ISSN 2304-2354
Number 2, Volume 44, 2013

ADVANCES OF DENTAL CERAMICS VENEERS: MATERIALS, APPLICATIONS AND TECHNIQUES

Orion MUÇAJ

Lectures of Professional Studies Faculty "Aleksandert Moisiu" University

Introduction

Currently, the use of adhesive technologies makes it possible to preserve as much tooth structure as is feasible while satisfying the patient's restorative needs and aesthetic desires. With indirect restorations, clinicians should choose a material and technique that allows the most conservative treatment; satisfies the patient's aesthetic, structural, and biologic requirements; and has the mechanical requirements to provide clinical durability (1). Aesthetic veneers in ceramic materials demonstrate excellent clinical performance and, as materials and techniques have evolved, veneers have become one of the most predictable, most aesthetic, and least invasive modalities of treatment (3). For this reason, both materials and techniques provide the dentist and patient an opportunity to enhance the patient's smile in a minimally invasive to virtually noninvasive way. Ceramic veneers are considered the ultimate option for a conservative aesthetic approach because they leave nearly all of the enamel intact before the veneer is placed (5). Since its introduction more than two decades ago, (6,7) etched ceramic veneer restoration has proven to be a durable and aesthetic modality of treatment. The clinical success that the technique has found can be attributed to great attention to detail in a set of procedures, including planning the case, with the correct indication; conservative preparation of the teeth; proper selection of ceramics to use; proper selection of the materials and methods of cementation; and proper planning for the ongoing maintenance of these restorations (6).

A number of medium-term clinical studies have confirmed the favorable clinical performance of these restorations, as their maintenance of aesthetics was excellent, patient satisfaction was high, and no adverse effects on gingival health were present (4,5,67). Most authors reported a low failure rate (0%–7%) (13). Higher failure rates (14%–33%) were noted in other clinical trials,13,14 probably due to some predisposing factors, such as unfavorable occlusion and articulation, excessive loss of dental tissue, use of inappropriate luting agents, unprepared teeth, and partial adhesion to large exposed dentin surfaces. Nevertheless, porcelain veneers are considered more durable than direct composite veneers, on the conditions that patients are adequately selected and the veneers are prepared following a meticulous clinical procedure (7,13). Other authors found that the feldspathic porcelains showed similar long-term survival rates: 96% in 5 years, 93% in 10 years, 91% in 12 years, 16 and 94% in 12 years (17). Mechanical and biological causes of failures were related to aesthetics (31%), mechanical implications (31%), periodontal support (12.5%), and loss of retention (12.5%), caries (6%), and tooth fracture (6%) (18). Both feldspathic porcelain and glass-infiltrated ceramics presented long-term survival rates of about 96%-98% in 5 years (15,17).

Currently, there are systems, like computer-aided design/computer-aided manufacturing (CAD/CAM), which may make the production of veneers easier. CAD/CAM restorations have a natural appearance because the ceramic blocks have a translucent quality that emulates enamel and they are available in a wide range of shades (19,20). Finally, quality is consistent because prefabricated ceramic blocks are free from internal defects and the computer program is designed to produce shapes that will stand up to wear (19). Dentists should base their choice of material on the requirements of the tooth being restored, such as the indication and the necessity of the tooth preparation to improve aesthetics and function (23).

Feldspathic veneers

Porcelain laminate veneers have undergone significant evolution. Nowadays, their use has expanded beyond a simple covering for anterior teeth to include coverage of coronal tooth structures. Porcelain veneer consists of fluorapatite crystals in an aluminum-silicate glass that may be layered on the core to create the final morphology and shade of the restoration. By using a layering and firing process, ceramists developed veneers that could be made as optically close to natural teeth as possible (25). Due to the nature of the glass matrix materials and the absence of core material, the veneering porcelains are much more susceptible to fracture under mechanical stress. Therefore, a good bond, in combination with a stiffer tooth substructure (enamel), is essential to reinforce the restoration (1).

