J Oral Res
research in oral sciences

ORIGINAL ARTICLE

IN VITRO COMPARISON OF MARGINAL INFILTRATION BETWEEN A CONVENTIONAL RESIN AND A BULK-FILL RESIN, IN THE RELOCATION OF CERVICAL MARGINS TECHNIQUE

Comparación *in vitro* de la infiltración marginal entre una resina convencional y una resina bulk-fill, en la técnica de reubicación de márgenes cervicales

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ABSTRACT

Introduction: Proximal lesions that exceed the cement enamel limit (ACE) under the gingival margin complicate impressions and the adhesive technique. Compare the magnitude of micro infiltration between conventional resin and bulk fill resin in the cervical margin relocation technique.

Materials and Methods: 48 samples of human teeth received two preparations: occluso-mesial (OM) and occluso-distal (OD) under LAC; first they received the cervical margin relocation technique (RMC) with bulk fill and conventional resin; then restored with semi-direct resinous inlays. Sample analysis: immersion in 50% colloidal silver nitrate solution, 24 hours, 37°C and cut mesiodistally. Observed under a stereoscopic magnifying glass to assess dye penetration and digitally photographed, analyzed with "Image J" software.

Results: Sample of 96 cavities in two groups of 48 units; control group restored with conventional resin with incremental technique and study group restored with bulk fill resin, mono-incremental technique. Probabilistic sampling. No statistically significant differences in percentage of microinfiltrated area between Filtek™ Z250™ and Filtek™ Bulk Fill™ (p-value= 0.68).

Discussion: Various studies show that the presence of marginal microinfiltration exist independent of restorative technique, consistency, adhesive mechanism and polymerization technique. The research carried out is no exception, observing a similar degree for both systems.

Conclusions: Results allow us to conclude that conventional resin and bulk fill resin did not show significant differences in microleakage percentages for the RMC technique. Outside the study framework, bulk fill resins would have comparative advantages; better behavior against light in depths greater than 2 mm, less sensitivity to the "C" factor, and less clinical time.

Keywords: *Proximal box elevation; Microleakage; Dental materials; Composite resin; Bulk-fill; In vitro.*

RESUMEN

Introducción: Las lesiones proximales que superan el límite cemento esmalte (ACE) por debajo del margen gingival complican las impresiones y la técnica adhesiva. Comparar la magnitud de la microinfiltración entre la resina convencional y la resina de relleno en la técnica de reubicación del margen cervical.

Materiales y Métodos: 48 muestras de dientes humanos recibieron dos preparaciones: ocluso-mesial (OM) y ocluso-distal (OD) bajo LAC, primero recibieron la técnica de reubicación del margen cervical (RMC) con relleno en bloque y resina convencional; luego restaurado con incrustaciones resinosas semidirectas. Análisis de la muestra: inmersión en solución de nitrato de plata coloidal al 50%, 24 horas, 37°C y corte mesiodistal. Observado bajo una lupa estereoscópica para evaluar la penetración del tinte y fotografiado digitalmente, analizado con el software "Image J".

Resultados: Muestra de 96 cavidades en dos grupos de 48 unidades; grupo control restaurado con resina convencional con técnica incremental y grupo estudio restaurado con resina bulk fill, técnica mono-incremental. Muestreo probabilístico. No hubo diferencias estadísticamente significativas en el porcentaje de área microinfiltrada entre Filtek™ Z250™ y Filtek™ Bulk Fill™ (p-value = 0,68)

Discusión: Diversos estudios evidencian presencia de microinfiltración marginal, independiente de técnica restauradora, consistencia, mecanismo adhesivo y técnica polimerizadora. La investigación realizada no es excepción, observándose grado similar para ambos sistemas.

Conclusiones: Los resultados permiten concluir que resina convencional y resina bulk fill no presentaron diferencias significativas en porcentajes de microinfiltración para técnica RMC. Fuera del marco del estudio, resinas bulk fill tendrían ventajas comparativas; mejor comportamiento frente a la luz en profundidades superiores a 2 mm, menor sensibilidad al factor "C", y menor tiempo clínico.

