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# Prospective Clinical Study of Zirconia Full-coverage Restorations on Teeth Prepared With Biologically Oriented Preparation Technique on Gingival Health: Results After Two-year Follow-up

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### Clinical Relevance

Tooth preparation with the biologically oriented preparation technique prior to restoration by zirconia fixed prostheses is a safe treatment option that provides excellent clinical outcomes, with greater gingival thickness and gingival margin stability.


## SUMMARY

**Objectives: To evaluate the clinical behavior of one-piece complete-coverage crowns and fixed partial dentures (FPDs) on teeth with vertical preparation without finish line biologically oriented preparation technique (BOPT).**

**Methods and Materials: This prospective study included 52 patients requiring treatment with restorations in the esthetic region: 74 crowns and 27 FPDs. The sample included a total of 149 teeth that were prepared vertically without finish line. The sample was divided into two groups: one-piece crowns and FPDs, all with zirconia cores, feldspathic ceramic veneer, and a 0.5-mm prosthetic finish line of zirconia. All procedures were carried out at the University of Valencia from 2013 to 2014. The following parameters were evaluated over a two-year follow-up: oral hygiene, periodontal state, gingival thickening, gingival margin stability, the presence of complications, and restoration survival rate. Patient satisfaction**



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DOI: 10.2341/17-124-C

**with treatment was assessed by means of a visual analogue scale (VAS).**

**Results: Two years after treatment, 80.5% of treated teeth remained free of gingival inflammation and bleeding. Mean gingival thickening was 0.41 ± 0.28 mm for one-piece crowns and 0.38 ± 0.36 mm for FPDs. Gingival margin stability was 100%, but 2% of the sample presented biological complications. The VAS patient satisfaction scores were eight out of a maximum score of 10.**

**Conclusions: Two years after treatment, vertical preparation without finish line produces gingival thickening, margin stability, and optimal esthetics. Neither crowns nor FPDs presented any mechanical complications.**

## INTRODUCTION

Maintaining gingival tissue stability is one of the main challenges when restoring teeth with fixed prostheses in the esthetic region.[1,2] One of the most frequent complications when teeth are restored with tooth-supported fixed prostheses is gingival recession that occurs over time.[3] When the restorations are in the anterior region, this can compromise esthetics and lead to biological and functional problems.[4-7]

Gingival margin recession around tooth-supported fixed prostheses is largely associated with iatrogenic effects produced during dental preparation or caused by inadequate prosthetic fit, which can cause chronic inflammation leading to gingival margin recession around the restoration.[7,8]

Tooth preparation prior to placing fixed prostheses can be classified as three types (Figure 1): horizontal finish line such as rounded shoulder margin, knife-edge finishing line,[9,10] or without finish line, the latter described by Loi as biologically oriented preparation technique (BOPT).[5]

BOPT is a protocol in which the crown's anatomical emergence profile corresponding to the cemento-enamel junction (CEJ) is eliminated to create a new junction with the prosthesis at the moment it is placed.[5,11,12] The protocol for fabricating the interim prosthesis is of key importance as this determines the new emergence that will support the gingival margin and guide healing, reinsertion, and thickening of the gingival tissue; this will be reproduced when the definitive prosthesis is placed. The clinical experience of the authors who have published in the literature on the BOPT technique is that they appreciate an increase in the gingival thickness and better soft tissue stability in the restorations,[5,11,12] but there is no scientific evidence with prospective clinical studies in the literature.

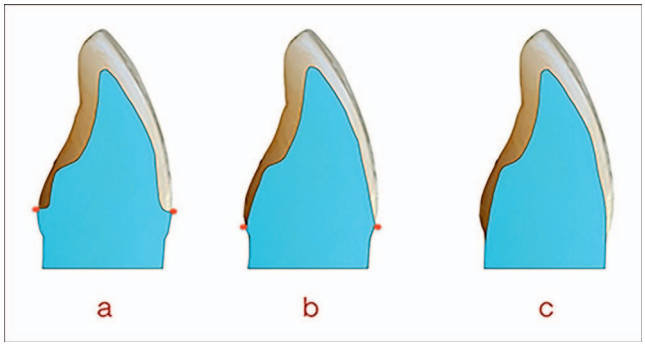


Figure 1. *(a): Rounded shoulder margin with horizontal stop for the final restoration marked with red points. (b): Knife-edge finish line with horizontal stop for the final restoration marked with red points. (c) BOPT preparation technique without horizontal stop.*

The aim of this study was to evaluate the clinical behavior of full-coverage restorations made with zirconia cores, feldspathic ceramic veneer, and a 0.5-mm prosthetic finish line of zirconia on teeth prepared without finish line over a two-year follow-up, registering probing depth, inflammation, gingival thickness and margin stability, any resulting complications, and the restoration survival rate.

