



# Minimally invasive vertical preparation design for ceramic veneers

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## Abstract

The esthetic treatment of anterior teeth has always presented a challenge in clinical practice. With the improvement of dental materials, many restorative options such as composite resins, all-ceramic crowns, and ceramic veneers have become available. The current challenge in reconstructive dentistry is to obtain excellent esthetic results while preserving the biological structures involved as much as possible. Thanks to the introduction of high-strength etch-

able dental ceramics, clinicians and technicians have materials and procedures at their disposal that allow them to restore esthetics and function through a minimally invasive approach. New-generation all-ceramic restorations and adhesive systems allow a greater preservation of residual hard tooth structures, especially with regard to single elements. This article describes a vertical preparation technique for ceramic veneers.

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## Introduction

Porcelain laminate veneers (PLVs) are a minimally invasive esthetic restorative option with a good long-term success rate. This treatment option has been used due to its color stability, biocompatibility, mechanical properties, and favorable esthetic outcome<sup>1</sup> (Figs 1 to 3).

The idea of minimally invasive dental restorations is essential for successful restorations.<sup>2-4</sup> Thus, minimum-thickness full-ceramic restorations have been increasingly indicated.<sup>5-13</sup> Lithium disilicate ceramic, used in its monolithic form and individualized with a staining technique, is a material particularly suited to situations of erosion or abrasion where it is necessary to replace or restore damaged enamel through a re-enameling process,<sup>14-16</sup> or for prosthetic correction of malpositioned or diastematic teeth, as well as for restorations of teeth incongruous in shape or color due to extended, poor-quality composite restorations (Figs 4 to 7). This material can be bonded to residual enamel and dentin after etching the ceramic with hydrofluoric acid (HF) and silanization, using

latest-generation dual-curing composite resin cements.

## The preparation dilemma

Tooth preparations for fixed prosthetic restorations can be performed in different ways. There are basically two kinds of preparation: 1) preparation with a defined margin, and 2) the so-called vertical (or feather-edge) preparation.

Preparation with a defined margin is traditionally performed for full-ceramic restorations. This type of preparation was originally used for prosthetics on teeth that had been treated with resective surgery for periodontal disease. Although vertical preparation is commonly indicated where periodontally involved teeth are being used as abutments for fixed prostheses,<sup>17-20</sup> this approach may represent a less-invasive alternative to a horizontal margin in various clinical conditions. The vertical preparation technique, when compared to other preparation techniques (chamfer, shoulder, etc), is simpler and faster in terms of clinical steps.



**Fig 1** Rehabilitation of the anterior zone through implants and lithium disilicate veneers on teeth 1.3 and 2.3.

**Fig 2** The veneers on the cast, aimed at harmonizing the morphology and improving function.

**Fig 3** Follow-up after 8 years of clinical service (veneers on vertical preparation are highlighted by red arrows).



**Figs 4 and 5** The veneers can be used to modify the morphology of the anterior teeth.



**Figs 6 and 7** The veneers can be used to correct diastematic, worn, and stained teeth.

The main advantages of vertical preparation are:

- Minimally invasive in the cervical area.
- Saves dental structure and allows enamel preservation in the cervical area. In fact, this approach may contribute to limiting pulpal irritation in vital teeth as a consequence of a well-preserved pulp-preparation distance in the cervical area, which represents the most sensitive zone for the pulp.<sup>21</sup>
- Possibility of positioning the final finish line at different levels, either more coronally or more apically within the gingival sulcus, without affecting the quality of the restoration's marginal adaptation.
- Possibility of modulating the emergence profile.
- Easy and fast to execute.
- Ease of impression taking.
- Ease of provisional manufacturing and finishing.



**Figs 8, 9, and 10** Preoperative views of the clinical case. The patient complained of numerous discolored teeth and changes in form and color, as well as the visibility of previous restorations that were stable.



**Figs 11 and 12** The clinical examination and the cast analysis help the clinician to evaluate the emergence profile of the existing dentition. The lateral view of the central incisor allows the clinician to assess whether it is appropriate to increase the emergence profile.

Moreover, the introduction of high-strength ceramics has allowed the clinician to use this margin preparation also in full-ceramic restorations. The vertical finish line has already been tested *in vitro*<sup>22,23</sup> and *in vivo*<sup>24,25</sup> with zirconia crowns. Furthermore, *in vitro*<sup>26</sup> and clinical<sup>27,28</sup> observations reported results with high success rates with lithium disilicate full crowns on vertical preparations. No publications to date have examined the use of vertical margins with lithium disilicate ceramic veneers. This article presents a step-by-step prosthetic technique for periodontally healthy teeth us-

ing vertical preparation for lithium disilicate ceramic veneers.

