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Case Report

Cosmetic Dentistry with Ceramic Veneers Revisited

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Abstract

An ideal aesthetic treatment plan should be minimally invasive, preserving as much of the natural tooth structure as possible. The ceramic veneers have achieved great success since their introduction nearly three decades ago as they fulfil the above criteria very well. Continuous evolution of materials, laboratory techniques and clinical procedures have made the ceramic laminate veneers a reliable modern technique. Veneers are mainly fabricated from conventional low fusing feldspathic porcelain. Two popular methods for fabrication of porcelain veneers are the platinum foil technique and the refractory die technique. However these are time consuming and technique sensitive. In contrast, the CAD/CAM restorations can be made in one visit and the new equipment and soft wares have been shown to result in improved marginal fit. The use of CAD/CAM nowadays is a useful tool that also allows for digital impression taking, digital design as part of the treatment planning, and the elaboration of monolithic restorations for ceramic materials, used most recently in the field of ceramic veneers. This scientific paper reviews the various clinical and laboratory considerations for CAD CAM ceramic veneers highlighted with case reports for better understanding of the subject. A systematic review was conducted online using PRISMA and designated databases.

Keywords: Ceramic Veneers; CAD CAM Materials; Techniques; Technology; Clinical Cases

Cosmetic Dentistry entails realignment of the ideal form and function of the teeth and tissues while enhancing the aesthetics without compromising the patient's oral health or the stability of his or her teeth. An ideal esthetic treatment plan attempts to achieve perfection in every way. However, not all patients are willing to accept all the components necessary to achieve that level of perfection. In those cases, when compromises become necessary, it is important to review a range of treatment options in an attempt to create the illusion of the ideal while maintaining a healthy oral environment. A cosmetic dental procedure using porcelain veneers is a common method of creating this illusion. Natural-looking teeth are polychromatic in colour with the body of the tooth fairly uniform in colour and the gingival third more rich in chroma. The incisal portion of the tooth typically exhibits a translucency that can vary from bluish-white to blue, gray, orange and other variations. Digital imaging is an invaluable tool in demonstrating to the patient the possible outcomes using different RED (recurring esthetic dental) proportions and width/length ratios and can help them make informed decisions regarding additional procedures and the extensiveness of the prosthetic restoration.

Glass ceramic materials have been widely used to restore enamel loss due to its mechanical and optical properties. This restorative material, used for the indirect method, can be processed by traditional laboratory procedures which are the platinum foil technique and the refractory die technique. However these methods are time

consuming and technique sensitive. In contrast CAD/CAM technology in dentistry has greatly reduced the time of fabrication of ceramic restorations to chair side session. Besides, CAD/CAM is a useful tool that allows digital impression taking, digital designing as part of the treatment planning, and the elaboration of monolithic restorations for ceramic materials, used most recently in the field of ceramic veneers [1]. Lithium disilicate is a glass ceramic reinforced material which can be processed by CAD/CAM systems or through the press technique. In case of CAD/CAM, this material is presented as blocks of lithium metasilicate in a pre crystallized state which contains cores of lithium metasilicate and disilicate, reducing its flexural strength to 130 ± 30Mpa. This allows the milling process, in which the shape of the restoration is obtained. Thereafter it is recrystallized at 850 ^{0}C for 20 to 25 minutes. During this procedure, the lithium metasilicate dissolves and the lithium disilicate crystalizes, obtaining the final translucency of the restoration. Finally, the quantity of crystals and the flexural strength increases to 70% in volume and to 360–400Mpa, respectively which is sufficient to cover the optical and functional needs [2]. One such material is the IPS e max CAD system which is available in HT: high translucency, LT: low translucency, and MO: medium opacity; translucency blocks, colours (20 colours for HT and LT and 5 for MO). Another recently introduced zirconia reinforced lithium silicate material includes VITA Suprinity (VITA) and Celtra Duo (Dentsply). These possess improved mechanical properties, which can also be considered to restore the posterior teeth, however are available in only two types of translucency (HT and T for VITA Suprinity; HT and LT for Celtra Duo), with less number of colours and shapes of the blocks, thus having less clinical potential in comparison with the IPS e.max CAD system. The feldspathic CAD CAM ceramics e.g Triluxe™, Triluxe™ Forte and RealLife™ blocks by VITA Zahnfabrik, Germany also contain multi shade layers and offer a gradient of colour and translucency.

