UNIVERSIDADE FEDERAL DE SANTA MARIA
CENTRO DE CIÊNCIAS DA SAÚDE
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS ODONTOLÓGICAS

Danielle Zorzo Righes

FENDAS EM CLASSE V DE RESINAS BULK FILL: UMA AVALIAÇÃO EM MICROSCOPIA ELETRÔNICA DE VARREDURA

Santa Maria, RS
2019

Danielle Zorzo Righes

FENDAS EM CLASSE V DE RESINAS BULK FILL: UMA AVALIAÇÃO EM MICROSCOPIA ELETRÔNICA DE VARREDURA

Dissertação apresentada ao Curso de Mestrado do Programa de Pós-Graduação em Ciências Odontológicas, Área de Concentração em Odontologia, ênfase em Dentística, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do grau de **Mestre em Ciências Odontológicas**.

Orientador: Prof. Dr. Alexandre Henrique Susin

Santa Maria, RS
2019

Righes, Danielle Zorzo
FENDAS EM CLASSE V DE RESINAS BULK FILL: UMA AVALIAÇÃO EM MICROSCOPIA ELETRÔNICA DE VARREDURA / Danielle Zorzo Righes.- 2019.
38 p.; 30 cm

Orientador: Alexandre Henrique Susin
Dissertação (mestrado) - Universidade Federal de Santa Maria, Centro de Ciências da Saúde, Programa de Pós Graduação em Ciências Odontológicas, RS, 2019

1. Odontologia 2. Biomateriais 3. Dentística 4. Fendas 5. Microscopia eletrônica de varredura I. Susin, Alexandre Henrique II. Título.

Sistema de geração automática de ficha catalográfica da UFSM. Dados fornecidos pelo autor(a). Sob supervisão da Direção da Divisão de Processos Técnicos da Biblioteca Central. Bibliotecária responsável Paula Schoenfeldt Patta CRB 10/1728.

Danielle Zorzo Righes

FENDAS EM CLASSE V DE RESINAS BULK FILL: UMA AVALIAÇÃO EM MICROSCOPIA ELETRÔNICA DE VARREDURA

Dissertação apresentada ao Curso de Mestrado do Programa de Pós-Graduação em Ciências Odontológicas, Área de Concentração em Odontologia, ênfase em Dentística, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do grau de **Mestre em Ciências Odontológicas**.

Aprovado em 4 de julho de 2019:

____
Alexandre Henrique Susin;Dr. (UFSM)
(Presidente/Orientador)

____
Marciano de Freitas Borges;Dr. (UFN)

____
Luana Severo Alves; Drª. (UFSM)

Santa Maria, RS
2019

AGRADECIMENTOS

A concretização deste trabalho ocorreu, principalmente, pelo auxílio, compreensão e dedicação de várias pessoas. Agradeço a todos que, de alguma forma, contribuíram para a conclusão deste estudo e, de uma maneira especial, agradeço:

À Deus, em primeiro lugar, pela minha saúde e por me permitir ir atrás dos meus sonhos, sempre com fé e rodeada de pessoas especiais e do bem.

Ao meu orientador, Prof. Alexandre Henrique Susin, por toda dedicação nesses últimos anos, desde o TCC, onde comecei a ter contato com o mundo da pesquisa. A cada desafio lançado por ti, era uma oportunidade de crescimento. Obrigada por todo ensinamento e pela confiança dada a mim.

À Universidade Federal de Santa Maria e ao Programa de Pós-Graduação em Ciências Odontológicas, pela oportunidade de me aprimorar intelectualmente e por todo o aprendizado adquirido durante os cursos de Graduação e Mestrado nesta instituição.

À CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), pela concessão de bolsa de estudos que viabilizou a execução desta dissertação.

À banca examinadora, prof. Dr. Marciano e profa. Dra. Luana, por ter aceitado participar da banca examinadora da minha defesa de Dissertação de Mestrado. Vocês são pessoas que estimo muito e com certeza fizeram desse dia mais especial. Todo meu respeito e admiração a vocês.

À minha família, em especial meus pais, pelo apoio e amor incondicional. Quando tudo parecia muito distante e difícil de conquistar, vocês estavam ao meu lado dizendo que daria tudo certo. Vocês impulsionam os meus sonhos e me dão todo o suporte necessário para eu vencer os desafios. Amo vocês.

Às minhas amigas, que mesmo de longe, estiveram sempre presentes. Obrigada pelo apoio, pelos momentos de descontração e por sempre torcerem por mim.

Às amigas Gabriela, Bruna S, Bruna G e Bibiana, as gurias da Dentística, pela amizade, companheirismo, momentos de desabafo e convívio diário. Além de colegas de profissão, nos tornamos grandes amigas.

Aos colegas e amigos que conheci através desta Universidade, ter vocês ao meu lado fez da caminhada mais leve e mais divertida. Desejo sucesso a todos vocês.

RESUMO

FENDAS EM CLASSE V DE RESINAS BULK FILL: UMA AVALIAÇÃO EM MICROSCOPIA ELETRÔNICA DE VARREDURA

AUTORA: Danielle Zorzo Righes
ORIENTADOR: Alexandre Henrique Susin

O objetivo deste estudo *in vitro* foi avaliar, através da microscopia eletrônica de varredura (MEV), a formação de fendas devido ao estresse de contração de uma resina convencional (Filtek Z350XT [3M ESPE]) e duas resinas compostas Bulk-fill (Filtek Bulk Fill [3M ESPE] e Opus Bulk Fill [FGM]) ao longo das margens de restaurações de classe V. Em cada um dos 36 dentes molares humanos hígidos extraídos, cavidades classe V foram preparadas nas faces vestibular e lingual/palatal, as quais foram divididas em seis grupos (n=6), de acordo com a técnica restauradora: incremental e inserção única. Após a restauração, cada molar foi cortado ao meio na direção vestíbulo-lingual entre as duas restaurações, resultando em dois espécimes por molar. Os espécimes foram avaliados em MEV e os dados foram submetidos à análise de variância de um fator e teste de Tukey, com significância de 5%. As fendas foram mensuradas em três pontos diferentes de todas as paredes das restaurações com ampliação de 250x para determinar a média de cada parede. Todas as resinas compostas testadas individualmente nas técnicas incremental e inserção única não apresentaram diferença estatística, entretanto, a resina composta Filtek Bulk Fill quando utilizada na técnica de inserção única obteve melhor resultado quando comparado à resina composta Z350 XT na técnica incremental. Todos os grupos apresentaram predomínio de fendas na parede gengival, sendo a região mais crítica.

Palavras-chave: estresse de polimerização, fenda, microscopia eletrônica de varredura (MEV), resina composta Bulk-fill.

ABSTRACT

GAP FORMATION IN CLASS V OF BULK-FILL RESINS: A SEM EVALUATION

AUTHOR: Danielle Zorzo Righes
ADVISOR: Alexandre Henrique Susin

The aim of this *in vitro* study was to evaluate under scanning electron microscopy (SEM), the gap formation due to the shrinkage stress of a conventional resin (Filtek Z350XT [3M ESPE]) and two types of bulk-fill resins (Filtek Bulk Fill [3M ESPE] and Opus Bulk Fill [FGM]) along the margins of class V restorations. On each of the 36 extracted human non-carious molar teeth, class V cavities were prepared on the medium third of buccal and lingual surfaces, which were divided into six groups (n = 6), according to the restorative technique: incremental and unique insertion technique. After restoration, each molar was cut in half in the buco-lingual direction between the two restorations, resulting in two specimens per molar. The specimens were evaluated in SEM and the data were submitted to one-way ANOVA and Tukey test, at a significance level of 5%. The gaps were measured at three different points from the all walls to the restoration with 250x magnification to determine the mean of each wall. All the composites resins (Filtek Z350 XT, Filtek Bulk Fill and Opus Bulk Fill) tested individually in the unique and incremental insertion techniques did not present statistical difference, however, Filtek Bulk Fill composite when used in the technique recommended (unique insertion) shows better result compared to Z350 XT in the incremental insertion technique. All the groups had a predominance of gingival wall gaps being the most critical region.

Keywords: bulk-fill composite, gap formation, scanning electron microscopy (SEM), shrinkage stress.

SUMÁRIO

1 INTRODUÇÃO

A odontologia adesiva tem ocupado espaço importante não apenas nas restaurações estéticas como na reabilitação direta e indireta de dentes posteriores, antes tradicionalmente realizados com amálgama de prata ou coroas metálicas ou metalo-cerâmicas. As resinas compostas são amplamente utilizadas tanto em restaurações anteriores como posteriores, devido à suas propriedades estéticas, mecânicas e adesão (FULOLIN; PFEIFER, 2017).

