ADHESIVE TECHNIQUE FOR VERTICAL PREPARATION IN RETREATMENTS

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ABSTRACT

One of the key tools to control the presence of a visible gingival margin in anterior regions may be the utilization of the biologically oriented preparation technique, helping to enhance the quality of periodontal tissues and extending their stability over time. Currently, there is a wide array of materials that allow highly esthetic and predictable replacement of the lost tooth structure. These materials without metallic nucleus include the lithium disilicate or zircon oxide-reinforced crowns, which present promising esthetic outcomes and high resistance to fracture, besides the possibility of adhesive bonding to the tooth, substantially enhancing the long-term success of indirect restorations.

KEYWORDS

BOPT. Vertical preparation.
Lithium disilicate crown.
Adhesive dentistry.

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INTRODUCTION

When we discuss the success of fixed prosthetic restorations of anterior teeth, one of the main factors is the preservation of soft tissue stability around the restorations.[3-6] Fundamentally, gingival recessions or apical migration of the gingival margin should be avoided, as they may expose the line where the restoration ends and, therefore, the prosthesis-tooth interface, an undesirable esthetic result.[7-8]

The biologically oriented preparation technique (BOPT), described by Loi and Di Felice[3], includes the preparation of a slight overcontouring of the final prosthetic restoration in the finish zone, only up to the finish line, which prevents violation of the biological width. Soft tissues will accommodate as they migrate coronally and produce highly esthetic results.

TYPES OF TOOTH PREPARATION

There are three basic types of tooth preparations for fixed prosthetic restorations: horizontal preparations, preparations without vertical or finish line,[9] and restorations with no tooth preparation[10].

HORIZONTAL PREPARATIONS

The most common types of finish lines for tooth preparations for fixed prosthetic restorations are shoulder, shoulder with bevel, chamfer, or chamfer with bevel. They belong to the group of tooth preparations for fixed prosthetic restorations called horizontal preparations,[11,12] in which the tooth is prepared with a perfectly visible and evident finish line, both clinically and in the laboratory, after impressions and plaster pouring are completed[3].

VERTICAL PREPARATION

The other group of tooth preparations for fixed prosthetic restorations is the vertical preparation, which are preparations without a finish line. These preparations should be chosen when the anatomic and clinical crowns do not coincide[3,4,13].

This tooth preparation technique, described in this study, includes a feather-edge finish line and is relatively conservative when preparing the tooth structure for a crown restoration.

This tooth preparation, in which there is no finish line to accommodate the soft tissue around the tooth, has been described by Loi and Di Felice[3] and is known as biologically oriented preparation technique (BOPT). Its objective is to create a prosthetic emergence profile that may mimic that of a natural tooth adapted to its surrounding gingiva.[14] Thanks to this technique, the anatomic cementoenamel junction may be corrected in natural teeth without any type of preparation, and the finish line may be eliminated in prepared natural teeth. It places the end of the restorations at different levels, more coronal or more apical, but still in the sulcus, at a 0.5 mm depth. This may induce soft tissue migration, which may later be used to achieve a more natural emergence profile of the restorations,[15] as well as to increase gingival thickness and gingival stability over time, resulting in a better fit.[5]

Greater gingival thickness is a definitely beneficial factor of this technique. There is limited prospective scientific evidence of this, but the few studies in the literature that have investigated it have reached the same conclusions.[3,6]

However, BOPT does not have only advantages. Differently from horizontal preparations, this technique is more complicated and has a steeper learning curve, in addition to longer patient chair time.[3] Moreover, it requires that a provisional prosthesis be fabricated, and bleeding teeth and the need to obtain a perfect fit to these tissues are further difficulties. These conditions, fundamental for BOPT success, may ensure the increase of gingival thickness and clot stabilization[3].

This technique has so far received little scientific support, as few prospective clinical trials have evaluated its efficacy[3].

NO TOOTH PREPARATION

This smaller group of indirect restorations, such as ceramic fragment restorations, have developed thanks to advances in adhesive dentistry and in new materials.

The conditions for their use are:

- Possibility of indirect restorations, that is, no tissue in the buccal and/or incisal area of retracted tooth in relation to the rest of the dental arch.
- Presence of enamel to achieve excellent bonding.
- Proper shade of underlying tooth or material: restorations are ultrathin (0.2-0.3 mm), and the desired shade may not be achieved with great variations[10].