The final restoration manufactured from these materials may still not have the ideal tooth optical properties which can be modified with three methods for characterization of the incisal third. The layering technique allows a tri dimensional effect that simplifies the correction of texture and shape. On the other hand, the staining technique is very common and its real advantage for the characterization and application of stains in the ceramic surface is the ease and speed with which it can be realized. However it is a superficial pigmentation which is easily removed in case correction of shape or texture is needed. In the layering technique since characterization is given by ceramic masses, the modification of the shape or texture of the restoration is not so critical as in the staining technique [3]. It is therefore recommended to finish the monolithic CAD/CAM restorations with nanofluorapatite ceramics to ensure optimal reproduction of details of the incisal third in the anterior teeth [4].

These contemporary reinforced ceramic materials can be used to produce minimally invasive restorations, with thicknesses ranging from 0.1 to 0.7 mm, thus requiring minimum or no tooth structure preparation. Owing to those varieties, material selection is considered to be one of the most substantial determinants for fabrication of clinically successful veneers.

It is essential to understand the Challenges faced in clinical and laboratory procedures of CAD CAM ceramic veneer to achieve cosmetic success. These are as mentioned below.

Aesthetic shade matching of the ceramic veneer is a challenge owing to the thinness of the restoration. Shade matching requires correct communication to dental lab technician apart from clinical procedure of reduction or use of bleaching techniques as in the case of masking of tetracycline stains [5]. The key to success is understanding that the final colour obtained is due to combined metamerism of the tooth, the resin cement selected, and the ceramic material selected for the restoration. The final opacity, translucency, and distribution of colour of the existing tooth should be communicated in detail to the technician by intraoral photographs, shade drawings, and custom shade guides to allow him/her to plan the final restoration.

The luting cement used too plays a crucial role in the final shade obtained for the concerned tooth. Under normal circumstances, the cement is probably the least responsible for the final result obtained, contributing less than 10% of the final colour of the restoration. Generally, the higher the filler content of cement, the more refractive and opaque is the final colour of the restoration. If the laboratory technician incorporates a spacer on the die on which the veneer is fabricated, this important component of the process can be addressed. Studies show that the value and opacity of the underlying cement are generally more important than the hue or chroma

selected [6]. It is documented that thin viscosity; highly filled resin cements cause fewer long-term problems with marginal discoloration and air entrapment than do more viscous resin formulations. Recent-generation resin cements eg, Calibra; Dentsply Caulk, Variolink I and Appeal; Ivoclar Vivadent, Ultra Bond Improved; Den-Mat Corp., etc can be light cured and cause little interference in the final colour of the restoration obtained. Once the dual-cure component is added, the likelihood exists that the restoration may change slightly in colour over time because of the aromatic tertiary amine component of dual-cure cement. Success has also been attained with microhybrid restorative resins used as cements e.g. TPH Spectrum by Dentsply Caulk, Venus; Heraeus Kulzer, etc. These resin cements are opaque enough to mask stained teeth [7].

Marginal discoloration is seen in ill fitting, poorly seated restorations and can be avoided by placing the margins in easily accessible areas, using the correct consistency of the luting agent, proper seating of the veneer as well as proper glazing of the restoration. Breakdown of bond between the cement tooth or veneer tooth interface may also lead to leakage and discoloration. This can be prevented by following the correct protocol for etching, bonding and isolation during cementation [8].

Proper case selection is an essential pre requisite for success of the veneer. This includes the aesthetic evaluation both from the frontal as well as lateral aspect of the tooth with respect to the laid down guidelines. A through occlusal analysis in centric, protrusive and lateral movements to check for clearance of the concerned tooth so as not to place it under undue stress is also mandatory.

