Porcelain veneers: Treatment guidelines for optimal aesthetics

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Historically, the most predictable and durable treatment of unaesthetic anterior teeth was with the preparation of full coverage crowns with the removal of substantial amounts of tooth structure. This invasive preparation could lead to possible adverse effects on pulpal and periodontal tissues.

Following the introduction of bonding by Buonocore in 1955, research led to the development of conservative adhesive techniques to treat aesthetic problems. Resin composites can be used to mask tooth discolourations and improve tooth contours and positions. However, these have shortcomings in that they remain susceptible to wear, marginal fracture and discolouration. Due to these concerns, resin composites have been recommended for minor cases and for short to medium term restorations.

Charles Pincus introduced porcelain veneers in 1938 to provide temporary aesthetic improvement to patients in the film industry. These were retained with the use of a denture adhesive, but it was the development of enamel etching and porcelain surface treatment in the early 1980s that allowed this to become a more widely recognised procedure. Porcelain veneers have superior aesthetics especially over the longer term. Due to the biocompatibility and non-porous nature of the porcelain, this minimises plaque adherence, with no adverse effect on gingival heath in well-maintained mouths.

Figure 1. Portrait smile of patient.

Porcelain veneers have become an important treatment modality in providing solutions to patient's aesthetic and functional problems and need careful planning and execution to ensure a successful long-term result.

Figure 2. Frontal smile.

Figure 3. Frontal retracted photos.

Figure 4. Diagnostic wax-up.

Figure 5. Silicone reduction indexes in use.

Figure 6. Completed preparation.

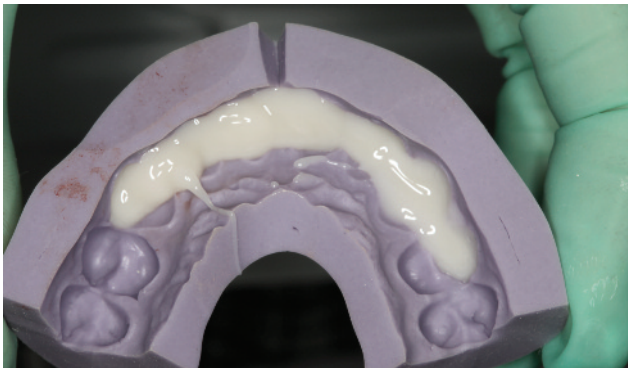


Figure 7. Bis-acryl resin temporaries being constructed.

Figure 8. Provisionals straight after removal of putty key.

Figure 9. Spot-etch temporisation.

Informed consent

Porcelain veneers are often an aesthetic and elective procedure and as such require a full discussion on the benefits and risks with the functional and aesthetic objectives defined within this process. Alternative means of achieving the patient's goals must be mentioned and a discussion on the procedures involved with the steps from start to completion. The patient must be educated on the care and maintenance of the veneers and mention made of the longevity of the veneers and their eventual replacement.

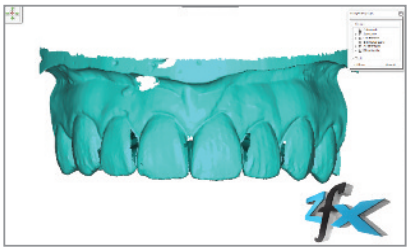


Figure 10. Scan of the wax-up.

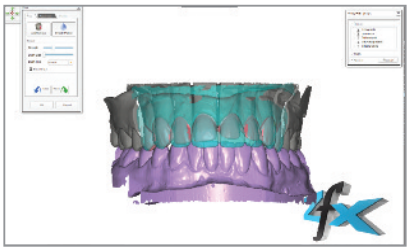
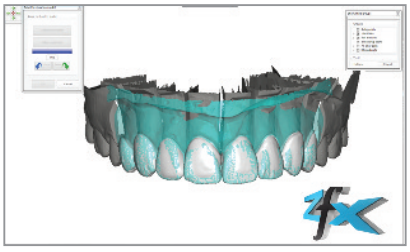
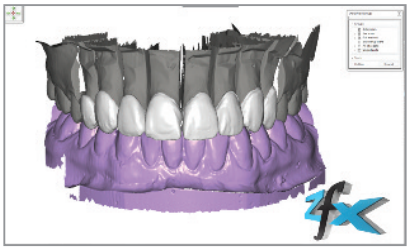
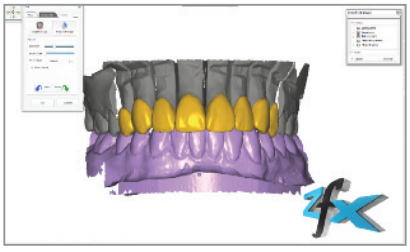


Figure 11. The wax-up scan is overlaid on the working model and made transparent, it will be used to position the initial shapes.







