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Using CAD/CAM–Modified Correlation Mode to Produce Laminate Veneers: A Six-Month Case Report

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Clinical Relevance

This six-month clinical report demonstrates the use of a new self-etching glass ceramic primer with the CAD/CAM–modified correlation and biogeneric modes in the fabrication of porcelain laminate veneers to achieve esthetic clinical outcomes.

SUMMARY

The expectation of an esthetically harmonious smile increases the level of difficulty when treating patients. Laminate veneers stand out as a treatment option for cosmetic rehabilitation in clinical practice, as they are a more conservative procedure and mimic dental structures. These laminate veneers are generally made with different techniques; the most common requires an impression of the prepared tooth, an impression antagonist, fabrication models, and extensive laboratory time. The computer-aided design/computer-aided manufacturing (CAD/CAM) system optimizes the fabrication of prosthetic structures, reducing chairside time and promoting good esthetic results. Thus, the purpose of this case report is to present the esthetic result of multiple CAD/CAM manufactured laminate veneers using a new self-etching glass ceramic primer

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with a lithium disilicate ceramic, using the modified correlation and biogeneric modes.

INTRODUCTION

Techniques and materials for indirect dental restorations have evolved quickly. Laminate ceramic veneers are becoming a more popular conservative treatment to achieve esthetic demands.[1] Restorative treatment using porcelain laminate veneers is done with different techniques, all of which typically require an impression of the prepared teeth, impression of the opposing arch, preparation of casts, and extensive laboratory time.[2-4]

Recently, manufacturing materials, techniques, and office time have been simplified by digital dentistry and the introduction of stronger glass-infiltrated ceramics. With the introduction of these ceramics, especially pressed lithium disilicate (LD), laminate veneers can be made using either the conventional lost-wax technique or by designing a prosthetic structure on a computer, followed by its manufacture in a milling machine. This technique is referred to as *computer-aided design/computer-aided manufacturing* (CAD/CAM).[5,6]

The use of LD in a pressed technique and its applications in the dental clinic were introduced by Brodkin and others in 1998.[7] The material is composed of 65% LD in the form of crystalline structures,[8] resulting in a relatively strong ceramic.[9] The LD ceramic has a flexural strength of about 400 MPa, a fracture toughness of 3.3 MPa, and good translucency. In addition to all these, the LD glass portion can be etched using a 5% to 10% hydrofluoric acid (HF) solution and can be bonded to enamel and dentin. The HF etching makes a microporous surface, which increases the bond strength.[10] Different clinical applications are suggested for LD, including veneers, anterior and posterior single crowns, and anterior or posterior fixed prostheses of up to three elements.[11]

The LD glass ceramic (IPS e.max CAD, Ivoclar-Vivadent, Barueri, SP, Brazil) was designed for the CAD/CAM processing technology. In the presintered state, the CAD/CAM block exhibits a flexural strength of 130-150 MPa, allowing for small intraoral adjustments. After sintering at 850°C, LD has a flexural strength of 360 MPa.[12] Because of the translucency and variety of colors, LD can be used for full anatomical restorations (monolithic) with subsequent surface color characterization.[12]

Because of differences in professional judgment regarding the number of steps for cementation, manufacturers have released more versatile self-etching glass-ceramic primers to shorten the pretreatment of dental restorations, which includes providing the etching and silanization steps in only one bottle.

Figure 1. *Baseline aspect of smile.*

There is not enough information in the literature regarding the performance of this new class of universal primers and the development of a high reactivity between the glass ceramic and the primer.

Digital technology is rapidly emerging and has introduced many new possibilities in dental practice because of the different advantages that the system offers. Therefore, the aim of this case report is to present the esthetic results of multiple LD ceramic veneers manufactured with CAD/CAM using the correlation mode associated with the biogeneric mode and a new self-etching glass ceramic primer.

Figure 2. *Immediate result of gingivectomy.*
Figure 3. *Preparations made following the wear tab for guidance.*
Figure 4. *Aspect before polishing and finishing preparations.*

TECHNIQUE DESCRIPTION

A 36-year-old female patient presented to the School of Dentistry at the State University of Ponta Grossa for esthetic treatment. Her main complaint was the presence of clinical diastemas between her maxillary anterior teeth after orthodontic treatment. These anterior maxillary teeth were restored using composite resin five years previously, presenting several fractures and staining of the resin composite (Figure 1).

