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Fabrication of Porcelain Veneer Provisional Restorations: A Critical Review

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A B S T R A C T

Fabrication of provisional restorations for porcelain veneers can be a difficult and time-consuming procedure, often being poorly done or even omitted altogether at times which can lead to undesired consequences. The purpose of this article is to review and describe several of the most commonly used techniques for fabrication of provisional restorations for porcelain veneers. The clinical techniques include direct composite resin, indirectly fabricated provisionals, direct-indirect technique, rapid simplified veneer provisional system (RSVP), and the shrink wrap technique. These methods will be described in detail for each technique, along with the indications and contraindications thus providing the practitioner with guidelines to assist in selection of the provisionalization technique best suited for the clinical scenario.

Introduction

Dr. Charles Pincus first described the use of porcelain laminate veneers (PLV's) that were adapted to unprepared teeth by means of denture adhesive [1]. The popularity of porcelain veneers has increased since their introduction in the early 1980's due to their conservative nature and esthetics with ultrathin ceramic retained with resinous cement [2,3]. The fabrication of properly contoured, well-fitting provisional restorations is paramount to the success of the definitive restoration(s) and ultimately to the overall treatment [4]. Provisionalization of teeth offers more than just protection of the tooth structure, it also allows for communication between the patient, laboratory, and the dentist. Originally the technique for placing ceramic veneers [5] did not involve the use of a provisional phase since the extension of the tooth preparation was maintained rigorously in enamel and limited to the facial surface. Recommendations from early literature described temporization as unnecessary in most cases as preparations were conservative with minimal risk of dentinal tubules exposure, as well as considered undesirable for the most part due a higher risk for gingival inflammation [2]. Today however, the indications for porcelain veneers have greatly expanded that often involves greater extension of the tooth preparation [6]. Provisional restorations serve several purposes in that they protect and seal the tooth, provide occlusal stability, prevent tooth migration, guide in tissue regeneration or development of soft tissue emergence profile, and provide interim esthetics as well as comfort and function to the patient. Additionally, they serve as a template to evaluate esthetic and functional changes [7,8]. Once approved by the patient, these changes are subsequently duplicated in the definitive restorations [4]. Patients receiving porcelain veneer restorations typically have high expectations for a natural appearance to their restorations often focusing on esthetics rather than function. Fabrication of provisional restorations for porcelain veneer preparations can be time consuming due to the difficulty of fabrication, preciseness, and often high esthetic demands of the patient. As a result, veneer provisional restorations are often poorly fabricated. Some dentists have chosen not to place provisional restorations due to time constraints or concern about the durability of these interim restorations [9]. Poorly adapted restorations with open, irregular, and over- or under contoured margins can lead to plaque accumulation and subsequent gingival inflammation [10] which can be detrimental to the adhesion process [11]. It should be noted as well that aggressive use/misuse of gingival retraction cord can also lead to gingival recession and a compromised esthetic result. Reproducing the diagnostic wax up to be properly fitted into the oral cavity is one of the main objectives with provisional restorations [6] allowing the patient to visually see the proposed restorations before fabrication of the definitive porcelain veneers. The clinical techniques that will be discussed include the direct composite resin, indirectly fabricated provisionals, direct-indirect method, rapid simplified veneer provisional system (RSVP), and shrink wrap techniques. While there are additional methods that can be utilized and which will be discussed briefly in the discussion section, the techniques discussed in this article are the ones more commonly used in the practice setting. These methods of provisional fabrication will be described in detail for each technique, along with the indications and contraindications, thus providing the practitioner with guidelines to assist in selection of the provisionalization technique best suited for the particular clinical scenario. Each technique is capable of yielding clinically acceptable results provided the dentist is experienced and proficient and takes the time needed to accomplish the procedure well. Provisional restorations not

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Table 1
Summary of Advantages/Disadvantages of Veneer Provisional Fabrication Techniques

Provisional Technique	Advantages	Disadvantages
Direct Composite Resin	• Minimal contouring/finishing • Reduced risk of damage to prep margins/soft tissue • Better interproximal adaptation	• Can be more time consuming (especially for multiple preps) • Difficult to precisely replicate the diagnostic wax-up
Indirect Technique	• Less risk of marginal or soft tissue damage during finishing • Better control of interproximal embrasures • Can measure thickness of provisionals before cementing to ensure adequate reduction • Rest break for patient	• Additional time required to take impression/pour solid cast • Provisionals must be cemented and excess cement removed
Direct-Indirect Technique	• No cast of preparations needed • Extraoral trimming thus less risk of marginal or soft tissue damage • Can measure thickness of provisionals before cementing to ensure adequate reduction	• Provisional must be cemented and excess removed • Provisionals if thin (minimal prep cases) can fracture during removal for trimming/finishing
RSVP Technique	• Can rapidly complete the incisal 2/3's of the provisional restoration • More accurate sculpting of gingival 1/3 of provisionals thus better control of gingival margins/embrasures • Less rotary finishing	• Time required for free hand placement of composite resin for gingival 1/3 of provisional restorations • Potential refractive index discrepancies if use different materials not from same manufacturer
Shrink Wrap Technique	• No cast of preparations needed • Most rapid of the techniques	• Care needed to avoid damage to soft tissue and prep margins in removing excess • Difficult to open gingival embrasures

only serve to provide the functions listed previously, but will also instill confidence in the patient for the practitioner's ability to deliver exceptional definitive care.

Materials and Methods

Techniques for porcelain veneer provisional fabrication are greatly varied and range from more time consuming and complex options to the use of no provisional restorations in cases of no prep or minimal prep veneers. In more recent years, newer materials have evolved and thus have improved the durability of these provisional restorations and the ability to utilize options that were not available in the past. The following techniques as described in this review are the more commonly used options as described in the literature and selected from clinicians/researchers who are considered to be experts in their respective fields. Additionally, advantages and disadvantages of each technique discussed are summarized in table 1.