## METHODS AND MATERIALS

Fifty-two patients were selected who were attending the Prosthetics Clinic at the Department of Dental Medicine, Faculty of Medicine and Dentistry, University of Valencia, Spain. The sample consisted of 22 men and 30 women between 18 and 65 years of age. All were treated between January 2013 and January 2014.

Inclusion criteria included patients older than 18 years, nonsmokers, in good or well-managed periodontal health, and with former treatment in the anterior sector (one-piece crowns or fixed partial dentures [FPDs]) requiring replacement because of differences between the gingival margin and the restorative margin that created an esthetic problem, discoloring, secondary caries, or some other complication (Figure 2).

The study protocol was approved by the University of Valencia Clinical Trial Committee (No. H1448361523684). Patients gave their informed consent in writing to take part.

The sample included a total of 149 teeth (incisors, canines, and premolars), divided into two groups according to the type of prosthetic rehabilitation to

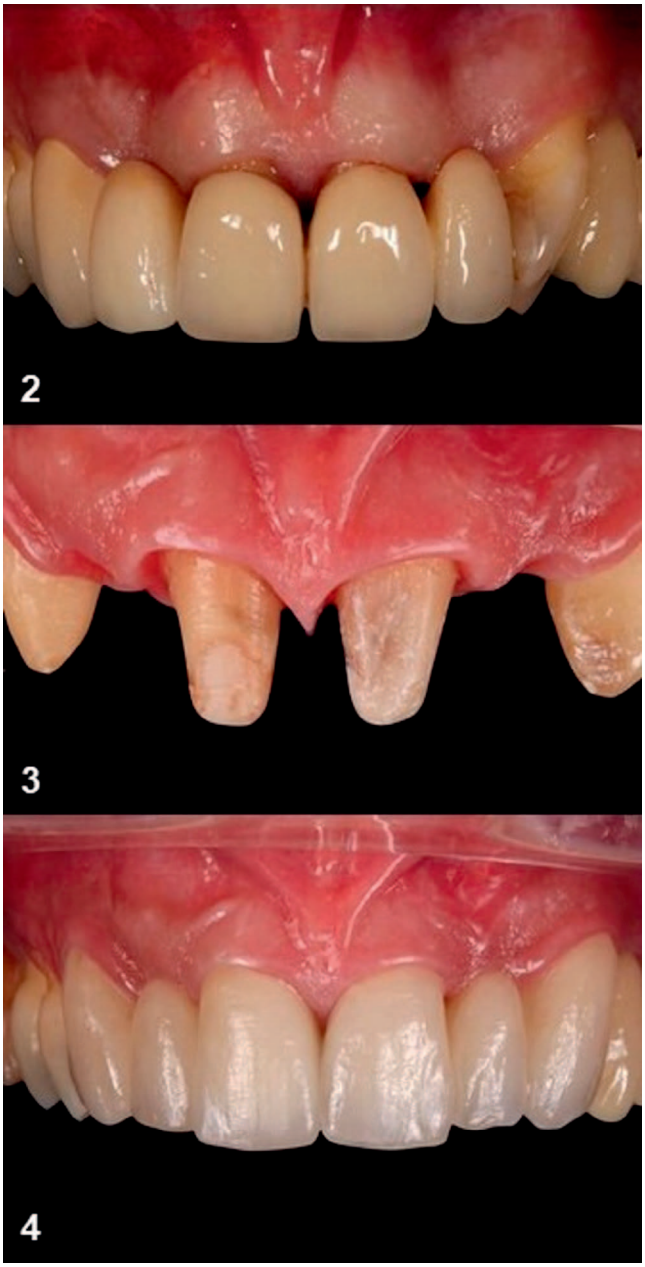


Figure 2. *Labial view of earlier treatment in anterior region with fixed prosthesis presenting recession of the gingival margin and recession.*

Figure 3. *Labial view of dental and soft-tissue preparation after eight weeks of maturation with the provisional prosthesis.*

Figure 4. *Definitive restorations with zirconia core after two years (labial view).*

be performed: one-piece crowns or FPDs (three-unit FPDs). To perform comparable analyses of FPDs and crowns, each tooth was analyzed individually (74 teeth supporting crowns and 75 teeth supporting FPDs).