CASE REPORT

A 53-year-old woman with no medical history of interest (American Society of Anesthesiology [ASA] Type I) sought dental treatment because she was unhappy about the esthetics of her anterior maxillary teeth, and, specifically, her right maxillary central incisor. Clinical examination revealed deficient marginal adaptation of this tooth, and a new prosthetic restoration was suggested (Fig 1).

The first step was to draw a treatment plan to present to the patient. Baseline photos and radiographs were obtained to evaluate which material should be used to reproduce the missing tooth, and what type of preparation should be indicated for that purpose.

In this case, the best possible treatment to match adjacent tooth and respond to the patient's needs was a fixed prosthetic restoration including the entire tooth contour (crown) and made of lithium disilicate. The prosthesis should be placed after tooth preparation using BOPT.

Figure 1:

Baseline photos of patient with unsatisfactory esthetic appearance of gingival margin in region of tooth #11. (**A**) Frontal view. (**B**) Lateral view. (**C**) Occlusal view.

DIAGNOSIS

The steps followed in her treatment plan were:

- Diagnosis: clinical history, clinical and radiographic examinations, photos and study models.
- Tooth preparation using BOPT.
- Provisional restoration after tooth preparation.
- Replacement of provisional restoration with final restoration.

The conclusion that the best procedures for this patient was the treatment plan aforementioned was based on an accurate diagnosis according to photos, evaluating the esthetic anomaly with which the patient was dissatisfied, radiographs, probing and impressions, and working models of both dental arches.

Radiographs and tooth probing are always fundamental to determining whether a patient has no other apical or periodontal problems. The first step of preparation is the measurement of the sulcus using a periodontal probe to confirm epithelial attachment of the tooth to be treated.[3] In this step of the case described here, probing was normal and, therefore, restoration could proceed as planned.

Another fundamental step during diagnosis is the definition of tooth shade. The shade of the tooth to be prepared and its adjacent teeth should always be determined before preparation begins. Tooth shade was evaluated using a shade guide and a photograph, in this case.

Conventional photographs and a Polar_eyes cross-polarization filter were used (Fig. 2) to eliminate unwanted specular reflexes that the flash light might produce on the teeth.

Conventional photographs may show a diffuse reflection; therefore, the worst color should be evaluated (Fig 3). These specular reflexes may hide details in the teeth and induce communication problems with the laboratory. The filter polarizes the lens and the flash light, and the tooth shade is better visualized, because only the light waves vibrating in the vertical plane pass through it.

Tooth shade should be recorded using the stratification technique and the ceramics system to be used[16].

Figure 2:
Determination of tooth shade using VITA (**A3 and B3**) scale and Polar_eyes® cross-polarization filter.

Figure 3:
Conventional photo to determine tooth shade using VITA (**A3 and B3**) scale with double flash lights.

TOOTH PREPARATION

The first step is the preparation of the tooth contour, and the second, the preparation of the gingival margin.

The measurement of the crevice and the definition of whether depth and gingival health parameters are normal should be followed by supragingival preparation[3]. For that purpose, a 100–200-µm flame bur (Fig 4) should be used at a 15-degree inclination to the long axis of the tooth, avoiding a vertical preparation. The bur should cut with the body and not the tip, to avoid visible margins,[4] not desired in this technique.

Buccal preparation should include the gingival and the incisal approaches, so that this surface is reproduced and later adjusted as well as possible to the preparation.

The bur used in the direction of the gingiva characterizes the gingitage technique for intracrevicular preparation, proposed by Ingraham[42,43] and adapted by Loi et al.[3] Both the tooth and the gingiva are prepared at the same time and at the same vertical axial plane (Fig 5).[4] Therefore, the bur interacts at the same time with the internal crevicular wall and with the epithelial component of the gingival attachment[3]. The purpose of this preparation is to make the gingiva bleed, so that the provisional later stabilizes the clot and, thus, creates a gingival emergence profile adequate for the definitive restoration. Moreover, clot stabilization will induce gingival thickening that prevents recession, and that results, according to some authors, from the intracrevicular placement of the restorations, defining the new emergence profile adapted to the restoration[3].

Figure 4:
Removal of old crown.