Palabras Clave: *Elevación de márgenes proximales; Microinfiltración; Materiales dentales; Resinas compuestas en bloque; Bulk fill; In vitro.*

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CITE AS: **Lorca D, Tiffi C, Sarmiento R & Sarmiento J.** *In vitro* comparison of marginal infiltration between a conventional resin and a bulk-fill resin, in the relocation of cervical margins technique. **J Oral Res. 2023; 13(1): 1-11.** doi:10.17126/joralres.2023.001

Received: March 23, 2022
Accepted: November 10, 2022
Published online: May 03, 2023

ISSN Print 0719-2460
ISSN Online 0719-2479.

INTRODUCTION

Nowadays, due to the use of minimally invasive techniques with adhesive systems, we frequently find ourselves with problematic clinical situations, where lesions in proximal areas exceed the cementoenamel limit (LAC) at the cervical level, remaining below the gingival margin, making impression-taking more complex and worsening the performance of a good adhesive technique due to the environmental conditions.[2]

It is known that subgingival cavities can present contamination during adhesion procedures, causing restoration failure[2] as well as making it difficult to detect excess material and bad adjustments in adaptation that allow marginal infiltration (microleakage) or negative effects on marginal sealing.

Marginal infiltration is questioned today as an accurate technique to determine the effectiveness of marginal sealing, given the possibility of errors during sample processing. Although there are currently more accurate and precise methodologies, their availability and cost limit the possibility of conducting marginal sealing studies. However, medium and long-term evidence allows us to establish that *in vitro* infiltrating staining studies allow us to determine absolutely and, if we can control the undesired effects of sample pro-cessing, in percentage terms, the effect of a technique or biomaterial on immediate and late adaptation or sealing when samples are processed with or without accelerated aging techniques in the laboratory.

The "Cervical Margin Relocation" (CMR) technique offers the possibility of staggered relocation of deep proximal cavities to create more favorable preparation margins for direct or indirect restorations, by allowing dentin sealing, avoiding bacterial contamination due to poor peripheral sealing and moving the final restoration area away from a unfavorable sector and under surgical control.[1-3]

The most widely used restorative material is conventional direct composite resin, which requires the use of an incremental reconstruction technique used to improve the handling of the inherent shrinkage stress of the material. However, it entails adding more operative steps, which ultimately translates into complicating clinical execution, and spending more clinical time on the restoration process, increasing the chances of operator error. Faced with this problem and recognizing that currently the clinician seeks to reduce clinical work time, achieving satisfactory results, a new concept has emerged in composite resins for the posterior sector, called block resins or "bulk", which allow the restoration of cavities with increased thicknesses. up to 4 mm, breaking with traditional layering protocols, in a shorter time than usual.[4]

In the literature, it is possible to find characteristics, advantages, disadvantages, indications, and information on the clinical performance of conventional resins and bulk fill resins.[5] However, insufficient evidence was found to indicate whether there is a difference in difference between these two types of resins. Behavior in terms of marginal microinfiltration when used in cavities below the amelodentinal limit of cervical proximal areas, finding a gap to fill. Therefore, the

ISSN Print 0719-2460 - ISSN Online 0719-2479.

objective of this study is to verify the existence of differences between the percentage of microleakage of Bulk Fill composite resin restorations (Filtek™ Bulk Fill™, 3M/ESPE), compared with conventional composite resin restorations (Filtek™ Z250™ 3M/ESPE), in the proximal floor lift technique. The experimental hypothesis tested was the magnitude of microleakage of bulk-fill composite resin restorations (Filtek™ Bulk Fill™, 3M/ESPE®), compared with conventional composite resin restorations (Filtek™ Z250™ 3M/ESPE®). There are no differences in the proximal floor lift technique.

The present work was carried out within the framework of the process of graduate seminars to obtain the professional title at the University of Valparaíso, for which it has the approval of the research committee of the Faculty of Dentistry and the authorization of the biosafety committee. and central bioethics of the University of Valparaíso that do not make individual decisions.