In addition, the patient was not satisfied with the color and shape of her natural teeth. After clinical and radiographic examinations and obtaining initial impressions, it was determined that the patient had a low caries risk and did not have active caries lesions or signs of periodontal disease.

The esthetic treatment plan alternatives were discussed with the patient, including dental bleaching and gingivectomy, followed by direct composite resin or ceramic veneers. After careful evaluation of the patient's expectations regarding her smile, a dental bleaching, gingivectomy, and ceramic veneers option was selected. Dental bleaching provides the

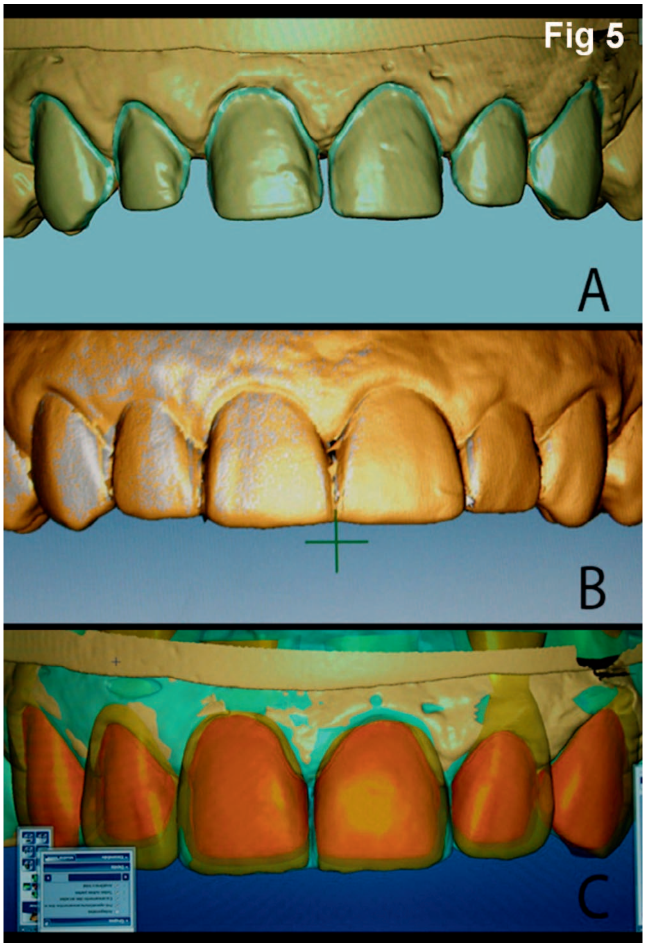

Figure 5. *(A): Digitally planning the correlation mode through the digitalization wax-up model. (B): Scanning model with the prepared teeth. (C): Supplement to the biogeneric order to improve and adapt shape and contour.*

dentist the opportunity to use a more translucent glass ceramic, preventing opaque teeth and ensuring greater translucency, better esthetics, and a more natural look. Minor soft-tissue crown lengthening was recommended to the patient before veneer preparations to correct soft-tissue asymmetry. Ceramic laminate veneers are considered a conservative treatment with excellent results.

In-office dental bleaching was performed using 35% hydrogen peroxide (35% Whiteness HP Maxx, FGM, Joinville, SC, Brazil) for 40 minutes at two sessions separated by a one-week interval (Whiteness HP Blue, FGM). The initial shade of the patient's teeth was A2 (Vita-Zahnfabrik, Spitalgasse, BS, Germany); after bleaching, the shade was A1.

One week after dental bleaching, the patient underwent an esthetic periodontal surgery. (Figure 2). Soft-tissue recontouring (gingivectomy) was indicated in this case to remove the excess gingival tissue because the cementoenamel junction was more than 2 mm below the free gingival margin. An external bevel incision was performed for teeth 7, 8, 9, and 10, and a collar of marginal gingiva was removed to expose more of the crown of the tooth. After waiting for a healing period of 21 days, an initial impression was made using addition silicone (Virtual, Ivoclar-Vivadent) to prepare stone models and a diagnostic wax-up. A mock-up was also prepared to make the procedure more predictable.

The maxillary anterior teeth were prepared following the silicone preparation guides made from the diagnostic wax-up model (Figure 3). The preparation started with a butt-joint diamond bur No. 1013 (KG Sorensen, Cotia, SP, Brazil). Guides from 0.5 to 0.7 mm in depth were prepared following the slope of the buccal surface of the tooth with a rounded-tip, diamond bur No. 2135. Reductions of 1.5 to 2.0 mm were also performed at the incisal surface. The dental preparation was refined using a No. 2135 FF diamond bur (KG Sorensen). After that, the preparations were finished and polished using Sof-lex discs (3M ESPE, Sumaré, SP, Brazil; Figure 4).

