UNIVERSIDADE DE UBERABA

MESTRADO EM ODONTOLOGIA

JÚLIO CÉSAR LEMOS DUARTE

EFEITO DA CICLAGEM MECÂNICA E TÉRMICA NAS CARACTERÍSTICAS INTERFACIAIS, RESISTÊNCIA DE UNIÃO E DISTRIBUIÇÃO DE TENSÃO ENTRE DIFERENTES RESINAS COMPOSTAS E SUBSTRATOS DENTAIS

UBERABA-MG
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Dissertação apresentada como requisito para obtenção do título de Mestre em Odontologia, no Programa de Pós-Graduação em Odontologia da Universidade de Uberaba.

Área de concentração: Clínica Odontológica Integrada

Orientador: Prof. Dr. Gilberto Antonio Borges

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"EFEITO DA CICLAGEM MECÂNICA E TÉRMICA NAS CARACTERÍSITCAS INTERFACIAIS, RESISTÊNCIA DE UNIÃO E DISTRIBUIÇÃO DE TENSÃO ENTRE DIFERENTES RESINAS COMPOSTAS E SUBSTRATOS DENTAIS"

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“Lute com determinação,

abrace a vida com paixão,

perca com classe e vença com ousadia,

porque o mundo pertence a quem se atreve

e a vida é muito bela para ser insignificante.”

(Charles Chaplin)

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Nada é mais bonito que agradecer...

Perceber que Deus nos presenteia, todos os dias, é saber o quão a vida é maravilhosa...

Independente dos “nãos”, dos acasos e dos tropeços...

Independente de tudo o que atrapalha o nosso riso...

Agradecer é só uma questão de percepção...

Olhar ao redor e perceber os detalhes divinos que Ele coloca no nosso caminho,

Reconhecer os milagres diários e entender que a gente pode, sim, ser feliz o tempo todo,

Com tudo o que a gente já tem...

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“Veni, vidi, vici”

(Júlio César, Imperador Romano, 47 a.C.)

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RESUMO

O objetivo deste estudo foi avaliar o efeito da ciclagem térmica e mecânica nas características interfaciais, resistência de união e distribuição de tensão em dentes humanos restaurados com diferentes resinas compostas. Foram selecionados 72 dentes molares humanos limpos e montados em cilindros de poliestireno para simular o ligamento periodontal com material de moldagem a base de poliéter. Os dentes receberam preparos padronizados de Classe II Slot Vertical, face proximal mesial, com 4 mm de largura vestíbulo-lingual, 2 mm de profundidade e 6 mm na direção ocluso-gengival. Metade com a margem localizada em dentina e a outra em esmalte. Foram divididos em 12 grupos de acordo com as diferentes técnicas de restauração, ciclagem térmica e mecânica e análise interfacial. As resinas compostas foram aplicadas de acordo com 3 técnicas diferentes: (1) técnica incremental: resina composta Tetric N-Ceram foi aplicada em incrementos de 2 mm de espessura; (2) técnica Bulk Fill: resina composta Tetric N-Ceram Bulk Fill foi aplicada em único incremento de 4 mm, os 2 milímetros restantes foram preenchidos com resina composta convencional Tetric N-Ceram; (3) técnica Sonic: resina composta SonicFill foi aplicada em um único incremento de 5 mm e o milímetro restante foi preenchido com resina composta convencional. Impressões com silicone por adição foram realizadas e os moldes vazados com resina epóxi. Após a polimerização da resina epóxi os modelos foram removidos dos moldes e fixados em dispositivos metálicos, cobertos com ouro e a interface analisada em microscópio eletrônico de varredura. Dente adicional foi seccionado verticalmente e as fatias incluídas em resina epóxi e polidas, desidratadas e então cobertas com ouro. A interface foi analisada com MEV. Em seguida, cortes foram realizados na interface (parede cervical) de cada dente para obter espécimes em formato de palito com área adesiva aproximada de 1 mm^2, os quais foram submetidos ao ensaio de resistência de união à microtração em máquina de ensaio universal, com velocidade de deslocamento 0,5 mm/min. Foi realizada análise de elementos finitos bidimensional para correlação das tensões geradas na interface adesiva. Os valores de resistência de união mostraram que não foi encontrada diferença estatística para Tetric N Ceram e Tetric Bulk fill antes da ciclagem térmica e mecânica, independentemente do tipo de substrato (dentina ou esmalte). Os valores de resistência de união da Tetric N Ceram foram maiores do que SonicFill ($p < 0,05$). Não houve diferença estatística na resistência de união entre Tetric Bulk Fill e SonicFill. Para o esmalte, Tetric N-Ceram exibiu os valores de resistência de união mais elevados do que as outras resinas compostas após a ciclagem

