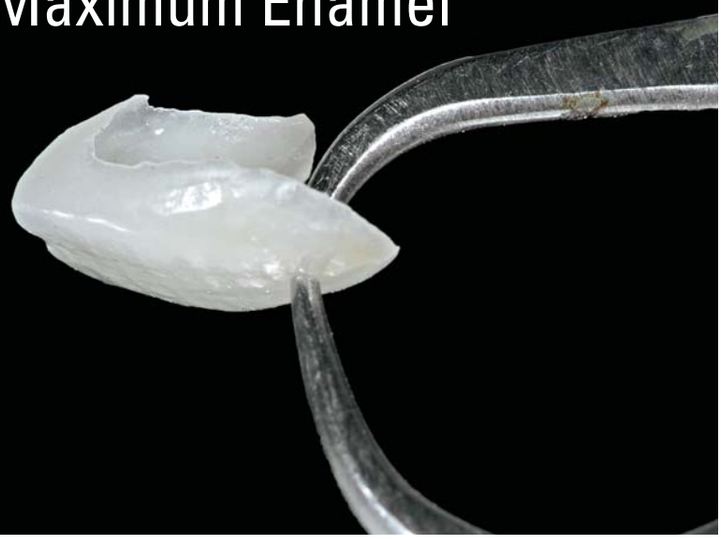
Ultimate Ceramic Veneers: A Laboratory-Guided Ultraconservative Preparation Concept for Maximum Enamel Preservation



Oswaldo Scopin de Andrade, DDS, MS, PhD[1]
José Carlos Romanini, CDT[2]
Ronaldo Hirata, DDS, MS, PhD[3]

The use of ceramic laminate veneers is a well-documented, effective, and predictable treatment option.[1,2] This predictability results from the physical properties of the ceramic, which remain stable in terms of color and shape as long as proper treatment planning is carried out. Further, ceramic demonstrates low plaque adherence, thus permitting soft tissue stability. Harmony among the soft tissues, esthetics, and function depends of the bonding ability of the material. Altering the intaglio surface of ceramic using hydrofluoric acid associated with a silane coupling agent enables better bonding to dental structures by providing a smooth interface between the restoration and enamel.

Among the materials available for laminate veneers, glass-ceramic made using the refractory die technique is the most documented.[3] Nevertheless, many clinicians and dental technicians encounter difficulties with this technique, partly because powder-and-liquid glass-ceramic has a very low fracture resistance prior to bonding.

From a laboratory perspective, the refractory die technique is time consuming, and the ceramic build-up used to control all phases of treatment must be fabricated without incorporating air bubbles, which can influence the final physical and optical properties of the restoration. From a clinical perspective, the try-in procedures and lack of stability before bonding make the technique difficult to execute in some cases, such as those with minimal or no tooth preparation.

An experienced ceramist can produce laminate veneers as thin as 0.2 mm, resulting in a very conservative treatment.[4] However, a restoration of this thickness is difficult to fabricate and to handle, which makes the procedure expensive and therefore unavailable to

[1]Director, Advanced Program in Implant and Esthetic Dentistry, Senac University, São Paulo, Brazil.
[2]Dental Technician and Ceramist, Romanini Dental Laboratory, Londrina, Parana, Brazil.
[3]Director, Advanced Program in Restorative Dentistry, Latin American Institute of Dental Research and Education, Curitiba, Brazil.

Correspondence to: Dr Oswaldo Scopin de Andrade, Rua Barão de Piracicamirim 889, Apt 61, Piracicaba, São Paulo, Brazil 13416-005. Email: osda@terra.com.br

many patients. This limitation has been reduced in the last two decades following the development of pressed ceramic in the early 1990s.[5] The addition of leucite to the composition of ceramic enabled pressing of the material, such as through the lost wax technique, which represented a landmark development for ceramic restorations. The advantages of pressed ceramic include less technique-sensitive laboratory procedures and easier clinical handling due to its enhanced physical properties.