Direct Composite Resin Veneer Provisional Technique

The direct composite resin technique allows the provider to directly apply and contour the composite resin provisional intraorally. After the teeth are prepared, the preparations are spot etched [12] and spot bonded. If the incisal edge needs to be lengthened, a prefabricated lingual matrix made from the diagnostic wax up will allow the replication of the proper incisal length to be transferred to the provisional phase. Direct composite resin is placed incrementally on the prepared teeth shaping and contouring as closely as possible to the diagnostic wax up in order to minimize finishing. The provisional is contoured and polished using one's own preferred method. Fig. 1a depicts an intraoral example of a debonded porcelain veneer on the maxillary left central incisor that was to be remade and thus an ideal indication for using a directly fabricated composite resin provisional veneer (Fig. 1b). The bonded definitive replacement Lithium Disilicate porcelain veneer is shown in Fig. 1c.

This technique has been discussed in the literature as the "free-hand" direct method [13]. The advantage of this technique is that minimal contouring and finishing is required (due to more precise placement of composite prior to polymerizing) and thus less risk of potential damage to the preparation margins and soft tissue. Additionally, the composite resin can be placed and sculpted for better interproximal adaptation and ultimately better soft tissue maintenance and health during the interim phase. The main disadvantage to this technique is the time spent to obtain precise detail especially in cases with multiple units. Thus, in most instances, this option is selected by practitioners for cases of

Fig. 1a. Debonded porcelain veneer on maxillary left central incisor

Fig. 1b. Direct composite resin provisional veneer placed

Fig. 1c. Definitive Lithium Disilicate porcelain veneer bonded

Fig. 2a. PVS matrix (supported by impression tray) for fabricating provisional veneers

a single or limited number of preparations due to the chair time that would likely be required for larger cases. Additionally, it is difficult to precisely replicate the diagnostic wax up but use of a lingual matrix will allow for precise placement of the incisal edge. Practitioners who are well trained in delivering large direct composites or composite veneers may feel more comfortable with this technique of provisionalization and thus likely to utilize it more frequently.

Indirect Veneer Provisional Fabrication Technique

The indirect technique requires a solid cast of the preparations to allow for fabrication of the provisionals. After the teeth are prepared, an impression is taken and poured in dental stone or a hard but flexible polyvinyl siloxane material. After separation, if a stone cast is utilized it should be lubricated with a non-stick agent on the prepared surfaces and adjacent areas. From the diagnostic wax up, a rigid polyvinyl siloxane (PVS) matrix (Fig. 2a) is used as a template to fabricate the provisional veneers. A rigid impression tray can be utilized to provide additional support for the PVS matrix if desired. It is recommended to routinely duplicate the diagnostic wax up in stone to preserve the integrity of the wax up and yield a solid cast for the fabrication of all provisional matrices, reduction guides, etc. The matrix once filled with the provisional material of choice, typically polymethyl methacrylate (PMMA) or bis-acryl resin, is reseated on the provisional stone or silicone cast, and any excess that extends beyond the matrix can be wiped away. The matrix can be supported by use of the rigid impression tray (as described above) or by means of a plaster seating guide that can be secured to the provisional cast to stabilize the matrix [14]. If desired and using PMMA, the cast can be cured in hot water which has been shown to significantly reduce the amount of MMA elution and increase the microhardness [15].

Fig. 2b. Trimming of provisional veneers extraorally using a thin flexible diamond disk

Fig. 2c. Polishing of provisional veneers extraorally using a soft robinson bristle brush

The provisional veneers are carefully removed from the matrix allowing the provider to adjust the shape and trim as needed (Fig. 2b). The provisionals can be separated into individual units, if desired, or left in segments to reduce possible dislodgment intraorally under function. After final trimming and polishing using a soft Robinson bristle brush (Fig. 2c) followed by a soft felt cotton wheel and polishing paste (or other polishing instruments of the provider's choice), the provisionals are taken to the mouth for try-in. Once the margins and incisal edge positions are verified, the provisionals are then prepared for cementation. Prior to provisional cementation, the restorations can be gently micro-etched (Fig. 2d) with low pressure (to remove any debris and create micromechanical retention), rinsed and dried, and a thin layer of unfilled resin applied and air thinned. Using 50 micron aluminum oxide air particle abrasion (APA) at a pressure of two bar (30 psi) for 10 seconds at a distance of approximately10 mm has been shown to enhance the shear bond strength of the bis-acryl temporary material by cleaning and increasing surface roughness and thus micromechanical retention [16]. To minimize damage to the provisional restorations however, this author chooses to use smaller particle size (30 micron) aluminum oxide or 30 micron silica impregnated aluminum oxide with reduced pressure to still provide micromechanical retention while reducing the risk of damage to the provisionials. Advantages of using a

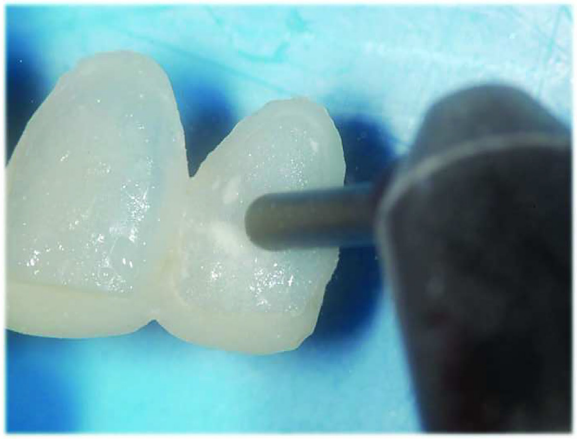


Fig. 2d. Microetching of provisional veneers to clean intaglio surfaces and create better mechanical retention

