

Porcelain laminate veneers. What, when and how?

Porcelain veneers have been around for many years and have shown high success rates. They can be used to correct discrepancies of size, shape, colour and position of teeth. This article aims to discuss the restoration of aesthetics with porcelain laminate veneers.

The 1998 Adult Dental Health Survey highlighted that 27% of dentate adults were dissatisfied with the appearance of their teeth. The most common reason for dissatisfaction was the colour of their teeth followed by tooth alignment, spacing and broken teeth (Bradnock et al, 2001).

As a result we have seen a change in patient attitude towards dentistry, with more patients seeking cosmetic treatment to improve their aesthetic appearance. It is not uncommon for today's patients to present at the surgery requesting cosmetic procedure such as porcelain veneers, which they have read about on the internet and magazines or seen on the television.

Porcelain veneers were first described by Horn in 1983 as a minimally invasive restoration used to improve the overall colour and shape of teeth. Veneers have only recently become more popular due to advances in porcelain materials and bonding techniques, allowing bonding of porcelain to an etched enamel



Figure 1. A single porcelain veneer.

surface. The porcelain veneer itself is a thin shell of porcelain (Figure 1) which has relatively poor strength but once bonded to enamel with resin its strength increases (Walls et al, 2002). They are often referred to as porcelain laminate veneers as they are placed on the labial surface of teeth, particularly the upper anterior teeth in order to create an illusion that improves the aesthetics of the original underlying teeth.

Indications for porcelain veneers

Masking discolouration and visual defects of anterior teeth

The aesthetic appearance of teeth affected by intrinsic staining can be improved with veneers (Toh et al, 1987). The common causes of intrinsic staining are shown in Table 1. The level of staining can vary and the ability of veneers to mask heavily-stained teeth depends on the opacity of the porcelain used, luting cement shade and opaquers used, and thickness of the restoration (RCS(Eng), 1997).

Discoloured teeth often require more aggressive preparations, which allows for a greater thickness of porcelain to mask the discolouration (Gabra et al, 1988). Physiological ageing can also result in numerous crack lines appearing in the enamel which, over time, can pick up and internalize stains (Table 1). Veneers can be used to mask these visual surface defects of enamel (Toh et al, 1987).

Correction of malaligned teeth and tooth size/shape discrepancies

Patients with anterior malaligned teeth should be encouraged to correct the malocclusion to improve arch form and tooth position with a non-invasive approach using orthodontics as a gold standard. In cases where the malocclusion is associated with intrinsic discolouration and/or discrepancies in tooth size and shape, such as peg-shaped laterals, orthodontics alone may not improve the aesthetics. In these situations, veneers may be considered as an adjunct to orthodontic treatment to improve the overall aesthetics (Spear, 2004).

While orthodontics remains the treatment of choice for correcting malocclusions, there are many adult patients who will be reluctant to accept this option and will want an alternative restorative treatment option (Curry, 1999). This is often due to the duration of orthodontic treatment and the need to wear a fixed orthodontic appliance (Shannon, 1999). If the occlusal

Mital Patel and Kathryn Durey are Specialist Registrars in Restorative Dentistry, Paul A Brunton is a Professor of Restorative Dentistry, Leeds Dental Institute, Clarendon Way, Leeds

Email: mitalpatel_1@hotmail.com

Table 1. Sources of stains affecting the teeth

Extrinsic stains

Stains that are outside of the tooth substance, either on the tooth surface or the acquired pellicle. Causes include: cigarettes/cigars; poor oral hygiene/chromogenic bacteria; tea, coffee, red wine and other foods; mouthwashes (for example, chlorhexidine)

Intrinsic stains

Discolouration that has occurred due to changes to the structural composition of the teeth. These stains are within the structure of teeth and are caused by:

Metabolic changes: Alkaptonuria, congenital erythropoietic porphyria, congenital hyperbilirubinaemia

Inherited disorders: Amelogenesis imperfecta, dentinogenesis imperfecta

Iatrogenic causes: Tetracycline staining, fluorosis

Traumatic causes: Enamel hypoplasia, pulpal haemorrhage products

Idiopathic causes: Molar incisor hypomineralisation

Ageing: Thinning of enamel and increased dentine deposition

Internalised stains

Incorporation of stain into the tooth structure post eruption due to development of defects on enamel surface. Usually occurs due to: caries and/or restorations

create an illusion which restores correct anatomical proportions (Rouse, 1997).