ISSN 2304-2354
Number 2, Volume 44, 2013

To preserve the health of the gingival tissues and prevent overcontouring, a slight 0.5 mm reduction of tooth surface is found to work best. When additional wear is necessary on the enamel, it is important to pay attention to the condition of the reminiscent structure, which will affect thebond of the porcelain veneers. The ideal conditions for the bond between the veneer and the substrate are the presence of a rate of 50% or more of the enamel remaining on the tooth; 50% or more of the bonded substrate being enamel; and 70% or more of the margin being in enamel (1,15).

Glass-based ceramics

Improvement in properties depends on the interaction of the crystals and glassy matrix, as well as on the size and amount of crystals. Finer crystals generally produce stronger materials. They may be opaque or translucent, depending on the chemical composition and percent crystallinity (12,23). Increased strength in glassy ceramics is achieved by adding appropriate fillers that are uniformly dispersed throughout the glass, such as aluminum, magnesium, zirconia, leucite, and lithium disilicate (26). The flexural strength depends on the shape and volume of these crystals. The manufacturer's instructions recommend its use for anterior or posterior crowns, implant crowns, inlays, onlays, and veneers (26). The microstructure is similar to that of powder porcelains; however, pressed ceramics are less porous and can have a higher crystalline content. The ceramics reinforced by lithium disilicate are true glass ceramics, with the crystal content increased to approximately 70% and the crystal size refined to improve flexural strength (12,27). The material is translucent enough that it can be used for full-contour restorations or for the highest aesthetics and can be veneered with special porcelain. Therefore, in situations in which there is more than 0.8 mm of working space, glass ceramics should be considered due to their increased strength and toughness, as well as the presence of sufficient room to achieve the desired aesthetics. These materials are efficient for bonding in substrate, even if less than 50% of the remaining enamel remains; however, at the margin, at least 30% of the enamel must be present (1).

Applications

Composite resin can be used to mask tooth discolorations and/or to correct unaesthetic tooth forms and/or positions. However, such restorations still suffer from limited longevity, because composites remain susceptible to discoloration, wear, and marginal fractures, thereby reducing the aesthetic result in the long-term. In the search for more durable aesthetics, porcelain veneers were proposed to be durable anterior restorations with superior aesthetics. Laminate veneers should be used as a conservative solution to an aesthetic problem (3). The correct indication for their use is the main factor in the clinical success of the application of ceramic materials. The indications for a no-preparation or minimally invasive laminate veneer include teeth that have: discoloration that is resistant to vital bleaching procedures; displeasing shapes or contours and/or lack of size and/or volume, requiring morphologic modifications; diastema closure; minor tooth alignment, restoring localized enamel malformations; fluorosis with enamel mottling; teeth with minor chipping and fractures; and misshapen teeth (3,4,5). In many of these cases, the use of stacked ceramics would often not be the first choice. This factor is important when choosing ceramic material. More extensive restorations would benefit from the stronger leucite-reinforced or lithium disilicate materials, excluding the application of the feldspathic veneer (3). The placement of veneers is contraindicated when there is reduced interocclusal distance; deep vertical overlap anteriorly, without horizontal overlap; or severe bruxism or parafunctional activity (20). Severely malpositioned teeth, the presence of soft tissue disease, and teeth with extensive existing restorations are other factors that prevent the placement of laminate veneers (3). Generally, higher tensile and shear stresses occur when there are large areas of unsupported porcelain, deep overbites, or overlaps of teeth; when bonding to more flexible substrates, such as dentin and composite; when bruxism is present; and when the restorations are placed more distally (2). In these higher-risk clinical situations, the glass ceramics should be considered.

Techniques. Preparation of teeth

The preparation of the teeth greatly influences the durability and color (translucency and tonality) of the ceramic restoration, since the tooth preparation will determine the inner superficial contour and the thickness of the ceramic material. The preparation design for laminate veneers should simultaneously allow an optimum marginal adaptation of the final restoration and demonstrate utmost respect for the hard tissue morphology (29). Enamel reduction is required to improve the bond strength of the resin composite to the tooth surface. In addition and when possible, care must be taken to maintain the preparation completely in enamel to realize an optimal bond with the porcelain veneer. 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 (6,7). Thus, one of the main objectives of the technique is to maintain the entire contour in intact enamel whenever possible, because the better the adhesion between the veneer and the prepared tooth, the better the stress distribution in the system enamel–composite–ceramic (18). At the cervical third, the gingival margin of the veneer must be located at the

ISSN 2304-2354
Number 2, Volume 44, 2013

same level as the gingival crest or lightly subgingival for the anterior teeth.