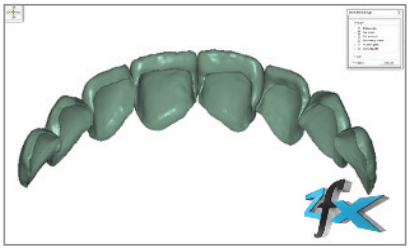


Figure 12. Veneers being designed with computer aided design (CAD).

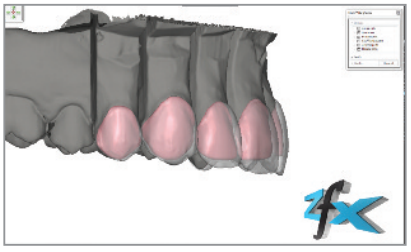


Figure 13. Lateral view of CAD designed veneers.

Shade selection

The selection of a shade and masking with veneer restorations can be a challenging procedure due to the thin nature and translucency of the restoration. The final colour that is attained is a result of the underlying tooth colour, the resin cement that is selected and the opacity/translucency of the porcelain used.

The underlying tooth structure may be discoloured due to previous endodontics, old restorations, age, trauma and tetracycline cases. The colour of the existing teeth should be communicated to the ceramist (stump shade), as this allows the ceramist to determine the final opacity and translucency needed of the restoration. The influence of the substrate determines the final shade.

Diagnostic wax-up/mock-up

It is critical to have a clear plan of where treatment is heading and the utilisation of a wax-up can assist the planning of the desired aesthetic appearance. This should incorporate the patient's wants that were expressed in the initial treatment planning discussions.

This wax-up also allows the manufacture of putty keys for provisionalisation and reduction guides for the preparation process. The contours and form of the final teeth can be transferred from the desired wax up to the provisionals allowing patients to have a preview of their desired appearance and reconfirm that they are happy with the changes that are planned.

Preparation

A mental picture should be developed of the requirements of the tooth preparation needed from the amount of depth reduction, to the preparation margins to attain the final outcomes.

The aims of tooth preparation are to:

- Provide enough thickness for the porcelain for sufficient fracture resistance and to not over contour the final restoration;
- Provide a margin, so that the ceramist has a definite finishing line, allowing normal emergence of the veneer from the gingival margin;
- Maintain the preparation within enamel wherever possible;
- Provide a finished preparation, which is smooth and free of any sharp internal line-angles, which may cause stress concentration within the ceramic; and
- Provide definite seating landmarks making proper seating of the veneer.

Labial preparation

The preparation of the buccal plane of the incisors (which are convex) needs to be addressed in three planes with incisal, middle third and cervical planes.

A careful labial reduction of tooth structures is carried out to provide a minimum of 0.3mm (feldspathic porcelain) or 0.6mm (Empress esthetic, e.max) preparation.

Figure 14. Pumice slurry used to clean preparations. If a spot etch provisional technique has been used this area is carefully prepared with a diamond bur to remove any resin tags.

Figure 15. Interproximal margins cleaned with finishing strips prior to bonding.

Figure 16. Full arch rubber dam (Roeko Flexi Dam, Coltene) applied with knitted retraction cord (Ultrapak 0, Ultradent).

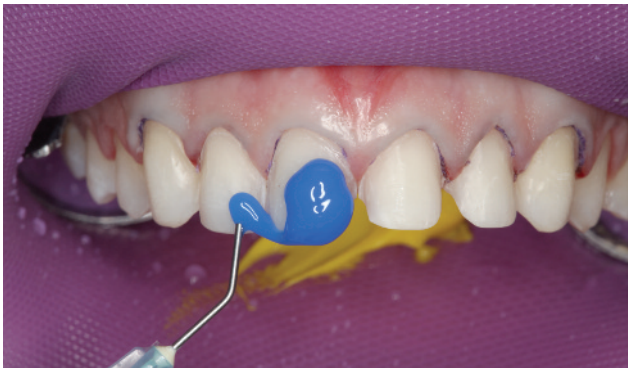


Figure 17. The use of a total etch technique, etching dentine for 15 seconds maximum.

There are several methods of attaining the reduction required with the preparation:

1. Freehand;
2. Use of depth cuts/grooves. The use of depth cutters or grooves and dimples has been recommended to control tooth preparation, as the use of standardised objects allows accurate judgement of depth; or
3. Use of silicone putty index.

Using a silicone index may help in assessing the amount of tissue reduction and can be prepared by the dental ceramist from the initial wax-up model. When viewed from the occlusal view, this can be cut in horizontal slices which can be peeled back to assess different vertical positions of the reduced teeth (Figures 16-20). Utilisation of a silicone index derived from the wax-up allows a visualisation of the reduction required to achieve the form and contours of the pre-planned shape and length of the final veneers.