térmica e mecânica, e tera Tetric Bulk Fill não diferiu estatisticamente da SonicFill. Para a dentina após a ciclagem térmica e mecânica, não houve diferenças estatísticas entre as resinas compostas. Os valores de resistência de união foram maiores para o esmalte do que a dentina antes e após a ciclagem térmica e mecânica, independentemente da resina composta. A ciclagem térmica e mecânica influenciou a resistência de união da resina composta ao esmalte e à dentina; o esmalte resultou em valores de resistência de união superiores em relação à dentina para todas as resinas compostas avaliadas; a dentina mostrou maiores valores de tensão em relação ao esmalte; e a técnica Sonic mostrou bolhas e descontinuidades maiores do que as técnicas incremental e Bulk Fill.

Palavras-chave: Resina composta. Adaptação marginal dental. Dentina. Esmalte dental.

ABSTRACT

The aim of this study was to evaluate the effect of thermo mechanical cycling in the interface characteristics, bond strength and stress distribution in restored teeth with different composite resins. Seventy-two sound human third molars were selected, cleaned and mounted in polystyrene cylinders to simulate the periodontal ligament using a polyether impression material. The teeth received cavity preparation (slot) with 6 mm occlusal-gingival direction by 4 mm wide labial-lingual direction and 2 mm deep mesial-distal direction. Half of the teeth had the gingival end in dentin and half in enamel. The teeth were divided into 12 groups in agreement with the different restorative techniques, thermal/mechanical cycling, and interfacial analysis. The resin composites applied in according to three different techniques: (1) Incremental technique: Tetric N-Ceram composite resin was applied in approximately 2 mm thickness increments, (2) Bulk Fill technique: Tetric N-Ceram Bulk Fill composite resin was applied in a bulk increment of 4 mm. The remaining millimeter was filled with Tetric N-Ceram, and (3) Sonic technique: SonicFill composite resin was applied in a bulk increment of 5 mm and the remaining millimeter was completed with Tetric N-Ceram. Following, impressions were taken with polyvinyl siloxane of the gingival interface and the molds pored with epoxy resin. The dies were taken out from the molds after the epoxy polymerization and then examined using electron microscopy. An additional tooth was vertically sectioned and the slices invested with epoxy resin, polished dried and prepared to be examined in SEM as well. Each restored tooth was sectioned perpendicular to the bonded area to obtain beams with a transversal bonding area of approximately 1 mm^2. The test was conducted in a testing machine at a crosshead speed of 0.5 mm/min until failure. Bi-dimensional finite element analysis was performed to correlate the tensions generated at the adhesive interface. The bond strength values showed that no statistical difference was found for Tetric N Ceram and Tetric Bulk fill before the thermo-mechanical cycling regardless the substrate type (dentin or enamel). Tetric N Ceram bond strength values were higher than SonicFill ($p<0.05$). There was no statistical difference between the bond strength of Tetric Bulk Fill and SonicFill. For the enamel, Tetric N Ceram exhibited the higher bond strength values than the other composites after thermo-mechanical cycling, and the Tetric Bulk Fill did not differ statistically from the SonicFill. For dentin after thermo-mechanical cycling there were no statistical differences between the composites. Bond strength values were higher for the enamel than the dentin after and before the thermo-mechanical cycling regardless the composite type. The thermo

mechanical cycling influenced the bond strength of composite resin to enamel and dentin; enamel resulted in bond strength values higher compared to dentin for all composite resin evaluated; dentin showed higher stress values compared to enamel; and the Sonic technique showed bubbles and discontinuity higher than the incremental and bulk fill techniques.

Keywords: Composite resins. Dental marginal adaptation. Dentin. Dental enamel.

