A Step-by-Step Ultraconservative Esthetic Rehabilitation Using Lithium Disilicate Ceramic

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Perfect harmony of the soft and hard tissues is the main goal of anterior rehabilitation. Laminate ceramic veneers are widely accepted as the treatment of choice for long-term esthetic anterior restorations. Compared with conventional crown preparation, this modality allows the clinician to obtain an acceptable outcome in terms of esthetics through a conservative preparation that will save a significant amount of tooth structure. However, clinical success depends on adequate treatment planning and clinical knowledge of biology and dental materials.

Ceramic laminate veneers are indicated for discolored, worn, malformed, and fractured teeth because of its conservative approach and biomimetic properties. Ceramic veneers have outstanding esthetic properties and acceptable biocompatibility, abrasion resistance, translucency, shade, and dimensional stability. Further, plaque accumulation has been shown to be reduced with ceramic laminate veneers when compared with natural teeth, resulting in a low risk of gingival inflammation.

One of the most important aspects of ceramic veneers is their ability to be bonded to the tooth. After the intaglio surface is etched, the resin cement can penetrate into the interstices caused by the hydrofluoric acid, resulting in adequate bond strength. Therefore, if the restoration can be bonded to the tooth, the presence of enamel is a sine qua non for high clinical success of this restorative technique. The maintenance of sound enamel for bonding not only increases the bond strength, but also grants long-term clinical survival. Preservation of enamel during preparation lowers post-cementation sensitivity, improves ceramic

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support, and reduces endodontic interventions compared to preparation into the dentin.6

Enamel preservation depends considerably on the preparation design. Facial enamel wear must be identified prior to preparation to restore the original enamel volume. Defining the restored tooth volume is key to achieve an adequate thickness for the final restoration. In the early years of laminate veneers, classical tooth preparation was based on using the preexisting surface as a guide. However, preparing under preexisting conditions often results in a considerable amount of tissue loss with dentin exposure, especially in the cervical and proximal areas.7 Dentin exposure leads to an unpredictable longevity, since dentin bonding remains a challenge and is not as stable as enamel bonding.8–10 [Au: Reference no. 11 is not called out in text; please cite]

Ultraconservative enamel preparation offers a considerable advantage over conventional preparation. The amount of dental structure removal required for metal-ceramic crowns is 4.3 times greater than that needed for ceramic veneer preparation and 2.4 times greater than that for a complete ceramic veneer preparation.8 For an ultraconservative veneer preparation, careful analysis of the teeth involved must be performed to keep the preparation entirely in enamel. The final restoration must have a homogeneous thickness to provide a balance of functional stresses in the anterior dentition.9

Laminate veneers made with low-fusing glass ceramics is widely recognized as an effective restorative technique regarding esthetics.5 Another option that has become popular is pressed ceramic. Initially, pressed ceramics required a full-body injection of the restoration followed by extrinsic characterization with ceramic stains. However, new technologies for pressed ceramics allowed for use of the cut-back technique and intrinsic stratification of the restoration. In addition, the conventional silica-based ceramics were reinforced by the addition of lithium disilicate, significantly increasing the strength. Moreover, pressing laminate veneers with a thickness between 0.3 to 0.5 mm is an interesting clinical option, yielding durability and life-like esthetics.

The purpose of this article is to demonstrate how to obtain a reliable esthetic restoration with minimal tooth reduction.

CASE REPORT

A 25-year-old man came to the Senac University Dental Clinic, São Paulo, Brazil, to request a procedure to improve his smile and change the tooth shape and shade.

Diagnostic Approach

The initial clinical evaluation included analysis of the occlusal scheme, periodontal probing, and a photographic protocol. Clinical examination revealed that the patient had a gummy smile (Figs 1 to 4). Based on the data obtained and facial photographs, a digital simulation of the final restoration was created using computer software (Photoshop CS4, Adobe, San Jose, CA, USA). The digital image was presented to the patient to explain the treatment prognosis (Fig 5).