Failure in bond between the cement- tooth or veneer–cement interface can be controlled by keeping the preparation completely in enamel. Although the results of the newest generation dentin adhesive systems are very promising, the bond strength of porcelain bonded to enamel is still superior when compared with the bond strength of porcelain bonded to dentin [9]. If dentine is exposed, protection is recommended for the period between preparation and cementation in order to prevent post-operative sensitivity and bacterial invasion. The temporary materials whether resin composite or acrylic resin, only partially seal the surface. More effectively, the exposed dentine can be protected by means of a primer which is a hydrophilic reactive monomer in an organic solvent. Paul and Scha¨rer even proposed the application of the dentin bonding agent immediately after completion of tooth preparation [10]. This new dentin bonding agent application technique may prevent the development of bacterial leakage and dentin sensitivity during the temporary phase, and this technique is also associated with improved bond strength.

By etching the inner side of the porcelain veneer with hydrofluoric acid and subsequently silanizing the etched surface, the bond strength of a luting composite to the etched porcelain surface has been measured to be higher than the bond strength of a luting composite to etched enamel and even exceeding the cohesive strength of the porcelain itself [11].

For cementation of porcelain veneers a light-curing luting composite is preferred. A major advantage of light curing is that it allows for a longer working time compared with dual cure or chemically curing materials. It is important that there is enough light transmittance throughout the porcelain veneer to polymerise the light-curing luting composite. The porcelain veneer absorbs between 40–50% of the emitted light. The thickness of the porcelain veneer is the primary factor determining the light transmittance available for polymerisation. In case of porcelain with a thickness of more than 0.7 mm, light-cured resin composites do not reach their maximum hardness. A dual-cured luting composite, which contains the initiation systems for both chemically and light-cured composites, is advisable in such situations.

Tooth preparation for CAD CAM ceramic veneers

Earlier simplified techniques for tooth preparation included the use of depth cutters guided by the existing tooth surface; however that approach did not take into consideration alterations of the tooth owing to aging, wear, or loss of enamel and thus leading to greater risks for dentin exposures. More recent and sophisticated methods have integrated an additive diagnostic procedure (wax-up or mock-up) to compensate for these alterations. This approach allows for more enamel preservation and, as a consequence more predictable bonding, biomechanics, and aesthetics [12]. A minimum amount of preparation geometry is required to facilitate insertion and positioning of the ceramic restoration during the final bonding procedure. The recommended thicknesses are approximately < 0.3 to 0.5 mm in the cervical area, 0.7 mm in the middle

and incisal thirds, and a minimum of 1.5 mm for incisal. These values are compatible with average measurements of enamel thickness.

Apart from the regular crown preparation burs, there are dedicated kits for tooth reduction for veneers that simplify the preparation offering limited number of instruments, eg. the Shofu all ceramic kit, the Touati Brasseler (TPS) kit etc. The shape of each instrument in the kit determines the profile of preparation for example in the TPS kit; the instrument gauges TFC1 and TFC2 are used to monitor labial reduction. These serve to guide, visualize and quantify enamel reduction with diameters ranging from 0.3-0.8mm with an average of 0.5mm. The instruments TFC3 and TFC4 are for systematic facial reduction of enamel in two stages with simultaneous preparation of 0.3mm of chamfer. The instruments TFC5 and TFC6 are used for occlusal reduction. The finishing instruments are TFC7 and TFC8 (Figure 1).

Figure 1: Touati Brassler Kit.

During preparation for veneers, the margins are kept supragingival. The advantages of doing so are under mentioned:

- Allows for increased areas of enamel in the preparation
- Simplifies moisture control
- Marginal fit of the veneer can be visually confirmed
- Easy access of margins for finishing, polishing as well as for routine maintenance.

Another important aspect for preparation is preservation of natural contact area of the concerned tooth for the following reasons:

- This is an anatomical feature that is extremely difficult to reproduce
- It prevents displacement of the tooth between the preparation and placement sessions when no provisional restorations are used
- Simplifies try in procedures
- Saves clinical adjustment of contact areas; which is intricate with such fine ceramics
- Simplifies bonding and finishing procedures
- Allows better access for home care techniques.