At the medium third, the preparation may achieve 0.5–0.8 mm (3,18). At the incisal third, the preparation may be modified. The options include the "window" preparation, the most conservative and maintain enamel in incisal third, which results in a visible line between enamel, resin, and ceramic; in addition, the remaining structure is more prone to fracture. The critical points of this technique are the difficulty in positioning the ceramic restoration at the moment of its cementation and in matching the optical properties of the remaining incisal structure (18). So, to obtain adequate color properties at the incisal third of the laminate veneers, the preparation needs to allow a thickness of ceramic of 1.5–2.0 mm, and this is possible with the "overlap" preparation. At the proximal region, the preparation must follow the papilla and extend until interproximal contact (18,29). The success of the porcelain veneer is greatly determined by the strength and durability of the bond formed between the three different components of the bonded veneer complex: the tooth surface, the porcelain veneer, and the luting composite (7). Because of the improvements to adhesive procedures, it is expected that the biomechanical and structural integrity of the enamel-dentin complex could be partially mimicked using porcelain veneers.

Tooth surface (enamel and dentin)

The enamel surface must be conditioned with phosphoric acid (37%). This procedure increases the surface energy of the structure, which leads to a perfect wetting of the surface with the bond. Therefore, isolation with a rubber dam is highly recommended, which lowers stress input during the clinical procedure (32). It is difficult to obtain the correct dryness or wetness of the surface, which is elementary for a successful bond. In cases of dentin exposition, sealing this structure with a dental bonding agent is suggested immediately after the completion of tooth preparation and before the final impression itself (10,31) because the newly prepared dentin is ideal for the adhesion (25,33,34). This technique, called the "resin-coating technique", consists of interposing a layer of low viscosity resin between the dental substrate and the luting cement (35,36). This procedure seems to produce an increase in the union strength and a reduction of crack formation, bacteria infiltrations, and postoperative sensitivity, as it allows for acid conditioning of the enamel while avoiding the conditioning of the dentin and allowing better control of the conditioning of the enamel (30). The use of a conventional adhesive with three steps or autoconditioning with two steps, with polymerization of the adhesive separated from the composite resin, is recommended (30,33,37).

Luting cements

The clinical success of laminate veneers depends on the cementation of the indirect restorations, among other factors (11). Luting cements are versatile materials that can achieve excellent aesthetic results. They are recommended for cementation of veneers, inlays, onlays, and all-ceramic restorations and fiber posts, for their adhesion capacity with the tooth, as with restorative materials, such as ceramics and composite resin (37).

Table nr.1 Ceramic composition and surface treatment protocols Ceramic Conditioning

Feldspathic	9.5% hydrofluoric acid for 2 to 2.5 min; 1 min washing; silane application
Leucite-reinforced	9.5% hydrofluoric acid for 60 s;1 min washing; silane application
Lithium disilicate-reinforced	9.5% hydrofluoric acid for 20 s; 1 min washing; silane application

Summary and conclusion

Currently, the properties of ceramics indicate that they are materials capable of mimicking human enamel and their mechanical properties are expanding their clinical applications. Therefore, based on this literature review, it is possible to conclude that the clinical success of laminate veneers depends on both the suitable indications of the patient and the correct application of the materials and techniques available for that, in accordance with the necessity and goals of the aesthetic treatment.