Unfortunately, the first generation of this type of ceramic required more space to build the restoration compared with the refractory die technique, making it impossible to fabricate restorations with a conservative preparation in most cases. Additionally, the esthetic characteristics of pressed ceramic were less life-like than those of glass-ceramic. Despite these limitations, veneers and crowns fabricated with pressed ceramic have been widely used and reported.[2,6]

Following the success of the pressed technique, a new class of glass-ceramic was developed based on lithium disilicate crystals. Lithium disilicate glass-ceramic (LDGC) has a wide range of applications for esthetic indirect restorations. Formerly developed as Empress 2 (Ivoclar Vivadent, Schaan, Liechtenstein), this heat-pressed ceramic was indicated for crowns and short-span fixed partial dentures up to the second premolar.[7] For the latter indication, the manufacturer recommended a strict protocol to achieve sufficient resistance to the occlusal forces. For anterior and posterior restorations, high survival rates were observed in short-, mid-, and long-term clinical studies,[8–10] confirming the results obtained in laboratory tests.[11]

The use of LDGC for single-unit restorations was restricted to crowns and posterior partial restorations due to the opacity of the core material. This opacity limited the esthetic results in cases with conservative preparations or restorations with reduced thickness. To solve this limitation, an advanced version of LDGC (IPS e.max Press, Ivoclar Vivadent) with improved physical properties and translucency was developed.[12]

Compared to the original system, the flexural strength of the material jumped from 350 to 440 MPa. Thanks to its increased mechanical properties and better shade control, the pressable LDGC can now be used beyond its original indications using a monolithic technique.[13] The range of indications for this material now include applications such as inlays, onlays, overlays, and laminate, occlusal, and full veneers. The adhesive characteristics were maintained in the new version. The intaglio surface can be etched by hydrofluoric acid for 20 seconds, and the use of a silane coupling agent increases the bond between the ceramic structure and resin cement.[14]

Laboratory results show that this material can be used for minimally invasive restorations, and current clinical data demonstrate high survival rates for partial restorations as well as for complete crowns and fixed partial dentures.[15] Laminate veneers represent a particularly effective use of this material.[16] The rise of minimally invasive dentistry and biologically driven preparations that aim to conserve sound tooth structure caused the dental field to rethink the application of veneers and return to the primary concepts of minimally invasive restorations.[17,18] Currently, the development of LDGC and the concept of ultraconservative veneers enable clinicians and ceramists to apply these techniques to a large number of patients.

This article presents the ultimate ceramic veneer (UCV), an innovative technique for ultraconservative veneer treatment. Tooth preparation for a UCV is laboratory-guided and fabricated after final impression taking, which means that, if necessary, the ceramist trims the cast only where there is no space for the ceramic material. Utilizing customized laboratory-made preparation guides, the clinician may reduce a specific tooth area, but only if necessary. The UCV technique is a highly conservative approach to bonded ceramic veneers in which all preparations are kept in enamel, thus ensuring preservation of the tissues, which is essential for bonding stability and for successful long-term clinical results.

CASE REPORT

The primary complaint of the young female patient was the "anatomy of her smile," which showed misalignment and irregularities at the incisal edge (Figs 1 to 3). All treatment options were discussed with the patient, eg, direct composite resin restorations. Ultimately, the patient and clinician chose an esthetic rehabilitation of the six maxillary anterior teeth with ceramic laminate veneers.

CASE REPORT


1a


1b


1c


2a


2b


2c

Figs 1a to 1c Preoperative smile views showing irregularities at the incisal edge and misalignment from canine to canine.

Figs 2a to 2c Preoperative intraoral views.

Figs 3a and 3b Lateral views showing the lack of symmetry on both sides, resulting in an unesthetic smile.