Contraindications to porcelain veneers and alternative options

The primary goal of veneers is to improve aesthetics and not to restore



relationship of the anterior teeth is favourable (adequate overbite/overjet and no crossbites), veneers can be used to correct mildly malaligned, crowded and rotated teeth (Spear, 2004).

The veneers can be placed so that it allows correction of the bucco-lingual position of individual teeth and levelling of the incisal edges. Veneers however do not allow the correction of any discrepancies in the gingival zenith levels, which also play an important role in the overall aesthetic appearance. The position of the gingival zeniths can be corrected with crown-lengthening surgery, soft tissue grafting or by movement of teeth in the vertical plane using orthodontics prior to placement of veneers (Kokich, 1997; Weihe, 1997).

Patients presenting with a median diastema or anterior interproximal spacing often have well-aligned teeth; however, there is a discrepancy between the size of the jaw and the teeth. Often the teeth are too small for the jaw (microdontia), which results in spacing and an unaesthetic appearance. These discrepancies in the tooth size and

shape can be corrected with veneers, along with establishment of correct interproximal contacts in an attempt to



Figures 2a–d. Pictures a and c show preoperative photos of teeth affected by amelogenesis imperfecta. Aesthetics have been improved using composite resin as shown in pictures b and d.



Figure 3. Reduction of incisor in at least two planes and the use of silicone index for tooth preparation.

function (Toh et al, 1987). It is, therefore, important that they are placed only in areas of minimal occlusal loading and also avoided in patients who are bruxists (Christensen, 1985). The labial surfaces of upper anterior teeth are well suited to this when they are in a class I incisal relationship; however, veneers should be avoided in patients who have an edge-to-edge (class III) incisal relationship or a cross bite as these can result in excessive stresses during function resulting in the veneers failing (Sheets and Taniguchi, 1990). Veneers, along with other advanced restorative procedures, should also be avoided in patients with poor oral hygiene and unstable periodontal disease.

Alternative more conservative treatment of extrinsic stains (Table 1), and some intrinsic stains, can include a combination of microabrasion and tooth whitening. Advances in tooth whitening/bleaching techniques have recently seen a reduction in the need for veneers to improve the overall aesthetic appearance. Where these methods are not effective, or tooth size and shape is to be altered, modern composite resins now provide an excellent alternative veneering material to porcelain.

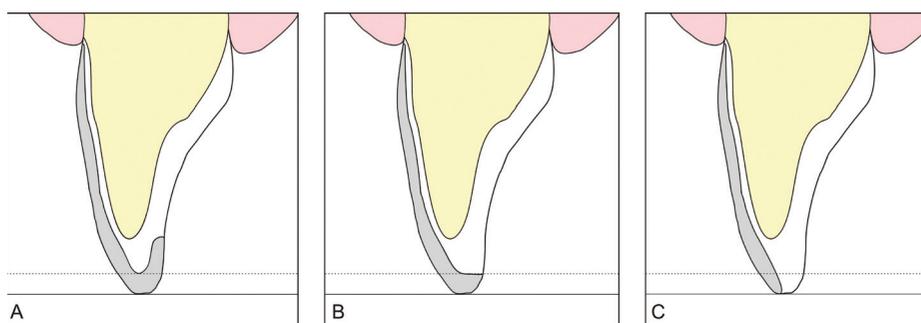


Figure 4. Commonly used incisal preparations. A—incisal overlap. B—incisal bevel. C—feathered incisal finish. (Incisal reduction required for a and b.)

The teeth can often be restored with very minimal bevelling or no preparation using composite resins (Figure 2). The material can be directly bonded to the tooth and, unlike porcelain, it does not need to be a certain thickness for strength and optimal light-reflecting properties. Although composites stain more easily than porcelain, they have the advantage that they can easily be polished, repaired or replaced. Composites are however time consuming, technique sensitive and require more patient compliance than traditional veneers.

Recently there has been much hype in the media about lumineers. A lumineer is a very thin veneer made from patented cerinate porcelain, which is strong in thin sections. They are approximately one-third to a half of the thickness of conventional porcelain veneers and have been referred to as ‘contact lenses for teeth’.