LISTA DE TABELAS, GRÁFICOS E FIGURAS

LISTA DE ABREVIATURAS, SIGLAS E SÍMBOLOS

% - Porcentagem

mm – Unidade de Comprimento (milímetro)

mm^2 – Unidade de Área (milímetro quadrado)

m/s – Unidade de Velocidade (metro por segundo)

Kgf – Unidade de Força (quilograma-força)

J – Unidade de energia mecânica e térmica (Joule)

MPa – Força / Área (Mega Pascal)

min. – Unidade de Tempo (minutos)

JCE – Junção Cemento Esmalte

MEV – Microscopia Eletrônica de Varredura

MEF – Método Elementos Finitos

mW/cm^2 – Unidade de Intensidade de Luz/cm^2 (miliWatts por centímetro quadrado)

SUMÁRIO

1 Introdução

A aplicação de resinas compostas como material restaurador direto tem sido extensivamente realizado com sucesso clínico comprovado (PALLESEN & VAN DIJKEN, 2015; DEMARCO et al., 2012; HEINTZE & ROUSSON, 2012). Todavia, tecnicamente o emprego deste tipo de material não é simples e envolve vários passos clínicos que exigem do profissional conhecimento científico e habilidade (HERVÁS-GARCÍA et al., 2006). Por outro lado, quanto menor a quantidade de passos clínicos para a realização da restauração, menor será a possibilidade de erros (BAYRAKTAR et al, 2016). Neste sentido não somente as empresas de materiais odontológicos, quanto os profissionais tem trabalhado em materiais que exigem menos passos clínicos. Da mesma forma, os sistemas adesivos têm evoluído consideravelmente e atualmente há no mercado materiais com eficiência comprovada, bem como lançamento de materiais promissores (KEMALOGLU et al., 2015; ALEX G, 2015; PASHLEY et al., 2011; MANTZOURANI & SHARMA, 2013). Não tem sido diferente para as resinas compostas restauradoras e neste sentido o desenvolvimento das resinas compostas conhecidas como “Bulk Fill” trouxeram redução nos passos clínicos e simplificação dos procedimentos que tem resultados em grande interesse aos profissionais (FLURY et al., 2012; ZORZIN et al., 2015).

Há diferentes tipos de resinas compostas Bulk Fill no mercado com diferenças em composição, propriedades e métodos de aplicação. A literatura pertinente tem demonstrado resultados com alguma controvérsia tanto em trabalhos laboratoriais de ensaios estáticos, quanto dinâmicos (LEPRINCE et al., 2014; CZAC & ILIE, 2013; FLURY et al., 2014; VIDHAWAN et al., 2015;). As resinas compostas Bulk Fill podem ser indicadas em diferentes situações clínicas, todavia, restaurações mais complexas como do tipo classe II que envolvem término cervical em dentina podem ser consideradas uma boa indicação, pois com a técnica mais simplificada os resultados parecem promissores (FLURY et al., 2012).

Seria prudente pensar que um único incremento do ponto de vista de aplicação, resultaria em uma massa de material melhor distribuída sem presença de bolhas ou outras imperfeições. Por outro lado, a colocação de um incremento muito grande poderia resultar em falta de contato entre o material restaurador e as paredes da cavidade, o que certamente poderia ampliar a infiltração marginal e a degradação da margem gengival (ROSATTO et al, 2015).

Outra perspectiva seria que o processo de polimerização poderia ser diferente e um incremento muito espesso não permitiria a passagem de luz com eficiência, e alguns estudos têm mostrado resultados diferentes (GARCIA et al., 2014, BENETTI et al., 2015; JANG et al., 2015). Entretanto, por se tratar de material recente, poucas pesquisas sobre suas propriedades e desempenho clinico estão disponíveis. Desta forma, o objetivo deste estudo foi avaliar o efeito das ciclagens mecânica e térmica nas características interfaciais, resistência de união e distribuição de tensão entre diferentes resinas compostas e substratos dentais.

2 Objetivo

2.1 Objetivo geral

Avaliar o efeito da ciclagem mecânica e térmica nas características interfaciais, distribuição de tensão e resistência de união de dentes humanos restaurados com resinas compostas utilizando diferentes estratégias restauradoras.