Fig. 2e. Indirect provisional veneers on the silicone model prior to cementation intraorally

Fig. 2f. Indirect provisional veneers easily removed from the silicone model without risk of fracture

Fig. 2g. Healthy soft tissue response to well contoured and polished provisional veneers

silicone model of the preps are faster set of the model as compared to a stone cast, and flexibility of the silicone model allows for easier removal of the provisional veneers with less risk of breakage (Fig. 2e, f show provisional veneers on the silicone model and Fig. 2g illustrates the nice tissue response intraorally). The preps can then be spot etched and a desensitizer applied (if desired), followed by a thin application of unfilled resin over the selective etch areas and intaglio of the provisional veneers. Some practitioners choose not to apply adhesive to the restorations as it is felt that the lower viscosity of flowable composite resin will adequately infiltrate the roughened intaglio surfaces without an intermediary adhesive. The unfilled resin is air thinned and flowable composite resin placed in the provisionals which are then seated, excess cleaned and gently flossed, and light cured. Any final adjustment to the length of the incisal edges can be performed as needed as the provisional restorations are now more stable following temporary cementation. Once approved by the patient in terms of esthetics and function, an alginate impression can be taken of the provisionals intraorally (if there were any changes made to the provisional restorations intraorally from that of the diagnostic wax up), poured in stone, and cross mounted with the opposing cast to serve as a template for fabrication of the definitive veneers.

This technique can be found dating back to the early 1990's [14] with the main difference in their described technique being that the provisionals were not cemented to allow the patient to remove to clean the teeth and allow for better soft tissue health. Research has shown that indirectly fabricated provisional restorations are stronger and denser and have better marginal integrity than directly fabricated provisional restorations [17,18]. The advantages of the indirect technique are that most of the contouring and finishing can be done outside of the mouth thus posing less risk of damage to the margins and soft tissue as compared to intraoral finishing. In most cases, the gingival interproximal areas can be better contoured extraorally which will allow for better home care maintenance during the interim phase. Using this extraoral technique can be less stressful for the dentist and patient alike and provide a "rest period" after a long session of preparing teeth. An additional advantage of this indirect technique is that the thickness of the provisional veneers can be measured to confirm the desired reduction. If an area within the provisional is found to be too thin, the preparation can be further reduced to provide adequate reduction for the restorative material chosen. Hence, it is advantageous to fabricate the provisional veneer restorations prior to taking the final impression in case such modifications to the preparation(s) are needed. Disadvantages of the indirect technique are generally limited but include the extra time to take a provisional impression and pour the solid cast. This technique lends itself better to scenarios where there is good draw between the preps and no interproximal undercuts which could make it difficult to remove the provisional veneers from the solid cast or potentially fracture during removal. In such cases, one may need to alter the preps to accommodate. However, if correcting for draw or removal of undercuts could lead to over prepping or to significant dentin exposure, then sectioning the veneers into smaller segments could be considered or alternatively another method for provisional fabrication, such as shrink wrap, may be warranted. Additionally, the provisional restorations must be cemented and the excess cement cleaned which can be somewhat tedious if the practitioner chooses to use a flowable composite resin or other light cured provisional cement.

Direct-Indirect Veneer Provisional Fabrication Technique

From the diagnostic wax up, a rigid PVS matrix can again be used or a very precise clear rigid pressure formed matrix such as that fabricated from a unit that utilizes both heat and pressure. Again, as with the indirect technique, it is recommended to fabricate the matrix from a duplicated stone cast of the diagnostic wax up in order to preserve the diagnostic wax up itself. With this direct-indirect technique however, the clear pressure formed matrix seems to work better as it can be removed slightly on/off the preps (and better visualized to ensure proper reseating over the preparations) during setting of the provisional material to avoid getting locked into place from any undercuts that may be present or from polymerization shrinkage and help dissipate exothermic heat that could have negative pulpal effects [19,20]. The use of the putty matrix is more difficult to visualize to ensure full re-seating during this on and off phase of provisionalization and thus the clear matrix

Fig. 3a. Diagnostic wax up to close maxillary midline diastema and reproportion maxillary central and lateral incisors

Fig. 3b. Lubricating preparations to assist with provisional removal and better marginal capture

is preferred by some providers. Additionally, the dental assistant can also spray water over and under the clear matrix to minimize excessive heat transfer to the teeth [21] and keep the preps lubricated which also helps avoid "locking on". The use of bis-acryl does not provide as much of an exothermic reaction during setting as PMMA [22,23], but in large numbers of units it still can produce some exothermic heat. Intraenamel preparations or minimal preparations into dentin would not be affected as greatly by exothermic reactions as there is more enamel and dentin to protect the pulp from thermal changes (remaining dentin thickness) [20,24,25] as compared to teeth with deeper preparations into dentin to allow for better alignment, color alteration, etc. For cases involving fewer numbers of preparations, such as the one illustrated (see diagnostic wax up, Fig. 3a), either type of provisional matrix should be acceptable for use. Prior to seating of the matrix containing the bis-acryl resin, it is recommended to lightly lubricate the preps with a water soluble liquid lubricant (Fig. 3b) to not only prevent the bis-acryl from adhering to the preps, but also act a wetting agent to provide better flow of the bis-acryl resin and thus improve marginal accuracy in the provisionals. If the rigid clear pressure formed matrix is used, it may need to be sectioned in multiple places (for cases with large numbers of preparations) in order to carefully remove the provisional restorations without breakage. Since this matrix will often be destroyed in removing the provisionals, it is recommended to have a second matrix fabricated in case there is the need to remake the provisionals or any segment of them. A PVS matrix supported by a rigid metal tray (Fig. 3c) was used in this case given there were a limited number of preparations and thus less risk for fracture of the provisionals upon matrix removal. Once the provisionals are fabricated intraorally and gently removed from the matrix, or from the preparations as in this case (Fig. 3d, e), the margins can be marked using an extra fine lead pencil (Fig. 3f) and the provisionals then carefully adjusted to the desired margins and contours (Fig. 3g, h) using fine diamond or finishing carbide burs. Polishing the restorations can be completed before or after cementation; however, some clinicians prefer to do the final polishing and glazing after the cementation. Cementing the provisionals is the same technique as described in the indirect technique (Fig. 3i). The before and after photos of treatment shown