Compared to conventional veneers, they require minimal or no preparation of the tooth and can restore an aesthetic appearance in as little as two visits. Currently there is no data on the long-term outcome for lumineers and only dentists who are registered with the company that manufactures lumineers in USA can provide them (Pillai, 2010).

Clinical technique from start to finish

Preoperative planning

Long-term follow up studies of veneers have shown high survival rates (Friedman, 1998; Dumfahrt and Schaffer, 2000); however, to achieve these rates,

case selection and careful preoperative treatment planning is essential (Walls et al, 2002). The most important factor in restoring an aesthetic smile is the need to maintain symmetry and harmony in both the horizontal and vertical plane across the patient’s facial midline (Tipton, 2001).

Patient assessment begins from the moment the patient walks into the surgery with an assessment of their smile line and amount of tooth and gingival display at rest and while talking and smiling. This is followed by an intraoral assessment of the soft tissues and teeth in terms of size, shape, colour, position and relative proportions.

The idea of golden proportion has been mentioned in the literature but is proven to be too rigid for use in dentistry, often resulting in narrowing of the maxillary arch (Magne et al, 2003). It is, therefore, better to plan treatment based on average width-to-length ratios of teeth. If the length of teeth need to be increased, then a decision needs to be made as to whether or not you can add length to the incisal portion of the veneer, i.e. to increase incisal show or does the gingival margin need to be moved apically with crown lengthening surgery or a combination of both.

The decision will depend on amount of gingival display, tooth display, smile line and the incisal plane. The incisal plane of the upper maxillary teeth should be level with and follow the lower lip line when the patient is smiling.

Once a detailed assessment has been made alginate impressions, facebow and interocclusal record need to be taken for

articulated study casts. The laboratory technician should be given a detailed prescription for a diagnostic wax up based on your clinical assessment. The laboratory should also be asked to provide a clear suck-down matrix of the wax up, which can be filled with temporary crown and bridge material chair-side and used to create a chair-side aesthetic preview to show the patient what the final results will look like.

Once the patient and the clinician have approved the wax up, the teeth can be prepared for the veneers. The aim of tooth preparation is to define the margin of the veneer for the technician and create adequate space so that the veneer can be made without over contouring the restoration, which can lead to poor aesthetics and periodontal inflammation. At the same time the preparation needs to be as conservative as possible.

Tooth preparation

Buccal reduction

Ideally the preparation should remain within enamel; however, a number of studies have suggested that even with care, the exposure of dentine is likely (Nattress et al, 1995), which can result in sensitivity and microleakage around the margins if into dentine (Pashley, 1990). At the cervical margin where the enamel is thinnest, a reduction of 0.4 mm is advised, increasing to 0.7 mm towards the middle third of the tooth (Walls et al, 2002).

Preparation techniques can include free-hand preparation using diamond burs or the use of depth grooves which are made using standard burs of known diameter or specially designed depth-gauge burs. While these burs have shown a reduction in the variation in preparation depth in comparison to free-hand preparation (Cherukara et al, 2002), several authors have reported that preparations made using depth-gauging burs are often over prepared in comparison to those prepared freehand, which tend to be underprepared (Linden et al, 1991). The use of a sectioned putty matrix (Figure 3),



Figures 5a–b. Clinical photographs showing possible complications of porcelain laminate veneers.

made using the diagnostic wax up, can help the clinician to visualize the shape and depth of preparation required in order to achieve the final desired aesthetic result (Brunton et al, 2000). The overall shape of the preparation should mimic the natural curvature of the tooth and therefore it should be performed in at least two planes (Figure 3).

Marginal definition

At the cervical margin, a chamfer finish line of 0.4 mm depth should be produced. Where possible, subgingival extension of the buccal margin should be avoided as this increases the risk of gingival trauma and makes it difficult to control moisture during cementation. However, in cases with marked discolouration, this may be necessary to achieve an acceptable aesthetic result and the use of retraction cord or a flat plastic instrument to protect

the soft tissue during preparation should be considered (Walls et al, 2002).

