Longevity of ceramic veneers in general dental practice

Philip Newsome and Siobhan Owen discuss how to prolong the lifetime of ceramic veneers

Ceramic veneers have been around now for more than a couple of decades and in that time have become a very useful and relatively conservative way of improving aesthetics. Their use has grown considerably in recent years in line with developments such as dentine bonding and ultra-thin veneer systems. Not all of these developments have, however, been received entirely favourably and concerns have been expressed about the widespread proliferation of ceramic veneers (Burke 2008, Christensen 2006). When they were first introduced it was recommended that veneers be restricted to those cases in which a predominantly enamel substrate was available, accompanied by minimal crowding, a favourable occlusion and relatively little underlying tooth discolouration. Over time though these recommendations have tended to be ignored with the result that veneers are being used in ever more testing circumstances. One of the major consequences of this trend is the willingness of many dentists to cut veneer preparations deeper than before into dentine in order to mask dark teeth, to provide a bulk of ceramic capable of withstanding heavier occlusal loading and to correct crowding – so-called ‘instant orthodontics’ (Figure 1). The consequences are that firstly, the veneer suddenly ceases to be a particularly conservative preparation and secondly, retention of the restoration is almost entirely dependent on the strength of the bond between the luting cement and the dentine substrate. As Swift (2006) has observed though: ‘Recent reports of 50% failure at six years and 34% fracture are disturbing when compared with 93% to 100% success rates of 15 years observation in the 1980s i.e. at a time when veneers were universally bonded almost entirely to enamel.’ This view is reinforced by recent UK data indicating a success rate for veneers placed within the General Dental Services in England and Wales of just over 50% at 10 years (Burke 2009).

The purpose of this paper is to review the various studies that have been carried out...
regarding veneer longevity and to determine what conclusions can be drawn in order to help practitioners provide conservative, long-lasting, durable, aesthetic veneers.

Clinical studies

A number of clinical trials involving ceramic veneers are shown in Table 1 and it can be seen that failure rates range from 0% at four years (Kihn 1998) to as high as 50% over five years (Shaini 1997). Different studies have considerably different criteria for success and failure but in general failure is seen as a probable survival of greater than 90% after three years. A review of the literature in 2000 (Layton & Peumans) reported rates of 0 to 5% over 0 to five years.

What comes out of these various studies is that veneers offer acceptably high levels of durability and extremely high levels of patient satisfaction. What is equally clear though is that great care must be taken in case selection, treatment planning and clinical technique and that in order to get the very best out of the veneer technique the following basic fundamental principles must be taken into consideration:

1) Bond to an enamel substrate wherever possible

The notion of etching enamel to accept resin luting cement is very well accepted and this will be familiar to all dentists. It has taken more time for the idea of dentine bonding to be accepted (Perdigao et al 1999). In principle, for dentine bonding to be effective the dentine surface must be conditioned and then primed to form a hybrid layer onto which an adhesive is placed and which copolymerises with the composite luting agent. The first bonding agents used a four-step process to etch enamel, etch dentine, prime the dentine followed by application of the adhesive. This evolved into the so-called ‘total-etch’ system in which the dentine and enamel are etched simultaneously while the primer and bond remain separate components. More recently ‘self-etch bonding’ systems have been introduced which combine all the steps. These have had a mixed reception (Tay 2005) despite the obvious convenience they represent, claims that they reduce post-operative sensitivity and despite manufacturers’ claims of bond strengths equivalent to those with enamel.

As far as ceramic veneers are concerned, the advent of dentinal adhesives has created the illusion that veneers bonded to dentine will be as successful as those bonded to enamel, thus encouraging dentists to use the technique in a wider range of clinical situations. Why is it that practitioners increasingly feel the need to extend veneer preparations into dentine and interproximally to the extent of breaking contacts with adjacent teeth? The main reasons would seem to be the ability of a thicker layer of porcelain to hide dark discolourations and mildly crowded teeth as well as greater ease of handling. Technicians also tend to find making thick ceramic veneers less challenging than very thin ones. As a result, tooth reduction into enamel alone can lead to bulky veneers and so in many cases the dentist will cut further into the tooth to prevent overbuilding of the final restoration. Unfortunately, in spite of the considerable advances made in the field of dentine bonding, the longevity of a veneer continues to be a direct function of the amount of enamel substrate supporting it. There is an almost complete lack of clinical evidence to support the technique of bonding veneers to dentine as opposed to enamel with Calamia (2007) observing recently that ‘The key con-

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* This study specifically looked at preparation design – the 96% success rate refers to veneers with incisal coverage, while the 86% success rate refers to veneers without incisal coverage.
cept of preservation of enamel somehow has gone by the wayside or is considered less important. This may be a huge mistake."

Why is this the case when reported dentine bond strengths appear to match those achieved when bonding to enamel? Most longitudinal studies of dentine adhesives are performed using composite restorations directly-bonded onto non-carious Class V lesions where the strength and elastic modulus of the teeth are hardly affected (Perruans 2005). The difficulty of dentine bonding in the context of ceramic veneers is the disparity in flexibility between a rigid veneer and less rigid dentine. As Barghi and Overton (2007) have observed, removal of facial enamel or selection of teeth without facial enamel for veneer restorations is an attempt to match up high elastic modulus porcelain with lower elastic modulus dentine. It is predictable that functional loading of the veneered tooth will transfer this energy to the interface resulting in debonding or cracking in the porcelain. For this reason, the smaller the amount of enamel available for bonding and the greater the amount of dentine that is exposed during laminate veneer preparation the greater the likelihood that a full coverage restoration should be chosen.