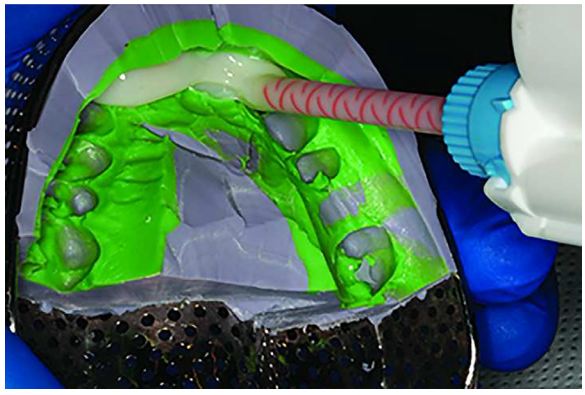


Fig. 3c. Injecting bis-acryl resin into the PVS matrix using care not to entrap air bubbles

Fig. 3d. Gently removing directly fabricated provisionals to allow for trimming

Fig. 3e. Provisonals removed intact for extraoral finishing and polishing

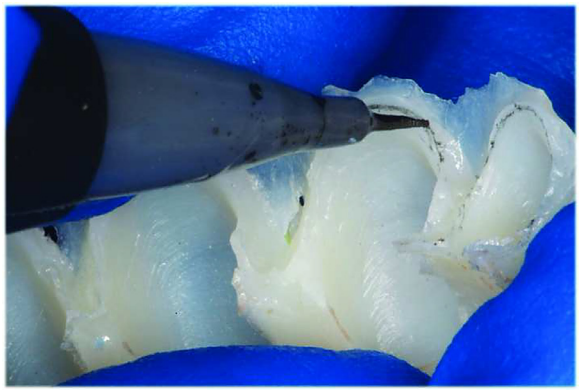
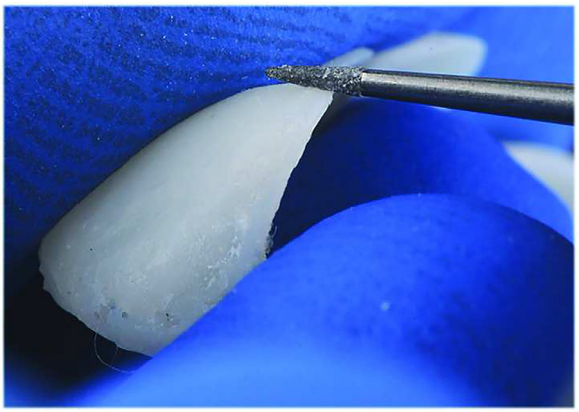


Fig. 3f. Marking margins with extra fine lead pencil to assist in trimming



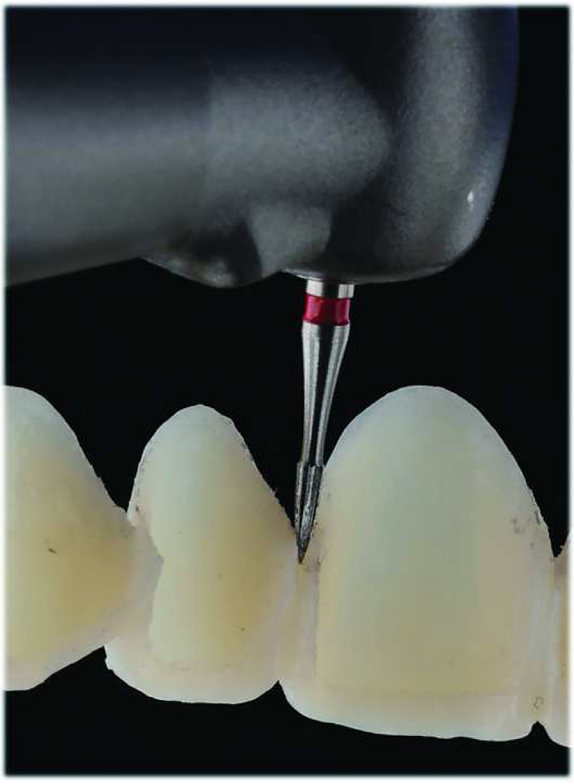


Fig. 3g. and **h** Use of fine diamond and finishing carbide burs to trim and smooth margins and open interproximal embrasures

Fig. 3i. Maxillary anterior four provisional restorations cemented with flowable composite resin cement

Fig. 3j. and **k** Before and after images of treatment of the maxillary incisors to close the midline diastema and achieve better proportions

(Fig. 3j, k) illustrate closure of a maxillary midline diastema and include preparations to the lateral incisors as well for better space allocation and proportions of all the maxillary incisors.