MATERIALS AND METHODS

Experimental *in vitro* study

This was obtained through probabilistic sampling. Forty-eight healthy human third molars were used, which had an indication for surgical or orthodontic extraction. The samples were obtained in Maxillofacial Surgery services in the Valparaíso region. The people who agreed to donate dental pieces for this study previously signed an informed consent.

The considered potentials were intact and unprocessed third molars, which were maintained under storage conditions in isotonic saline in new glass containers that were washed in an ultrasonic tub with a neutral detergent for 30 minutes and then rinsed in ultrasound for 30 minutes. minutes with distilled water prior to use. The storage temperature of the molars was a constant 5°C in a refrigerator for industrial use with temperature controlled by thermostat and connected to a safe network with a supplementary unit of electrical energy until they were occupied for a maximum period of 3 months. Third molars with crown or root fractures produced in the extraction procedure and with unfavorably irregular anatomy for the study were excluded from the sample.

Sample preparation

The procedure was carried out in the laboratory of the Faculty of Dentistry, Universidad de Valparaíso, Valparaíso, Chile.

Each molar was disinfected with 5% thymol, followed by prophylaxis of the crown (with a suspension of fine pumice stone in water, applied with a hard cup brush), and of the root zone (with ultrasound and standardized Gracey type curettes for the removal of residual periodontal ligament), they were subsequently stored in 0.9% sodium chloride in a properly labeled, hermetic container and refrigerated at 4°C to maintain their hydra-tion until used in the experimental stage. Each molar was apically sealed with cyanoacrylate and subsequently individually mounted on a stone plaster base.

In order to have the most skilled operator doing the execution of the restorative stages of the samples, a selection process was previously carried out among three sixth-year students of the Faculty of Dentistry after comparing them with a "gold standard" that corresponded to a teacher with at least 10 years of clinical experience in the management of the restorative technique, from the same School of Dentistry.

Restoration of the Samples

Two cavities were made in each of the selected third molars, one occlusal-mesial (OM) and the other occlusal-distal (OD) in all the selected sample units, for this a 0.25-thread truncated-conical diamond stone was used. high speed, water cooled. The cavity made had the characteristics of an ideal cavity, in which the cervical floor was located 2 mm below the cementoenamel line (LAC), with a depth of 4 mm in the vestibulopalatal/lingual direction and 1.5 mm in the mesio-distal direction. Standardization of preparation measurements was verified using a new North Carolina™ periodontal probe and 10X stereo loupe by a single evaluator in a single session under standardized 5000K light conditions.

Each OM and OD cavity, of each sample, was filled according to a restorative protocol, and with the manufacturer's instructions (Table 1), by the previously selected operator, who used conventional composite resin (Filtek™ Z250 3M ESPE) for a cavity, using incremental technique, and for the other cavity Bulk Fill composite resin (Filtek™ Bulk Fill, 3M ESPE) using mono-incremental technique.

Table 1. PRISMA flowchart adapted from the bibliographic systematic review process carried out and its results.

Sample	Protocol
Orthophosphoric Acid 37% Scotchbond™ Universal Etchant™ 3M ESPE / Saint Paul, Minnesota, EE.UU.	Apply 20 seconds to enamel and 15 seconds to dentin. Rinse for 20 seconds. Remove excess water by applying a gentle stream of air, leaving the tooth moist.
Single Bond™ Universal™ Adhesive 3M ESPE / Saint Paul, Minnesota, EE.UU.	Using an adhesive saturated tip for each layer, apply 2 consecutive layers of adhesive to the etched enamel and dentin surfaces, rubbing for 20 seconds. Dry with a gentle stream of air for 2 to 5 seconds; Light cure for 10 seconds.
Filtek™ Z250™ Composite Resin 3M ESPE Saint Paul, Minnesota, EE.UU.	Apply the material in increments less than 2.5mm of thickness; light cure each layer for 20 seconds
Filtek™ Bulk fill™ Composite Resin 3M ESPE Saint Paul, Minnesota, EE.UU.	Apply the material in increments up to 5 mm of thickness; Light cure 10 seconds occlusally, 10 seconds vestibular and 10 seconds lingual.