Para o melhor desempenho das resinas compostas, é necessária uma adequada conversão de seus monômeros em polímeros, processo esse conhecido por reação de polimerização, no qual acompanha uma redução volumétrica do material, conhecida como contração de polimerização (BRAGA; BALLESTER; FERRACANE, 2005; SOARES et al., 2017). A contração de polimerização leva a um estresse na interface dente-restauração, podendo causar danos à linha adesiva, representados por infiltração marginal, descoloração, lesões de cárie secundária, dor pós-operatória, deflexão de cúspide e formação de fendas (FERRACANE; HILTON, 2016; ROSATTO et al., 2015).

Para minimizar as consequências causadas pela contração de polimerização, a técnica incremental vem sendo preconizada há anos. Contudo, uma nova classe de resinas compostas, denominadas resinas Bulk Fill, recomenda a sua inserção de forma única na cavidade (BENETTI et al., 2015; GAMARRA et al., 2017). Por possuírem características de menor tensão de polimerização, menor contração volumétrica e maior profundidade de polimerização, ou seja, maior conversão do monômero em polímero, esse tipo de compósito permite incrementos de até 5mm de profundidade (CHESTERMAN et al., 2017; YAP; PANDYA; TOH, 2016).

As resinas Bulk Fill de modo geral apresentam monômeros especiais de alívio de estresse, permitindo a modulação da reação de polimerização, uso de fotoiniciadores mais reativos e a incorporação de diferentes tipos de cargas, como partículas de pré-polímero e segmentos de hastes de fibra de vidro (FURNESS et al., 2014; FRONZA et al., 2015; OLIVEIRA et al., 2018). Isso repercute em menores tensões de contração geradas durante a polimerização e, consequentemente, menor contração de polimerização.

Além disso, possuem a vantagem de simplificar a técnica e diminuir o tempo clínico. A técnica de inserção única minimiza a incorporação de espaços vazios e a contaminação entre as camadas, resultando em uma massa mais uniforme e compacta. Tais vantagens são possíveis devido ao aumento da translucidez das resinas, o que permite maior transmissão de luz (LASSILA et al., 2012; KOC-VURAL; BALTACIOGLU; ALTINCI, 2017).

O presente estudo teve como objetivo analisar, através de microscopia eletrônica de varredura, a presença de fendas em cavidades classe V especificamente na interface dentina/resina das paredes axial, gengival e oclusal, em molares humanos hígidos extraídos, restaurados com diferentes categorias de resinas compostas. A hipótese nula é que a técnica incremental e a técnica de inserção única não apresentarão diferenças quanto à presença de fendas.

2 ARTIGO - GAP FORMATION IN CLASS V OF BULK FILL RESINS: A SEM EVALUATION

Este artigo será submetido ao periódico *Operative Dentistry*, ISSN: 0361-7734; Fator de impacto = 2.893; Qualis A1. As normas para publicação estão descritas no Anexo A.

GAP FORMATION IN CLASS V OF BULK-FILL RESINS: A SEM EVALUATION

Danielle Zorzo Righes[a], Gabriela Simões Teixeira[b], Bruna Gabrielle da Silva Sutil[c], Alexandre Henrique Susin[d]

[a]Post-Graduate Program in Dental Sciences , Federal University of Santa Maria, Santa Maria, RS, Brazil. (righesdanielle@hotmail.com)

[b]Post-Graduate Program in Dental Sciences , Federal University of Santa Maria, Santa Maria, RS, Brazil. (gabisimoesteixeira@gmail.com)

[c]Post-Graduate Program in Dental Sciences , Federal University of Santa Maria, Santa Maria, RS, Brazil. (brunasutil@hotmail.com)

[d]Department of Restorative Dentistry, Federal University of Santa Maria, Santa Maria, RS, Brazil. (alexandre.susin@ufsm.br)

Declarations of interest: none.

Corresponding author:

Danielle Zorzo Righes

Tuiuti Street, #744, Zip code: 97015660, Santa Maria, Brasil.
Telephone: +55-55 996136521.
E-mail adress: righesdanielle@hotmail.com

SUMMARY

The aim of this *in vitro* study was to evaluate under scanning electron microscopy (SEM), the gap formation due to the shrinkage stress of a conventional resin (Filtek Z350XT [3M ESPE]) and two types of bulk-fill resins (Filtek Bulk Fill [3M ESPE] and Opus Bulk Fill [FGM]) along the margins of class V restorations. On each of the 36 extracted human non-carious molar teeth, class V cavities were prepared on the medium third of buccal and lingual surfaces, which were divided into six groups (n = 6), according to the restorative technique: incremental and unique insertion technique. After restoration, each molar was cut in half in the buco-lingual direction between the two restorations, resulting in two specimens per molar. The specimens were evaluated in SEM and the data were submitted to one-way ANOVA and Tukey test, at a significance level of 5%. The gaps were measured at three different points from the all walls to the restoration with 250x magnification to determine the mean of each wall. All the composites resins (Filtek Z350 XT, Filtek Bulk Fill and Opus Bulk Fill) tested individually in the unique and incremental insertion techniques did not present statistical difference, however, Filtek Bulk Fill composite when used in the technique recommended (unique insertion) shows better result compared to Z350 XT in the incremental insertion technique. All the groups had a predominance of gingival wall gaps being the most critical region.

Keywords: gap formation, bulk-fill composite, shrinkage stress, scanning electron microscopy (SEM).

Clinical Relevance

The filling of the deep cavities with composite fillers in bulk is attractive. These composite resins, Bulk-fill, simplify the restorative technique by optimizing clinical time.

1. INTRODUCTION

The composite resins are restorative materials widely used in restorative dentistry due to its esthetic aspect, adhesion and mechanical properties. Its performance depends on the proper polymerization of its components, characterized by the conversion of the monomers in polymers, which is accompanied by a volumetric reduction of the material. This process is known as "polymerization reaction" where the distance between the monomeric chains is reduced by converting the double bond chains (C = C) to single bond (C-C) and causes the polymerization shrinkage[1,2].

The shrinkage process can compromise the integrity of the tooth/restoration interface and its seal, and thereby decrease the longevity and clinical success of the restorations. One of the consequences of polymerization stress is (1) postoperative sensitivity, (2) marginal infiltration, (3) marginal discoloration, (4) secondary caries, and (5) cusp fractures[2,3]. In addition, excessive shrinkage of the restorative materials may lead to marginal gaps, which may be a consequence of the polymerization stress of the material and the magnitude of the polymerization shrinkage[4].

The incremental insertion technique has been proposed to minimize the polymerization shrinkage and to optimize the internal adaptation of the composite resin using multiple oblique increments of 2 mm thickness separately polymerized[5]. This technique is considered as a way of control of the polymerization stress, to reduces the final volumetric shrinkage of the material and, therefore, minimizes the formation of internal voids. However, the incremental technique has some disadvantages such as: the need for several increments of composite resin, allowing the incorporation of voids between the layers, being a complex technique and expending a longer clinical time[6,7].

In order to simplify the technique and minimize clinical time, bulk-fill composite were released on the market. These resins are used as a unique increment in the cavity of a large volume of material thus replacing the need for incremental layers. This composites exhibit lower polymerization stress, reduced volumetric shrinkage and greater curing depth, *i.e.*, greater conversion of the monomer to polymer, allowing a single increment in layers up to 4-5 mm deep[8,9].

This is due to the formulation of these restorative materials which generally have special stress relieving monomers allowing the modulation of the polymerization reaction, the use of more reactive photoinitiators and the incorporation of different types of fillers, such as pre-polymer and fiberglass particles[6,10,11].

In addition, with the unique insertion technique, it is possible to avoid the incorporation of voids and the contamination between the layers, resulting in a more compact mass. The modified protocol is possible due to the increased translucency of the resins, which allows greater light transmission[12,13].

Studies have been carried out with this new class of materials; however, the results reported in the literature vary considerably; whereas some authors stated similar or higher degree of conversion and lower shrinkage[11,14–17]**,** others show higher volumetric shrinkage[7,9,18]. Thus, the advantages of the use of these materials seems to be still unclear.

Therefore, the aim of this study was to examine gap formation in the class V cavities specifically in the dentin/resin interface of the axial, gingival and occlusal walls, in extracted human molars restored using a bulk-fill and conventional composites. The null hypothesis is that the incremental technique and the unique insertion technique will not show differences in the presence gaps.

2. MATERIALS AND METHODS

2.1. Study design

Thirty-six extracted, non-carious and non-restored, human third molars were obtained from the Permanent Human Teeth Bank of the Federal University of Santa Maria. The protocol for use in this study was approved by the Local Ethics Committee under approval number CAAE 82950518.8.0000.5346. The teeth were stored in 0.5% chloramine solution at 37ºC during 7 days for disinfection.