References

1. **McLaren EA, Whiteman YY.** Ceramics: rationale for material selection. *Compend Contin Educ Dent.* 2010;31(9):666–668.
2. **McLaren EA, LeSage B.** Feldspathic veneers: what are their indications? *Compend Contin Educ Dent.* 2011;32(3):44–49.
3. **Radz GM.** Minimum thickness anterior porcelain restorations. *Dent Clin North Am.* 2011;55(2):353–370.
4. **Belser UC, Magne P, Magne M.** Ceramic laminate veneers: continuous evolution of indications. *J Esthet Dent.* 1997;9(4):197–207.
5. **Strassler HE.** Minimally invasive porcelain veneers: indications for a conservative esthetic dentistry treatment modality. *Gen Dent.* 2007;55(7):686–694.
6. **Calamia JR, Calamia CS.** Porcelain laminate veneers: reasons for 25 years of success. *Dent Clin N Am.* 2007;51:399–417.

ISSN 2304-2354
Number 2, Volume 44, 2013

7. **Peumans B, Van Meerbeek B, Lambrechts P, Vanherle G.** Porcelain veneers: a review of the literature. *J Dent.* 2000;28:163–177.
8. MEDLINE® [database on the Internet]. Bethesda, MD: National Library of Medicine; nd. Available from: http://www.ncbi.nlm.nih. gov/pubmed/. Accessed January 9, 2011.
9. PubMed. gov [database on the Internet]. Bethesda, MD: National Center for Biotechnology Information, US Library of Medicine; nd. Available from: http://www.ncbi.nlm.nih.gov/pubmed/. Accessed January 9, 2011.
10. **Donovan T.** Factors essential for successful all-ceramic restorations. *J Am Dent Assoc.* 2008; Suppl 139:14S–18S.
11. **Soares CJ, Soares PV, Pereira JC, Fonseca RB.** Surface treatment protocols in the cementation process of ceramic and laboratory-composite restorations: a literature review. *J Esthet Rest Dent.* 2005; 17: 224–235.
12. **Giordano R, McLaren EA.** Ceramics overview: classification by microstructure and processing methods. *Compend Contin Educ Dent.* 2010;31(9):682–684.
13. **Peumans M, De Munck J, Fieuws S, Lambrecht P, Vanherle G, Van Meerbeek V. Prospective** ten-year clinical trial of porcelain veneers. *J Adhes Dent.* 2004;6(1):65–76.
14. **Walls AW.** The use of adhesively retained all-porcelain veneers during the management of fractured and worn anterior teeth. Part II: clinical results after 5-years follow-up. *Br Dent J.* 1995;178:337–339.
15. **Della Bona A, Kelly JR.** The clinical success of all-ceramic restorations. *J Am Dent Assoc.*2008;Suppl 139:8S–13S.
16. **Layton D, Walton T.** An up to 16-year prospective study of 304 porcelain veneers. *Int J Prosthodont.* 2007;20(4):389–396.
17. **Fradeani M, Redemagni M, Corrado M.** Porcelain laminate veneers: 6- to 12-year clinical evaluation – a retrospective study. *Int J Periodontics Restor Dent.* 2005;25(1):9–17.
18. **Della Bona A.** Bonding to Ceramics: Scientific Evidences for Clinical Dentistry. São Paulo: Artes Médicas; 2009.
19. **Davidowitz G, Kotick PG.** The use of CAD/CAM in Dentistry. *Dent Clin North Am.* 2011;55(3):559–570.
20. **Seydler B, Schimitter M.** Esthetic restoration of maxillary incisors using CAD/CAM chairside technology – a case report. *Quintessence Int.* 2011;42:533–537.
21. **Wittneben JG, Wright RF, Weber HP, Gallucci GO.** A systematic review of the clinical performance of CAD/CAN single-tooth restorations. *Int J Prosthodont.* 2009;22:446–471.
22. **Wiedhahn K, Kerschbaum T, Fasbinder DF.** Clinical long-term results with 617 Cerec veneers: a nine-year report. *Int J Comput Dent.*2005;8:233–246.
23. **Spear F, Holloway J.** Which all-ceramic system is optimal for anterior for anterior esthetics? *J Am Dent Assoc.* 2008;Suppl 139:19S–24S.
