Ceramic veneers in general dental practice. Part four: Clinical procedures 2

Philip Newsome and Siobhan Owen look at the very technique-sensitive procedures involved in trying-in, bonding and finishing ceramic veneers

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Step 1 Try-in

Following tooth preparation and temporisation (if provided) the patient returns one to two weeks later to try in the ceramic veneer(s). Some operators treat the try-in phase as a separate, standalone, visit and will return the adjusted veneers to the laboratory for final finishing prior to the bonding appointment. In most cases, however, the veneers can be bonded immediately after try-in.

Firstly, the veneers must be checked to ensure they fit the stone model (Figure 1) and, importantly, that they fit an untrimmed second pour, in order to ensure that the fit, contour, shade and overall aesthetics as well as the occlusion all appear satisfactory and, in particular, that the ceramic has not been over-trimmed. It is also important to examine the fitting surface of the veneer to confirm that this has been correctly etched by the laboratory (Figure 2). Although it is possible to etch veneers at the chairside using 10% hydrofluoric acid (for one minute followed by cleansing in 95% alcohol for four minutes in an ultrasonic bath), most dentists prefer that this stage be carried out in the laboratory. Conversely, the practice of applying silane coupling agent in the laboratory has been largely discontinued in favour of chairside application (Blatz 2003).

Remember that prior to bonding, ceramic veneers are extremely fragile and need to be handled with great care - some operators have even suggested that the above checks be carried out over a sink full of water in case a veneer is accidentally dropped. Remember too to wear powder-free gloves to prevent possible contamination of the fitting surface and hence the final bond.

However well the veneer sits on the trimmed and un-trimmed casts, the restorations must clearly be evaluated on the prepared teeth prior to bonding. Any provisional restorations are therefore removed and magnification used to verify that no residual acrylic material remains attached to the tooth surface. Evaluation of the veneer must take into account all the factors mentioned above although occlusion is often difficult to assess fully only once the veneers have been bonded in place. Veneers are first of all tried in individually and then simultaneously using a water soluble try-in paste. This is a critical step as the shade and opacity of the cement can dramatically influence the final outcome, especially when thin, translucent veneers are used and/or when discolourations are being masked. It is often difficult to seat all the veneers simultaneously since there is usually very little physical retention available and, in many cases, wedges are required to separate the teeth to allow full seating – especially so when the proximal contacts have been breached during preparation. Use of thin articulating paper placed interproximally provides a guide to where adjustment of any heavy contact is required. Should extensive modification of the veneers be necessary it may well be prudent to return them to the laboratory for final finishing.

Once the try-in has been completed and the cement shade chosen then the fitting surface of the veneer must be cleaned to ensure optimal bond strength. A number of different cleansing methods have been suggested to remove not only the try-in paste but also contamination with die stone, saliva etc. Acetone is one of the most widely recommended agents for cleaning the fitting surface of the veneer (Swift 1995, Della Bona 1994). Treatment with 37% phosphoric acid has also been shown to restore the bond strength of veneers contaminated by saliva (Nicholls 1988, Aboush 1998).

Following try-in and cleaning, a two-part silane is mixed and painted (not puddled or dropped) onto the fitting surface of the veneer. This step is vital and should not be overlooked or rushed as the chemical reactions that take place between the porcelain surface and the silane agent are universally regarded to be responsible for the high shear bond strengths found in the porcelain/resin/tooth complex. Plueddemann (1991) demonstrated the complex, yet reliable, nature of this bond between the silane coupling agents and both organic and inorganic substrates. Activation of the si-

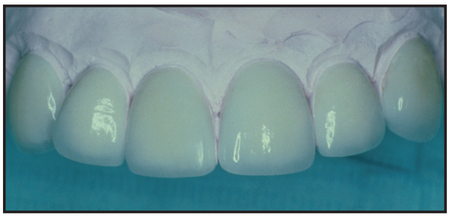

Figure 1: The veneers should be checked on the stone cast prior to being tried-in in the mouth