Interproximal preparation

Interproximally, it may also be necessary to extend the preparation further proximally below the contact point to disguise discolouration, but care should be taken to avoid the creation of undercuts. Ideally the preparation should not extend through the contact points. In cases where veneers are being used to correct malaligned teeth, this may be necessary—in which case, appropriate temporization is necessary to prevent tooth movement between preparation and cementation (Rouse, 1997).

Incisal preparation

Four types of preparation for the incisal edge have been described and these were illustrated clearly by Walls et al (2002).

Of these the three most commonly used are shown in *Figure 4*. The decision relating to type of preparation is mainly an aesthetic one, as there is little evidence available to support one particular technique in terms of longevity. If the length of the tooth needs to be increased or the tooth is heavily discoloured, the veneer should be extended over the incisal edge, using either the incisal overlap or bevel preparation. This allows greater control of aesthetics; however, sufficient reduction must take place to ensure that porcelain thickness is at least 0.5 mm in order to resist fracture.

Impression taking

A good impression is paramount in the successful provision of porcelain veneers. Due to the precise nature of the restorations the impression material used needs to be accurate and dimensionally stable. Elastomeric materials are considered to be the materials of choice. In the general practice setting, addition cured silicones are commonly used for indirect restorations (Brunton et al, 2005) due to their superior dimensional stability, which means dies are accurate even if impressions are not poured straight away. A delay in casting is often unavoidable if the impression needs to be posted or transferred to a laboratory off site. Usually a light-bodied material is syringed over the prepared teeth and the margins to pick up fine detail and a heavier material is placed in the stock tray for the bulk of the impression.

For an accurate impression, it is also necessary to ensure good moisture control as silicone-based materials are hydrophobic (repelled by water). This can often be achieved with the use of salivary ejectors, cotton wool rolls and patient education. Just prior to seating the impression the teeth, especially around the margins, should be dried using the air from the 3 in 1. Once set the impression needs to be carefully assessed under good lighting and magnification to check for obvious flaws like air blows or drags.

Temporization

The ideal temporary restoration is one that is aesthetic, protects the tooth and maintains the occlusion while being easy to remove without causing damage to the preparation. Temporization of veneers is best avoided where possible as the typically unretentive form and minimal nature of the preparations makes it notoriously difficult. However, if there is a risk of sensitivity, tooth movement or the aesthetics of the preparations are poor, direct composite veneers or resin-based temporary veneers made from temporary crown and bridge material can be placed.

A preformed clear suck-down matrix based on a wax up can facilitate this (Reshad et al, 2008). Ideally the matrix should not extend beyond the gingival margins of the preparations so that excess material can be removed easily. It is important to ensure that the temporaries fit well and do not compromise oral hygiene or gingival health as gingival inflammation can make cementation difficult due to compromised moisture control. To increase strength, the temporaries can be linked together.

The temporary restorations can be cemented using a spot-etch technique in the centre of the labial surface only to ensure easy removal. Often, if a suck-down matrix is used the material can be left to set in situ. While it sets, there will be some shrinkage of the material around the preparations which will help retain the temporary veneers, thus eliminating the need for a temporary cement.

Cementation

The definitive veneers should be tried in the mouth prior to their cementation. As the restorations are generally less than 1 mm thick, they are fragile and difficult to handle and care is required. The shade of the veneer should be assessed and if necessary, there is some capacity to alter shade by choosing an appropriate shade of luting cement. The effect of the luting cement can be assessed by using the try-in paste provided in most kits, which is equivalent to the shade of cement lute chosen.

The setting mechanism of the cement should also be considered. Light-cure and dual-cure cements are available and a decision should be made considering the thickness of the veneer. This is important as polymerization of cements light-cured through opaque porcelain or porcelain of more than 0.7 mm, has been found to be inadequate (Linden et al, 1991). In this situation, dual-cure materials are recommended (Santos, 2004). Where porcelain is thinner, light-cured cements are advised as dual-cure materials do not polymerize as effectively and this may affect their long-term colour stability (Peutzfeldt, 1995).

Once the luting cement has been selected the veneer should be cleaned with an alcohol-based solvent prior to cementation to remove contaminants. Similarly, the preparations should be pumiced immediately prior to cementation and ideally any existing composite restorations replaced (Dunne and Millar, 1993).

