied.	☐	☐	☐	☐	☐	
9. Please rate the administrative arrangements for this course.	☐	☐	☐	☐	☐	

10. How likely are you to recommend MetLife's CE program to a friend or colleague? *(please circle one number below:)*

10 9 8 7 6 5 4 3 2 1 0

extremely likely neutral not likely at all

What is the primary reason for your 0 - 10 recommendation rating?

_____

11. Please identify future topics that you would like to see:

_____

Thank you for your time and feedback.

To Complete Program Traditionally, Please Mail Your Post Test and Evaluation Forms To:

MetLife Dental Quality Initiatives Program
501 US Highway 22
Bridgewater, NJ 08807