2.2 Objetivo específico

Avaliar o efeito da ciclagem mecânica e térmica nas características interfaciais, resistência de união e distribuição de tensões entre resina composta incremental e Bulk Fill (incremento único) de acordo com os seguintes fatores em estudo:

1. Ciclagem térmica e mecânica
    a. Sem ciclagem
    b. Com ciclagem
2. Tipo de término
    a. Esmalte
    b. Dentina
3. Tipo de estratégia restauradora
    a. Tetric N-Ceram
    b. Tetric Bulk Fill
    c. SonicFill

3 Capítulo Único

EFFECT OF MECHANICAL AND THERMAL CYCLING IN THE INTERFACIAL CHARACTERISTICS, BOND STRENGTH AND STRESS DISTRIBUTION AMONG DIFFERENT COMPOSITE RESINS AND DENTAL SUBSTRATES

OPERATIVE DENTISTRY

Manuscript Type: Original Article

Title: Effect of Mechanical and Thermal Cycling in the Interfacial Characteristics, Bond Strength and Stress Distribution Among Different Composite Resins and Dental Substrates.

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Effect of Mechanical and Thermal Cycling in the Interfacial Characteristics, Bond Strength and Stress Distribution Among Different Composite Resins and Dental Substrates

Mechanical and thermal cycling effect in the interfacial and mechanical characteristics for the composite resins

Clinical relevance

The clinicians should be aware that even though the Bulk Fill composite resins are reliable and comparable to the conventional ones, some of them might be difficult to achieve a continuous interface.

SUMMARY

Objective: The aim of this study was to evaluate the effect of thermo mechanical cycling in the interface characteristics, bond strength and stress distribution in restored teeth with different composite resins.

Methods: Seventy-two sound human third molars were selected, cleaned and mounted in polystyrene cylinders to simulate the periodontal ligament using a polyether impression material. The teeth received cavity preparation (slot) with 6 mm occlusal-gingival direction by 4 mm wide labial-lingual direction and 2 mm deep mesial-distal direction. Half of the teeth had the gingival end in dentin and half in enamel. The teeth were divided into 12 groups in agreement with the different restorative techniques, thermal/mechanical cycling, and interfacial analysis. The resin composites applied in according to three different techniques: (1) Incremental technique: Tetric N-Ceram composite resin was applied in approximately 2 mm thickness increments, (2) Bulk Fill technique: Tetric N-Ceram Bulk Fill composite resin was applied in a bulk increment of 4 mm. The remaining millimeter was filled with Tetric N-Ceram, and (3) Sonic technique: SonicFill composite resin was applied in a bulk increment of 5 mm and the remaining millimeter was completed with Tetric N-Ceram. Following, impressions were taken with polyvinyl siloxane of the gingival interface and the molds pored with epoxy resin. The dies were taken out from the molds after the epoxy polymerization and then

examined using electron microscopy. An additional tooth was vertically sectioned and the slices invested with epoxy resin, polished dried and prepared to be examined in SEM as well. Each restored tooth was sectioned perpendicular to the bonded area to obtain beams with a transversal bonding area of approximately 1 mm². The test was conducted in a testing machine at a crosshead speed of 0.5 mm/min until failure.

Results: the bond strength values showed that no statistical difference was found for Tetric N Ceram and Tetric Bulk fill before the thermo-mechanical cycling regardless the substrate type (dentin or enamel). Tetric N Ceram bond strength values were higher than SonicFill ($p<0.05$). There was no statistical difference between the bond strength of Tetric Bulk Fill and SonicFill. For the enamel, Tetric N Ceram exhibited the higher bond strength values than the other composites after thermo-mechanical cycling, and the Tetric Bulk Fill did not differ statistically from the SonicFill. For dentin after thermo-mechanical cycling there were no statistical differences between the composites. Bond strength values were higher for the enamel than the dentin after and before the thermo-mechanical cycling regardless the composite type.

Conclusion: The thermo mechanical cycling influenced the bond strength of composite resin to enamel and dentin; enamel resulted in bond strength values higher compared to dentin for all composite resin evaluated; dentin showed higher stress values compared to enamel; and the Sonic technique showed bubbles and discontinuity higher than the incremental and bulk fill techniques.