Regarding the incisal preparation for ceramic veneers, three basic types of preparation have been described namely, the window or intra-enamel preparation, the overlapped incisal edge preparation and the feathered incisal preparation. Several authors favoured the overlapped incisal preparation. With this type of incisal preparation, the dental technician has more control on the aesthetic characteristics of the incisal part of the porcelain veneer. In addition, this preparation is stated to make the restoration more resistant to incisal fractures as this type of preparation distributed the occlusal load over a wider surface area reducing stress concentration within the veneer [13]. On the contrary, an *in vitro* study by Hui., *et al*. [14] and Gilde., *et al*. [15] demonstrated that an overlap porcelain veneer design transmits maximum stress on the veneer which increases the risk of cohesive fracture. In contrast, a window design prepared entirely into enamel withstood axial stress most favourably. They therefore concluded that where strength is an important requisite, the most conservative type of veneer, namely the window preparation, was the design of choice. However, in a clinical study by Meijering., *et al.* no relation was seen between survival and incisal preparation design whether with or without overlap for both indirect resin composite and porcelain veneers [16] after 2.5 years of clinical functioning.

Case Report 1: Closure of multiple diastema between Incisors and canine in the Maxillary arch rehabilitated with CAD CAM Ceramic laminates without incisal overlap

A 28-year-old male patient reported to our hospital with the chief complaint of spacing in upper anterior teeth compromising

both his looks as well as speech (Figure 2A,2B,2C,2D,2E). Orthodontic treatment for closure was ruled out due to both constraints of time and unavailability for multiple visits. CAD veneers which would suit his requirements of aesthetics, elimination of hissing in phonation, time restraints and longevity of the prosthetic restoration were key factors in choosing VITA SUPRINITY, ZLS (Figure 5B) (VITA Zahnfabrik, German) of medium opacity for restoration. The diastema varied from 1.0 to 1.4 mm between the anterior teeth. Maxillary central incisors were prepared following the same principles as mentioned above except that the preparation was terminated at the incisal edge without the overlap (Figure 4B). The final restorations with a mesial overlap varying from 0.50mm to 0.70 mm each were prepared and cemented (Figure 3A,3B,3C,3D,3E).

Figure 2A: Pre op frontal view.

Figure 2B: Pre op right lateral view.

Figure 2C: Pre op left lateral view.

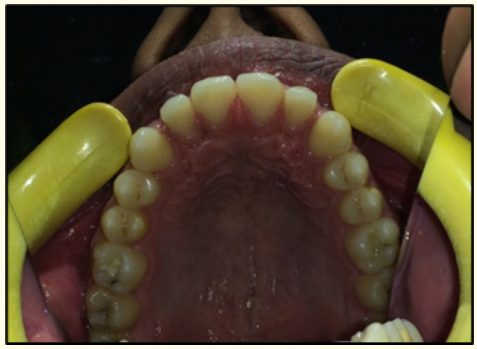

Figure 2D: Pre op occlusal view of maxillary arch.

Figure 2E: Pre op occlusal view of mandibular arch.

Figure 3A,3B,3C: Intra op frontal, right and left lateral views of coronal preparation for ceramic veneers without incisal overlap.

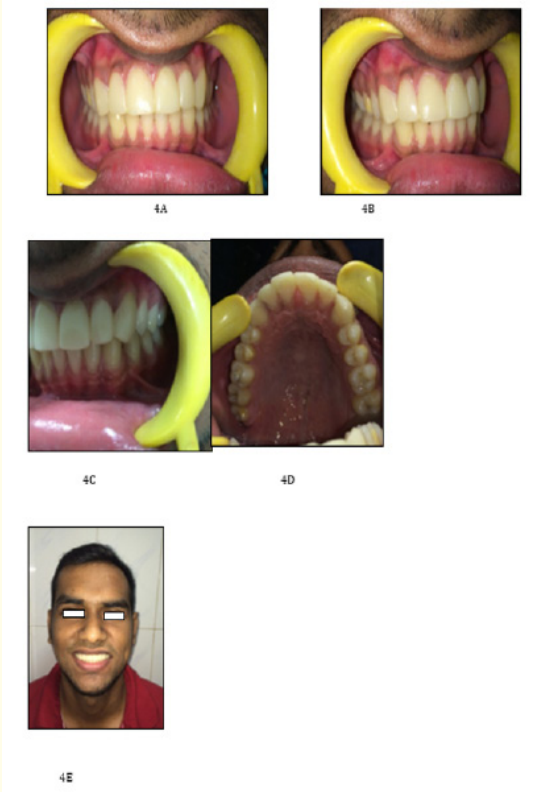

Figure 4A-4E: Post op frontal and lateral views with All ceramic laminates *in situ.*