The advantages of the direct-indirect technique are the elimination of an impression and cast of the preparations (as required with the indirect technique), and the trimming of the margins can be done extraorally thus reducing the risk of damaging the preparation margins or soft tissue. Again, as with the indirect technique, the thickness of the provisionals can be measured to see if any further reduction is needed to the preparations (as can be seen in the midbody and cervical portion of the provisional for the maxillary left central incisor in Fig. 3l) prior to taking the final impression. The disadvantages are the separate cementation step and time for proper clean up depending on the type and amount of cement. Also, the provisional restorations if too thin (as may be the case with minimally or no-prepped veneers) can break more easily during the removal or trimming process. Thus, in these types of cases it may be better indicated to utilize the RSVP or shrink wrap technique.

*Rapid Simplified Veneer Provisional Fabrication Technique

A clear polyvinyl siloxane matrix is fabricated for the rapid simplified veneer provisional (RSVP) technique from the diagnostic wax up cast (Fig. 4a) or from the duplicated diagnostic wax up cast poured in stone (as described previously). The gingival third of the matrix is eliminated ("cut") from the matrix (Fig. 4b) before insertion into the mouth. Once the veneer preparations are completed, the preparations can be spot etched followed by sealing with an antibacterial densensitizer containing glutaraldehyde or benzalkonium chloride and HEMA. An unfilled resin is then applied over the spot etch, gently air thinned, and light cured to help with retention as well as minimize sensitivity. The clear matrix is then filled (in the incisal one-half to two-thirds) with a medium viscosity composite resin, or a composite designed specifically for this technique, and inserted in the mouth. Prior to insertion of the clear matrix, floss threaders or small rubber dam stabilizing cord can be inserted into the gingival embrasures to minimize flash locking into these spaces as illustrated in this case of veneer preparations of tetracyclined stained teeth (Fig. 4c). The excess composite is removed from the gingival third of the prepared teeth followed by light curing for three seconds per tooth through the clear matrix. The matrix is gently removed and each restoration fully light polymerized. Any excess or

Fig. 3l. Use of provisionals to identify areas of under reduction in need of additional preparation prior to taking the final impression

Fig. 4a. Fabrication of clear provisional matrix on duplicate cast of diagnostic wax up

Fig. 4b. Use of clear matrix to accurately apply composite resin to the incisal 1/2 to 2/3's of the preparations followed by light polymerization

Fig. 4c. Separate case illustrating use of floss threaders to help block gingival interproximal spaces to minimize excess flash from locking into undercuts

Fig. 4d. Matrix removed and any gingival excess composite flash removed

Fig. 4e. Addition and hand sculpting of composite resin in the gingival 1/3 of the preparations to minimize amount of finishing needed upon polymerization

Fig. 4f. Completed provisional restorations using the RSVP technique

flash in the gingival third of the preparations can then be carefully removed with a fine diamond or multi-fluted carbide bur (Fig. 4d). The gingival one-third of each preparation is now restored with a more viscous, sculptable composite resin using the free-handed technique and sculpted carefully to the desired contours followed by light polymerization (Fig. 4e). The provisionals are then finished and polished (Fig. 4f) but should only require minimal finishing by utilizing this technique.

Although not as widely known, this technique or variations upon it has been discussed in the literature [13,26]. The advantage of this technique is that the incisal one third to one half of the preparation can be precisely located via the matrix and the gingival contour better controlled to allow proper home care. The main disadvantage could be the time required for free-handed placement and contouring of the composite in the gingival one third for cases that involve multiple preparations. The restorative materials chosen should complement each other to minimize any esthetic mismatch due to potential differences in the refractive indexes (due to the differing viscosities) especially if mixing materials from different manufacturers.

Shrink Wrap Veneer Provisional Fabrication Technique

After completion of the diagnostic wax up, the gingival margin of each tooth is sharply delineated (Fig. 5a). This "bead line" provisional [27] is carefully scribed with a sharp hand instrument or a small round

Fig. 5a. "Bead line" created around cervical margins of planned preparations

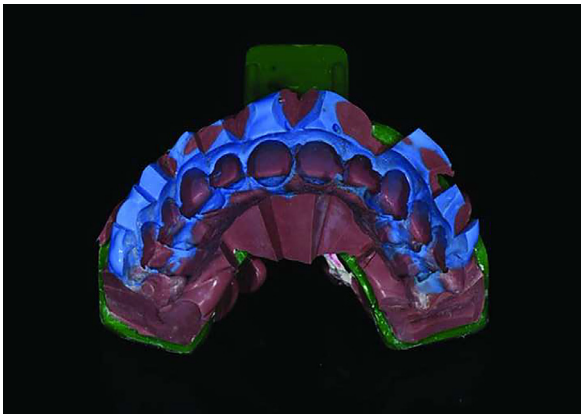


Fig. 5b. PVS provisional matrix fabricated and escape grooves cut into the matrix to assist with removal of excess bis-acryl resin

bur (0.5-1 mm in depth and no wider than 0.5-1 mm) and should extend around the entire gingival cavosurface margin of the teeth and up into the interproximal embrasures to create a separation point for excess bis-acryl resin to be more easily removed following polymerization. A PVS impression (in an impression tray) or rigid PVS putty is next fabricated over the diagnostic wax up (or duplicated stone cast) for the shrink wrap technique. Use of rigid-clear matrices (as described previously) are not recommended due to their rigidity which can possibly lead to fractures of the bis-acryl provisional material during removal of the matrix. Additionally, PMMA is not indicated for this technique due the exothermic reaction during setting and to the fact that the provisionals are not removed from the preparations during the polymerization phase to help dissipate the generated heat (as can be performed with traditional crown preps) that could adversely affect pulpal tissues [19,20]. The impression/matrix can be trimmed to better allow escape of excess bis-acryl resin to minimize the amount of excess material requiring removal during finishing (Fig. 5b). The palatal/lingual embrasures can be blocked out by applying periphery wax (Fig. 5c) or other block out material to dry teeth in order to minimize excess interproximal flash resulting in less time required for finishing. The preparations are treated and sealed as with the RSVP technique. The bis-acryl resin is injected into the matrix (Fig. 5d) and then inserted over the preparations and the matrix lightly compressed apically against the gingival tissues to reduce the thickness of resin flash at the margins. Any excess material that exudes beyond the matrix can be wiped away with a cotton roll or cotton tip applicator before polymerization leaving less flash to trim upon removal of the matrix. After the bis-acryl resin is set, the matrix is carefully removed (Fig. 5e) and any remaining excess material is carefully trimmed away using a fine finishing diamond bur or multi-fluted carbide while the provisional restorations remains adhered