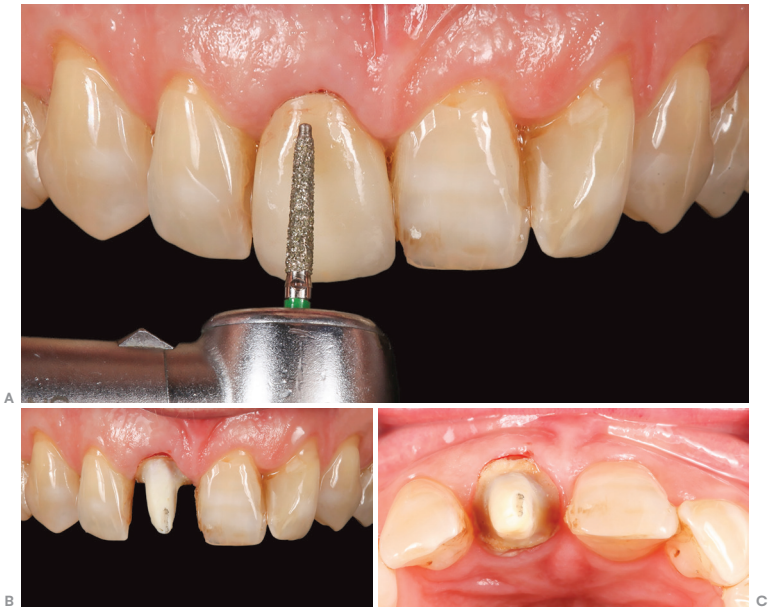
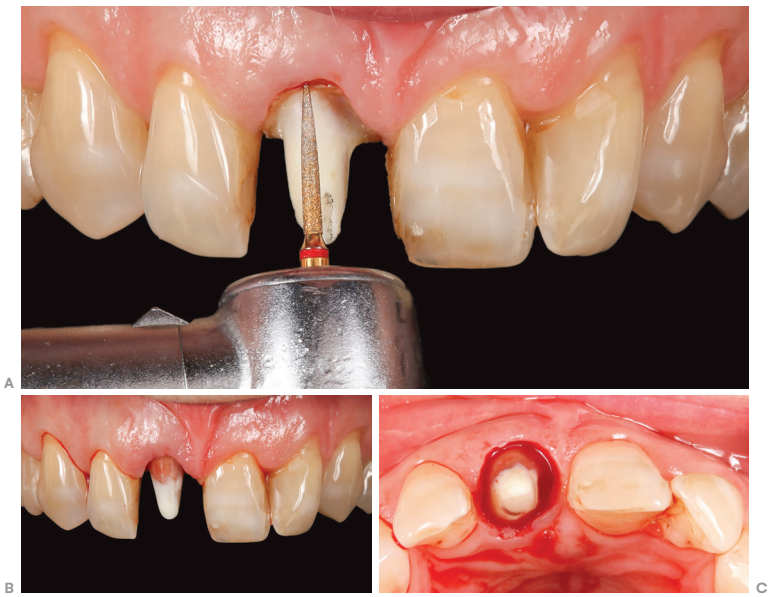


Figure 5:
Intracrevicular preparation using a flame bur. Clot formation using gingitage technique.



After supragingival and intracrevicular preparation, the entire surface should be polished using a 20-µm flame bur[4]. This ensures that the restoration is more effectively placed.

PROVISIONAL PREPARATION

Once the preparation described above was ready, a provisional acrylic crown was placed in contact with the gingiva to stabilize the clot that formed in the gingival crevice during intracrevicular preparation.[3,4]

Stabilization allows the provisional restoration to remodel the gingiva, so that after some time it induces the formation of a natural emergence profile of the definite crown.

To obtain an adequate provisional preparation, a silicon impression was taken in a single step. Tooth preparation should be accurately visible in the impression, without discrepancies from what is found in the patient's mouth. It should also reproduce the intracrevicular preparation, so that the provisional restoration is fabricated using all the space that will be later occupied by the definitive restoration. If the intracrevicular preparation is not accurately recorded, the provisional restoration will not be correctly inserted in the crevice and will not stabilize the clot, which is, as discussed before, a necessary step for the proper emergence of soft tissues.

After the impression was taken, the working model was prepared, and the laboratory technician used it to fabricate the provisional restoration (Fig 6), which had the thickness of the negative image of the gingiva[3].