Three commercial composite resins were studied: one conventional product (Filtek Z350 XT- 3M) and two high-viscosity, bulk-fill composites (Filtek Bulk Fill- 3M and Opus Bilk Fill- FGM) applied both incrementally and in unique insertion. Product specifications are presented in the Table 1.

2.2. Teeth preparation

Seventy two standardized cavities (diameter: 4mm and depth: 3mm, C-factor = 5.0 - figure 1) were prepared under water cooling in the vestibular and palatal/lingual surfaces of the molars using a conical diamond bur item number 3131 (KG Sorensen Co., Barueri, Brazil) . The dimensions of each preparation were measured using a millimeter probe (Duflex, Rio de Janeiro, RJ, Brazil). After preparation, the cavities were randomly randomized to form the groups.

2.3. Teeth restoration

All composite resins were applied in two restorative techniques: incremental filling and unique insertion technique, so the teeth were divided into 6 experimental groups (n=6) (figure 2). The restorative procedures followed the protocol according to the group to which they belong, following the recommendations of the manufacturer (table 1) and using a irradiation monitored at 1000 mW/cm² LED (Emiter C LED, Schuster, Santa Maria, RS) for photopolymerizing following completion of cavity restoration, excess restorative material was removed using a finishing multilaminated bur, under copious water irrigation (KG Sorensen, São Paulo, Brazil), to expose the cavo surface margin. The restored teeth were then placed into distilled water at room temperature.

2.4. Scanning electron microscopy preparation (SEM)

After 24 hours of water-immersion, each molar was cutusing ISOMET 1000 (Buehler Lake Bluff, IL, USA) at the half in the buco-lingual direction to expose the centrally two restorations, resulting in two slices of specimen each molar. After obtaining the specimens, they were polished using 800-1200 grit Si-Carbide paper and conditioned with 4% acetic acid solution for 60 seconds to remove the smear layer and standardizes the observing surface. The cleaning of the area was by immersion in an ultrasonic vessel for 10 minutes. The samples were fixed in 2.5% glutaraldehyde solution buffered with 0.1 M sodium cacodylate for 3 hours. Subsequently they were submitted to chemical dehydration protocol in ascending degrees of ethanol: 25%, 50% and 75% for 5 min and absolute ethanol for 30 min. Specimens were mounted on aluminum bases and metallized on Desk II SputterCoater (DentonVacuum, Moorestown, NJ USA).

2.5. Image analysis

Each sample was observed in 250x of magnification and the images were obtained in a SEM (TESTAN VEGA3; TESTAN Brno, Czech Republic). In order to measure the gaps, the software ImageJ (ImageJ v1.46r, National Institutes of Health, Bethesda, MD, USA) was used. The locations to measure were determined at specific locations with a standardized bar, along the internal tooth/restoration interface: axial, gingival and occlusal walls (figure 3).

2.6. Statistical Analysis

Gap formation values in micrometers in the gingival wall were analyzed using one-way ANOVA analysis and Tukey test for multiple comparisons, at a significance of 5%. In the occlusal and axial walls the results were very irregular and then the analysis was limited.

3. RESULTS

The gaps were measured at three different points from the all walls to the restoration with 250x magnification to determine the mean of each wall. The results of gap formation measurement are presented in table 2. Both groups had a predominance of gingival wall gaps. Filtek Bulk Fill and Opus Bulk Fill composites presented similar behavior in the gingival wall. Comparing the techniques recommended for Filtek Bulk Fill (unique insertion technique) and Z350 XT (incremental technique) better results were obtained by Filtek Bulk Fill. The composite resin Filtek Bulk Fill when used in the incremental technique showed smaller gap formation than the other composites in the same technique. High values of standard deviation were observed, especially in the Z350 XT composite resin in the incremental technique. The other walls were not feasible for statistical analysis due to irregular distribution. Representative SEM for the sample specimens are shown in figures 4 to 9 for margins with gap formation.

4. DISCUSSION

The present study investigated marginal gap formation along the margins of class V cavities and the results. Regardless of the incremental and unique insertion technique, all composite resins exhibited gap formation along all cavity walls. Therefore, the null hypothesis was rejected, since incremental technique and the unique insertion technique showed specifics differences.

The polymerization shrinkage is determined by intrinsic factors related to composite resin composition: organic matrix, inorganic filler, degree of conversion and elastic modulus; and other extrinsic factors such as light intensity and cavity configuration[19]. The shrinkage process occurs when neighbors monomeric chains react to establish a covalent bond. On this way, the distance between molecules is reduced and occurs a reduction in free volume resulting in volumetric shrinkage[20].

Gap formation is one of the consequences of polymerization shrinkage[8,21]. This is a complex phenomenon and depends on the interaction of several factors[20,22]. In addition, the viscoelastic behavior of the material, characterized by its ability to flow in the initial stages of the curing reaction and by the elastic modulus acquired during pre-gel phase on the polymerization process, are also important factors in the development of shrinkage stress[15,23].

Corroborating with Benetti et. al. 2015[8], all groups in the present study showed gap formation predominantly in the gingival wall (Table 2). The presence of gaps in the gingival wall can be attributed to the fact that the polymerization shrinkage occurs towards the light source and the organic content of the dentin substrate. It has been reported that in Class V cavities with gingival margins located 1-1,5 mm apical, the CEJ dentinal tubules are oriented parallel to the cervical wall. Therefore, the classical hybrid layer is not formed, which is another factor that can influence[24,25]. This factor explain the “why” the cervical wall in class II restorations the fails occur predominantly on this interface, showing that it is the most critical point of a restoration[26,27].

In our study, all the composite resins individually tested in the unique and incremental insertion techniques did not present statistical difference, only a small advantage for the unique insertion technique. The unique insertion technique, besides simplifying the restorative technique, optimizes the clinical time because it allows the unique insertion of increments of up to 5mm[1,9,28]. This is possible because the molecular basis of the Bulk-Fill composites has been modified by the incorporation of higher molecular weight monomers -the low molecular weight monomers promote a greater number of double bonds per unit weight, allowing a higher degree of conversion, but also leading to increased polymerization shrinkage -[29–31].

The composition of Bulk-Fill composites varies considerably and their manufacturers do not disclose the entire formulation or chemical composition variations. What may explain the best performance of the Bulk-Fill is the presence of AUDMA, monomer having a high molecular weight (849g/mol), which was indicated to reduce shrinkage and, consequently, shrinkage stress[29,32]. This allows monomers to connect more flexibly to achieve a high degree of conversion and density of network[5].

Leprince et. al. 2014[33] state that by decreasing the elastic modulus, it is possible to decrease shrinkage stresses, whereas the translucency is increased by decreasing filler load and larger size of these particles[34]. In general, the Bulk-Fill composites present less filler load and particles of larger size (Filtek Bulk Fill: 42,5vol%, Filtek Z350XT: 59,5vol%). Increasing the size of the filler leads to an increase in light transmission, which directly influences the translucency of the material, allowing the light to penetrate deep[35]. This has a higher monomer conversion, allowing a greater deep of cure when compared to conventional composites[17].

The elastic modulus is an intrinsic characteristic of the composite resin in which it interferes with the shrinkage of polymerization[20]. The Bulk-Fill composites exhibit lower elastic modulus when compared to conventional composite[36]. It is suggested a relation between amount of filler and elastic modulus, where higher filler content would imply in a higher elastic modulus[37]. The higher the elastic modulus would result in higher shrinkage stresses[34].

The present *in vitro* study, shows limitations in the measurement of gap formation by scanning electron microscope (SEM), although it is a well-established procedure to perform qualitative and quantitative evaluation of tooth-restoration interface analysis, moreover it is a destructive method and therefore, creates some uncertainty as to whether the gap formed was before and/or after photopolymerization[38], i.e. the gap formation could be also produced by technical artifact[39].

The polymer formation is dependent on the conversion of monomer to double bonds which inevitably promote the shrinkage. Our results show that in both incremental and unique insertion techniques gap formation occurred, with Filtek Bulk Fill composite having a better behavior in relation to gap formation due to the less polymerization stress.

Studies on Bulk-Fill composites vary considerably with regard to the methodology employed, therefore further studies are needed to evaluate the restorative properties of such composite resins.

5. CONCLUSION

All the composite resins tested individually in the unique and incremental insertion techniques did not present statistical difference, however, Filtek Bulk Fill composite when used in the technique recommended (unique insertion) obtained better result compared to Z350 XT in the incremental insertion technique. All the groups had a predominance of gingival wall gaps being the most critical region.

Acknowledgements

The authors would like to thank CAPES for providing the scholarship to the postgraduate student involved in the project.

Conflict of Interest

The authors of this manuscript 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.

REFERENCES

1. Guo Y, Landis FA, Wang Z, Bai D, Jiang L, & Chiang MYM (2016) Polymerization stress evolution of a bulk-fill flowable composite under different compliances *Dental Materials* **32(4)** 578–586.