Fig. 5c. Block out of lingual embrasures of prepared teeth to minimize flash needing to be removed

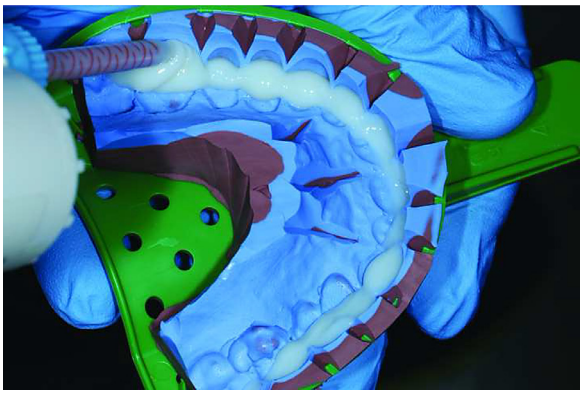


Fig. 5d. Addition of bis-acryl resin to the PVS matrix reinforced by a stock impression tray to prevent flexure and possible distortion with multiple preparations

Fig. 5e. Use of vented provisional matrix allows for easier removal of bis-acryl flash

to the teeth. The gingival interproximal embrasures should be opened as much as possible to allow for flossing during the interim period and allow room for interproximal papillae health. Care in finishing (feather light touch with good magnification) should be exercised to minimize the risk of damage to preparation margins as the final impression has already been taken. The provisionals are then polished and a surface glaze can be applied if so desired (Fig. 5f).

This technique (although not called the "Shrink Wrap Technique)" dating back to the early 2000's was described as a simple technique to fabricate porcelain veneer provisional restorations [28]. The advantage of this technique is that it does not require an impression to be taken of the preparations, and subsequently poured, thus saving time and materials. For this reason, this technique is likely the method most commonly used in practice today. A variant of this technique includes the use of a clear PVS matrix with composite resin and the composite is

Fig. 5f. Veneer provisionals cemented with flowable composite resin

Fig. 6. Use of bis-acryl "mock-up" as the reduction guide for veneer preparations

cured directly through the clear matrix [9]. The key to success with this technique is fabrication of a precise provisional matrix that will greatly reduce the amount of flash to be removed. The major disadvantages are that if less than ideal wax up and matrix is utilized, it can lead to excess flash which can be time consuming to remove and preparation margins and/or soft tissue could be damaged in the process. Additionally, if the gingival interproximal embrasures are not opened properly, the interproximal papillae can be compressed apically leading to blunted papillae and open gingival embrasures at the delivery appointment in which the practitioner will need to make a clinical decision as to whether or not the papillae will fill in (rebound) with time. Also, less than ideal interproximal gingival health can lead to complications during delivery of the porcelain veneers due to increased risk of bleeding during the bonding process.

Discussion

Prior to initiating treatment via preparations, it is important to transfer the diagnostic wax up to the patient's mouth for a "mock up" or "esthetic preview". The transfer of this reproduction of the diagnostic wax up intraorally allows the patient to more accurately visualize the anticipated final result [29,30] and can be used to assess function, phonetics, and esthetics. Additionally, it can serve as a reduction guide to control depth cuts (Fig. 6) thereby helping to achieve more conservative preparations and ultimately enamel preservation [30,31]. During the treatment planning phase, the clinician must make the decision about which technique for provisional fabrication will be best suited for a particular situation based on clinician confidence, preference, and experience. The provisionals must provide an esthetic appearance, function properly, and provide comfort to the patient during the interim period [6]. In some instances provisional restorations may not be needed as in cases where minimal or no prep veneers are planned, or where the practitioner is not making significant changes to size, shape, contour, or incisal edge position. Additionally, when provisional restorations are not needed, the risk for dislodgement as well as chipping/fracturing is eliminated, and it is easier for the patient to maintain soft tissue health. Dealing with complications such as these is an inconvenience to both the dentist and patient and can lead to patient dissatisfaction or loss of confidence in the provider.

Long-term survival rates (best success rates) of porcelain veneers significantly increase when preparations are confined to enamel with the second-best scenario being having preparation margins in enamel [32]. Preparations in enamel provide the highest shear bond strength for porcelain veneers as removal of enamel (which imparts stiffness to the tooth) leads to an increase in flexure under load and ultimately cohesive fracture [33]. Preparations with significant dentin exposure can result in reduced bond strengths with higher risk for microleakage [34]. For cases where a significant amount of dentin may be exposed, it would be advisable to apply an antibacterial densensitizer such as gluteraldehyde over the exposed areas or consider immediate dentin sealing (IDS) as proposed by many clinicians for indirect restorations. [35–38] A recent literature review on IDS [39] states there are no documented reasons preventing clinicians from utilizing IDS in their everyday practices as it has advantages with regard to bond strength, gap formation, bacterial microleakage, and dentin hypersensitivity. However, there are issues that can arise with regards to interaction with impression materials, the provisional phase, and conditioning methods before cementation. While there are advantages to using IDS, use of this technique could lead to difficulties in removing the provisional restorations should they become inadvertently bonded to the preparations as sealed dentin surfaces have the potential to bond to resin-based provisional materials and cements [37]. Following IDS, the prep should be spot etched and a viscous petroleum or glycerin gel should be carefully applied over the remaining sealed dentin (avoiding coating the spot etch sites) to minimize the risk of the provisionals from bonding to the preparations. Excessive use of separator may lead to provisional restorations dislodging given that the preparations are not inherently self-retentive. It has been shown in one study that dentin exposure of less than 25% of the bonding surface did not benefit from IDS application [40] and an additional study concluded that teeth with 50% dentin exposure significantly benefitted from IDS [41]. Long term success with porcelain veneers relies largely on keeping preparations in enamel, thus dentin exposure should be kept as minimal as possible though orthodontic care (if needed) to allow for more conservative preparations, use of the additive technique whenever possible, and use of preparation reduction guides (Fig. 6). In cases where significant dentin is exposed and the decision made to still proceed with veneer preparations, it may be advisable to splint the provisionals to help with retention when the path of insertion will allow.