This restoration was polished and provisionally cemented (Fig 7).[3]

This restoration will produce an increase in gingival convexity and improve gingival profile. As it is slightly overcontoured and modifies the soft tissues of the gingival margin, a larger space is created to place the 0.5 mm definitive intracrevicular restoration later on. All tissues should fit perfectly around it. The internal part of the provisional restoration should always be feather-edge and reproduce its preparation, although the part in contact with the internal wall of the crevice may be slightly overcontoured[3,4].

Figure 6:
Provisional restoration remodels soft tissues to support future natural emergence of definitive restoration.

Figure 7:
Placement of provisional restoration.

IMPRESSIONS AND WORKING MODELS

The periodontium stabilizes in about one month, and then the definitive impressions can be taken. In this technique, impression taking is much easier because there is no finish line, and, therefore, it does not have to be perfectly reproduced in the impression.[3]

After one month, the gingival tissue will be already adapted to the provisional crown, and its morphology will be adequate for the reproduction of the crevice and tooth preparation. In spite of that, the first step here, before a good impression is taken, is to place a retraction cord in the crevice, so that the finish line may be reproduced in the definitive model at the point the restoration should end. If a retraction cord is not used, the intracrevicular area that was prepared may not be fully reproduced in the definitive impression. Moreover, the connective tissue should not be violated, to prevent bleeding.[17-19]

The definitive impression should reproduce all the finish area, so that the laboratory technician may accurately fabricate the lithium disilicate restoration up to the finish line of the tooth preparation. This impression may be taken using intraoral scanning. However, in the case reported here, impressions were taken using the traditional method with addition silicone (polyether, Aquasil Ultra, Dentsply Caulk) (Fig 8).

Once the gingiva model was removed, a rigid gingival mask was fabricated (Fig 9). This mask facilitated the reproduction of the gingival architecture more realistically and, therefore, makes it easier to apply to it the gingival changes necessary to create an adequate emergence profile.

Because of its feather-edge shape, the impression of the finish line will be difficult to visualize in the working model. However, in this type of vertical preparation, the finish line, about 0.5 mm from the apical gingival margin, should always coincide with a line between the gingival margin line and the crevicular fundus line, to avoid violation of the biological width.[17-19]

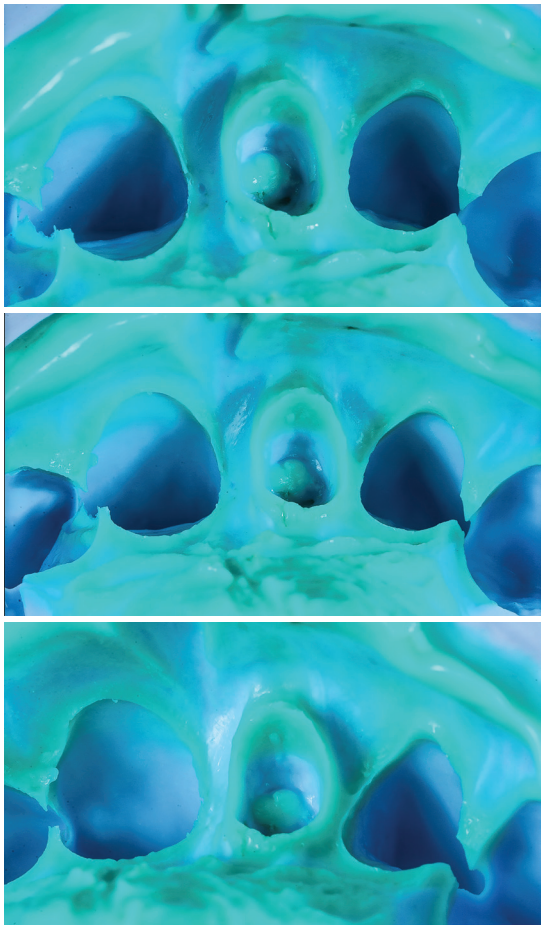


Figure 8:
Definitive impression with addition silicone.