Incisal edge reduction

Different preparation designs have been advocated from feather and window preparations that involve no reduction of the incisal edge or preparation of the lingual surfaces, to other preparations that involve a reduction of the incisal edges. The author prefers an incisal preparation that is carried over the incisal edge from buccal to palatal, with up to 1.5 mm of incisal reduction. According to Calamia, a tooth preparation that incorporates incisal overlap is preferable, because the veneer is stronger and provides a positive seat during cementation. This preparation design has the advantage of simple tooth preparation and the aesthetic characteristics are easier to fabricate with the ceramist, as it is possible to develop incisal translucency. The margin is not in a position where it will be subjected to protrusive forces and the preparation is reported to reduce stress concentration within the veneer by distributing the occlusal load over a wider surface (Highton et al, 1987).

Proximal preparation

This preparation in the interproximal region can be made either by stopping short of breaking the contact, or by preparing through the contact point.

Breaking the contact (sometimes called the "slice preparation") may be necessary to clear the contact in certain situations, such as changing the shape or position of teeth. With the additional space inter-proximally, this allows the ceramist freedom to adjust the contours and position of the teeth.

Cervical margin

The cervical preparation for a veneer is recommended to be a chamfer design with a maximum depth of 0.4mm. This allows the veneer to reproduce natural tooth contours and not be over-contoured. Additionally, it allows simple seating of the veneer and minimises stresses, enhancing the future fracture resistance of the veneer. Unlike crown margins that are often buried in the sulcus,

Figure 18. The use of a total etch technique with a fifth generation bonding agent Optibond Solo Plus (sds Kerr).

Figure 19. The adhesive luting of the veneer with light cure resin cement (Nexus 3; Kerr).

Figure 20.The use of a tacking tip (Demi LED KERR) which is typically 2-4mm in diameter spot tacks the veneer, stabilising it in the correct position. Cleanup of the excess cement is undertaken followed by final curing.

Figure 21. The use of a #12 blade to carefully remove excess cement.

the use of the thin translucent porcelain allows often a "contact lens" effect where the margins are blended with no discernible demarcation. This enables margins to be either equi-gingival or supra-gingival. Additionally there is a greater possibility that the margins will be in enamel. This "contact lens effect" may extend the longevity of the veneer, with the apical migration of gingival margins not revealing a distinct line of demarcation between the veneer and the natural tooth.

A supra-gingival margin has many advantages with less risk of exposing dentine and less chance of injury to the soft tissues during preparation. Impression taking is also easier with no need for retraction and the likelihood of a clear margin captured. Due to the likelihood of the margin being in enamel, there is less chance of microleakage associated with enamel bonding. Sub-gingival margins may be required when there are caries or previous restorations extending sub-gingivally.

Facebow transfer and bite registration

To communicate clearly to the ceramist the correct final orientation of the incisal plane of the planned veneers, it is important that they receive a "stick bite" or "symmetry bite". This can be as simple as two sticks within the bite registration to register the midline and the interpupillary line to the teeth.

Provisionalisation

Some clinicians that feel that provisionalisation is not necessary with veneers due to the minimal tooth reduction required. On the contrary, provisionalisation is an integral part of the treatment process with the ability to communicate with the patient and laboratory what enhances a patient's smile. The provisionals are constructed from the diagnostic wax-up with many patients not able to determine their desires or visualise the final result by just discussing the changes verbally.

Utilising provisionals gives the patient a "test run" or preview of the final result planned, which is strongly recommended (Figures 7-9).

Material selection

A lithium disilicate (e.max, Ivoclar Vivadent) material was selected for its optical properties and excellent flexural strength and fracture toughness.

It is also available in different translucencies and opacities allowing the ceramist better colour masking if required. The procedure for manufacture of this material can be from either hot pressing or CAD/CAM.

In this case, the veneers were CAD designed by copying the contours from the diagnostic wax-up using software from zfx.

Figure 22. Final portrait smile.

Figure 23. Frontal smile.

Figure 24. Completed veneers - retracted view.

Laboratory procedures

Creating lifelike ceramic veneers has been a skill reserved for great ceramists using feldspathic porcelain or meticulous waxers using the hot press technique, but now CAD/CAM is giving technicians the ability to easily create veneers with a few clicks of a mouse.

The diagnostic waxup which has been approved by the patient and is now wearing the design as temporaries, can be scanned into the system to be used as the blueprint for the final veneers. At this stage in the dental veneer process, the job of the technician is to exactly reproduce the design that the patient and clinician have approved. Any deviation from this design can result in numerous problems with acceptance, aesthetics, phonetics and function. Small details and surface characteristics can be improved and minor design changes can be made to improve the artistic and aesthetic outcome (Figures 10-11.

The fit of the restorations can be precisely controlled so that the individual preferences of clinicians and variations in bonding materials can be accommodated.