2. Soares CJ, Faria-E-Silva AL, Rodrigues M de P, Vilela ABF, Pfeifer CS, Tantbirojn D, & Versluis A (2017) Polymerization shrinkage stress of composite resins and resin cements - What do we need to know? *Brazilian oral research* **31(suppl 1)** e62.

3. Rosatto CMP, Bicalho AA, Veríssimo C, Bragança GF, Rodrigues MP, Tantbirojn D, Versluis A, & Soares CJ (2015) Mechanical properties, shrinkage stress, cuspal strain and fracture resistance of molars restored with bulk-fill composites and incremental filling technique *Journal of Dentistry* **43(12)** 1519–1528.

4. Han S-H, & Park S-H (2018) Incremental and Bulk-fill Techniques With Bulk-fill Resin Composite in Different Cavity Configurations *Operative Dentistry* 17-279-LR.

5. Van Ende A, De Munck J, Lise DP, & Van Meerbeek B (2017) Bulk-Fill Composites: A Review of the Current Literature. *The journal of adhesive dentistry* **19(2)** 95–109.

6. Fronza BM, Rueggeberg FA, Braga RR, Mogilevych B, Soares LES, Martin AA, Ambrosano G, & Giannini M (2015) Monomer conversion, microhardness, internal marginal adaptation, and shrinkage stress of bulk-fill resin composites *Dental Materials* **31(12)** 1542–1551.

7. Alqudaihi F, Cook N, Diefenderfer K, Bottino M, & Platt J (2018) Comparison of Internal Adaptation of Bulk-fill and Increment-fill Resin Composite Materials *Operative Dentistry* 17-269–L.

8. Benetti A, Havndrup-Pedersen C, Honoré D, Pedersen M, & Pallesen U (2015) Bulk-Fill Resin Composites: Polymerization Contraction, Depth of Cure, and Gap

Formation *Operative Dentistry* **40(2)** 190–200.

9. Gamarra VSS, Borges GA, Júnior LHB, & Spohr AM (2017) Marginal adaptation and microleakage of a bulk-fill composite resin photopolymerized with different techniques Odontology.

10. Furness A, Tadros MY, Looney SW, & Rueggeberg FA (2014) Effect of bulk/incremental fill on internal gap formation of bulk-fill composites *Journal of Dentistry* **42(4)** 439–449.

11. Almeida Junior LJ dos S, Lula EC de O, Penha KJ de S, Correia VS, Magalhães FAC, Lima DM, & Firoozmand LM (2018) Polymerization Shrinkage of Bulk Fill Composites and its Correlation with Bond Strength *Brazilian Dental Journal* **29(3)** 261–267.

12. Lassila LVJ, Nagas E, Vallittu PK, & Garoushi S (2012) Translucency of flowable bulk-filling composites of various thicknesses. *The Chinese journal of dental research : the official journal of the Scientific Section of the Chinese Stomatological Association (CSA)* **15(1)** 31–5.

13. Koc-Vural U, Baltacioglu I, & Altinci P (2017) Color stability of bulk-fill and incremental-fill resin-based composites polished with aluminum-oxide impregnated disks *Restorative Dentistry & Endodontics* **42(2)** 118.

14. Gonçalves F, Campos LM de P, Rodrigues-Júnior EC, Costa FV, Marques PA, Francci CE, Braga RR, & Boaro LCC (2018) A comparative study of bulk-fill composites: degree of conversion, post-gel shrinkage and cytotoxicity. *Brazilian oral research* **32(0)** e17.

15. Almeida LJ dos S, JUNIOR(a), PENHA(a KJ de S, SOUZA(a) AF, LULA(b) ECO, MAGALHÃES(c) FC, LIMA(a) DM, & FIROOZMAND(a) LM (2017) Is there correlation between polymerization shrinkage , gap formation , and void in bulk fill composites ? A μCT study *Original research Dentistry* **31** 1–10.

16. Jang J-H, Park S-H, & Hwang I-N (2015) Polymerization shrinkage and depth of

cure of bulk-fill resin composites and highly filled flowable resin. *Operative dentistry* **40(2)** 172–80.

17. Veloso SRM, Lemos & CAA, Moraes & SLD de, Vasconcelos & BC do E, Pellizzer & EP, & Monteiro & GQ de M (2019) Clinical performance of bulk-fill and conventional resin composite restorations in posterior teeth: a systematic review and meta-analysis *Clinical Oral Investigations* **23(1)** 221–233.

18. Jung JH, & Park SH (2017) Comparison of Polymerization Shrinkage , Physical Properties , and Marginal Adaptation of Flowable and Restorative Bulk Fill Resin-Based Composites *Operative Dentistry* 375–386.

19. Giachetti L, Scaminaci Russo D, Bambi C, & Grandini R (2006) A review of polymerization shrinkage stress: current techniques for posterior direct resin restorations. *The journal of contemporary dental practice* **7(4)** 79–88.

20. BRAGA R, BALLESTER R, & FERRACANE J (2005) Factors involved in the development of polymerization shrinkage stress in resin-composites: A systematic review *Dental Materials* **21(10)** 962–970.

21. Davidson CL, & Feilzer AJ (1997) Polymerization shrinkage and polymerization shrinkage stress in polymer-based restoratives. *Journal of dentistry* **25(6)** 435–40.

22. Peutzfeldt A, Mühlebach S, Lussi A, & Flury S (2017) Marginal Gap Formation in Approximal "Bulk Fill" Resin Composite Restorations After Artificial Ageing *Operative Dentistry* 17-068–L.

23. Peutzfeldt A, & Asmussen E (2004) Determinants of in vitro gap formation of resin composites. *Journal of dentistry* **32(2)** 109–15.

24. Kimyai S, Mohammadi N, Alizadeh Oskoee P, Pournaghi-Azar F, Ebrahimi Chaharom ME, & Amini M (2012) Effect of different prophylaxis methods on microleakage of microfilled composite restorations. *Journal of dental research, dental clinics, dental prospects* **6(2)** 65–9.

25. Han SH, & Park SH (2017) Comparison of Internal Adaptation in Class II Bulk-fill

Composite Restorations Using Micro-CT. *Operative dentistry* **42(2)** 203–214.

26. van Dijken JWV, & Pallesen U (2016) Posterior bulk-filled resin composite restorations: A 5-year randomized controlled clinical study *Journal of Dentistry* **51** 29–35.

27. Dewaele M, Asmussen E, Devaux J, & Leloup G (2006) Class II restorations: influence of a liner with rubbery qualities on the occurrence and size of cervical gaps *European Journal of Oral Sciences* **114(6)** 535–541.

28. Heintze SD, Monreal D, & Peschke A (2015) Marginal Quality of Class II Composite Restorations Placed in Bulk Compared to an Incremental Technique: Evaluation with SEM and Stereomicroscope. *The journal of adhesive dentistry* **17(2)** 147–54.

29. Rizzante FAP, Mondelli RFL, Furuse AY, Borges AFS, Mendonça G, & Ishikiriama SK (2019) Shrinkage stress and elastic modulus assessment of bulk-fill composites *Journal of Applied Oral Science* **27(0)** e20180132.

30. Münchow EA, Meereis CTW, de Oliveira da Rosa WL, da Silva AF, & Piva E (2018) Polymerization shrinkage stress of resin-based dental materials: A systematic review and meta-analyses of technique protocol and photo-activation strategies *Journal of the Mechanical Behavior of Biomedical Materials* **82** 77–86.

31. Kruly P de C, Giannini M, Pascotto RC, Tokubo LM, Suga USG, Marques A de CR, & Terada RSS (2018) Meta-analysis of the clinical behavior of posterior direct resin restorations: Low polymerization shrinkage resin in comparison to methacrylate composite resin *PLOS ONE* **13(2)** e0191942.

32. Kim Y-J, Kim R, Ferracane J, & Lee I-B (2016) Influence of the Compliance and Layering Method on the Wall Deflection of Simulated Cavities in Bulk-fill Composite Restoration *Operative Dentistry* **41(6)** e183–e194.

33. Leprince JG, Palin WM, Vanacker J, Sabbagh J, Devaux J, & Leloup G (2014) Physico-mechanical characteristics of commercially available bulk-fill composites

Journal of Dentistry **42(8)** 993–1000.

34. Bucuta S, & Ilie N (2014) Light transmittance and micro-mechanical properties of bulk fill vs. conventional resin based composites Clinical oral investigations.

35. Fujita K, Ikemi T, & Nishiyama N (2011) Effects of particle size of silica filler on polymerization conversion in a light-curing resin composite *Dental Materials* **27(11)** 1079–1085.