3a


3b

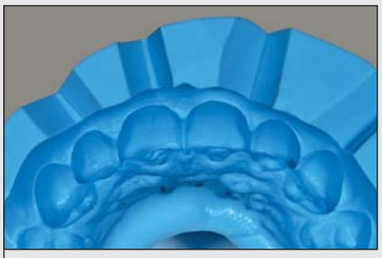
Diagnostic Approach and Treatment Planning

The initial clinical procedure included careful analysis of the occlusion, periodontal examination, and facial and intraoral photography. A preliminary impression was taken with an accurate material that can be poured more than once with the same precision. The authors prefer to work with vinyl polysiloxane (VPS) even for initial impressions used for treatment planning. The patient had intact canine and anterior guidance. Canine guidance is important not only as an esthetic parameter, but also to help maintain adequate functional height and the quantity and quality of disocclusion. This role is crucial to preserve the long-term quality of any restorative treatment in anterior dentition. Facial photography helps the ceramist attain the correct midfacial line, detect any inclination of the smile line, and establish harmony between the soft tissues and smile line. A facebow record was taken and transferred to a semi-adjustable articulator.


4a


4b


4c


5a


5b

Figs 4a to 4c Initial additive wax-up for the mock-up procedure.

Figs 5a and 5b Mock-up made with bis-acrylic resin loaded into a vinyl polysiloxane template.

Figs 6a to 6c Patient's smile with the mock-up in place.


6a


6b


6c

Additive Preliminary Wax-up

For cases in which a minimal preparation is planned, the wax-up procedure must be conducted with an additive technique (Fig 4). The information collected through the photography protocol and semi-adjustable articulator enabled the development of all characteristics required for a successful smile during the additive wax-up, based on an esthetic checklist.[19]

The ceramist added wax to the preliminary cast based on the anatomical parameters of natural teeth and respecting the function and occlusion. In this step, the technician should recover the desired smile and establish adequate occlusal function.

Another important issue in cases with no or minimal preparation is the lack of a provisional stage. Therefore, the patient must approve the final esthetic design in the mock-up session.

Mock-up

The waxed-up preliminary cast was transferred to the mouth for clinical evaluation in terms of shape, size, and length. The mock-up acts as a blueprint for the final restoration. A bis-acrylic resin (Protemp 4, 3M ESPE, St Paul, Minnesota, USA) was used. The material was loaded into a silicone guide made on the wax-up (Fig 5) and positioned in the patient's mouth (Fig 6). Any alterations desired by the patient or deemed necessary by the clinician must be analyzed. This step is important in any treatment involving laminate veneers because it will help the ceramist finalize the smile design. After patient approval, all information was collected from the mock-up using digital photography and an alginate impression to obtain a cast. The mock-up was then removed from the mouth, and the teeth were cleaned and pumiced for impression procedures.

7a

7b

7c

Figs 7a to 7e Retraction cord in place for the final impressions.

7d

7e

8a

8b

8c

Figs 8a to 8e Silicone guide in position on the final casts, showing the clearance available for the final restoration.

8d

8e

Impression Procedures

A VPS one-step, double-mix impression technique was used to produce an appropriate reproduction of the teeth and surrounding tissues. Two impressions of each arch were taken to ensure proper control. Thin retraction cord (Ultrapack no. 00, Ultradent, Salt Lake City, UT, USA) was placed in the sulcus for better visualization of the cervical region. In this case, there was no intrasulcular margin even though the cord was placed to deflect the gingival tissue (Fig 7). This procedure helps to establish the limits of the restoration in the final cast. In some cases, the interproximal areas of the mold may tear during removal from the mouth. If this occurs, the interproximal spaces must be filled with composite resin (Opal Dam, Ultradent).

Laboratory Procedures

All information obtained from the mock-up, including a new set of photographs and alginate impressions, was sent to the laboratory. Two casts were poured from the same mold. The molds were poured and remounted on the articulator. One was kept intact and the other was sectioned. Based on the wax-up and the cast obtained by the mock-up, the ceramist determined the space available for the veneers (Fig 8).