Case Report 2: Masking discolouration due to fluorosis

A 26-year-old male patient reported to our hospital with the chief complaint of grossly discoloured teeth since childhood (Figure 5A,5B,5C,5D). History revealed that the individual hailed from a fluoride deficient area of our country with other family members also similarly affected. A diagnosis of moderate dental fluorosis (Deans' index code-4) was established. Various treatment options from all ceramic crowns, in direct and direct composite veneers to conventional as well as CAD CAM ceramic veneers were discussed with the patient and finally it was decided to give him the feldspathic ceramic; Triluxe™ veneers (VITA Zahnfabrik, Bad Sackingen, Germany) having incisal overlap for teeth 11, 12, 13, 14, 21, 22, 23, 24, 31, 32, 33, 34, 41, 42, 43, 44. This suited the requirements of our patient as regards aesthetics, time restraints and longevity of the prosthetic restorations. Diagnostic impressions along with diagnostic wax up was carried out. The teeth were cosmetically contoured taking care that the preparation was driven to restore the original instead of existing volume of the tooth (Figures). Preparation was done using the Shofu all ceramic preparation kit. It was initiated from the labial surface using the depth cutting burs from mesioproximal line angle to distoproximal line angle. Three-depth cuts in each cervical, middle and incisal third of the teeth were given and then merged maintaining dual convergence of labial reduction to preserve anatomical form. Supragingival chamfer finish line was established using a long tapered medium or fine grit snub-nosed diamond bur. The chamfer margin was continued from distal papilla tip to beginning of contact. The incisal edges of the teeth were prepared to provide the bulk for the porcelain terminating at the linguoincisal line angle. Preparation was carried out in two stages, first the maxillary teeth were prepared and restored by the veneers followed by the mandibular teeth so as to preserve the original, stable, occlusion/ incisal guidance of the patient (Figure 6A,6B,6C,6D,6E). Gingival retraction was done and impression was made using polyvinyl siloxane elastomeric impression material. The cast was poured and the porcelain laminate veneers were fabricated. The finished laminates were tried in using colourless silicone (memosil by Heraeus-Kulzer) and finally bonded after etching of tooth surface with 37% phosphoric acid, etching of laminate with hydrofluoric acid followed by silane treatment and using the composite resin bonding kit, Calibra marketed by Dentsply caulk Milford DE USA (7A,7B,7C,7D,7E,7F). The occlusion was refined with microthin articulating film of 0.0008 in. The final polishing of

the laminate was done with a series of ceramic polishing points and rubber cups with diamond dust impregnated paste using the Shofu ceramic polishing kit (Figure 3A,3B). Instructions for maintenance were given followed by periodic recall.

Figure 5A,5B,5C,5D: Pre op frontal, left and right lateral views.

Figure 6A,6B,6C,6D,6E: Intra Op views.

Figure 7A,7B,7C,7D,7E,7F: Post op frontal, lateral and occlusal views.

Conclusion

CAD CAM all ceramic veneers are one of the most aesthetically pleasing prosthodontic restorations. Their chief disadvantage is their susceptibility to fracture, although this can be lessened by use of the resin-bonded technique and higher strength ceramics as brought out in the above case report. The RED proportion states that the proportion of the successive widths of the teeth as viewed from the front should remain constant as one moves distally. The frontal view width of every maxillary tooth becomes smaller by a certain percentage as one moves posteriorly. This is a two-dimensional evaluation of a three dimensional smile, so the buccal/palatal placement of the teeth affects their apparent widths. The range of suggested RED proportions is between 62% and 80%. The golden proportion (62% RED proportion) is applicable as one of many proportions that fit within the definition of the RED proportion. Different RED proportions can be proposed for use with the same

individual according to the desired length of the teeth, the scope of treatment possible, and the desire to have the size of the teeth match the size of the face and body. Digital imaging is an invaluable tool in demonstrating to the patient the possible out comes using different RED proportions and width/length ratios and can help them make informed decisions regarding additional procedures and the extensiveness of the prosthetic restoration.

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