A frontal facial photograph with the patient in a natural postural head position and slightly smiling was made and then digitally converted to black and white. Two white lines were drawn: (1) a straight line following the facial midline and (2) a parabolic line contouring the lower lip line (with the lips slightly open), following the commissural line toward the ear lobes. In an ideal situation, the facial midline is centered and vertical. The lower lip line was designed to guide the future location of the maxillary incisal edges.12 Next, five red horizontal lines were drawn to serve as horizontal references. The bipupillary line was drawn to serve as the main horizontal reference. A second horizontal line was also drawn at the eyebrow line to visualize possible lack of facial harmony. A third horizontal line was drawn connecting the commissural line at the upper lip (with the patient smiling). The fourth line revealed the gingival zenith, and the fifth line corresponded to the actual incisal border of the maxillary anterior teeth.

The ideal tooth exposure was decided based on the cross section of all lines, with special emphasis on the horizontal lines. It was concluded that the patient had no anatomical discrepancies that would jeopardize the treatment.

After careful esthetic analysis in conjunction with the close-up photographs and preoperative casts, the treatment plan was designed and discussed with the patient. In more complex rehabilitations, with a pa-
CASE REPORT

Fig 1  Patient with the lips in a rest position, showing 2.5 to 3.2 mm of the maxillary incisors.

Figs 2a to 2c  Preoperative view showing lack of width/length ratio on maxillary central incisors, diastemas, and a discrete gingival smile.

Fig 3  Gingival contour of the maxillary anterior teeth. The gingival zenith of central incisors was not the same height as that of the canines.

Figs 4a to 4c  Close-up images of the maxillary anterior teeth showing incomplete eruption of the incisors.

Figs 5a to 5c (a) Preoperative facial view. (b) Esthetic analysis. (c) Digitally enhanced image showing a possible outcome.
tient exhibiting anatomical discrepancies, a more detailed planning stage would be necessary. 13,14

In the authors’ experience, many patients require digital evaluation of the smile before accepting the treatment. However, the digital image only provides a two-dimensional view of the treatment. If there is any doubt regarding esthetics, phonetics, or patient acceptance, a direct mock-up must be fabricated.

After all treatment options were explained and discussed, the patient chose an esthetic rehabilitation including the following: a gingivoplasty (to establish a new line for gingival tissue), ceramic veneer restorations on four maxillary incisors, and two partial veneers on canines. Since loss of dental tissue was a concern for the patient, an ultraconservative preparation was suggested.

Esthetic Crown Lengthening

Surgical crown lengthening was performed for the six maxillary anterior teeth. The final length of the teeth was determined based on sulcus probing with the patient under anesthesia. Two points were determined: the cementoenamel junction and the height of the bone crest. The periodontal biotype was classified as thick and flat. The new gingival margin was planned to increase the bone level by 3 mm after gingivectomy (Fig 6) [Au: Correct as edited?]. Semi-lunar incisions exposed the desired teeth surface, based on bone and tissue probing. After soft tissue was removed, a single flap was raised and the bone architecture was redefined to establish a new biologic width (Fig 7). Figures 8a and 8b show the amount of soft tissue removed by comparing the initial incision for the gingivectomy with the situation immediately after crown lengthening.
Fig 7a  Gingival flap positioned apically to access the bone. Note the bone thickness, which is a characteristic of thick periodontal tissue.

Fig 7b  Comparison between the bone of the right central incisor and the intact bone on the left central incisor, where the bone was already reshaped.

Fig 7c  Delimitation of the new bone architecture for the left central incisor.

Fig 7d  New bone architecture and contour.

Fig 8a  Initial demarcation for gingivectomy as planned to remove a gingival strip 1 mm below the cementoenamel junction.

Fig 8b  Gingival contour after the suture.
Additive Wax-up

After 90 days of healing, the periodontal tissues were reevaluated, and home bleaching was suggested. The teeth were bleached for 2 weeks using 9.5% hydrogen peroxide gel (Poladay, SDI, Melbourne, Australia). No operative procedure was performed until 20 days after bleaching to ensure shade stabilization. At this time, a new set of photographs was taken to check the results with the patient and dental team (Figs 9 and 10). A polyvinyl siloxane impression of each arch was made to produce a study cast. Polyvinyl siloxane was selected because it offers stability and the possibility to obtain more than one cast with equal precision from the same impression. The additive wax-up requires a general analysis that unites the teeth characteristics, patient's smile and age, opposing dentition, and gingival architecture.