9a


9b

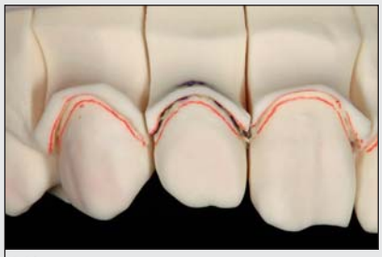

9c


10a


10b


10c


11a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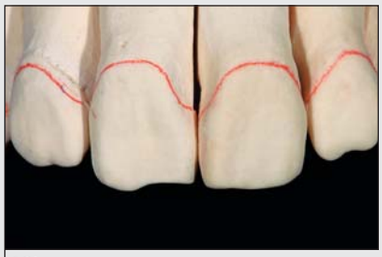
11c


12a


12b

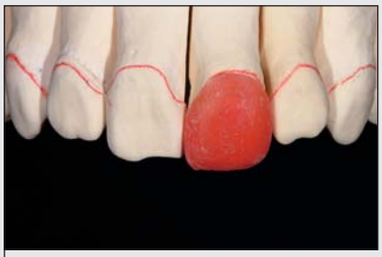
Figs 9a to 9c Final master cast before preparation to produce the final restorations.

Figs 10a to 10c Sectioned cast preserving the area reflected by the retraction cord.

Figs 11a to 11c The limits of the gingival margins were marked with red pencil.

Figs 12a and 12b The cast and dies after the stone margin was trimmed. Note that the red line marks the limit of the restoration and helps maintain the veneer at the level of the gingival margin.

An important step in this technique is the stone cast preparation of the sectioned mold. The retraction cord used for the final impression permits better visualization of the intrasulcular area (Fig 9). An initial trimming procedure was carried out 1 mm below the gingival margin of each individual die (Fig 10). A line was drawn with red pencil at the level of the gingival margin (Fig 11). As the retraction cord reflected these areas, the red line marked the finishing line of the future restoration. Next, each die was trimmed (Fig 12).



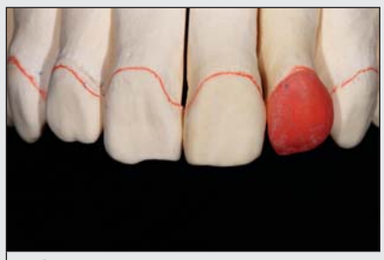
13a

13b

13c

Figs 13a to 13e UCV preparation guide for the left central and lateral incisors. Tooth preparations were performed through the guide window only where insufficient space was available for the veneers.

Figs 14a and 14b Red marks on the solid master cast showing the prepared areas.



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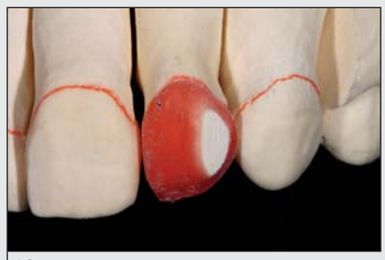


13e

14a

14b

For this treatment modality, the path of insertion of the future restoration must be evaluated. The UCV is based on the concept that tooth reduction should be performed only when there is insufficient clearance for the restoration. As planned, the laboratory would guide any reduction necessary. Only areas that showed no path of insertion or insufficient space for the ceramic would be altered on the cast. After determining those areas, if any, the technician must create a preparation guide to use in the patient's mouth. Thus, before preparation of the cast, the ceramist for this case created the UCV preparation guide with acrylic resin (GC Pattern Resin, GC America, Alsip, Illinois, USA). The guide was fabricated in the specific area that required reduction. The reduction was carried out through the window of the guide (Fig 13). After proper reduction, the preparation guide was removed, and the clearance was checked using the previously made silicone guide obtained from the wax-up. If more room was necessary, the guide was repositioned on the cast and more stone was removed. The same UCV preparation guide used in the cast would be used for intraoral tooth reduction. In this case, only the facial aspect of the left central and lateral incisors required reduction (Fig 14).