ISSN Print 0719-2460 - ISSN Online 0719-2479.

A selected operator restored all the cavities, defined the side of the molar, corresponding to each material with a green dot for bulk fill and a red dot for conventional Resin. To finish the restorations, semidirect inlays were used on the CMR in each molar, with Filtek™ Z350™ A2 Body composite resin, and cemented with Relyx™ U200™ (3M ESPE).

Immersion in Silver Nitrate solution

The samples were immersed in a 50% colloidal silver nitrate solution for 24 hours at 37°C in complete darkness, stored in an amber glass container covered with aluminum foil. After this period, they were washed with distilled water for one minute and submerged in X-ray developer solution (Kodak GBX™, Eastman Kodak Company™, New York, USA) for 8 hours and exposed to fluorescent light. The stained samples were again fixed to a sample holder to be sectioned mesio-distally in relation to the long axis of the tooth using a diamond blade with a low-speed Isomet™ cutter (Isomet 1000™, Buehler™, Lake Bluff Illinois, USA).

Sample analysis

To determine the sample size, initial data obtained from the Domínguez 2014 study were used for the calculation.

$$n = \frac{2\,(Z\alpha + Z\beta)2 \times S2}{d2}$$

Where:

Zα= 1,645 - Zα= 0.842 - S2 = 1.17 - d2 = 0.3025 - n = 48

*Considering 20% for tooth loss which is 48 (1/1-020) = 60

Applying the hypothesis contrast formula (Formula 1) for two means, with a significance level of 95% and a power of 80 %, a result of n = 48 teeth is obtained for each experimental group.

Initially, 60 human third molars (defined according to inclusion criteria) were collected. Of which 9 were used to carry out an exercise to select the operator of the restorative technique. Three molars were removed after the cut was made since the anatomy presented in the area to be studied did not meet the necessary mar-gins for further analysis.

Immediately after making the cut, they were removed from the sample holder, and the dental area exposed in the samples were completely covered by transparent self-curing acrylic, to help fix the excess dye.

The research group chose an operator (randomly assigned from among the professors of the Department of Dental Surgery) who was unaware with which resins the restorative stage of the CMR technique had been performed, for each of the cavities of the third molars. he could only group them by red or green color (single-blind technique).

This operator analyzed stain penetration under a stereoscopic loupe at 40X magnification and a translucent millimeter grid to establish measurements at 40X. A digital photograph was taken for each restoration as a record for analysis through a color analysis program. images ("Image J"). Subsequently, each of the photographs of the sample unit observed in the stereoscopic magnifying glass was analyzed, obtaining the percentage of infiltrated area. The data collected for each

sample were recorded in Excel™ format for further analysis.

Statistical analysis

The data collected was tabulated in the Microsoft™ Excel™ 2010 program, obtaining a database, which was later transferred to the Stata 13 program. Descriptive statistics was applied for data analysis. Values of measures of central tendency and dispersion were calculated through descriptive statistical analysis. The statistical tests used were Shapiro Wilks and Mann Whitney.

Figure 1. Diagram of a cavity preparation.