To ensure maximum bond strengths, strict moisture control should be maintained throughout the cementation procedure. This can be achieved using rubber dam or by more conventional means such as cotton-wool rolls and gingival retraction cord. It is important to read the manufacturer's instructions, as there are likely to be subtle differences in procedure between luting systems. In general terms, after pumicing, the preparations should be etched, washed, dried and a dentine/enamel bonding agent applied to the tooth. The veneer can then be positioned and excess cement removed from the margins prior to light curing. If finishing is required, this should be done using fine diamond burs and finishing discs.

Prognosis

Patient satisfaction rates with porcelain veneers are generally high (Granell-Ruiz et al, 2010). Nonetheless, porcelain veneers are unlikely to maintain aesthetics for as long as the tooth remains in function and will over time require replacement causing some further damage to the underlying tooth structure. In a study of 323 veneers followed up for a minimum

three years, marginal discolouration was described as the most frequently occurring complication (39.2 per cent of veneers). This, however, may not necessitate replacement of the veneer. Reasons for replacement may include decementation of the veneer, fracture of the porcelain, gingival recession causing exposure of the veneer margin, secondary caries, and sensitivity (Peumans et al, 2004).

Figure 5 shows clinical photographs of replacement veneers in the upper arch to restore aesthetics in teeth heavily stained by tetracycline staining. While aesthetic have been improved there is still some show through of the heavily discoloured teeth. Also note the lower veneers which were placed several years ago but now show exposed veneer margins due to recession and fractures of the veneers. Fortunately these complications occur relatively infrequently (Granell-Ruiz et al, 2010) and, in general, given appropriate case selection, survival rates are good.

A small proportion of veneered teeth may lose vitality and as a result will require endodontic treatment. This is most likely to occur in young teeth with large pulp chambers and those where discolouration necessitates a more extensive preparation. If the veneer is clinically sound, this scenario is unlikely to require its replacement.

Conclusions

It is important to remember the ultimate objective of any dental treatment is to restore health and function as well as aesthetics using the most conservative method of treatment. Porcelain laminate

veneers have been proven to give a good aesthetic result; however, it is an invasive and irreversible treatment option which subjects the patient to life-long commitment to restorative dentistry. Successful provision of porcelain laminate veneers requires careful preoperative planning and a high level of operator skill from tooth preparation to cementation. DN

- Bradnock G, White DA, Nuttall NM, Morris AJ, Treasure ET, Pine CM (2001) Dental attitudes and behaviours in 1998 and implications for the future. *Br Dent J* **190**(5): 228–32
- Brunton PA, Aminian A, Wilson NH (2000) Tooth preparation techniques for porcelain laminate veneers. *Br Dent J* **189**(5): 260–2
- Brunton PA, Christensen GJ, Cheung SW, Burke FJ, Wilson NH (2005) Contemporary dental practice in the UK: indirect restorations and fixed prosthodontics. *Br Dent J* **198**(2): 99–103
- Cherukara GP, Seymour KG, Samarawickrama DY, Zou L (2002) A study into the variations in the labial reduction of teeth prepared to receive porcelain veneers--a comparison of three clinical techniques. *Br Dent J* **192**(7): 401–4
- Christensen GJ (1985) Veneering of teeth. State of the art. *Dent Clin North Am* **29**(2): 373–91
- Curry FT (1999) Restorative alternative to orthodontic treatment: A clinical report. *J Prosthet Dent* **82**(2): 127–9
- Dumfahrt H, Schäffer H (2000) Porcelain laminate veneers. A retrospective evaluation after 1 to 10 years of service: Part II – Clinical results. *Int J Prosthodont* **13**(1): 9–18
- Dunne SM, Millar BJ (1993) A longitudinal study of the clinical performance of porcelain veneers. *Br Dent J* **175**(9): 317–21
- Friedman MJ (1998) A 15-year review of porcelain veneer failure--a clinician's observations. *Compend Contin Educ Dent* **19**(6): 625–8, 630, 632
- Gabra DA, Goldstein RE, Feinman RA (eds) (1988) *Porcelain Laminate Veneers*. Quintessence, Chicago
- Granell-Ruiz M, Fons-Font A, Lobaig-Rueda C, Martínez-González A, Román-Rodríguez JL, Solá-Ruiz MF (2010) A clinical longitudinal study 323 porcelain laminate veneers. Period of study from 3 to 11 years. *Med Oral Patol Oral Cir Bucal*