15a

15b

15c

15d

Figs 15a and 15b Master cast with the final wax-up.

Figs 15c and 15d Wax sprues in position for the investing procedure.

The wax-up of the final restoration was fabricated on the modified master cast (Fig 15). Six laminate veneers were injected with a high-translucency LDGC ingot (IPS e.max Press, Ivoclar Vivadent). A careful divesting process was carried out in two steps: rough divesting with polishing beads at a pressure of 4 bar (60 psi) and fine divesting with the same material at 2 bar (30 psi). Sprues were cut off using a diamond disk. Any morphologic corrections and marginal adaptation were performed, and the veneers were adjusted on the solid master cast. Marginal adaptation was checked on the sectioned cast.

The restorations were stabilized for occlusal adjustments, and confirmation of the anterior guidance was obtained in the wax-up. Final anatomy and morphology were also determined at this time (Fig 16a).

With the final morphology defined, stains were applied to achieve life-like characteristics. For example, blue stain was used for the incisal edge and interproximal areas, while white stain was used for the mammelons. The veneers were then baked. Glass powder was used to protect the stained surface, and superficial gloss was applied using a rubber wheel and pumice powder. The thin veneers were checked again in the master cast and delivered to the clinician (Figs 16b to 16f).

Fig 16a Laminate veneers adapted to the master cast before staining and glazing.

Figs 16b to 16d Final restorations on the solid master cast after polishing.

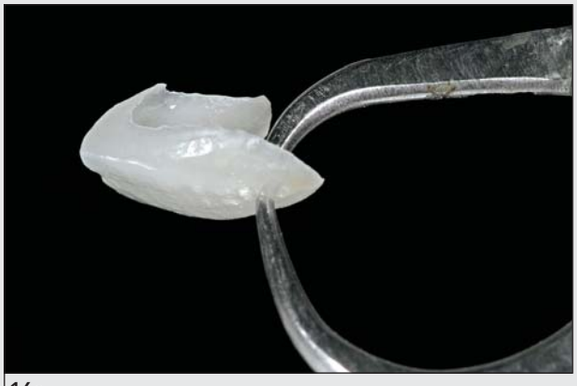
Figs 16e and 16f The final veneers were kept very thin.

16a

16b

16c

16d



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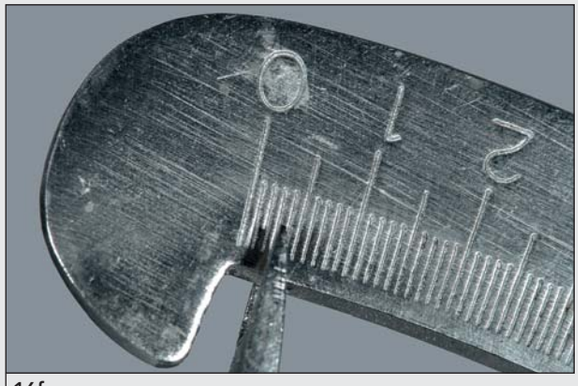

16f


17a


17b


17c


18a


18b


18c


18d

Fig 17a Solid master cast with the stone reduction of the left central and lateral incisors.

Figs 17b and 17c Sectioned master cast with the UCV preparation guide in position.

Figs 18a to 18c UCV preparation guide in position before enamel reduction.

Fig 18d Diamond bur used for the preparation through the guide window (previously trimmed in the laboratory).

Tooth Preparation

The laboratory sent the following materials to the clinician: the solid prepared cast, sectioned prepared cast, UCV preparation guide (Fig 17), and final restorations.