36. Ilie N, Bucuta S, & Draenert M (2013) Bulk-fill resin-based composites: an in vitro assessment of their mechanical performance. *Operative dentistry* **38(6)** 618–25.

37. Ilie N, & Hickel R (2009) Investigations on mechanical behaviour of dental composites *Clinical Oral Investigations* **13(4)** 427–438.

38. Al-Harbi F, Kaisarly D, Bader D, & El Gezawi M (2016) Marginal Integrity of Bulk Versus Incremental Fill Class II Composite Restorations. *Operative dentistry* **41(2)** 146–56.

39. Pereira CNDB, Daleprane B, Barbosa PF, Moreira AN, & de Magalhães CS (2014) Qualitative evaluation of scanning electron microscopy methods in a study of the resin cement/dentine adhesive interface. *Microscopy and microanalysis : the official journal of Microscopy Society of America, Microbeam Analysis Society, Microscopical Society of Canada* **20(1)** 268–75.

TABLES AND FIGURES

Table 1 – Material, classification, composition and application mode according to the manufacturer's instructions.

Material/Manufacturer	Classification	Composition	Restorative protocol and recommended curing light exposure (time – thickness)
Adper Single Bond 2 (3M ESPE, St. Paul, MN, USA) Lot: N855670	Adhesive system	Bis-GMA, HEMA, dimethacrylates, photoinitiator, methacrylate functional copolymer of polyacrylic and polyitaconic acids, 10% by weight of 5 nanometer-diameter spherical silica particles, water, etanol.	Apply two consecutive coats of adhesive to the tooth surface with gentle agitation for 15 seconds; gently air thin; light cure for 10 seconds.
Filtek Bulk Fill (3M ESPE, St. Paul, MN, USA) Lot: 1709400512 Shade: A1	Bulk-Fill: high-viscosity	Bis-GMA, Bis-EMA, UDMA, AUDMA, TEGDMA, DDDMA, Procrylat resins, Zirconia/silica, ytterbium, trifluoride.	Bulk: 20s – 3mm Incremental: 20s - 2mm.
Opus Bulk Fill (FGM, Joinville, Brasil) Lot: 130317 Shade: A1	Bulk-Fill: high-viscosity	Urethane dimethacrylate monomers, urethane oligomers, metacrylate oligomers with spatial conformation in alpha helix. Inorganic fillers of silanized silica, stabilizers and pigments.	Bulk: 40s – 3mm Incremental: 20s - 2mm.
Filtek Z350 XT (3M ESPE, St. Paul, MN, USA) Lot: 639699 Shade: A1	Conventional composite	Silica dioxide, aluminum oxide, sodium oxide, potassium oxide, boron trioxide, zirconia, calcium oxide, UDMA and TEGDMA.	Bulk: 20s – 3mm Incremental: 20s - 2mm.

Bis-GMA – bisphenol A glycidyl dimethacrylate; TEGDMA – triethylene glycol dimethacrylate; UDMA – urethane dimethacrylate; DDDMA – 1,12-dodecano dimetacrilato; HEMA – 2-hydroxiethyl methacrylate; Bis-EMA – ethoxylated bisphenol-A dimethacrylate.

Table 2. Measurement of gap formation according to cavity walls and composite resin.

Walls/ Groups	Filtek Bulk Fill Incremental G1	Filtek Bulk Fill Bulk G2	Opus Bulk Fill Incremental G3	Opus Bulk Fill Bulk G4	Z350 XT Incremental G5	Z350 XT Bulk G6
Gingival	15.36 (6.56) B	16.94 (5.96) B	20.86 (5.18) AB	19.98 (8.03) AB	28.58 (11.29) A	22.61 (7.36) AB
Occlusal	11.36 (6.49)	6.69 (7.58)	Id	Id	Id	Id
Axial	Id	Id	Id	Id	Id	Id

Abbreviations: Id: irregular distribution.

Similar capital (line) and lower (column) are not statistically significant ($p > 0.05$).

Figure 1. Schematic view of the cavities.

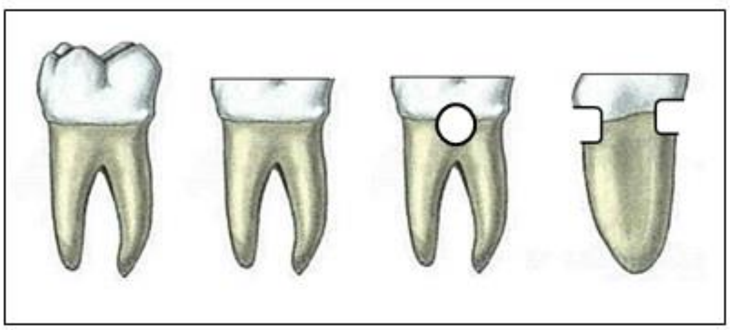


Figure 2. Study design.

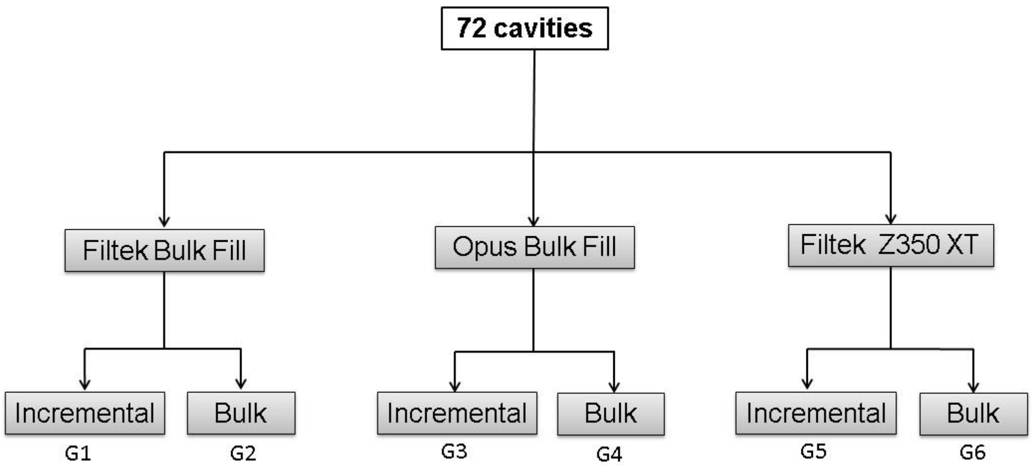
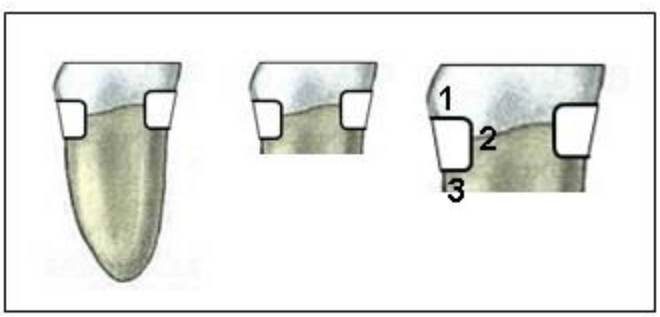
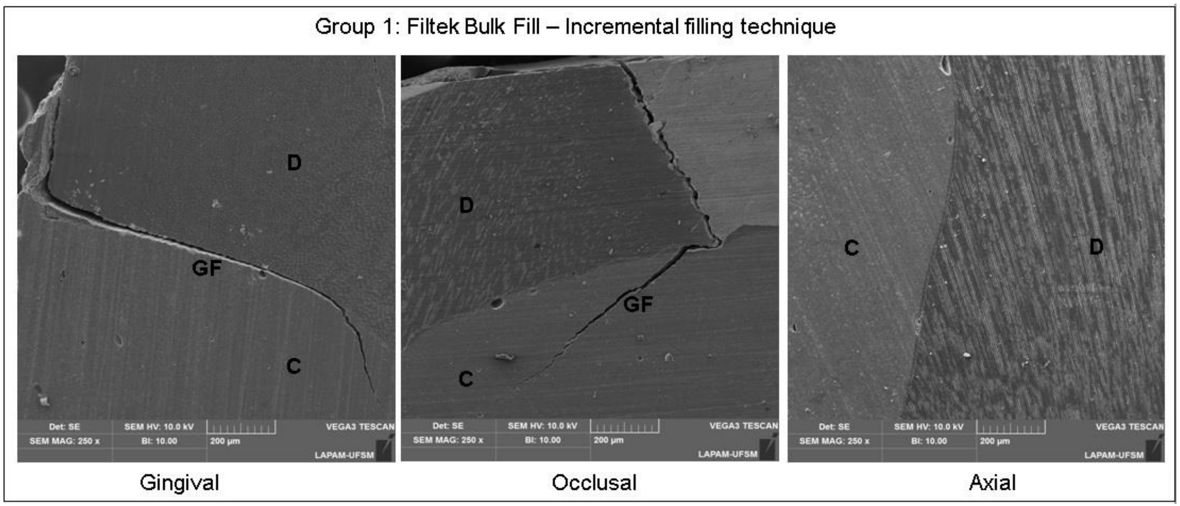


Figure 3. Scheme of the sites of measurement.