The laboratory technician performed the additive wax-up. No preparation was done in the cast. In addition, no incisal lengthening was planned, and a small amount of wax was used (Fig 11a). The dental technician was aware that maintaining the preparation in enamel was fundamental. Therefore, the wax-up was carefully performed with emphasis to close the diastema and to recover natural surface morphology based on facial analysis and function.

The wax-up was presented to the patient. After the patient provided informed consent, the wax-up was transferred to the mouth for clinical evaluation of shape, size, and length. Composite resin was applied directly to the teeth without acid etching to provide a three-dimensional evaluation. If modification of the mock-up was necessary, all data would be collected by digital photography and new casts would be obtained and sent to the lab. In this case, no modification was required, and the patient accepted the treatment plan using lithium disilicate ceramic veneers.

To facilitate tooth preparation, three silicone indexes were fabricated: facial, lingual, and incisal. The incisal index with a middle third facial cut was positioned on the waxed cast and checked for precise adaptation (Figs 11b and 11c). All silicone indexes were evaluated for fit before positioning in the pa-
patient's mouth (Fig 12). Silicone indexes are essential to check the clearance available for the ceramic material and to plan how much enamel should be removed.

**Tooth Preparation**

A conservative approach requires an accurate tooth preparation to restore the original volume. A few basic principles can be followed to save a significant amount of sound tissue, including not only enamel, but also the critical dento-enamel junction.¹⁵

Typical enamel reduction for ceramic laminate veneers is 0.5 mm in the cervical third, 0.7 mm in the middle and incisal thirds, and 1.5 mm for incisal overlap.¹⁶ This classical veneer preparation is based on the thickness of the restorative material. However, in most cases, the mean enamel thickness in the cervical area is less than 0.5 mm,¹⁷ and therefore if 0.5 mm of cervical enamel is removed, dentin will be exposed.¹⁸ An increased risk of restorative failure was found when laminate veneers were bonded to dentin.¹⁹ Thus, it is imperative to keep laminate veneer preparation to a minimum, since only ultraconservative preparations limited to enamel can grant long-term success.

As described earlier, there are two techniques for veneer preparations: those driven by the existing tooth surfaces and those driven by the final volume predicted by the wax-up. In this case, both techniques were applied. The first was based on the wax-up of the interproximal areas, and the second was based on the previous existing enamel.

The ultraconservative approach to obtain adequate clearance for the ceramic veneer started at the interproximal areas. A long tapered diamond bur was placed parallel to the long axis of the tooth and moved toward the interproximal embrasure. This procedure carefully straightened retentive areas and facil-
itated the placement of the future restoration (Fig 13). Next, incisal reduction of 1.5 mm was performed based on the wax-up. Since there was no modification to the length of the incisal border, the preparation was kept minimal to preserve as much enamel structure as possible (Fig 14).

Retraction cord was then placed before the facial reduction. Gingival margins were deflected to improve visibility for definition of the gingival finishing line. A silicone index was positioned to reveal areas of the tooth surfaces that required minimum preparation.20 Considering the final tooth volume and sound dental structure, the facial reduction was initiated using a round diamond bur as reference. Depth cuts were created with a 1.5-mm-diameter round bur. The difference between the diameter of the bur and the diameter of the shank must be close to 0.5 mm, leading to a 0.25-mm-deep cut when the shank is placed against the incisal third of the facial surface.21 A single horizontal groove was obtained (with the bur placed until the shank contacted the facial surface). Three depth cuts were enough to control the enamel reduction (Fig 15a). This simple operative step assisted the most critical step of enamel reduction. The operator was able to evaluate the reduction, leading to optimal enamel preservation.

Figs 13a to 13d (a) Proximal preparation with a tapered diamond bur. Only the retentive area of the tooth was carefully straightened to facilitate the insertion of the future restoration. (b to d) Maxillary incisors after proximal reduction.

Figs 14a and 14b Incisal reduction.
The facial reduction was performed with a tapered, round-ended chamfer bur (no. 5856 018, Brasseler, Savannah, GA, USA). This bur was carefully used parallel to the three planes of the tooth to even the depth (Figs 15b and 15c). The depth acquired was the clearance needed to build the laminate veneers.