The preparation guide was positioned in the mouth for tooth reduction. It is extremely important to stabilize the guide for preparation (Figs 18a to 18c). A thin tapered diamond bur (Fig 18d) was used to reduce the labial crests of both teeth as in the laboratory phase. Finishing procedures were carried out with finishing disks (Soflex, 3M ESPE) only at the areas prepared with the diamond burs. As for any procedure involving laminate veneers, the marginal adaptation, interproximal contact, anatomical characteristics, and shade were then examined.

19a

19b

19c

Figs 19a to 19c Glycerin-based try-in paste used to evaluate the fit and shade of the resin cement.

Try-in and Bonding

Since no provisional restoration was used, the soft tissue remained stable and healthy. For this reason, it was not necessary to apply any special hemostatic control protocols for try-in and bonding.

Correct selection of the resin cement plays an important role in the final result when using laminate veneers. Try-in paste (Variolink Veneer Try-in Paste, Ivoclar Vivadent) was used to determine the appropriate shade. Once the restorations were in place and filled with the try-in paste, the clinician and patient checked the final result (Fig 19).

The LDGC restorations were prepared for bonding. Initially, the intaglio surfaces of the veneers were etched with 9% hydrofluoric acid for 20 seconds. After washing to remove the acid, the UCVs were placed in a glass container with distilled water and cleaned ultrasonically for 5 minutes to remove any residual material. The surface was air dried, and a silane coupling agent was applied for 2 minutes. Evaporation of the solvent was completed with a constant blow of air. The intaglio surface was coated with a hydrophobic bonding agent (Heliobond, Ivoclar Vivadent) and thinned by a gentle blow of air. The adhesive was left uncured, and the previously selected resin cement (Variolink Veneer +2, High Value, Ivoclar Vivadent) was injected carefully into the veneer. The veneer was protected with a plastic cover to avoid premature adhesive polymerization.

The enamel was pumiced, followed by air abrasion with aluminum oxide particles at 40 psi (PrepStart H_2O, Danville, San Ramon, California, USA). The surface of each tooth was etched with 37% phosphoric acid (Ultraetch, Ultradent) for 60 seconds, washed, and dried. The same adhesive used for the intaglio surface of the ceramic was applied (Heliobond) and also left

20a

20b

20c

Figs 20a to 20f Final result showing the six laminate veneers after 4 months.

uncured. For laminate veneers, light-cured resin cement (Variolink Veneer, Ivoclar Vivadent) is indicated for better color stability.

Next, each restoration was positioned on the specific tooth. Excess resin cement was removed, and a light source was used for curing for 40 seconds in four directions. A glycerin-based jelly (Liquid Strip, Ivoclar Vivadent) was applied to block the air. Each surface was light cured once more for 20 seconds. A new and sharp scalpel was used to remove excess adhesive and resin cement. For interproximal areas, finishing procedures were performed with abrasive composite resin

20d

20e

20f

strips (Epitex, GC America). To prevent scratching of the ceramic surface, the use of diamond strips should be avoided and the procedure must be carried out with caution.

For better control of the bonding sequence, the veneers were cemented one at a time. Occlusal adjustments were made with a diamond polishing system designed specifically for ceramic (Optrafine, Ivoclar Vivadent). All interproximal spaces were flossed to remove any excess material. Figure 20 shows the final result after 4 months.

CONCLUSIONS

The clinical success of laminate veneers depends on careful treatment planning. Among the factors responsible for success, enamel preservation is the most important. When teeth are prepared for ceramic veneers without proper planning, overpreparation often leads to dentin exposure, thus reducing long-term clinical success. However, when the case is carefully planned and the tooth preparation is guided by the laboratory technician, maximum hard tissue preservation can be ensured. The UCV technique proposed in this article can be used to minimize tooth preparation and maximize enamel preservation. In addition, etchable LDGC associated with this technique facilitates superior handling and bonding procedures. The UCV makes it possible to provide highly esthetic restorations with minimal tooth preparation to a large number of patients.

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