Self-curing acrylics have traditionally been used for the fabrication of indirect provisionals because of the ability to reline and the elasticity of the material unlike resin composites rigidity and fragility [6]. Indirect provisional fabrication provides better marginal fit relative to direct methods when polymethyl (PMMA) or polyethyl (PEMA) methacrylate resins are used [42,43] as the acrylic resin polymerizes in an undisturbed manner [18]. Additionally, acrylic shells can be cured under heat and pressure to improve the physical characteristics allowing them to be cemented if desired, and more easily removed with less risk of breakage should any adjustments to the provisionals, or modification of the preparations, be needed [29]. Also, when the indirect technique is utilized, the prepared teeth are not exposed to the exothermic reaction inherent with acrylic resin materials [44]. However, many practitioners are now choosing to use bis-acryl resins due to less exothermic heat and shrinkage during polymerization resulting in better marginal fit, [45] and the ease of which marginal deficiencies can be repaired with flowable composite resins [4] that can be placed, contoured, and cured on command, and are compatible with bis-acryl and PMMA resins [46]. Additionally, it has been shown that both bis-acryls as well as acrylic polymethyl methacrylates (PMMA) exhibit low bacterial adhesion potential [47]. It should be noted however, that all bis-acrylates (bis-acryls) are not created equally and some offer better strength and physical properties than others [48,49]. The determination of which material to use will ultimately be based on provider preference and experience, and the needs of the particular case.

It is inevitable that fractured provisional restorations will occur at times, and the extent of the fracture and duration of remaining wear time will factor into the decision to repair versus remake. When bis-acryl restorations were first introduced, clinical attempts to repair with additional bis-acryl was suggested but proved to be ineffective [50]. Repair using flowable composite resin has been shown to be a viable option in the repair process with relative ease of use [4,50-52] and has proven to be effective and durable [4,50]. It has also been shown that flowable composite resin will bond with PMMA resins [53] and the bond can be increased by first wetting the surface with a bonding agent to promote a more effective chemical bond between the surfaces [54,55]. Defective or fractured surfaces can be roughened with a diamond bur or microabraded using air particle abrasion with 50 micron Al_2O_3 to create micromechanical roughening as it has been shown that the increased surface roughness can facilitate mechanical interlocking [56] and a combination of air abrasion and bonding resin seems to be the most effective protocol for composite-to-composite repairs [54]. Mechanical roughening to remove the contaminated surface layer is even more vital in cases of aged restorations due to the reduction in available free radicals [57] and from water sorption from saliva and other fluids into the surface [58]. For aged/contaminated surfaces, phosphoric acid can additionally be used following microabrasion to further clean the surface in preparation for the repair to follow. Bonding resin is then applied and air thinned, and flowable composite added to repair the defect and carried up onto the restoration with a brush or explorer to add bulk for better strength, retention, and blending followed by light polymerization [4]. One in-vitro study however found that specimens that were only air abraded resulted in higher shear bond strength than specimens that added bonding resin [50]. It was determined in this study that the flowable repair resin had an adequately low viscosity to penetrate the surface of the air-abraded bis-acryl composite without the use of an intermediate bonding resin. If using a higher viscosity restorative composite, the application of bonding resin may be more relevant. However, in either case of using or not using an intermediate bonding resin, no failures occurred adhesively at the repair interface and either technique resulted in shear bond strength values that exceeded the cohesive strength of the bis-acryl composite. The repair can then be smoothed and polished taking care not to damage preparation margins or soft tissue.

More recently with the improvements of indirect milling and printing, it is possible to fabricate provisionals indirectly that can be used as a removable “snap-on” interim appliance [59]. The major advantage is that it can be removed daily to allow for improved hygiene. These removable veneers can be fabricated directly by an analog method or by digital modality that offers the advantage that the information would be stored digitally and thus retrievable if necessary to fabricate new interim restorations [59]. It is important to note that most veneer provisional restorations are splinted (at least in segments) to help with retention [59]. Connector size and strength of the material is important to their survival during the temporization phase and thus the use of as large of connector size as prudently and esthetically possible is warranted. The main disadvantages are the time and cost (if indirectly fabricated using a commercial laboratory) required to fabricate such an appliance, and the likely need of intraoral reline should there not be a common path of draw across often numerous preparations.