## Technique description

Before starting the procedure, a careful esthetic and functional evaluation of the patient must be made. In this case, a carefully defined treatment plan and good communication between the clinician and the technician helped to maximize the efficiency of the treatment and the predictability of the esthetic outcome<sup>29</sup> (Figs 8 to 10).

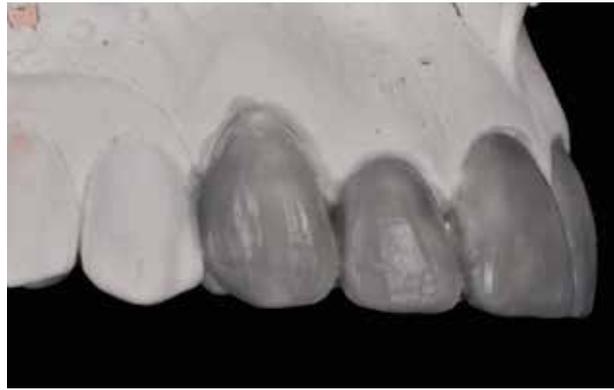


The clinical approach to preparation is founded on the selective reduction of tooth substance guided by a mock-up that mimics the golden reference: the wax-up itself. Regarding of thickness control, the preparations were performed according to the aesthetic pre-evaluative temporary (APT)<sup>30-32</sup> protocol. With this technique, after a three-dimensional (3D) smile design analysis, the clinician gives all the information and clinical records to the technician to execute the diagnostic wax-up. A digital analysis of the clinical picture is performed to evaluate the esthetic changes. Preoperative impressions are taken, and a wax-up is performed.

One of the key points in developing a proper wax-up is the evaluation of the emergence profile. The use of this technique is particularly indicated in cases of a semi-additive approach in the gingival third. The clinical evaluation and the cast analysis could give the proper information about the possible modification of the emergence profile (Figs 11 and 12). The gingival third was modified to obtain a contour that could mimic the morphology of the gingival tissues<sup>33</sup> (Fig 13) and the natural light over the contoured crown of the natural tooth (Fig 14).

This approach has several advantages:

- Improves the emergence profile of the restoration, allowing a more natural appearance.
- Saves tooth structure, especially enamel in the cervical third.
- Reduces patient discomfort (if the final volume of the restoration allows a semi-additive approach, local anesthesia is unnecessary in most cases).



**Fig 13** The wax-up is only additive, with care being taken to develop the contour of the gingival third so that it is as similar as possible in shape and volume to the gingival margin.



**Fig 14** The crown of an intact tooth shows a slight overcontouring at the cemento-enamel junction. (Image courtesy of Dr. Jordi Manauta.)



**Fig 15** Through a silicone index and bisacrylic resin, morphological changes can be transferred over the existing dentition.

The wax-up is then transferred to the mouth using a silicone index (Fig 15), which is tested esthetically and functionally. This wax-up represents the enhanced natural dentition, is the cornerstone of the entire approach, and will provide critical guidelines such as the position and length of the maxillary incisors. In most cases, the additive wax-up allows for the maintenance of the preparation entirely, or at least in the majority of cases within enamel,<sup>34</sup> limiting the need for immediate dentin sealing (IDS). Moreover, besides restoring esthetics, the restorative treatment improves the function of the anterior guidance, which is tried immediately after the application of the mock-up.

The mock-up should be tested for 1 to 2 weeks to ascertain the length and shape of the future restoration and ensure that there are no interferences with function, phonetics, and overall patient comfort. Once approved by the restorative team and the patient, the APT restoration is used as a precise guideline

to prepare the tooth structure, based on the planned final tooth contours. The tooth structure will undergo only the most necessary and minimal preparation, or even no preparation in certain areas, using depth cutter burs through the APT restoration, according to the pre-established final contour.

In the present case, starting with round burs, the teeth were prepared to generate 0.3 mm (gingival third), 0.5 mm (middle third), and 0.8 mm (incisal third) calibration grooves (Figs 16 to 24). The mock-up was removed from the teeth, and diamond burs were used for vertical preparation to remove the tooth substance between the depth cuts. The preparation was performed by using a 0.12-mm diamond bur for a feather-edge margin. A retraction cord (000) was placed into the gingival sulcus to displace the gingival margin, and the margin was finished with a 30- $\mu$ m diamond bur and silicone points. The final impression was taken with a polyether material, and the provisional restoration (in this case, necessary) was performed using a scalloped silicone index and bisacrylic composite resin.

### Laboratory procedure

The definitive cast was molded and the definitive wax-up performed following the initial project and the clinician's indications. The key point in the laboratory procedure is starting the wax-up of the gingival third before ditching the cast, so as to have the gingival tissues as point of reference.