To assure adequate clearance for the laminate veneers, the incisal facially sectioned silicone index was placed, and the available space for the facial surface was confirmed (Fig 16). The silicone index can be considered a multilayer index since it was sectioned transversely into three levels to certify adequate reduction on incisal, middle, and gingival thirds of the tooth. Facial and lingual silicone indexes were used to check for 1.5-mm incisal clearance. All teeth involved in the treatment were prepared using the same technique (Fig 17).

Fig 15a Depth cuts of 0.25 mm were created with a round diamond bur with a shank diameter of 1.0 mm.

Fig 15b Initial facial preparation on the maxillary left central incisor.

Fig 15c Angled view after initial preparation.

Figs 16a and 16b (a) Silicone guide used to ensure minimal enamel reduction. (b) A periodontal probe was used to check the preparation with the silicone guide.

Figs 17a to 17c Frontal and proximal views after preparation using medium-grit diamond burs.
To obtain precise dies, it is essential to finish and polish the preparations. This step was carried out using a red-series medium-grit diamond bur (no. 8856 018, Brasseler) of the same diameter as the bur used in the preparation. Finishing the preparations removed any scratches created by the previous bur (Fig 18). Figure 19 shows close-up views of the ultraconservative preparation. After finishing, the silicone indexes were used again to evaluate the preparations (Fig 20).

The canines were only polished to remove undercuts that could prevent the seating of the mini-veneers.

**Final Impression**

A one-step double-mix impression technique was used to provide appropriate reproduction of the preparations and surrounding tissues. Two retraction cords were placed into the gingival sulcus. The first cord, with a small diameter, was placed intrascularly before the finishing procedures and remained during the impression making to limit the flow of crevicular fluid. The second cord was then superficially placed to deflect the gingival tissues and to reveal the finishing line. The
second cord was left for 5 minutes before impression making to allow for expansion by water absorption. Polyvinyl siloxane impression material was used because of its accuracy for multiple pours, elasticity, and tearing resistance. Figure 21 shows the impressions and demonstrates the importance of retraction cord even for a preparation in which the finishing line is at the same level of the gingival margin.

**Provisional Restorations**

A challenge for laminate veneers is to create adequate and highly esthetic provisional restorations. Laminate veneer provisional have reduced thickness; therefore, adjustments are quite difficult to do chairside because the provisionals break easily. In this case, since the mechanical retention of the preparation was absent, bis-acrylic composite resin was used and retention relied on the interproximal contact and spot etching.

Following the final impression, the provisional restoration was fabricated using a rigid silicone matrix derived on the wax-up. The matrix was prepared with a scalpel by cutting the embrasures to allow the provisional material to flow (Fig 22). The preparations were spot etched for 60 seconds, then rinsed and dried (Figs 23a and 23b). Petroleum jelly was applied to the soft tissues to facilitate removal of overhangs (Fig 23c). Bis-acrylic resin (Luxatemp, DMG, Hamburg, Germany) was mixed and injected into the silicon matrix (Fig 24) and onto the prepared teeth (Fig 25). The matrix was positioned inside the patient's mouth until
the polymerization was complete. Four minutes later, a sharp explorer was used to check final polymerization (Fig 26a). As the gingival tissue was isolated, the resin was easily displaced (Figs 26b and 26c), and the matrix was removed (Fig 27a). Overhangs were removed using a no. 12 scalpel, with care taken to avoid any damage of the tissue (Fig 27b). External characterization was carried out to improve esthetic quality of the provisionals and to avoid a monochromatic aspect (Figs 28a to 28c).
A resin glaze sealant (Dry Coat, DMG) was applied to the provisionals, and each tooth was light polymerized for 40 seconds (Fig 28d). The provisionals were covered by a water-based glycerin gel to remove the oxygen inhibition layer. The provisionals were then light polymerized for 20 seconds (Fig 29). The glycerin gel was removed and the provisionals were polished with silicone points followed by a felt disk (FlexiBuff, Cosmedent, Chicago, IL, USA) and aluminum oxide polishing paste (Enamelize, Cosmedent) (Fig 30).

**Figs 28a to 28d** Characterization of the provisionals. (a) Ochre tint was applied to the gingival embrasure; (b) blue tint was used to mimic the incisal translucency; (c) crack lines and incisal halo were produced with white tint; (d) a light-cure glaze (Dry Coat, DMG) was applied to the entire provisional and light polymerized for 20 seconds.