In all cases, tooth preparation, the provisionalization phase, and laboratory procedures were carried out by a single clinician, following the simplified BOPT protocol described by Agustín and others.[12] Dental preparation eliminated the preexisting finish line (situated supragingival) using a turbine hand piece and 100-/200-μm cone diamond bur of 1.2-mm diameter (862.534.012, BOPT drills; Sweden & Martina, Due Carrare, Italy). The bur was inserted into the gingival sulcus at an angle of 10-15° to the tooth's axis[11]; in this way, the tooth and the gingival tissue underwent rotary curettage, producing bleeding in the gingival sulcus. Afterward, the provisional prosthesis was fabricated with self-polymerizing acrylic resin (Sintodent, Sintodent s.r.l, Rome, Italy) to create a new cementoenamel-prosthetic junction, situated in the gingival sulcus at a depth of 0.5 to 1 mm, with consideration of the biological width.[5,11,12]

Interim restorations were not removed until the soft tissues had completely matured—a period of 8 to 12 weeks (Figure 3). At this point, impressions were taken to fabricate the definitive prosthesis using the two-step impression technique, placing double gingival retraction cord to prevent gingival collapse.

Lastly, the definitive restorations were fitted, with zirconia core (Lava Frame Zirconia, 3M ESPE, Germany) and feldspathic ceramic veneer (Lava Ceram, 3M ESPE) fabricated using the stratification technique, covering up to 0.5 mm before the end of the restoration and a 0.5-mm prosthetic finish line of zirconia (Figure 4). All prostheses were cemented with temporary cement (Temp Bond Clear, Kerr Dental, Orange, CA, USA) during the first two months. After this time, we checked that everything was correct and the restorations were cemented with glass ionomer cement (Ketac Cem Radiopaque, 3M ESPE). It is advisable to use definitive radiopaque cements to check radiologically the correct removal.

### Clinical Patient Follow-up

A follow-up protocol was established, with the first checkup shortly after treatment (one week after definitive prosthesis cementation with glass ionomer cement), and at three months, six months, one year, and two years later.

The following parameters were registered at each follow-up visit: frequency of tooth brushing, probing depth (PD), gingival inflammation and bleeding, the presence of any complications, and marginal stability. Marginal stability was assessed using a millimeter-calibrated periodontal probe (PCPUNC156, Hu-Friedy, Des Plaines, IL, USA) to measure the distance (in millimeters) from the cementoenamel-prosthetic junction to the gingival margin.

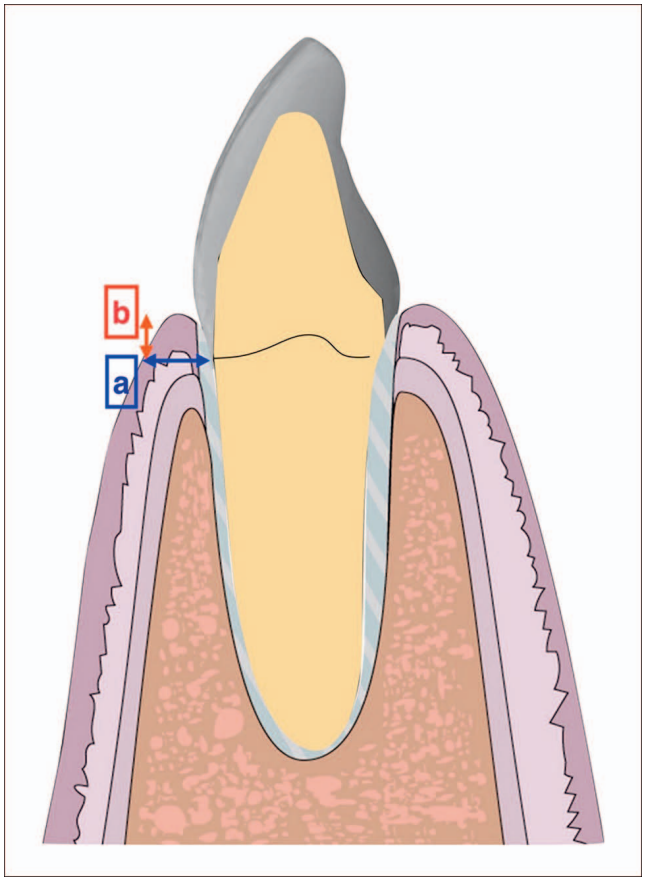


Figure 5. *(a): Measuring gingival thickness. (b): Vertical distance in relation to gingival margin for measuring vestibular gingival thickness.*