An impression of the prepared teeth was carried out using a double-cord technique with addition silicone (Virtual, Ivoclar-Vivadent), where the first single-cord Ultrapack No. 000 (Ultradent Products Inc., Indaiatuba, SP, Brazil) was inserted into the gingival sulcus and the second single-cord Ultrapack No. 0 (Ultradent Products Inc.) was positioned to enlarge the gingival sulcus. At the time of impressing, the second single cord was removed and the first single cord remained within the gingival sulcus.

To make the provisional veneers, A1 color Ceremill TEMP resin multilayer blocks (AmannGirrbach, Curitiba, PR, Brazil) were used with transitioning from the dentin to the incisal areas. The provisional veneers were designed using Ceramill Mind CAD software (AmannGirrbach) and milled under water cooling using the Ceramill Motion 2 system (AmannGirrbach). Excellent provisionals were made at the initial session to provide for adequate oral hygiene and to approximate the final restoration design, where the patient had the option to experience the esthetic result and determine possible changes to the final restorations.

This case was planned using the correlation mode,[13] but as the patient did not have an ideal shape of the contours of natural teeth to be intraorally scanned, the wax-up model was used for this purpose. A spray contrast was applied to the waxed

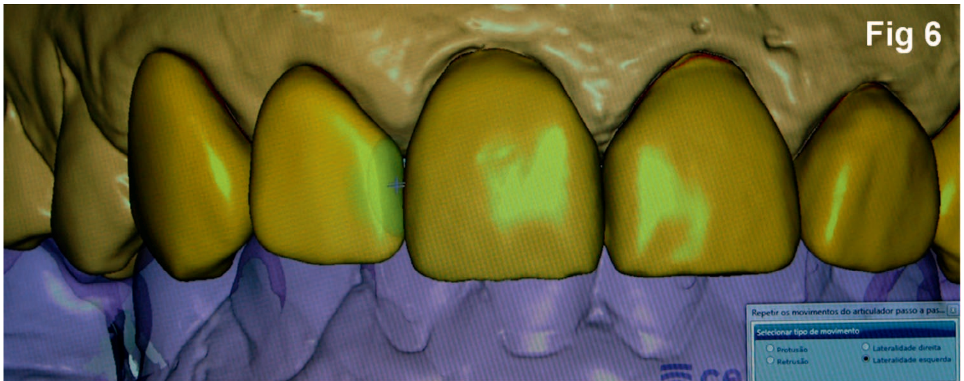

Figure 6. *Ceramill Mind computer-aided design software overlays digital information obtained from the upper and bottom model, scanning to form a record of the virtual bite of joint.*
Figure 7. *Provisional veneers made in Ceramill TEMP resin.*
Figure 8. *Cemented provisional veneers.*

model (Vita Cerec powder; Vita-Zahnfabrik, Spitalgasse, BS, Germany) to obtain the digital information. When necessary to aid and improve the contours, this procedure was complemented using the biogeneric mode to improve and adapt shape and contour (Figures 5A-C).

The CAD/CAM-software, Ceramill Mind (AmannGirrbach), superimposed the digital information obtained from scanning the maxillary and mandibular models to form a record of the virtual occlusal bite (Figure 6). Ceramill Map400 (AmannGirrbach) was used to manufacture provisional veneers using the digital information of the patient wax-up and the biogeneric model (Figure 7).

Provisional veneers were tried in for marginal integrity, functionality, occlusion, esthetics, and patient satisfaction. The provisionals were temporarily cemented (Figure 8) using an acid-etched point technique (midfacial) and bonded using the flowable composite resin, Filtek Z350 (3M ESPE) in the A2 color. Excess composite was removed, and the restorations were light cured with a LED device (Radii Plus, SDI, Bayswater, VIC, Australia) for 40 seconds. The occlusion was checked and adjusted. The provisional veneers were reevaluated after one week following the patient's evaluation of form, function, and esthetics. The patient was allowed to request modifications, which were performed, and