Figure 2: The fitting surface of a correctly etched veneer should have a frosted appearance

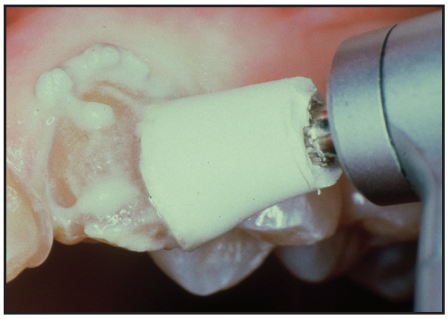

Figure 3: Pumice slurry is used to thoroughly clean the preparation

lane agent starts when it is mixed with water. The hydrolysis results in the formation of silanol which subsequently reacts with silanol on the surface of the porcelain (Soderholm 1993). Once applied, the silane must be left for sixty seconds to dry thus removing any excess absorbed water. If the mixed silane is not used within several hours it will polymerise to an unreactive and ineffective polysiloxane (Suh 1991). As a rule, two part products are preferred because of their longer shelf life – most single-component silanes are only suitable for use six months from manufacture because of their susceptibility to rapid solvent evaporation. A good indicator is the appearance of the liquid; a clear solution is useable whereas a milky-looking one should be discarded (Blatz 2003).

The prepared tooth should also be cleaned prior to etching. Prophylaxis paste containing fluoride is contra-indicacted as the presence of the fluoride has been shown to compromise bond strength. Pumice and water is widely used (Figure 3) although some concern has been expressed about the possibility of pumice remaining within dentinal tubules leading to reduced bond strength. Again, acetone is increasingly being used to clean the tooth surface.

Step 2 Etching

For many years, the use of etching tooth enamel and dentine with phosphoric acid - the so-called 'total etch' (Figure 4) - to create micromechanical retention of resin tags has been almost universally accepted by the profession. More recently though, the use of weaker acids, which do not require washing of the tooth surface after acid application and which leave the smear layer on the dentine and lead to a less aggressive etching of the enamel has gained popularity. Such "self etch" systems are thought to produce much less post-operative tooth sensitivity as compared with the total-etch approach (Perdigao 2003). This may be linked to the finding that self-etch dental adhesive systems could contribute to the elimination of residual bacteria and hence reduce the risk of secondary caries (Feuerstein 2007). This all begs the question 'Which etching technique is most appropriate for ceramic veneers?' Christensen (2005) advocated the following approach for those preparations which involve both exposed enamel and dentine:

1) Selectively etch the enamel with a well-controlled, viscous phosphoric acid gel.
2) Wash the phosphoric acid gel from the tooth with a significant amount of water spray. If it is washed slowly, the gel acid is spread all over the tooth preparation, thus etching it and reducing the sensitivity-prevention advantages obtained with self-etching primer application
3) Place the self-etching primer and bonding agent on the entire preparation, including the enamel that has been etched with the phosphoric acid gel. Do not cure the primer/bonding agent before seating the restoration otherwise the veneer will not seat fully owing to the film thickness of the self-etching bonding agent. An exception to this is with some of the newer generation self-etching primers which exhibit extremely thin film thicknesses.

Some operators recommend the use of rubber dam during the bonding phase of the treatment, the main benefit clearly being moisture control, not only of saliva and gingival fluid, but also of the moist air present during exhalation. Such considerations assume even greater significance when bonding veneers in the lower arch where moisture control is usually a considerable problem. Dunne (1993) however, found that use of rubber dam was not a significant factor in the long-term performance of porcelain veneers. The downside of using rubber dam is that it can be extremely difficult to apply properly when large numbers of veneers are being placed, especially when veneer preparations are subgingival (Figure 5). In an attempt to overcome these difficulties various modified techniques have been suggested (Liebenberg 1995).

A decision must also be taken as to the use of local anaesthetic. Where the preparations are wholly in enamel then often anaesthesia is usually not required. Whenever rubber dam clamps are being used, where there is dentine exposure or where considerable wedging of the teeth is necessary then local anaesthesia should be administered.