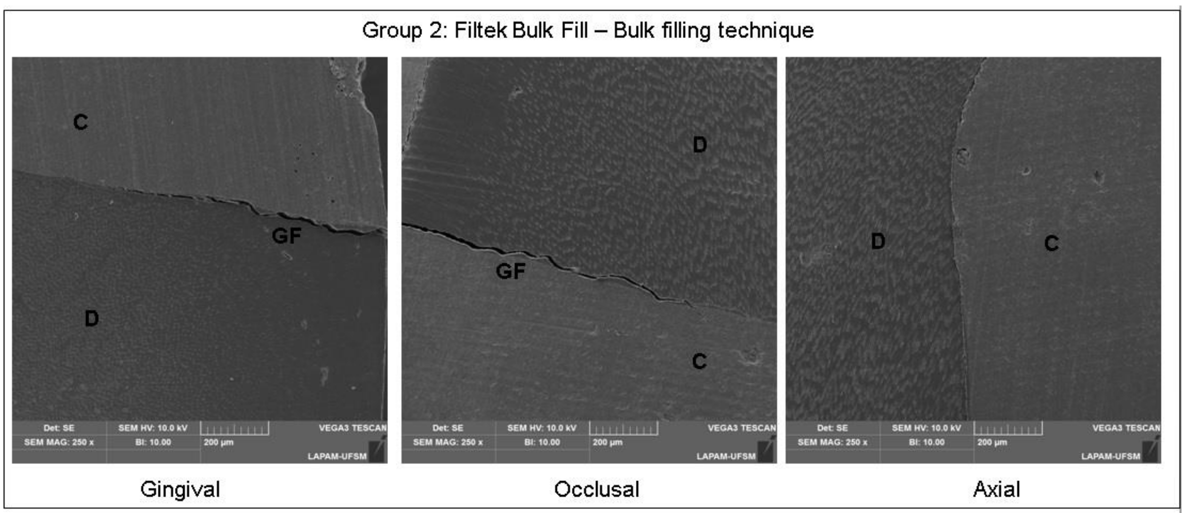
Abbreviations: occlusal (1), axial (2) and gingival (3) wall.

Figure 4. Group 1: scanning electron microscopy - image of resin-dentin interfaces (250x).



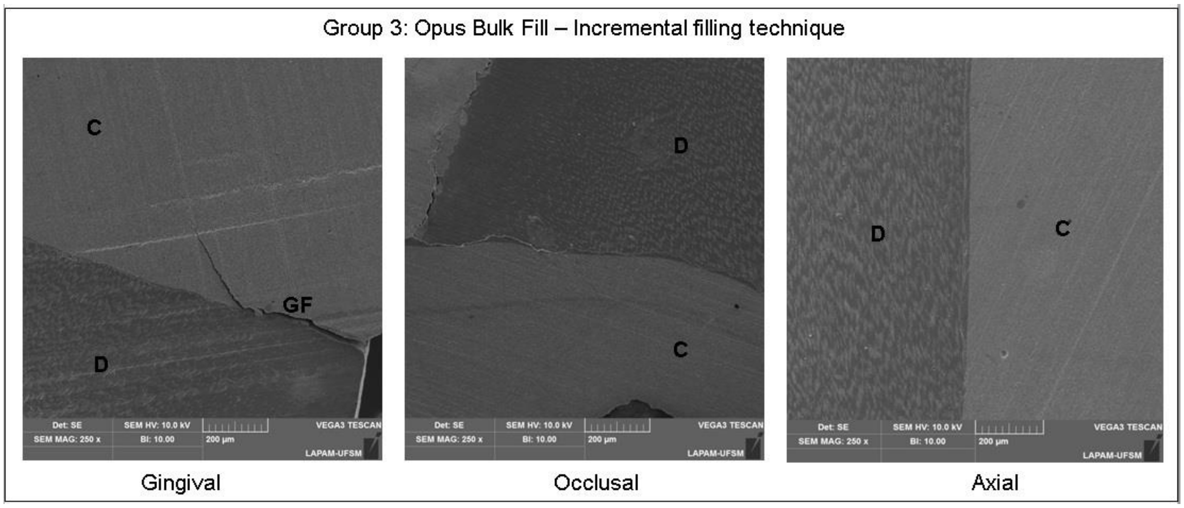
Abbreviations: GF (gap formation), D (dentin), C (composite).

Figure 5. Group 2: scanning electron microscopy - image of resin-dentin interfaces (250x).



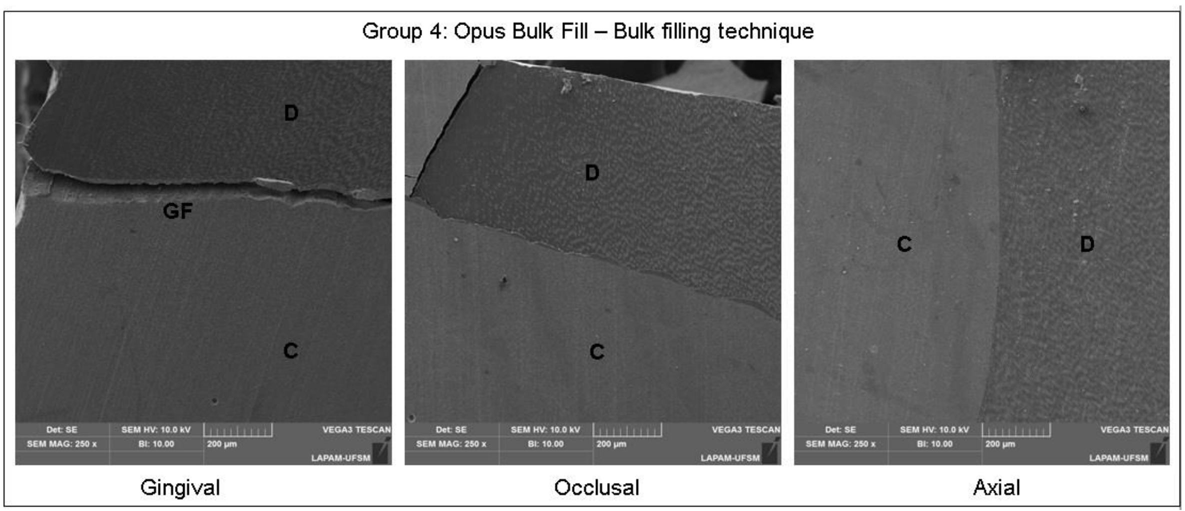
Abbreviations: GF (gap formation), D (dentin), C (composite).

Figure 6. Group 3: scanning electron microscopy - image of resin-dentin interfaces (250x).



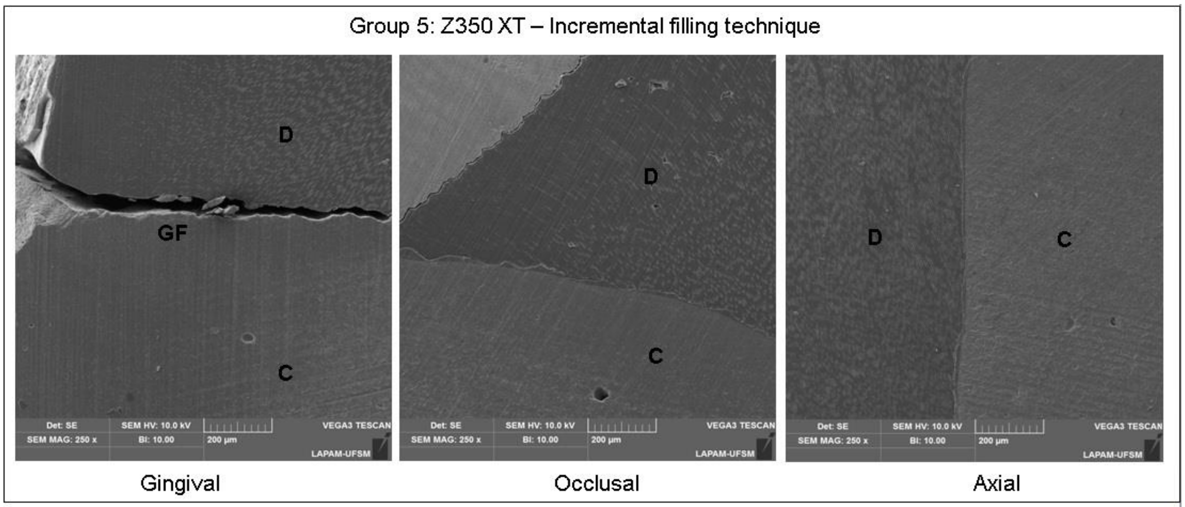
Abbreviations: GF (gap formation), D (dentin), C (composite).