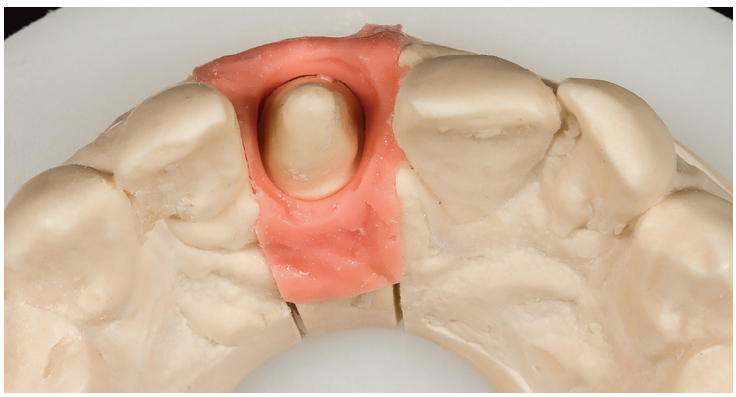


Figure 9:
Definitive working model with rigid gingival mask, which is a representation of patient's gingiva, to more accurately reproduce clinical reality.

DEFINITIVE RESTORATION FABRICATION

After all the steps described before, the laboratory technician fabricated the definitive restoration following the patient's esthetic demands. The crown reproduced the intrinsic stains on her teeth, such as the characteristic whitish horizontal lines seen on the baseline photo.

A lithium disilicate (IPS e.max CAD) covering (Fig. 10) was used and, due to its complexity, a recapping stratified ceramic (IPS e.max) restoration. (Fig. 11) was chosen.

After the lab technician had completed the restoration according to indications and the parameters previously examined, the correct placement and marginal adjustment were confirmed using the definitive working model[16].

Try-in should be conducted after this step. The provisional restoration should be carefully removed, and the tooth thoroughly cleaned, to make sure the definitive restoration is not stained. Moreover, cement rests should not remain in the interproximal spaces, as they are a probable cause of fitting problems. After that, the restoration should be inserted in the same way made on the working model used to confirm proper placement and fit[16].

The point of contact should be checked to ensure that the gingiva will remain healthy and to prevent food impaction[16].

Finally, despite the thorough cleaning of the restoration before try-in, some chemical contamination of surfaces and, therefore, of the restoration may remain. Therefore, the tooth should be etched only after try-in[20].

Figure 10:
Lithium disilicate covering fabricated using CAD-CAM (IPS e.max CAD) technology.

Figure 11:
Definitive stratified lithium disilicate (IPS e.max) ceramic restoration.

RESTORATION PREPARATION

The protocol described by Pascal Magne for the preparation of this type of crown begins with hydrofluoric acid pretreatment of the internal part of the crown.[16] In the case described here, the concentration was 4.5% applied for 15-20 s (IPS ceramic Etching Gel®) on all internal surfaces. The main goal was to dissolve weakened crystalline ceramic contents and produce a porous and more humid surface to strengthen the bonding between the ceramic surface and the resin cement.[21,22]

After that, 37% orthophosphoric acid was applied for 30 s to eliminate all the hydrofluoric acid rests and debris and to clean the surfaces and promote bonding.[16]

Once proper acid etching and surface cleaning are complete, a layer of a silane coupling agent is applied, and 60 s should be allowed for proper silanization. Silane increases the chemical adhesion of ceramics to the bonding resin, as it induces the coupling of the silicon in the lithium disilicate ceramics to the organic matrix of the resin by means of siloxane linkage.[21]

After that, a substantial layer of dual adhesive agent (XP Bond) was applied with a microbrush (Fig 12) with the Sirona® Dentsply catalyzer. This ensured that the chemical polymerization continued after conventional light curing, and, therefore, produced dual curing.

This type of ceramics is very fragile. Therefore, sandblasting with abrasive particles should be avoided in its surface treatment, because it produces microfissures and may result in fractures.[22]