Gingival thickness was measured around each tooth at the first checkup (one week after treatment) and at the last checkup (two years after treatment). The measurements were taken under local anesthesia introducing a millimeter-calibrated periodontal probe (PCPUNC156, Hu-Friedy) horizontally 2 mm below the vestibular gingival margin. To standardize this measurement, a transparent guide was fabricated following an Essix splint-type design. Measurements were taken buccally at a 2-mm distance from the gingival margin (Figure 5) indicated in a little hole in the transparent guide and reproduced at the same exact point two years after treatment completion (final measurement). The exact gingival thickness in millimeters was estimated by introducing an endodontic rubber stopper in the periodontal probe and checking the measurements with an endodontic rule.

Finally, the degree of patient satisfaction was assessed at the last visit (two years after treatment) using a visual analogue scale (VAS).[13]

### Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 21.0 software. Parametric tests were applied with significance set at $p<0.05$. Fisher exact test was applied with a 95% confidence level. Student *t*-test was used to compare independent samples with a power of 0.85.

## RESULTS

Analyzing the data obtained during the two-year follow-up, 76.8% of patients presented very good oral hygiene maintenance, brushing two or three times a day, while the other 23.2% of patients brushed only once a day.

At the start of treatment, PD values were 3 mm or less in all samples; during the follow-up, only 4.1% of teeth restored with crowns and 5.6% of teeth supporting FPDs showed some variation. A total of 120 treated teeth (80.5%) remained without gingival inflammation or bleeding, while 29 (19.5%) did show inflammation and/or bleeding. The presence of adequate periodontal parameters (PD of 3 mm or less, absence of gingival inflammation and bleeding) was statistically significantly related to good oral hygiene maintenance.

For teeth supporting one-piece crowns, initial mean gingival thickness was 1.26 mm (SD ±0.48 mm), increasing to 1.67 ± 0.58 mm at the end of the two-year follow-up (Table 1). This represents a mean increase of 0.41 mm (SD±0.28 mm) with statistical significance ($p<0.001$, *t*).

For teeth supporting FPDs, initial mean gingival thickness was 1.14 ± 0.42 mm, increasing to 1.52 ± 0.43 mm (Table 1). This represents a mean increase of 0.38 ± 0.36 mm, also with statistical significance ($p<0.001$, *t*; Figure 6)

Gingival margin stability was 100% for all one-piece crowns and FPDs ($p=0.999$; Table 2); no mucogingival alterations were observed around any of the restorations.

The total number of complications registered represented 2% of the treated teeth. Two cases of pulpitis were found (1.3%), and there was a single case of root fracture of a tooth that had undergone endodontic treatment before the start of the trial, which necessitated extraction of the tooth (0.7%). No mechanical complications—cracks or fractures—were observed in any of the restorations. The total survival index of the restorations supported by teeth prepared with BOPT was 100%.

Table 1: *Changes in Gingival Thickness (in Millimeters) During the Clinical Follow-up Period*

| | Gingival Thickness | | |
|---|---|---|---|
| | Total | Tooth Supporting Crown | Tooth Supporting FPD |
| Initial thickness | | | |
| *n* | 149 | 74 | 75 |
| Mean | 1.20 | 1.26 | 1.14 |
| Standard deviation | 0.45 | 0.48 | 0.42 |
| Minimum | 0.50 | 0.50 | 0.50 |
| Maximum | 2.50 | 2.50 | 2.00 |
| Median | 1.00 | 1.00 | 1.00 |
| Final thickness | | | |
| *n* | 149 | 74 | 75 |
| Mean | 1.59 | 1.67 | 1.52 |
| Standard deviation | 0.51 | 0.58 | 0.43 |
| Minimum | 1.00 | 1.00 | 1.00 |
| Maximum | 3.00 | 3.00 | 2.50 |
| Median | 1.50 | 1.50 | 1.50 |

Lastly, the degree of patient satisfaction assessed by VAS showed a mean value of 8.3 ± 1.2 with statistical significance ($p<0.001$).