Figure 7. Group 4: scanning electron microscopy - image of resin-dentin interfaces (250x).



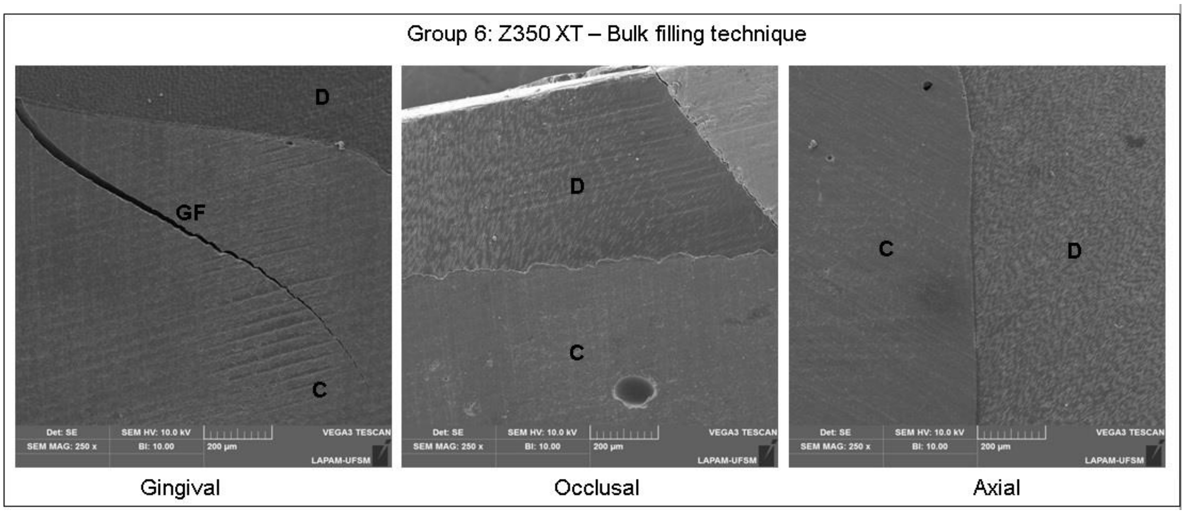
Abbreviations: GF (gap formation), D (dentin), C (composite).

Figure 8. Group 5: scanning electron microscopy - image of resin-dentin interfaces (250x).



Abbreviations: GF (gap formation), D (dentin), C (composite).

Figure 9. Group 6: scanning electron microscopy - image of resin-dentin interfaces (250x).



Abbreviations: GF (gap formation), D (dentin), C (composite).

3 CONCLUSÃO

Todas as resinas compostas testadas individualmente nas técnicas de inserção única e incremental não apresentaram diferença estatística, entretanto, a resina composta Filtek Bulk Fill quando utilizada na técnica recomendada (inserção única) obteve melhor resultado comparada a Z350 XT na técnica de inserção incremental. Todos os grupos apresentaram predomínio de fendas na parede gengival, sendo a região mais crítica.

REFERÊNCIAS

BENETTI, A.R. et al. Bulk-Fill Resin Composites: Polymerization Contraction, Depth of Cure, and Gap Formation. **Operative Dentistry**, [s.1], v. 40, n. 2, p. 190-200, 2015.

BRAGA, R.; BALLESTER, R.; FERRACANE, J. Factors involved in the development of polymerization shrinkage stress in resin-composites: A systematic review. **Dental Materials**, [s.1], v. 21, n. 10, p. 962-97-, 2005.

CHESTERMAN, J. et al. Bulk-fill resin-based composite restorative materials: A review. **British Dental Journal**, [s.1], v. 222, n. 5, p. 337-344, 2017.

FERRACANE, L.; HILTON J. Polymerization stress – Is it clinically meaningful? **Dental Materials**, [s.1], v. 32, n. 1, p. 1-10, 2016.

FRONZA, B. et al. Monomer conversion, microhardness, internal marginal adaptation, and shrinkage stress of bulk-fill resin composites. **Dental Materials**, [s.1], v. 31, n. 12, p. 1542-1551, 2015.

FUGOLIN, A. P. P.; PFEIFER, C. S. New Resins for Dental Composites. **Journal of Dental Research**, [s.1], v. 96, n. 10, p. 1085-1091, 2017.

FURNESS, A. et al. Effect of bulk/incremental fill on internal gap formation of bulk-fill composites. **Journal of Dentistry**, [s.1], v. 42, n.4, p.439-449, 2014.

GAMARRA, V. et al. Marginal adaptation and microleakage of bulk-fill composite resin photopolymerized with different techniques. **Odontology**, [s.1], 2017.

KOC-VURAL, U.; BALTACIOGLU, I.; ALTINCI, P. Color stability of bulk-fill and incremental-fill resin-based composites polished with aluminum-oxide impregnated disks. **Restorative Dentistry & Endodontics**, [s.1], v. 42, n. 2, p. 118, 2017.

LASSILA, L. et al. Translucency of flowable bulk-filling composites of various thicknesses. **The Chinese journal of dental research: the official journal of the Scientific Section of the Chinese Stomatological Association** (CSA), [s.1], v. 15, n. 1, p. 31-5, 2012.

OLIVEIRA, L. et al. Molar cusp deformation evaluated by micro-CT and enamel crack formation to compare incremental and bulk-filling techniques. **Journal of Dentistry**, [s.1], p.0-1, 2018.

ROSATTO, C. M. P. et al. Mechanical properties, shrinkage stress, cuspal strain and fracture resistance of molars restored with bulk-fill composites and incremental filling technique. **Journal of Dentistry**, [s.1], v. 43, n. 12, p. 1519-1528, 2015.

SOARES, C. et al. Polymerization shrinkage stress of composite resins cements – What do we need to know? **Brazilian oral research**, [s.1], v. 31, n. suppl 1, p. 62, 2017.

YAP, A.; PANDYA, M.;TOH, W. Depth of cure of contemporary bulk-fill resin-based composites. **Dental Materials Journal**, [s.1], v. 35, n. 3, p. 503-510, 2016.

ANEXO A – NORMAS PARA A PUBLICAÇÃO NO PERIÓDICO *OPERATIVE DENTISTRY.*

Operative Dentistry requires electronic submission of all manuscripts. All submissions must be sent to Operative Dentistry using the Allen Track upload site. Your manuscript will only be considered officially submitted after it has been approved through our initial quality control check, and any problems have been fixed. You will have 6 days from when you start the process to submit and approve the manuscript. After the 6 day limit, if you have not finished the submission, your submission will be removed from the server. You are still able to submit the manuscript, but you must start from the beginning. Be prepared to submit the following manuscript files in your upload:

• A Laboratory or Clinical Research Manuscript file must include:
◦ a title
◦ a running (short) title
◦ a clinical relevance statement
◦ a concise summary (abstract)
◦ introduction, methods & materials, results, discussion and conclusion
◦ references (see Below)
◦ The manuscript **MUST NOT** include any:
▪ identifying information such as:
▪ Authors
▪ Acknowledgements
▪ Correspondence information
▪ Figures
▪ Graphs
▪ Tables
• An acknowledgement, disclaimer and/or recognition of support (if applicable) must in a separate file and uploaded as supplemental material.
• All figures, illustrations, graphs and tables must also be provided as individual files. These should be high resolution images, which are used by the editor in the actual typesetting of your manuscript. Please refer to the instructions below for acceptable formats.
• All other manuscript types use this template, with the appropriate changes as listed below.

Complete the online form which includes complete author information and select the files you would like to send to Operative Dentistry. Manuscripts that do not meet our formatting and data requirements listed below will be sent back to the corresponding author for correction.

GENERAL INFORMATION

• All materials submitted for publication must be submitted exclusively to Operative Dentistry.
• The editor reserves the right to make literary corrections.
• Currently, color will be provided at no cost to the author if the editor deems it essential to the manuscript. However, we reserve the right to convert to gray scale if color does not contribute significantly to the quality and/or information content of the paper.

- The author(s) retain(s) the right to formally withdraw the paper from consideration and/or publication if they disagree with editorial decisions.
- International authors whose native language is not English must have their work reviewed by a native English speaker prior to submission.
- Spelling must conform to the American Heritage Dictionary of the English Language, and SI units for scientific measurement are preferred.
- While we do not currently have limitations on the length of manuscripts, we expect papers to be concise; Authors are also encouraged to be selective in their use of figures and tables, using only those that contribute significantly to the understanding of the research.
- Acknowledgement of receipt is sent automatically. If you do not receive such an acknowledgement, please contact us at editor@jopdent.org rather than resending your paper.
- **IMPORTANT:** Please add our e-mail address to your address book on your server to prevent transmission problems from spam and other filters. Also make sure that your server will accept larger file sizes. This is particularly important since we send page-proofs for review and correction as .pdf files.