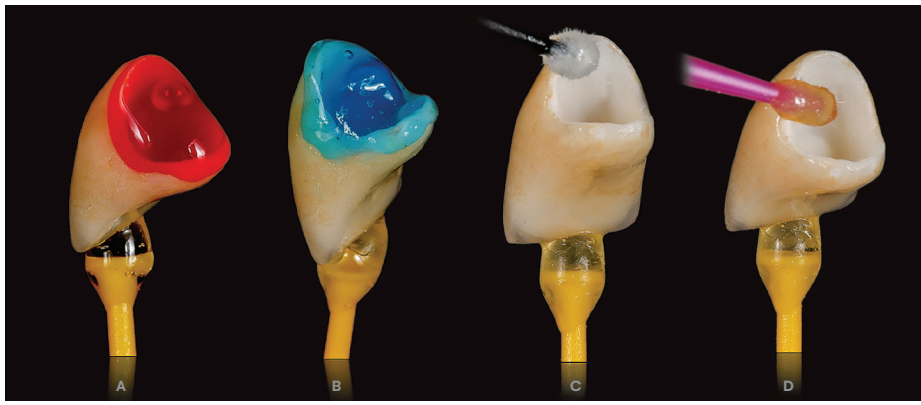


Figure 12:
Cementation sequence, beginning with application of 4.5% hydrofluoric acid (IPS Ceramic Etching Gel) (**A**), followed by application of 37% orthophosphoric acid (**B**), silanized acid (**C**) and XP Bond adhesive agent with catalyzer (Dentsply Sirona®) (**D**).

TOOTH PREPARATION

Once it was confirmed that the restoration fit the tooth perfectly, it was isolated using retraction cords, because isolation with rubber dams cannot be used for vertical preparations.

First, the post surface was cleaned by sandblasting with 50-µm aluminum oxide particles, followed by 37% orthophosphoric acid attack. The acid was applied for 30 s to the enamel and 15 s to the dentin.[23] The adhesive agent was applied next (Fig 13).

Figure 13:
Tooth treatment: (**A**) 50-µm aluminum oxide sandblasting, (**B**) application of 37% orthophosphoric acid and (**C**) XP Bond adhesive agent with catalyzer (Dentsply Sirona®).

CEMENTATION

After the surfaces were prepared for adhesion, a resin cement was applied to give the anterior teeth a natural appearance. This should be a dual curing cement, to ensure the correct amount of conversion in cases of thicker or more opaque restorations.[16]

In the case described here, the cement used was Calibra® Resin Esthet Cement. When resin cements, such as Calibra®, are used, the rests of cement in contact with the gingival margin should be eliminated, because they may otherwise induce gingival irritation or retraction.[24]

Once the cement rests were removed in this case, a LED light was used for light curing at about 2 mm from the tooth and for 40 s on the buccal surface and 40 s on the lingual surface (Fig 14).

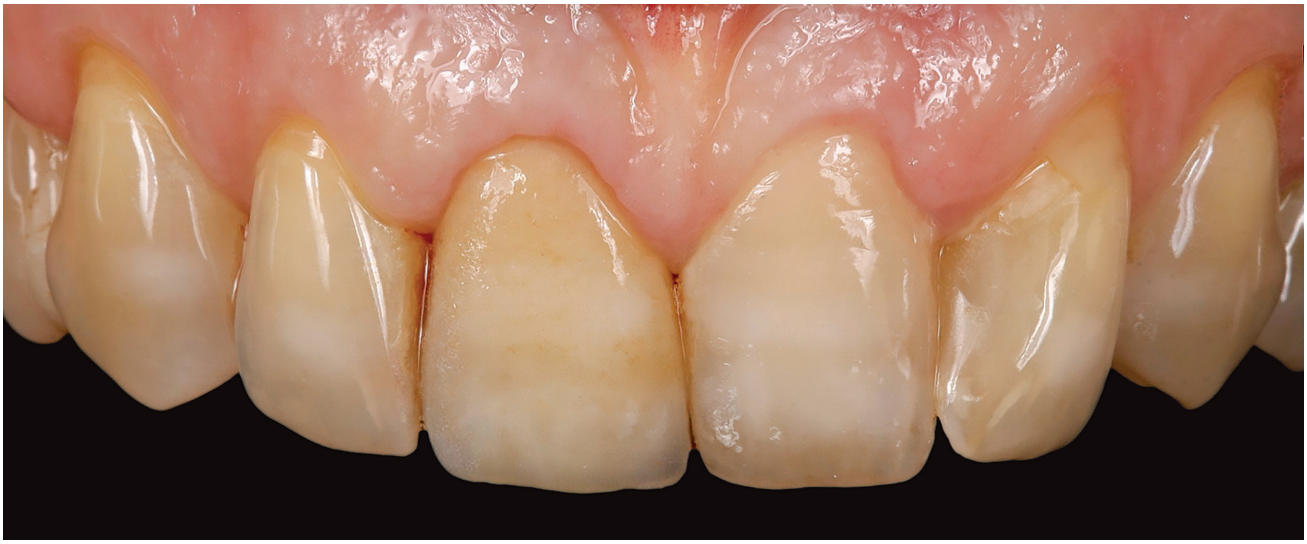


Figure 14:
Definitive restoration; successful result of BOPT use, excellent esthetic result and proper gingival emergence.