## DISCUSSION

Establishing a good relationship between dental restorations and the periodontum is crucial to the long-term clinical success of treatment and its esthetic harmony.[1,2] Gingival health and stability around fixed prostheses protects against recession of the gingival margin, which can expose the tooth-restoration finish line and so compromise esthetics.[3-6] Gingival recession is associated with several factors, including gingival biotype (quality and quantity of keratinized gingival tissue), iatrogenesis during the dental preparation phase, chronic inflammation, and inadequate prosthetic marginal fit.[7,8]

Several studies have indicated that subgingival restorations with a conventional finish line are associated with periodontal inflammation and possible gingival recession.[12-14] The present study obtained good gingival health outcomes in terms of PD, inflammation, and bleeding; the few cases that presented increased probing depth and signs of inflammation were associated with the patient's poor oral hygiene regime.

The clinical experience of BOPT reported in the literature[5,11,12] has found that the technique produces increases in gingival thickness and generates better soft-tissue stability in the medium and long term in comparison with other preparations with chamfered finish lines. A four-year prospective study by Peláez and others[15] studied the periodontal behavior of 20 FPDs made of zirconia core and feldspatic veneer, prepared with subgingival chamfer finish line. Of the teeth, 89.47% suffered gingival margin migration, whereby the finish line becomes juxta- or supragingival, and only 10.53% of the teeth maintained the initial subgingival margin.[15] These data show that there is a problem of gingival margin stability in teeth prepared with subgingival horizontal finish lines; however, in the present trial, 100% of teeth prepared with BOPT maintained their initial margin position and produced gingival thickening (mean thickening of 0.41 mm for crowns and 0.38 mm for FPDs) during the two-year follow-up.

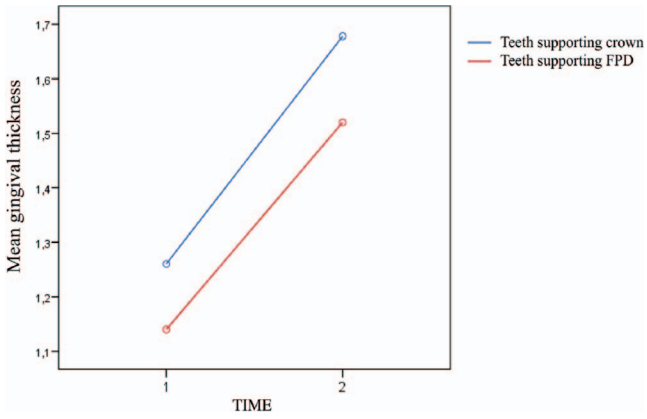


Figure 6. *Gingival thickening during follow-up period.*

In the BOPT technique, the four-week waiting period in the provisional phase is an initial disadvantage that is then compensated by an optimal gingival stability, a correct adaptation of the tissue to the new ovoid morphologies, and a thickening of the gingival tissue according to the results obtained in this study, but it is necessary to take into account that, because there are no long-term clinical studies on this technique, it has not been possible to compare our results with literature following the same procedure.

Regarding the restoration material and its survival, some studies have shown that contemporary ceramic materials such as zirconia offer sufficient resistance to fracture to allow this type of vertical preparation of the tooth stump without a horizontal finish line in the anterior region.[12] Reich and others[16] obtained higher strength with zirconium oxide crowns with a 0.5-mm knife-edge finish line in comparison with crowns with a chamfer finish line. These results concur with the present study in which the restoration survival rate was 100%.

Table 2: *Total Gingival Margin Stability According to Group (Crowns and Fixed Partial Dentures)*

| Gingival Margin Stability | Total | | Crowns | | FPDs | |
|---|---|---|---|---|---|---|
| | *N* | % | *n* | % | *n* | % |
| Total | 149 | 100.0% | 74 | 100.0% | 75 | 100.0% |
| 0 | 149 | 100.0% | 74 | 100.0% | 75 | 100.0% |

## CONCLUSIONS

Teeth prepared with BOPT and restored with zirconia crowns or FPDs presented a 100% survival rate. According to the present results, the technique generates gingival thickening (a mean thickening of 0.41 mm for crowns and 0.38 mm for FPDs), as well as gingival margin stability in 100% of samples. The technique provides high periodontal tissue and gingival margin stability, provided the patient maintains adequate oral hygiene. More longitudinal prospective clinical studies are needed to confirm the present findings in the longer term.

### Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Ethics Committee for Human Research of the Commission for Ethics in Experimental Research of the University of Valencia. The approval code for this study is 30-11-2015.

### Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

*(Accepted 13 September 2017)*

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