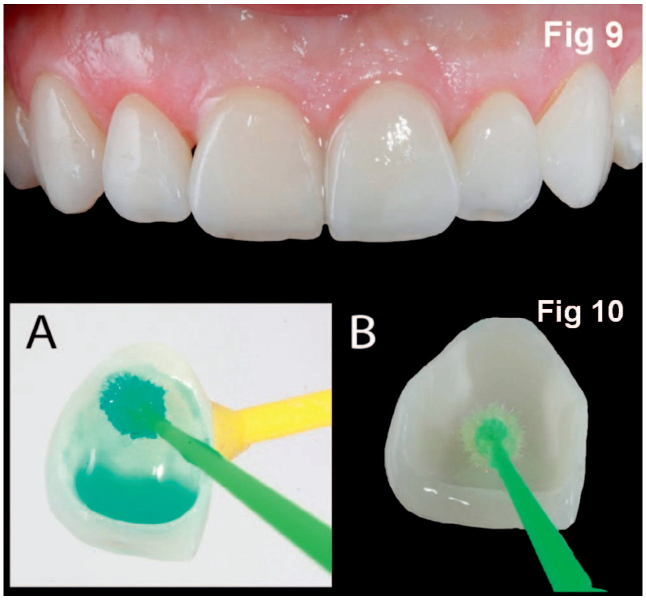

Figure 9. *Try-in test to select the color of the resin cement.*
Figure 10. *(A): Individual laminate veneers etched for 40 seconds with Monobond Etch & Primer. (B): Application of the Excite adhesive system.*

the ceramic laminate veneers were made using LD IPS e.max CAD HT–A1 (Ivoclar-Vivadent).

Prior to cementation, the marginal adaptation, interproximal contacts, and occlusion of the laminate veneers were checked and modified using a No. 2135 FF diamond bur (KG Sorensen) and polished using the Dialite LD ceramic polishing kit (Brasseler Dental EUA, Savannah, GA, USA). The color evaluation was tested with low-, medium-, and high-value try-in paste of the Variolink Veneer cement (Ivoclar-Vivadent; Figure 9).

The internal areas of the laminate veneers were conditioned using Monobond Etch & Prime (Ivoclar-Vivadent Inc., Amherst, NY, USA) by scrubbing for 20 seconds and allowing the primer to react on the surface for 40 seconds, according to the respective manufacturers' instructions. This single ceramic primer allows for etching and silanization of the glass ceramic surface. This combination is effective and shortens the pretreatment for glass-ceramic restorations as compared with the conventional method, making the process easy and reducing the risk of error. After conditioning, the surfaces were washed with an air-water spray to remove the Monobond Etch & Prime (Ivoclar-Vivadent Inc.) and dried prior to the application of the Excite adhesive system (Ivoclar-Vivadent; Figure 10A, B).

The adjacent teeth were protected using a Teflon strip, and the prepared tooth surfaces were etched with 37% Total Etch phosphoric acid (Ivoclar-Vivadent) and rinsed after 15 seconds with an air-water spray. Excess water was removed by gently blowing air. An Excite light-cure adhesive system (Ivoclar-Vivadent) was applied in two coats to the prepared surfaces. Gently blown air was used for solvent evaporation. The adhesive was not light cured. Then, the light-cured Variolink Veneer resin cement (Ivoclar-Vivadent) was placed on the intaglio surface of the veneer and seated into position. The excess resin cement was removed, and the veneers were light cured for 40 seconds from each of the dental surfaces (Figure 11A-D).

After cementation, the cervical edges of the indirect restorations and the gingiva were checked, and excess cement was removed using a No. 12