REQUIREMENTS

• FOR ALL MANUSCRIPTS

1 CORRESPONDING AUTHOR must provide a WORKING / VALID e-mail address which will be used for all communication with the journal. **NOTE:** Corresponding authors MUST update their profile if their e-mail or postal address changes. If we cannot contact authors within seven days, their manuscript will be removed from our publication queue.

2 AUTHOR INFORMATION must include:

▪ full name of all authors
▪ complete mailing address for each author
▪ degrees (e.g. DDS, DMD, PhD)
▪ affiliation (e.g. Department of Dental Materials, School of Dentistry, University of Michigan)

3 MENTION OF COMMERCIAL PRODUCTS/EQUIPMENT must include:

▪ full name of product
▪ full name of manufacturer
▪ city, state and/or country of manufacturer

4 MANUSCRIPTS AND TABLES must be provided as Word files. Please limit size of tables to no more than one US letter sized page. (8 ½ ” x 11”)

5 ILLUSTRATIONS, GRAPHS AND FIGURES must be provided as TIFF or JPEG files with the following parameters

▪ line art (and tables that are submitted as a graphic) must be sized at approximately 5” x 7” and have a resolution of 1200 dpi.
▪ gray scale/black & white figures must have a minimum size of 3.5” x 5”, and a maximum size of 5” x 7” and a minimum resolution of 300 dpi and a maximum of 400 dpi.
▪ color figures must have a minimum size of 2.5” x 3.5”, and a maximum size of 3.5” x 5” and a minimum resolution of 300 dpi and a maximum of 400 dpi.

▪ color photographs must be sized at approximately 3.5” x 5” and have a resolution of 300 dpi.

• OTHER MANUSCRIPT TYPES

1 CLINICAL TECHNIQUE/CASE STUDY MANUSCRIPTS must include:

▪ a running (short) title
▪ purpose
▪ description of technique
▪ list of materials used
▪ potential problems
▪ summary of advantages and disadvantages
▪ references (see below)

2 LITERATURE AND BOOK REVIEW MANUSCRIPTS must include:

▪ a running (short) title
▪ a clinical relevance statement based on the conclusions of the review
▪ conclusions based on the literature review…without this, the review is just an exercise
▪ references (see below)

• FOR REFERENCES

REFERENCES must be numbered (superscripted numbers) consecutively as they appear in the text and, where applicable, they should appear after punctuation.

The reference list should be arranged in numeric sequence at the end of the manuscript and should include:

1. Author(s) last name(s) and initial (ALL AUTHORS must be listed) followed by the date of publication in parentheses.
2. Full article title.
3. Full journal name in italics (no abbreviations), volume and issue numbers and first and last page numbers complete (i.e. 163-168 NOT attenuated 163-68).
4. Abstracts should be avoided when possible but, if used, must include the above plus the abstract number and page number.
5. Book chapters must include chapter title, book title in italics, editors’ names (if appropriate), name of publisher and publishing address.
6. Websites may be used as references, but must include the date (day, month and year) accessed for the information.
7. Papers in the course of publication should only be entered in the references if they have been accepted for publication by a journal and then given in the standard manner with “In press” following the journal name.
8. **DO NOT** include unpublished data or personal communications in the reference list. Cite such references parenthetically in the text and include a date.

EXAMPLES OF REFERENCE STYLE

• Journal article: two authors
Evans DB & Neme AM (1999) Shear bond strength of composite resin and amalgam adhesive systems to dentin *American Journal of Dentistry* **12(1)** 19-25.

• Journal article: multiple authors
Eick JD, Gwinnett AJ, Pashley DH & Robinson SJ (1997) Current concepts on adhesion to dentin *Critical Review of Oral and Biological Medicine* **8(3)** 306-335.

- Journal article: special issue/supplement
  Van Meerbeek B, Vargas M, Inoue S, Yoshida Y, Peumans M, Lambrechts P & Vanherle G (2001) Adhesives and cements to promote preservation dentistry *Operative Dentistry* **(Supplement 6)** 119-144.
- Abstract:
  Yoshida Y, Van Meerbeek B, Okazaki M, Shintani H & Suzuki K (2003) Comparative study on adhesive performance of functional monomers*Journal of Dental Research* **82(Special Issue B)** Abstract #0051 p B-19.
- Corporate publication:
  ISO-Standards (1997) ISO 4287 Geometrical Product Specifications Surface texture: Profile method – Terms, definitions and surface texture parameters *Geneve: International Organization for Standardization* **1st edition** 1-25.
- Book: single author
  Mount GJ (1990) *An Atlas of Glass-ionomer Cements* Martin Duntz Ltd, London.
- Book: two authors
  Nakabayashi N & Pashley DH (1998) *Hybridization of Dental Hard Tissues* Quintessence Publishing, Tokyo.
- Book: chapter
  Hilton TJ (1996) Direct posterior composite restorations In: Schwarts RS, Summitt JB, Robbins JW (eds) *Fundamentals of Operative Dentistry*Quintessence, Chicago 207-228.
- Website: single author
  Carlson L (2003) Web site evolution; Retrieved online July 23, 2003 from: http://www.d.umn.edu/~lcarlson/cms/evolution.html
- Website: corporate publication
  National Association of Social Workers (2000) NASW Practice research survey 2000. NASW Practice Research Network, 1. 3. Retrieved online September 8, 2003 from: http://www.socialworkers.org/naswprn/default

ANEXO B – APROVAÇÃO DO COMITÊ DE ÉTICA

UNIVERSIDADE FEDERAL DE SANTA MARIA/ PRÓ-REITORIA DE PÓS-GRADUAÇÃO E

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: ANÁLISE EM MEV DA FENDA RESULTANTE DA CONTRAÇÃO DE POLIMERIZAÇÃO DA RESINA COMPOSTA

Pesquisador: ALEXANDRE HENRIQUE SUSIN

Área Temática:

Versão: 1

CAAE: 82950518.8.0000.5346

Instituição Proponente: Universidade Federal de Santa Maria/ Pró-Reitoria de Pós-Graduação e

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.544.967

Apresentação do Projeto:

As resinas compostas estão entre as principais escolhas do cirurgião-dentista para restaurar dentes cariados ou fraturados. O desempenho das resinas compostas é dependente da polimerização adequada dos seus componentes. No entanto, a contração de polimerização pode resultar em fendas e comprometer a integridade da interface dente/restauração, diminuindo a longevidade e sucesso clínico de tais restaurações. O presente projeto pretende avaliar, por meio de Microscópio Eletrônico de Varredura (MEV), a presença ou

Investigador	projetocerto.docx	16/03/2018 12:24:16	ALEXANDRE HENRIQUE SUSIN	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	tcleassinado.pdf	16/03/2018 12:23:07	ALEXANDRE HENRIQUE SUSIN	Aceito
Folha de Rosto	scan0001.pdf	05/02/2018 13:44:58	ALEXANDRE HENRIQUE SUSIN	Aceito
Cronograma	Cronograma.docx	02/02/2018 10:18:53	ALEXANDRE HENRIQUE SUSIN	Aceito
Projeto Detalhado / Brochura Investigador	PROJETO_MESTRADO.docx	02/02/2018 10:18:25	ALEXANDRE HENRIQUE SUSIN	Aceito
Outros	projeto_59316.pdf	18/01/2018 12:48:50	ALEXANDRE HENRIQUE SUSIN	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	termo_de_disp.pdf	18/01/2018 11:38:02	ALEXANDRE HENRIQUE SUSIN	Aceito
Outros	termo_confi.pdf	18/01/2018 11:32:22	ALEXANDRE HENRIQUE SUSIN	Aceito
Outros	banco_de_dentes.pdf	18/01/2018 11:30:06	ALEXANDRE HENRIQUE SUSIN	Aceito
Outros	autorizacao_institucional.pdf	18/01/2018 11:29:13	ALEXANDRE HENRIQUE SUSIN	Aceito
Orçamento	Orcamento.docx	18/01/2018 11:24:18	ALEXANDRE HENRIQUE SUSIN	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

SANTA MARIA, 03 de Abril de 2018

Assinado por:
CLAUDEMIR DE QUADROS
(Coordenador)

Endereço: Av. Roraima, 1000 - prédio da Reitoria - 2º andar
Bairro: Camobi **CEP:** 97.105-970
UF: RS **Município:** SANTA MARIA
Telefone: (55)3220-9362 **E-mail:** cep.ufsm@gmail.com