INTRODUCTION

Composite resin as direct restorative material has been extensively used, and its clinical success has relied scientific based information.[1-3] However, the application of this kind of material requires some clinical steps, which demand not only clinical skills, but also a good scientific knowledge.[4]

Even though the steps to make a composite resin restoration are in some way identical, they increase the error bar. Thus, the smaller number of clinical steps, the lower the possibility of errors. In this way not only the dental materials companies, but also the practitioners have drew the attention to materials that require less steps.[5] Similarly, the adhesive systems have changed to try simplifying its application, and the adhesive systems showed different materials and techniques that have been studied and the results are pretty controversial among many types.[6-9] However, the adhesive systems that are considered gold standard and that have plenty of scientific support are the three steps etch & rinse and two steps self-etching.[10] In this sense, seems to be more appropriate to evaluate different composite restoration type of material using one of the gold standard adhesive systems.

Regarding to the restorative composite resin, the same behavior can clearly be seen in the pertinent literature, where clearly the tendency is to have materials with less steps and simpler procedures.[11] In this content the most important material to be launched in the market is called bulk fill composite resin that decreased the clinical steps and simplification in the procedures, which has brought great interest of the dentist.[12] There are many commercial bulk fill composite and they have some differences in composition, properties and method of application in agreement with the manufacturer's information.

It has been shown that Bulk-fill resin composites exhibit lower polymerization stress compared to composite resin using the incremental technique.[12,13] In this sense, it is important to evaluate the bond strength and its relation to the stress at the adhesive interface. Shrinkage stresses at the interface between the restoration and the tooth could be related to the polymerization rate of the material and stress from the polymerization contraction.[14] Furthermore, stresses generation is direct related to the composition and filler content of the resin composite. Degree of conversion and depth of cure could are also influenced by the composition of the material, and the bond strength is clearly dependent of these factors.[15] The stress at the interface and its relation to the bond strength in enamel and dentin could bring reliable information to the clinical application of these materials.

Laboratory and clinical studies have shown some controversial results that vary among the different Bulk Fill composite resins kinds and techniques.[16-19] Furthermore, as it is a recent launched kind of material, the most reliable studies are those of fatigue in laboratory and clinical those are not more than five years.[20] The bulk fill composites are indicated for different posterior restorations. It has been claimed that complex class II cavities with gingival wall ended in dentin is a reliable indication for the bulk fill.[20] Since an adhesive system correctly applied, considering the practitioner skills is pretty reliable, the variation of the restorative composite resin not only in composition, but also in the technique of application could result in a more reliable clinical application and maybe show the differences of clinical behavior of the composites.

Regarding to the composite resin technique of application, the literature has shown that a single bulk increment could result in a better stress distribution and that would bring a restoration with less bubble and discontinuity.[21] On the other hand, a placement of such a large bulk increment could result in contact failure between the composite and the adhesive layer. This could allow more bacterial infiltration, leakage as well as margin degradation. Other viewpoint is the polymerization procedure that even with the translucency of the bulk fills composites, could not be enough to allow the light to pass through and activate the material properly. In this sense some studies have shown controversial results.[22,23] As the bulk fill composites are recent materials, and its scientific evidence is not yet secure to have them applied, the aim of this study is to evaluate the effect of thermo mechanical cycling in the interface characteristics, stress distribution and bond strength among human teeth and different composite resins to gingival margins of class II restoration ended in enamel and dentin. The null hypotheses are that: 1- there will not have any statistical significant differences in bond strength and interface quality among the materials evaluated and 2 - there will be no statistical significant differences between the two substrate in bond strength and interface quality and 3 – the stress distribution among the materials and substrates would not have statistical significant difference.

MATERIALS AND METHODS

Teeth selection

Seventy-two sound human third molars were selected for this study in the surgery clinic of the Dental School at University of Uberaba after extraction. All patients signed an informed consent after approval from the Ethics Committee (56019916.8.0000.5145). The teeth were cleaned and disinfected in 0.5% chloramine T for 24 h and then stored in distilled water at 4 °C.