- 15**(3): e531–7
- Horn HR (1983) Porcelain laminate veneers bonded to etched enamel. *Dent Clin North Am* **27**(4): 671–84
- Kokich VG (1997) Esthetics and vertical tooth position: orthodontic possibilities. *Compend Contin Educ Dent* **18**(12): 1225–31
- Linden JJ, Swift EJ Jr, Boyer DB, Davis BK (1991) Photo-activation of resin cements through porcelain veneers. *J Dent Res* **70**(2): 154–7
- Magne P, Gallucci GO, Belser UC (2003) Anatomic crown width/length ratios of unworn and worn maxillary teeth in white subjects. *J Prosthet Dent* **89**(5): 453–61
- Nattress BR, Youngson CC, Patterson CJ, Martin DM, Ralph JP (1995) An in vitro assessment of tooth preparation for porcelain veneer restorations. *J Dent* **23**(3): 165–70
- Pashley DH (1990) Clinical considerations of microleakage. *J Endod* **16**(2): 70–7
- Peumans M, De Munck J, Fieuwes S, Lambrechts P, Vanherle G, Van Meerbeek B (2004) A prospective ten-year clinical trial of porcelain veneers. *J Adhes Dent* **6**(1): 65–76
- Peutzfeldt A (1995) Dual-cure resin cements: in vitro wear and effect of quantity of remaining double bonds, filler volume, and light curing. *Acta Odontol Scand* **53**(1): 29–34
- Pillai S (2010) Lumineers: minimal preparation veneers. <http://tinyurl.com/32b2c44> (accessed 20 July 2010)
- Royal Collage of Surgeons (Eng) (1997) *Faculty of Dental Surgery National Clinical Guidelines. Restorative indications for porcelain veneer restorations*. Faculty of Dental Surgeons of Royal College of Surgeons of England, London
- Reshad M, Cascione D, Magne P (2008) Diagnostic mock-ups as an objective tool for predictable outcomes with porcelain laminate veneers in esthetically demanding patients: a clinical report. *J Prosthet Dent* **99**(5): 333–9
- Rouse JS (1997) Full veneer versus traditional veneer preparation: a discussion of interproximal extension. *J Prosthet Dent* **78**(6): 545–9
- Santos GC Jr, El-Mowafy O, Rubo JH, Santos MJ (2004) Hardening of dual-cure resin cements and a resin composite restorative cured with QTH and LED curing units. *J Can Dent Assoc* **70**(5): 323–8
- Shannon A (1999) Reconstruction of the maxillary dentition utilizing a non-orthodontic technique. *Pract Periodontics Aesthet Dent* **11**(8): 973–6, 978
- Sheets CG, Taniguchi T (1990) Advantages and limitations in the use of porcelain veneer restorations. *J Prosthet Dent* **64**(4): 406–11
- Spear FM (2004) The esthetic correction of anterior dental mal-alignment conventional vs. instant (restorative) orthodontics. *J Calif Dent Assoc* **32**(2): 133–41
- Tipton PA (2001) Aesthetic tooth alignment using etched porcelain restorations. *Pract Proced Aesthet Dent* **13**(7): 551–5
- Toh CG, Setcos JC, Weinstein AR (1987) Indirect dental laminate veneers--an overview. *J Dent* **15**(3): 117–24
- Walls AW, Steele JG, Wassell RW (2002) Crowns and other extra-coronal restorations: porcelain laminate veneers. *Br Dent J* **193**(2): 73–6, 79–82
- Weihe RG (1997) Postorthodontic restoration with a combination of gingivoplasty and porcelain veneers. *Compend Contin Educ Dent* **18**(8): 744–8, 750

KEY POINTS

- Porcelain veneers are a minimally invasive method of improving the aesthetics of anterior teeth.
- Success depends on appropriate case selection and thorough planning.
- Tooth reduction should ideally remain within enamel and mimic the natural curve of the tooth.
- Complications such as discolouration, fracture and sensitivity may occur. However, generally these are relatively infrequent and patient satisfaction is high.