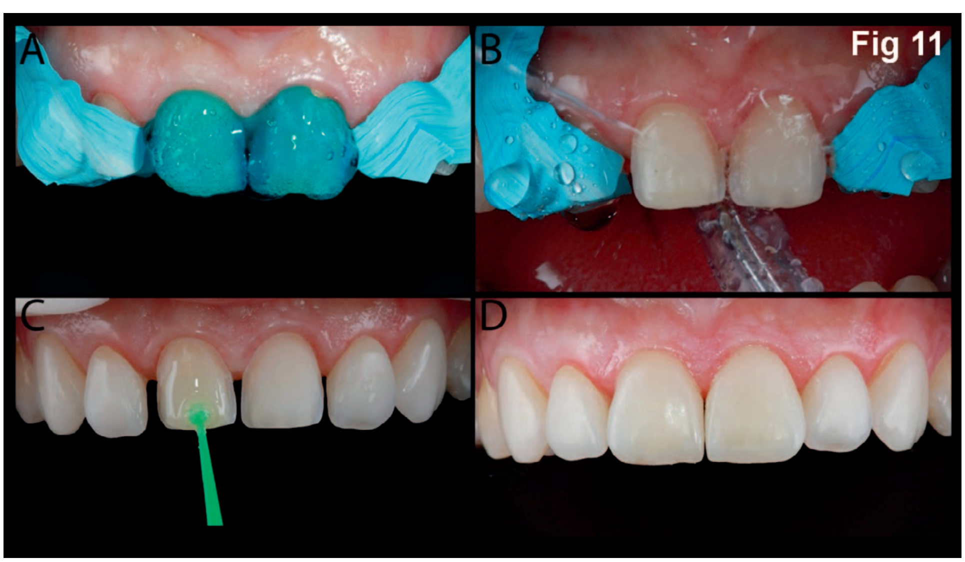

Figure 11. *(A): Etching of the teeth with phosphoric acid for 15 seconds. (B): Rinsed with an air-water spray. (C): Application of Excite adhesive system. (D): Cementation of the laminate veneers of teeth 11 and 21.*

Figure 12. *Appearance immediately after cementation.*
Figure 13. *Outcome after six months.*

scalpel blade for better hygiene and prevention of biofilm retention in the cervical region.

The immediate outcome of the restorative procedure can be seen in Figure 12 and the controlled outcome after six months in Figure 13. The patient was instructed on proper oral hygiene, and the case will be periodically evaluated at six-month intervals.

DISCUSSION

In 2005, an improved material consisting of pressable glass-ceramic LD, IPS e.max Press, was introduced. The chemical basis of this material is the same as IPS Empress 2 (Li_2O-$2SiO_2$) but with properties altered by using a different burning process.[14] When compared with IPS Empress 2, IPS e.max Press shows significant improvement in physical properties and provides a high translucency[15]; therefore, it was the material chosen for the present case report.

The use of CAD/CAM to design a dental restoration is efficient and highly precise.[16-19] Both the fatigue and tensile strength of e.max Press indicate that it is an excellent material for use with CAD/CAM.[20,21] Furthermore, the use of these systems to manufacture porcelain veneers allows the dentist to control the time as well as color, contour, and form. This treatment plan has the advantage of being conservative while providing great optical and esthetic results.[22]

The first method for designing a restoration using CAD/CAM is the biogeneric mode, which uses a database of hundreds of teeth that have been imported as a "library of shapes and forms." The shape and form are chosen by the dentist to best serve the patient's case. The second method of design is the correlation mode. This mode is recommended for duplicating a tooth in the patient's mouth, to provide the ideal contours of the teeth to be scanned intraorally before preparation. In this case report, we opted for the correlation mode with modification because it involved a wax-up model, since the patient had no contour and optimal shape in her natural teeth. When necessary, the projection of the model was improved by analysis of the library teeth (biogeneric model).[22,23] Although there are advantages of fabricating porcelain veneers using CAD/CAM in the laboratory, all the clinical procedures (ie, teeth preparation, cementation) are similar to the conventional fabrication of porcelain veneers.

In this case report, multiceramic laminate veneers were fabricated using an all-digital workflow. This technique provides the opportunity to produce precise provisional restorations with an as-proposed contour for the final laminate veneers, which could improve the esthetic results of the restorations to the patient's liking before cementation, allowing the patient to evaluate the provisional veneers critically for a period of time, providing more security for the patient and the final restoration.[24] This method also allows for the opportunity to further customize the final restorations based on feedback from the patient regarding his or her desires and expectations. The only disadvantage associated with this technique is the increased manufacturing costs of the provisional veneers.[4]

Moreover, a system that allows for the simultaneous conditioning and silanization of the ceramic was used in this case report. The Monobond Etch & Primer contains trimethoxypropyl methacrylate (methacrylate silane) for silanization and 15%-25% ammonium polyfluoride for conditioning the surface. In addition, this primer contains 75%-85% alcohol and water by weight as solvents and less than 1% of colorant by weight. This material creates a roughness pattern that is less pronounced than HF but is as efficient for bonding.[25-28] The silanization reaction with this primer is similar to silanization with Monobond S or Monobond Plus.[29]

CAD/CAM technology is emerging and there is a learning curve involving software, dentists, and dental lab technicians. With more experience, this innovative technology will yield further esthetic improvements in dentistry, ensuring better patient satisfaction.

CONCLUSION

This article presented a technique for producing laminate veneers using CAD/CAM technology.

Acknowledgements

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of State University of Ponta Grossa, Paraná, Brazil.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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