Step 3 Choice of luting resin

The purpose of the luting cement is to guarantee a durable bond between the ceramic and the tooth substrate. Additional, desirable, attributes include good marginal adaptation, optimal biomechanical properties, low solubility in the oral environment, radiopacity, controlled and manageable working time for easy manipulation, appropriate viscosity to allow complete seating and optimal aesthetic qualities. Any veneer's proverbial 'Achilles heel' is the restoration-cement-tooth interface, for the following reasons:

- Because it is being used as a luting agent, the bulk of the composite is greatly reduced. However, there will still be some volumetric polymerisation shrinkage of the order of 2-6% (Bausch 1982) which may lead to the creation of a marginal opening or loss of marginal seal.
- The thermal coefficient of expansion of the cement is also different from that of the tooth and the ceramic.
- Composite resins may wear and the wear will be greater the larger the gap width (Shinkai 1995).
- In-vitro studies have long demonstrated a dissolution of the resin matrix of composite resin in oral fluids (McKinney 1985, Roulet 1984, Vrijhoef 1985).

For all the above reasons it is clearly desirable to minimise the composite component by ensuring as close an adaptation of the porcelain veneer as possible. This is one of the reasons why pressed porcelains have become so popular in recent years.

Both light- and dual-cure composites are routinely used for veneer placement primarily as they allow considerable control over the

Figure 4: Total etch involves the use of 35% phosphoric acid over the whole preparation. Foil strips prevent etching of adjacent teeth

Figure 5: Rubber dam creates an ideal environment for veneer placement but can be difficult to apply

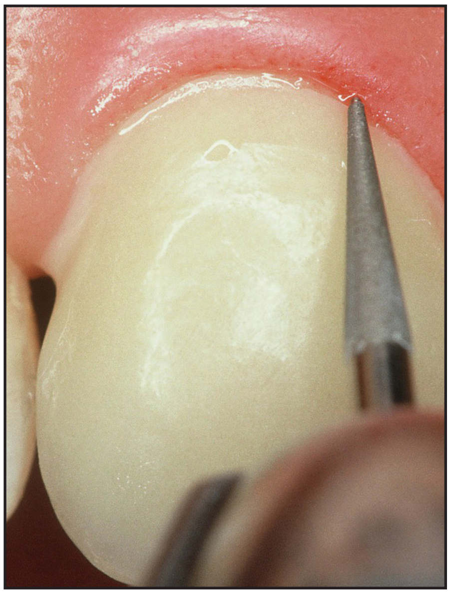

Figure 6: Luting cement that is allowed to harden fully must be removed by diamond finishing burs. It is far preferable to tack the veneers in place first so that excess cement can be easily peeled away from the tooth

setting process (as compared to wholly self-cure systems), ensuring proper seating and, importantly, more effective removal of excess composite prior to complete curing and hence much less post-cementation finishing. The choice of which particular type to use takes into account such factors as colour stability and veneer thickness.

For all ceramic veneers, but especially very thin ones, colour stability of the luting resin is an important consideration. A number of research papers have demonstrated that a period of accelerated aging of some dual-cure systems leads to noticeable colour change (Nathanson 2002, Lu 2004, Noie 1995, Hekimoglu 2000) Concern has been expressed over the colour stability of dual-cure systems as a result of the tendency of aromatic tertiary amine co-initiators used in the curing process to readily oxidize to form coloured oxidised products (Berrong 1993). Colour change can be measured using the Delta index – a Delta index of less than 3 is not detectable by the human eye (Alexander 2004) whereas a score of greater than 3 is detectable. A new generation of 100% light-cure resins with a Delta index much less than 3 have been introduced. A further potential source of colour change within the luting cement is HEMA within the resin (used to provide more hydrophilic properties to the resin). HEMA also makes the resin prone to water sorption leading to a reduction in cross-linking of the cure and can, accordingly, weaken the cement and for these reasons non-HEMA luting resins are gaining popularity.