2) Avoid tooth wear/ heavy occlusal loading cases
Although a veneer gains considerably in strength once it has been bonded to the tooth surface it is nevertheless a relatively brittle restoration especially vulnerable to heavy occlusal loading – the prospective study carried out by Walls (1995) used a patient population with a high likelihood of parafunctional habits along with a large amount of dentine substrate and unsurprisingly the combined high risk factors resulted in a decreased survival rate. In cases where occlusal loading is high the decision to use veneers in the first place should be thought through very carefully and consideration perhaps given to the use of stronger full-coverage restorations. If veneers are to be used then clearly a high-strength porcelain would be preferable (for example, an aluminium oxide ceramic such as Procera Alumina) and the accompanying higher opacity means that aesthetics may have to be compromised.

3) Don’t over-promise the ability of a veneer to mask deep discoloursations
There is often tremendous temptation to suggest to patients the use of veneers as a relatively conservative means of masking deep discolourations - for example in cases of tetracycline staining, hypoplasia etc and it has been shown that veneers, in combination with prior tooth whitening is an effective treatment in cases exhibiting mild discolouration (Newsome 2008). Veneers, however, become less and less useful the deeper the tooth discolouration becomes (Figure 3). This is because the ceramic needs to be of sufficient thickness in order to mask the dark colour effectively and this usually means cutting a deeper preparation than is normally recommended. This in turn results in the veneer being retained primarily by the luting agent’s bond to dentine and for the reasons outlined above this is undesirable. In addition, as one cuts deeper and deeper into the tooth its shade usually becomes increasingly dark making it harder for the veneer to provide an effective mask. Whenever veneers are chosen to treat discoloured teeth the use of a highly opaque porcelain is desirable as is the ability to deliver this level of opacity while still maintaining as thin cross-section as possible. Hence the porcelain should also be very strong and once again an aluminium oxide ceramic such as Procera Alumina would be appropriate.

4) Avoid using veneers to provide ‘instant orthodontics’
While veneers are, in many ways, ideal restorations for the treatment of spacing their use for the correction of tooth crowding is somewhat problematic and the greater the degree of crowding the more likely it is that tooth preparation will involve dentine, something which, as described above, is to be avoided if at all possible (Figure 4). The use of a pre-operative diagnostic wax-up and trial preparations will provide a useful indication of the degree of tooth reduction required and whether this is likely to be excessive and even result in pulpal involvement. In most cases it is far preferable to treat the crowding orthodontically first and only after this has been completed determine whether or not veneers are still required.

5) Replace old restorations prior to veneer placement
It is now widely recommended that old composite restorations, which may otherwise form part of the veneer preparation, be removed prior to bonding in order to ensure the best possible bond to the luting agent. This is usually done at the preparation stage (Figure 5) itself although in some cases it can also be performed simultaneously with veneer cementation. This latter approach has the advantage of ensuring the composite substrate is ‘fresh’ and has not been contaminated in any way although doing things this way can be quite difficult to accomplish and is really only practical when the restoration being replaced is relatively small.

6) Pay meticulous attention to clinical technique
Veneers are notoriously technique-sensitive and demand an understanding of dental materials, design principles and above all tremendous attention to detail. Down the years there have been various recommendations made regarding veneer preparations. Meijering et al (1998) followed 263 veneer cases and observed that because of the number of potential variables such as the dentist’s skill, materials used, hard tissue substrate, occlusion, degree of tooth discolouration, outcome criteria etc a definitive answer to which veneer design is most effective is very hard to provide. Various basic principles have, nevertheless, emerged: 1) Tooth preparation should remain wherever possible in enamel. 2) Sufficient thickness of porcelain should...
be present to allow masking of any underlying tooth discolouration without the need to overbuild tooth contour.

3) The preparation should result in a smooth transition between tooth and restoration and in the gingival region should maintain the correct emergence profile.

4) Restoration margins should not be placed in positions where there is high degrees of occlusal loading.

5) Sharp line angles should be avoided to prevent the propagation of undesirable stress fractures in the bonded ceramic material.

A number of studies have looked specifically at the incisal edge preparation. This is a critical area and variations range from the very conservative window approach, through one in which the margin is sited on the incisal edge itself, to the overlap reduction, which in turn can be finished either as a butt margin or as a palatal chamfer. Of these, incisal coverage preparations appear to be the preferred option. Various studies have been carried out to examine the effect of preparation design on veneer longevity. Smallest and Etemadi (2004) for example, investigated long-term survival rates of veneer restorations after a seven year period and found a 96% cumulative survival rate when incisal coverage preparations were used compared to 86% survival without incisal coverage. Priest (2004) found that incisal butt joints provide the best solution, resulting in not only a relatively simplified tooth preparation but also stronger, longer lasting, restorations. Retraction cord is usually necessary unless the veneer margin is being placed supra-gingivally and careful impression technique is vital.

The bonding phase is critical and the operator and, just as importantly, his/her chairside assistant must be fully versed in the sequence of events that have to take place for successful veneer placement. Do not underestimate just how taxing this phase of the treatment is and if necessary have a number of ‘dry runs’ to ensure that the whole process is as well practiced and choreographed as possible – remember the old British Army 6 Ps maxim: ‘Proper Preparation Prevents Pitifully Poor Performance’. 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.

### Conclusion

Ceramic veneers are a very useful treatment option, but it must be remembered that they are just that, an option. They are certainly not applicable in all clinical cases requiring improvement of anterior aesthetics and great care must be taken in case selection and treatment planning. When they are used appropriately, the clinical studies reviewed in this paper show that veneers are more than capable of providing a long-lasting, conservative, aesthetic solution.

### References


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