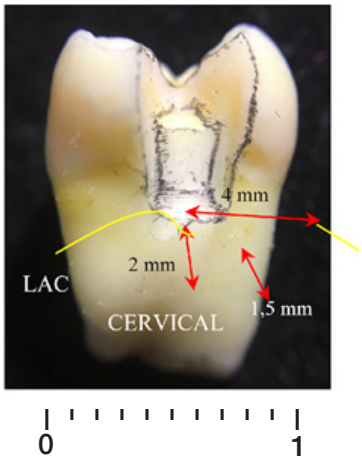
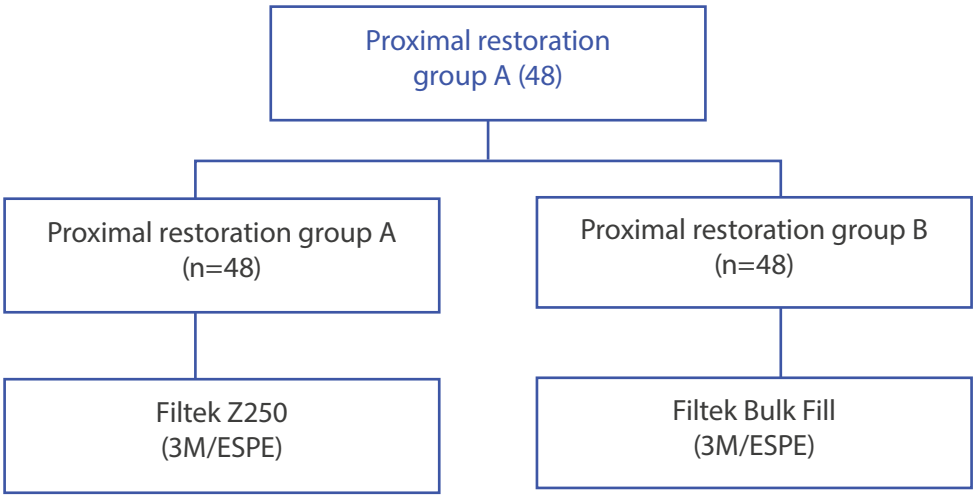


Figure 2. Distribution of the two experimental groups for each resin.



RESULTS

The sample studied included 48 teeth and 96 cavities in two groups according to the material used, identifying one: Group A (control): 48 cavities restored with conventional composite resin (Filtek™ Z250 3M ESPE), using the incremental technique, and; Group B: 48 cavities restored with Bulk Fill composite resin (Filtek™ Bulk Fill, 3M ESPE) using mono-incremental technique. A probabilistic sampling was used (Figure 2).

The study was carried out between the months of March and September (with a duration of 6 months of development, and the microinfiltration measurements will be made at a single moment for all the samples). According to the temporality it is a cross-sectional study.

ISSN Print 0719-2460 - ISSN Online 0719-2479.

There are no statistically significant differences (p = 0.6848) with respect to the percentage of microleakage area between Bulk Fill and conventional composite resins, using the restorative technique of cavities below the cementoenamel limit of proximal cervical areas. It was observed that the average for Bulk Fill resins is 28.6% with a standard deviation of 32.8% and, for conventional resins, 33.1% with a standard deviation of 35.2%. The median for Bulk Fill resins was 14.1%, while for conventional resins it was 24.9%.

Table 2 shows the means and standard deviations of the percentage of microleakage found in the experimental groups of conventional resin and bulk fill, respectively.

In addition, both resins infiltrated more frequently in the range of 0% - 25%. In the range of 76% - 100%, the Filtek™ Z250 resin micro-infiltrated in 8.33% and the Filtek™ Bulk Fill resin less frequently in 5.21% of the total sample. (Table 3)

Table 2. PRISMA flowchart adapted from the bibliographic systematic review process carried out and its results.

Resin	Mean	SD	Median	p75	CV	*p*-value
Bulk Fill	0,286	0.328	0.141	0.521	1.146	0.00049
Conventional	0.331	0.352	0.249	0.629	1.066	0.02622
Total	0.308	0.339	0.191	0.542	1.100	

SD: Standard deviation. CV: coefficient of variation. p75: 75TH percentile.

Table 3. Percentage of microleakage found in the experimental groups according to the resins used.

	Filtek Bulk Fill (%)	Filtek™ Z250 (%)	Total (%)
0 – 25	29.17	25	54.17
25 – 50	7.29	11.46	18.75
51 – 75	8.33	5.21	13.54

SD: Standard deviation. CV: coefficient of variation.

DISCUSSION

For the framework and experimental conditions of the present study, there is no statistically significant difference in terms of the magnitude of microleakage in restorations below the LAC, between both resin systems used in the work.

An ideal sample size was obtained for the study and each stage of this research was carried out by a duly calibrated operator and with standardized protocols. Microleakage is generally evaluated by a numerical score of stain penetration at the tooth-restoration interface on a visual scale with values from 0 to 3, which can be influenced by the operator, being associated with poor inter-examiner reliability 58 To avoid this problem, in this study, microleakage was evaluated objectively, using area percentage, which was calculated with the help of image analysis software ("Image J"), where the area of the resin interface dentin was measured in millimeters, the software calculated the amount of infiltrated tissue, and then the percentage of microinfiltration areas was calculated.