The difference between horizontal and vertical preparations is that in the



**Figs 16, 17, and 18** The calibration grooves are made horizontally by ball diamond burs of various thicknesses through the mock-up. Once they are made, it is useful to highlight them with a pencil.



**Figs 19, 20, and 21** The residues of the mock-up are removed and the tooth substance between the calibration grooves is removed, using a drill for a vertical preparation and taking care to change its inclination in the three thirds of the buccal surface.



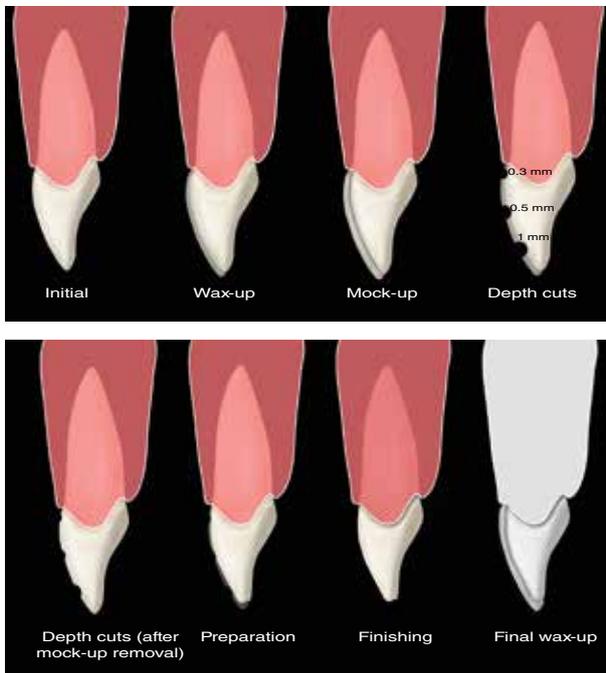
**Figs 22, 23, and 24** The preparations are finished and polished. After the impression taking, a direct temporary restoration is made using the same silicone index.

former, the margin is positioned by the clinician and leaves a well-defined line on the tooth, which is then replicated in the impression and the working model. In vertical preparations, the margin is positioned by the technician, based on the gingival tissue information. In this case, the position of the finishing line

was performed by the technician, taking as point of reference the cervical margin detected by the impression. The emergence profile was developed following the profile of the gingival tissue. The final wax-up was pressed and sintered (Figs 25 and 26), and finishing and mechanical polishing were performed,



**Figs 25 and 26** The final wax-up before and after the pressing procedure.



**Fig 27** Summary of the three main steps.



**Fig 28** The control of the thickness of the ceramic veneers shows how the volume of the final restoration was the same as the planned restoration.

always considering the maintenance of the planned emergence profile (Fig 27).

The finished veneers were tried on the tooth preparation, and the translucency was checked through the try-in paste of the luting agent. Careful attention was

paid to the cervical appearance and shade transition. The thickness of the veneers, once verified by an Iwanson gauge, was equal to the volume of the planned prosthetic restoration (Fig 28). The emergence profile of the veneers



**Figs 29 and 30** The integration of the restoration profile must be verified on all restorations before starting with the conditioning of the inner surface of the veneers and their cementation.



**Figs 31, 32, and 33** The emerging profile copies and adapts to the morphology of the gingival tissues.



**Figs 34, 35, and 36** The change of the emergence profile: preoperative vision after preparation and cementation of the final restorations.

must be checked carefully before starting with the luting procedure (Figs 29 to 33).

Following an adhesive protocol and the conditioning of the intaglio surfaces of the veneers, the restorations were luted.

The finishing of the margin was performed using a cutting blade, scalers, and a diamond rubber point specifically for intraoral adjustment of high-strength ceramics. The same adjustment was carried out for the occlusal surface. The



**Fig 37** Postoperative view: 1-year follow-up.

clinical control of the emergence profile in different steps is the key point of this technique. The ideal situation is a semi-additive scenario in which the controlled preparation and the vertical finishing line allow for the preservation of the enamel in the cervical third, as well as an improvement of the relationship between the emergence profile and surrounding tissues (Figs 34 to 37), avoiding bulky veneer restorations.

## Conclusion

Rehabilitation through porcelain veneers allows for the restoration of anterior teeth in a predictable manner. Moreover, it provides a good esthetic outcome and mechanical strength in the long term. However, the finishing of the horizontal margins of the preparations often requires more invasive clinical steps that are difficult to manage. The use of ceramics with high resistance, the pressing techniques, and a design of the cervical third that mimics the morphology of the gingival tissues allow for the use of vertical preparations for ceramic veneers. Such an approach considerably simplifies the procedures for preparing veneers, as it minimizes tooth preparation.

Although the clinical response to this prosthetic procedure seems to be extremely favorable, further scientific investigations are needed to adequately confirm the long-term predictability of the proposed method.

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