DISCUSSION

TYPE OF PREPARATION

There are three types of tooth preparations for fixed prosthetic restorations: horizontal preparations, preparations without a vertical or finish line, and restorations with no tooth preparation. Feather-edge vertical preparations have a better coronal sealing. In addition to their esthetic results, they induce better gingival health and less bacterial penetration. Therefore, tooth involvement underneath the restoration is drastically reduced.[25-27]

In addition, some studies confirm that the occurrence of periodontal problems due to an improperly fabricated or placed crown are much more frequent than those assigned to crown insertion in the crevice.[28-30] In fact, numerous authors describe the correlation of restoration positioning violating the biological width and inducing quantitative and qualitative changes in microbiome, as well as increasing plaque index, gingival index, recession, pocket depth and crevicular fluid.[3,14,31]

Paniz et al[32] studied the association of horizontal and vertical preparations with gingival tissue parameters. They found that subgingival margins in vertical preparations affect the response of soft tissue and induce adverse inflammatory periodontal reactions associated with multiple factors, such as difficulties to brush or violation of the biological width. However, they concluded that the finish line of a restoration affects only the bleeding index and gingival recession, and that, therefore, vertical preparations are better than horizontal or chamfer preparations.

In contrast, Loi and Di Felice,[3] in their description of BOPT, suggest the use of a crown with an overcontour in contact with the tissues, and reported no gingival recession or inflammation. This overcontour may in fact promote gingiva thickening and make it less susceptible to aggression, as well as better prepared to preserve the restoration in the short and long run.

The finish line does not significantly affect resistance to fracture of the lithium disilicate ceramic crowns.[33] Therefore, lithium disilicate ceramics can be used to fabricate thinner restorations than conventional metal ceramics, with no differences in resistance to fracture.

The effect of restorative material on marginal fit has not yet been confirmed, and it is still unclear whether choosing a CAD/CAM ceramic material, as the IPS e.max CAD used in the case described here, instead of conventional ceramics has any significant impact.[26] In contrast, Freire et al[34] compared monolithic zirconia restorations, lithium disilicate monolithic restorations (IPS e.max CAD) and metal ceramic crowns, and concluded that the marginal discrepancy of the lithium disilicate crowns was much greater than that of the other two groups at the several points of the margin where it was evaluated.

The present study is not the only one that suggests that the marginal adaptation of lithium disilicate restorations is much better than that of zirconia crowns[35]. The use of vertical preparation with later reconstruction with lithium disilicate ceramics has extraordinary esthetic and, according to the literature, functional results.

MATERIALS:

The evaluation of the mechanical and optical properties of lithium disilicate CAD/CAM ceramics (IPS e.max CAD) showed that it has the best discoloration properties, and that it is similar to other materials in terms of abrasion.[36] Another advantage of lithium disilicate is its good biocompatibility. This is the reason why it can be used in subgingival restorations, as the one in the case described here[36].

Restoration survival rates for single lithium disilicate crowns are 97.8% at 5 years and 96.7% at 10 years.[37] The results for single crowns, as the one in this clinical case, are 100% survival at 2 years,[38,39] both in experimental[40] and clinical[41] studies.

Moreover, after comparing lithium disilicate and metal ceramic crowns in the anterior and posterior teeth, survival rates in both areas were similar for both materials.[41] Therefore, lithium disilicate is an alternative to metal ceramics both in esthetic and posterior regions.[37,41]

In summary, these crowns have excellent mechanical and optical properties, are provided in many tooth shades and are fabricated using several techniques, which are unquestionably versatile qualities of prosthetic restorations. For these reasons, the material has been increasingly used in dentistry.

CONCLUSION

BOPT consists of tooth preparations with predictability confirmed by multiple studies in the last 20 years. This technique produces esthetic restorations with good response of surrounding soft tissues, which is fundamental, especially for restorations of anterior teeth, where esthetic demands are greater. Moreover, lithium disilicate restorations have a predictable resistance profile, documented in the literature, and may be bonded to the tooth, differently from metal ceramic or zirconia restorations.

However, further longitudinal clinical trials should be conducted to corroborate these results.

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