**Figs 29a and 29b** Additional polymerization was performed with the provisionals covered with water-soluble glycerin gel to avoid the oxygen inhibition layer.

**Figs 30a and 30b** Final outcome of the provisionals. Additional luster was obtained with aluminum oxide polishing paste (Enamelize, Cosmedent) and a felt disk (FlexiBuff, Cosmedent).
provisionals were checked and an irreversible hydrocolloid impression was made to send to the lab to help the final wax up on the master cast. A new set of pictures was taken 1 day after the preparation and provisionalization for better evaluation of the outcome. Final impressions, casts of the provisionals, bite registration, and shade information were sent to the laboratory.

Try-in and Bonding of Final Restorations

Since the preparation was ultraconservative, a high translucency etchable lithium disilicate ceramic (Emax Press, Ivoclar Vivadent, Schaan, Liechtenstein) was selected as the pressed core and layered with silica-based ceramic (Emax Ceram, Ivoclar Vivadent). The mini-veneers on the maxillary canines were built up on a refractory die (Fig 31). Three weeks later, the patient returned to the clinic for final restorative procedures.

Due to a precise hemostatic protocol with thin cords, the soft tissue was healthy after 21 days. Definitive insertion of the ceramic restorations was preceded by a try-in procedure to select the best shade for the resin cement. After removal of the provisionals, the adhesive layer created from the spot-etched area was removed using aluminum oxide disks (Soft-Lex, 3M ESPE, St Paul, MN, USA). The patient was not anesthetized for the try-in, because of the intra- enamel preparation.

To get the best outcome, the bonding procedures for very thin laminate veneers require special attention. In this case, a dedicated material with a try-in paste was used to select the best shade of the resin cement. The try-in paste is a water-soluble glycerin gel that simulates the final outcome. Figure 32 shows the differences in shade during the try-in. Several low and high value try-in pastes were tested (Variolink Veneer Try-in Paste, Ivoclar Vivadent). It was decided among the patient, dental technician, and clinician to select a light-cured resin cement with high value (High Value HV+3, Variolink Veneer, Ivoclar Vivadent) for final cementation (Fig 33). For laminate veneers, light-cured resin cements are preferable to dual- or self-cure resin cements because of long-term stability of the shade.

The patient was anesthetized to avoid any discomfort during bonding and finishing. Since the surround-
Figs 31a and 31b  Lithium disilicate ceramic laminates (Emax Press/Emax Ceram, Ivoclar Vivadent) on the master cast. Partial mini-veneers were produced for the maxillary canines using the refractory die technique (Emax Ceram, Ivoclar Vivadent).

Fig 32  The shade and fit were evaluated using a glycerin-based try-in paste (Variolink Veneer Try-in Paste, Ivoclar Vivadent). Two different shades were tested: a low value (LV-3) for the right central incisor and a high value (HV+3) for the left central incisor. The patient played an active role in shade selection.

Fig 33  Four anterior lithium disilicate laminates with high-value try-in paste, which was the final paste selected.

Fig 34a  Scanning electron micrograph of the intaglio surface of the lithium disilicate laminate after sandblasting with 50-µm aluminum oxide particles (magnification 35,000).

Fig 34b  Scanning electron micrograph of the intaglio surface of the lithium disilicate laminate after etching with 9% hydrofluoric acid, followed by ultrasonic cleaning immersed in distilled water (magnification 35,000).

Fig 34c  Scanning electron micrograph of the interface between the lithium disilicate and the veneered ceramic (magnification 35,000).
Rubber dam was removed, and the occlusal adjustments were made with a diamond polishing system for ceramic. The healthy gingival tissue was stable after 2 weeks (Figs 35 and 36). Figure 37 shows the smile 6 months after bonding.
Figs 37a to 37c  Final result after 6 months.

Fig 38  Final result after ??? months. [Au: Please provide month amount for this image or is this also 6-month results?]
CONCLUSIONS

The clinical success of laminate veneers depends on four major factors: enamel preservation, ceramic selection (etchable ceramic), bonding procedures, and careful occlusal adjustments. These factors rely on the clinician and technician’s knowledge of biology and dental materials. The ultra-conservative preparation approach used in combination with high-translucent pressed ceramic facilitates laboratory and clinical success.

REFERENCES