In a previous study, microleakage in cementum and dentin was compared for three composite resin systems in class II cavities, where the percentage of microleakage between them also had similar results. Other researchers analyzed marginal microleakage under scanning electron microscopy, in a study that compared three composite resins, with their adhesive systems, also obtaining the presence of microleakage.[6]

Some studies[7-8] show the presence of marginal microleakage, regardless of the restorative technique, the consistency of the composite resins, the adhesion mechanism selected, and the poly-merization technique used. The present investigation is not the exception, since a similar degree of marginal microleakage was observed for both composite resin systems used, both the conventional resin and the Bulk Fill resin.

Taking into account other studies that used a similar research technique, obtaining similar results,[9] it can be inferred that one or the other of the resins studied could be used interchangeably for the cervical-proximal floor lift technique, but because the Bulk Fill resins have qualities such as less clinical time used and execution of the less complex technique, the latter could be more advantageous for the clinician and the patient, since it would grant more clinical time to perform other dental procedures, as well as it could allow a greater number of patients to be attended promoting access to dental care for the population.

Currently, valid knowledge of the CMR technique is based on *in vitro* studies; A study carried out in 2019 showed that microleakage was significantly lower in the gingival margins located in the enamel compared to the dentin margins and that there were no statistically significant differences between the resins used.[10]

However, there is research that indicates that the use of flowable composite resins seems to be a valid treatment option, representing a new alternative to improve marginal adap-

ISSN Print 0719-2460 - ISSN Online 0719-2479.

tation and microleakage of restorations in the technique of this study,[11] so it would be interesting to consider this type of resins in new investigations. Further studies are needed to evaluate the marginal adaptation of these resins in the proximal cervical floor lift technique, as well as the degree of polymerization they achieve.

The microfiltered area percentage p-values of both resins used for the proximal cervical floor lift technique in this study did not have a statistically significant difference, so there are no preferences in the use of either of these two resins for the technique. Mentioned above, in restorations for human molars with cavitations below the cemento-cemental-cervico limit, it should be noted that microleakage is a phenomenon typical of the technique in resins, however it can be reduced by knowing and properly managing its causal factors.[7]

CONCLUSION

For the CMR technique, the use of a material such as conventional resin or bulk fill, (Filtek™ Bulk Fill™ and Filtek™ Z250™) does not seem to make a difference in terms of the magnitude of microleakage in the cervicoproximal area, when the cervical floor exceeds the cervico-proximal margin. Additionally, by virtue of the evidence reviewed and outside the framework of this study, due to the qualities of bulk fill resins such as better behavior against light at depth, less sensitivity to factor "C", and shorter clinical time, its use is highly recommended. More studies related to these issues are required.

Within the framework of this *in vitro* study, both materials are suitable for use with the CMR technique in cavities under LAC.

CONFLICT OF INTERESTS

The authors declare that they have no con-flicts of interest.

ETHICS APPROVAL

Study protocol approved by the research committee of the Faculty of Dentistry, Universidad de Valparaíso.

FUNDING

Self-financed project.

AUTHORS' CONTRIBUTIONS

Lorca D: Investigation, methodology.

Tiffi C: Investigation and project administration.

Sarmiento R: Writing – original draft; review and editing.

Sarmiento J: writing, original draft, writing - review and editing.

ACKNOWLEDGEMENTS

To our families, friends and colleagues.

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PUBLISHER'S NOTE

All statements expressed in this article are those of the authors alone and do not necessarily represent those of the publisher, editors, and reviewers.

PEER REVIEW

This manuscript was evaluated by the editors of the journal and reviewed by at least two peers in a double-blind process.

PLAGIARISM SOFTWARE

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ISSN Print 0719-2460 - ISSN Online 0719-2479.
https://www.joralres.com/index.php/JOralRes/issue/archive

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