Step 4 Placement

Different operators have different approaches to the actual veneer placement. One common recommendation, for example, is to simultaneously place the two central incisors first. The veneers have been silanated by this stage, the teeth etched and a thin layer of bonding adhesive placed, but not cured, on the veneer and the surface of the tooth. The luting cement is placed in the veneer which is then seated onto the tooth, ensuring that excess cement is visible all around the margin. If this is not the case then the veneer should be quickly removed and more cement applied. Light pressure is placed in the middle third of the veneer with a small condenser to ensure the restoration is fully seated.

The curing light is held about 1 cm from the tooth and the resin cured for no more than five seconds (the most appropriate time comes with experimentation and experience) using a sideways waving motion. The aim here is to cause the cement to gel so 'tacking' the veneer to the tooth and making clean up far easier as the cement will now peel off easily and floss can be passed down through the contact points to ensure they are 'free' and there is no excess cement lodged between the teeth. The palatal surface can be dealt with similarly and then once all the excess cement has been removed final curing can take place. Once the centrals are in place it is usual practice to then complete one side and before moving onto the contra-lateral teeth.

Apart from colour stability, the decision to use a light-cure or a dual-cure luting cement is based largely on the thickness of the veneers being placed. This is because the efficiency of light-curing is relative to the amount of light reaching the luting composite through the ceramic material. The porcelain absorbs 40-50% of the emitted light and clearly the veneer thickness is a major factor determining the amount of light getting through whereas the colour and opacity of the porcelain have been shown to have less influence on the amount of absorbed light (Linden JJ 1991, O'Keefe 1991).

The critical veneer thickness seems to be 0.7mm, any greater than this and it appears that light cured resin cements do not reach their maximum hardness. Thus light-cure luting systems are preferred for thinner (i.e. less than 0.7mm thickness) primarily as the dual-cure cement does not polymerise as effectively and may be susceptible to the aforementioned colour change. A dual-cured resin, which contains initiation systems for both chemically and light-cured composites is recommended for use with such thicker veneers (Cardash 1993).

Step 5 Finishing

Properly finished porcelain is well known as being one of the most biocompatible materials used in restorative dentistry and the less that can be done to damage the surface of the bonded restoration the better (Figure 6). The problem of dissolution of composite resin was discussed earlier and it is extremely important that any marginal discrepancies are completely filled with the luting composite so that as smooth a surface is achieved. Studies have shown that the marginal openings seen on ceramic veneers are two to four times wider in the gingivo-proximal corners when compared with the mid-labial position (Sim 1993). This is most likely the result of shrinkage of the porcelain towards the region of greatest bulk i.e. the centre. This has clear clinical significance as the interproximal region is the most difficult to access.

The previously described technique of tacking the veneer in place and then peeling off any excess cement seems to offer the best means of reducing the amount of finishing required. The more hardened excess resin that needs removing the greater the likelihood of removal of the glaze from the porcelain (Peumans 1998) which in turn will lead to increased plaque retention and corresponding gingival reaction (Figures 7a and b). While the goal is to reduce the amount of finishing required to a minimum there will always be situations, however, where some is necessary. Some authors have shown that polishing procedures can produce a polished surface that is equal to that of a glazed porcelain surface (Goldstein 1991). While these polishing instruments may perform satisfactorily on flat accessible surfaces at high speeds, they are less well suited for finishing crucial gingival or interproximal regions. Haywood (1988) evaluated finishing and polishing in these crucial areas in-vitro and found finishes equal or superior in smoothness to glazed porcelain were achieved through the use of a series of finishing grit diamonds followed by a 30-fluted carbide bur and polishing pastes. Polishing under water spray has also been shown to produce a smoother surface than dry polishing (Haywood 1989). Despite these apparently reassuring findings the general consensus is that the less finishing that needs to be done the better.

Figure 7: (a) Here upper and lower anterior veneers have been placed and yet gingival inflammation is restricted to two restorations whose glazed surfaces have been damaged during finishing procedures. (b) This inflammation began to resolve following careful and thorough re-polishing of the affected surfaces

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