The ZFX System has the ability to adapt your design to fit or duplicate the wax-up scan exactly. With conventional techniques, this duplication was difficult to achieve; wax injection into silicone putties made from the diagnostic wax-up can create exact duplication but this is still time consuming and technique sensitive. Now with the click of the mouse duplication is achieved.

The shapes are minimally altered to ensure proper contacts, embrasures and interdental spaces. Surface irregularities and final aesthetic alterations are made to ensure you get a great milling result. The design is then finalized (merged) and the milling preview is generated (Figures 12a-d).

The designs are milled from e.max CAD HT, shade B1, in a 5 axis ultrasonic milling machine. Final finishing requires all the usual ceramics techniques of shape, morphology and surface texture. The majority of this should be done in this blue (pre-crystalized) phase of the emax CAD material as it surface hardness is similar to layered glass ceramics. Once crystallized however, the material displays its full flexural strength but also a very high surface hardness which makes shaping and texturing with rotary burs very difficult.

Cut back and layering can be done if adequate space is available. A small incisal cut back can be made and e.max ceram layering ceramic can be fired onto the cutback to increase the incisal translucency and internal characteristics.

Try-in of veneers

The tooth surface should be cleaned of any residual resin cement or provisional material, to ensure perfect adaptation of the veneers (Figures 14-16).

Each veneer should be tried individually to assess fit. This is best done dry (without water or try-in gels) at this stage as complete seating and marginal adaptation can be better visualised. Incomplete seating is normally due to remaining provisional material, luting resin that has not been removed or tight contact points.

Once the patient is happy and has approved the final aesthetics, the restorations are prepared for cementation. The veneers (being silica-based restorations) must be etched with hydrofluoric acid, which allows a micro-mechanical bond when adhesively bonded. The intaglio surface is etched with 9.5% hydrofluoric acid for 20 seconds with lithium disilicate (e.max) or 60 seconds for other silica based ceramics. The use of hydrofluoric acid dissolves the glassy matrix surrounding the crystalline phase within the porcelain, leaving retentive areas between the acid resistant crystals.

The acid should be thoroughly cleansed with air-water spray and the porcelain should then be placed into a container of distilled water (or 95% alcohol or acetone) and put into an ultrasonic bath for 4 minutes to remove any residues remaining on the surface. Restorations are removed, dried and silane primer is applied to the fitting surface which helps provide a chemical covalent bond to the ceramic. This is allowed to remain on the veneer for 1 minute and after that the veneer should be gently blown with air to evaporate any remaining solvent.

Bonding veneers

The application of rubber dam is recommended to achieve adequate isolation, which helps to provide a clean, dry environment and minimises contamination from saliva and blood (Figures 17-20).

Light curing composite resin is preferred for cementation of the veneers as they have a longer working time than dual cure or chemically cured composites. This allows sufficient time to remove excess composite prior to curing and thus reduces the finishing procedures. The colour stability of light curing resin cements are much better compared to dual or chemical cure composites. Dual cure resin cements contain tertiary amines which may undergo long term colour change ("amine discolouration") with overall darkening and thus are normally contraindicated with veneers due to their thin nature and translucency.

The use of various coloured resin cements has an influence on the final result attained and is often used to fine tune the final shade of the restoration to attain the desired outcome. Its influence is minimal, contributing less than 10% of the final colour of the restoration, however maybe useful to fine tune the final aesthetics.

Finishing and polishing

If the bonding procedure was completed smoothly with a well fitting veneer, there should be very little cement to clean up from around the margins. It is preferred to not use a rotary instrument to finish the margins, as this may remove the glaze layer, increasing the roughness of the porcelain and causing increased plaque retention. The use of a #12 blade (Figure 21) to carefully remove excess cement is a preferred technique, however at times if necessary a fine diamond can be used to adjust the porcelain and then carefully polished.

Occlusion is carefully checked initially with centric occlusion followed by other excursive movements. The use of rugby-shaped diamonds with water spray can be used to adjust the porcelain. Any adjustments must be further polished.

The long term clinical success of porcelain veneers depends on a careful case selection and diagnostic approach, as well as accurate and appropriate tooth preparation and adhesive bonding procedures.

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Dr Christopher Ho received his Bachelor of Dental Surgery with First Class Honours at the University of Sydney. He has completed postgraduate studies in the Graduate Diploma in Clinical Dentistry in Oral Implants at the University of Sydney and Masters of Clinical Dentistry in Prosthodontics with Distinction from Kings College, London. Dr Ho is a lecturer on aesthetic and implant dentistry locally and internationally and is involved with the evaluation and development of new dental products and materials. He is a faculty member with the UCLA/Global Institute for Dental Education teaching in the one year Master programs in Esthetic Dentistry and Implant Dentistry. Dr Ho's research interests are in immediate placement and loading of dental implants. He has a referral-based private practice in prosthodontic and implant dentistry in Sydney, Australia.

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