Regardless of the provisional technique chosen, several factors are essential for success. Making very accurate preliminary impressions is essential to ensure non-distorted diagnostic casts and that the gingival margins are accurately captured. Second, it is mandatory to have a high-quality diagnostic wax up that is captured by a precise PVS or clear pressure formed matrix. It should be noted however that a digital workflow can be utilized as well and yield exceptional results [60]. Third, it is advantageous to use temporary cements that are not opaceous since the often-reduced thickness of the provisional veneer(s) can allow more opaque cements to show through. It is therefore more desirable to use a flowable resin that provides better translucency to allow for a more satisfactory esthetic result. Studies have also shown that some light-cured provisional cements result in lower bond strength of the definitive veneers [61] and minute cement debris can remain even after polishing as visualized by SEM [12]. Ultimately, it has been shown that significant reductions in bond strength can occur when dentin is contaminated with various provisional cements compared to freshly cut dentin, [37] and hence again why IDS is advocated by many especially in cases of moderate dentin exposure. Removal of provisional veneers are much easier to accomplish obviously when they are luted with temporary cement. However, as mentioned previously, these types of cements can lead to lower bond strengths of the definitive veneers [61]. Mechanical removal of temporary cements by use of hand instruments has shown to not be effective [62]. Although dentin surfaces may appear clean macroscopically, temporary cement residue was observed microscopically on dentin surfaces that decreases the bonding of resin cements to dentin [62]. It has also been shown that residual resin cement remaining after the removal of the provisional restorations can negatively affect the etching quality of the tooth surface and therefore the fit and final bonding of the definitive porcelain veneers [12]. Once provisional restorations are removed, the preparations should be cleaned of all residual cement by means of a prophy cup and a non-fluoridated pumice or prophy paste taking care not to injure the soft tissue resulting in bleeding that could be difficult to control. Pumice paste does not result in any residue deposition on dentin surfaces and eliminates bacterial plaque and may produce a thinner smear layer thus facilitating the acid conditioning effect on dentin to follow [63]. It has also been suggested that the combination of pumice paste and chlorhexidine should be tested to evaluate for potential synergistic effects on dentin bond strength [63]. Studies have additionally looked at the use of sodium bicarbonate spray on the effect of bond strength between dentin and self-etching adhesives and showed decreased adhesion [64]. Alternatively, use of microetching (air particle abrasion, APA) using 30-50 micron aluminum oxide at low pressure (15-30 psi) has been shown to be an effective method for cleaning cement residue from preparations and resulted in higher mean bond strengths than use of sodium bicarbonate spray [63,65]. Additionally use of aluminum oxide sandblasting has been shown to result in better dentin wettability [63,66] and consequently facilitating the infiltration of adhesive into dentin following acid etching [66]. Higher bond strength values were ultimately achieved when aluminum oxide sandblasting was used as the cleaning method. Use of temporary cements containing eugenol prior to bonding procedures has been a controversial topic but has been shown that after a period of seven days, any residual eugenol from the provisional cement did not affect the bond strength to dentin and thus, per this study, the temporary cement type does not seem to affect dentinal adhesion if the correct cleaning method is used [66]. Use of APA will additionally freshen the surface for cases where IDS was utilized in preparation for etching to follow. Another advantage to IDS is that these cleaning procedures can in most cases be accomplished without local anesthesia as the dentin has been previously sealed. When using the microetching (APA) technique, as with pumicing, care should also be exercised to avoid soft tissue bleeding. Provisional veneers cemented with flowable resin, use of the shrink wrap technique, or splinted provisionals will all likely be more difficult to remove. In these instances, a narrow diameter fine carbide or fine diamond bur can be used to section the provisional veneers in multiple places taking great care not to damage the prep margins and only prepping through the provisional veneer avoiding the underlying tooth structure. If a spot etch technique was utilized for better interim retention, it can be carefully removed again with a fine diamond or by gently microetching as described above.

Finally, an additional factor that must be considered is the role occlusion plays in the stability and integrity of the provisional restorations. During function, the restorations are stressed and often destabilized with frequent decementations and/or fractures due to the unsatisfactory mechanical retention [6] and nature of the materials from which provisional restorations are typically fabricated. In many cases the practitioner should consider fabrication of a temporary acetate protective guard [6] for the patient to use thereby reducing the likelihood of

provisional complications mentioned previously. An equilibrated guard used nocturnally helps to redistribute occlusal forces over a greater number of teeth and is especially important in bruxers. Additionally, as the guard is clear, it can also be worn during the day, if needed or desired, without significant esthetic concerns. It should be noted however that veneers may be contraindicated in patients with significant bruxism and other alternative options should be discussed. In cases where occlusal issues are of concern, collaboration with the dental technician should be of paramount importance in order to complete the definitive veneers as quickly as reasonably possible to allow insertion in a timely manner.

It is critical to remember that no elective dentistry should be initiated without a clear understanding of the patient's expectations and a discussion with the patient of the limitations of restorative therapy [8] in order to minimize the risk of not meeting the patient's goals and desires. The use of quality photographs, diagnostic wax ups and well-fitting provisional restorations are all critical to the success of the care provided, and ultimately to patient satisfaction. The technique that will ultimately be chosen should be based on the provider's confidence, knowledge, and skills thereby allowing them to provide exceptional provisional (and ultimately definitive) restorations for their patients. It is important to remember that patients often prejudge the dentists' indirect restorations by the quality, or lack thereof, of their provisional restorations. It is therefore critical that any practitioner providing indirect dental restorations have a good working knowledge of appropriate material selection and methods for provisional fabrication, and lastly take the time to do the job well as after all, they serve a much more critical role in the restorative process beyond that of being "just a temporary".

MeSH Terms: dental veneers, dental laminates, temporary dental restoration, porcelain veneer provisional restorations Clinical Significance: Provisional restorations play a vital role in treatment with porcelain veneers to ensure a successful outcome. Not only do they provide protection for the prepared teeth, they also serve as esthetic and functional prototypes for the proposed changes desired by the patient and dentist. For cases involving traditional veneer preparations, fabricating and placing well-fitting provisional restorations are critical to ensuring comfort for the patient and maintenance of soft tissue health that is vital to the future bonding process.

Disclosure Statement

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