24. **Conrad HJ, Seong WL, Pesun IJ.** Current ceramic materials and systems with clinical recommendations: a systematic review. *J Prosthet Dent.*2007;98(5):389–404.
25. **Culp L, McLaren EA.** Lithium disilicate: the restorative material of multiple options. *Compend Contin Educ Dent.* 2010;31(9):716–720, 722, 724–725.
26. **Guess PC, Schultheis S, Bonfante EA, Coelho PG, Ferencz J, Silva NRFA.** All-ceramic systems: laboratory and clinical performance. *Dent Clin North Am.* 2011;55(2):333–352.
27. **Kelly JR, Benett P.** Ceramic materials in dentistry: historical evolution and current practice. *Aust Dent Journal.* 2011;56 Suppl 1:84–96.
28. Griggs JA. Recent advances in materials for all-ceramic restorations. *Dent Clin North Am.* 2007;51(3):713–727.
29. **Magne P, Douglas WH.** Design optimization and evolution of bonded ceramics for the anterior dentition: a finite-element analysis. *Quintessence Int.* 1999;30(10):661–672.
30. **Della Bona A, Anusavice KJ.** Microstructure, composition, and etching topography of dental ceramics. *Int J Prosthodont.* 2002;15(2): 159–167.
31. **Magne P, Douglas WH.** Porcelain veneers: dentin bonding optimization and biomimetic recovery of the crown. *Int J Prosthodont.* 1999;12(2): 111–121.
32. Pilathadka S, Vahalová D. Contemporary all-ceramic systems, part-2. *Acta Medica.* 2007;50(2):105–107.
33. **Frankenberger R, Lohbauer U, Schaible RB, Nikolaenko SA, Naumann M.** Luting of ceramic inlays in vitro: marginal quality of selfetch and etch and rinse adhesives versus selfetch cements. *Dent Mater.* 2008;24(2):185–191.
34. **Magne P, Woong-Seup S, Cascione D.** Immediate dentin sealing supports delayed restoration placement. *J Prosthet Dent.* 2007;98:166–174.
35. **Jayssoiya PR, Pereira PN, Nikaido T, Tagami J.** Efficacy of resin Coating on bond strengths of resin cement to dentin. *J Esthet Restor Dent.* 2003;15:105–113.
36. **Udo T, Nikaido T, Ikeda M, et al.** Enhancement of adhesion between resin coating materials and resin cements. *Dent Mat.* 2007;26(4):519 525.
37. **Arrais CAG, Ruggeberg FA, Waller JL, Goes MF, Giannini M.** Effect of curing mode on the polymerization characteristics of dual-cured resin cement systems. *J Dent.* 2008;36(6):418–426.
38. **Addison O, Marquis PM, Fleming GJP.** Adhesive luting of all-ceramic restorations – the impact of cementation variables and short-term water storage on the strength of a feldspathic dental ceramic. *J Adhes Dent.* 2008;10:285–294.
39. **Moraes RR, Correr-Sobrinho L, Sinhoreti MA, Puppin-Rontani RM, Ogliari F, Piva E.** Light-activation of resin cement trough ceramic: relationship between irradiance intensity and bond strength to dentin. *J Biomed Mat Res.* 2008;85B:160–165.
40. **Radovic I, Monticelli F, Goracc C, Vulicevic ZR, Ferrari M.** Self-adhesive resin cements: a literature review. *J Adhes Dent.* 2008;10:251–258.
41. **Kumboglu O, Lassila LV, User A, Vallittu PK.** A study of the physical and chemical properties of four resin composite luting cements. *Int J Prosthodont.* 2004;17(3):357–363.
42. **Li ZC, White SN.** Mechanical properties of dental luting cements. *J Prosthet Dent.* 1999;81:597–609.
43. **Rosenstiel SF, Land MF, Crispin BJ.** Dental luting agents: a review of the current literature. *J Prosthet Dent.* 1998;80:280–301.
44. **Linden JJ, Swift EJ, Boyer DB, Davis BK.** Photo-activation of resin cements through porcelain veneers. *J Dental Res.* 1991;70:154–157.