Root embedment and periodontal ligament simulation

The teeth were mounted individually in plastic tubes (Tigre, Rio Claro, SP, Brazil) and the root embedded in polystyrene resin (Aerojet, São Paulo, SP, Brazil) chemically activated 2 mm below the cement enamel junction (CEJ). To create the space to the resin the root surfaces were covered with wax (Lysanda, São Paulo, SP, Brazil) until 2 mm below the CEJ. The wax was heated at 63º C to allow an approximately 0.3 mm thickness.

X-ray film X (Kodak, New York, EUA) with a circular central hole of 5 mm was used to stabilize the teeth at the correct position. This set was placed upside down on a wood plate, and a P.V.C cylinder (Tigre, São Paulo, SP, Brazil) with 20 mm in diameter was fixed hot wax. The polystyrene resin was mixed in agreement to the manufacturer’s instructions and poured into the tube. After the polymerization of the polystyrene, the teeth were removed from the P.V.C cylinder and the wax removed from the root surface. The wax was removed and an alveolus was present in the polystyrene cylinder. A polyether impression material (Impregum, 3M, Seefeld, Germany) was mixed and used to create the artificial periodontal ligament, being its excess removed with a scalpel blade.

Cavity preparation and restorative procedure

A vertical class II slot cavity was prepared at the mesial face of all selected teeth measuring, 4 mm wide buccal-lingual, 2 mm deep distal-mesial and 6 mm occlusal-gingival, from the highest cusp. The tooth preparations were carried out in order to obtain two types of gingival prep ends: enamel and dentin gingival ends. To the dentin gingival end it was necessary the wear of cusp using carbide paper disc in a metallographic politrix APL-4 (Arotec, Cotia, SP, Brazil). The cavities were prepared in a device especially developed that standardizes the preparation with diamond burs (#2096, KG Sorensen, Barueri, SP, Brazil) under abundant water refrigeration. Each diamond bur was replaced after five-cavity preparation.

All prepared teeth were adequately cleaned and dried before being divided into 12 groups in agreement with the different restorative techniques, thermal/mechanical cycling, and interfacial characteristics of dental substrates. Before the restoration placement a metallic matrix band was carefully placed in the proximal of all teeth to allow a correct insertion of the composites without cervical excess. For all groups the adhesive Clearfill SE Bond (Kuraray Co. Ltd., Osaka, Japan) was applied following the manufacturer’s instructions. When the gingival limit ends in enamel a selective etching was carried out with 35% phosphoric acid (Ultradent, South Jordan, EUA) before the adhesive application.

The resin composites applied in according to three different techniques: (1) Incremental technique: Tetric N-Ceram composite resin (Ivoclar/Vivadent, Schaan, Liechtenstein) was applied in approximately 2 mm thickness increments and photo-activated with a curing unit (Radii Cal, SDI, Australia) having a output of 400 mW/cm^2 for 40 s to get 16.000 mJ of energy (the curing unit was checked after each restoration), (2) Bulk Fill technique: Tetric N-Ceram Bulk Fill composite resin (Ivoclar/Vivadent, Schaan, Liechtenstein) was applied in a bulk increment of 4 mm and photo-activated the same way as in incremental technique. The remaining millimeter was filled, sculptured and photo-activated with Tetric N-Ceram, and (3) Sonic technique: SonicFill composite resin (Kerr, Orange, USA) was applied in a bulk increment of 5 mm and photo-activated the same way as in incremental technique. Following, the remaining millimeter was completed and photo-activated with Tetric N-Ceram (Table 1).

The restorative teeth with different techniques were divided in according to the thermal/mechanical cycling presence or not, and the interfacial analysis with enamel or dentin cervical ends. Bond strength test and SEM were carried out to 12 experimental groups (Figure 1).

Thermo-mechanical cycling

The restored teeth that were submitted to thermal/mechanical cycling received 60.000 thermo cycles (5°/55°C) in a specific machine MSCT-3 (Marcelo Nucci ME, São Carlos, SP, Brazil) (5º – 55º, 15 s dwell time). A total of 100.000 mechanical cycles were carried out in a mechanical cycling machine (Odeme, Luzerna, SC, Brazil), with 50N load and 2Hz frequency, which was applied at the occlusal face of the restoration.

Interface analysis by scanning electron microscopy (SEM analysis)

The interface (cervical end) of one tooth within each group was impressed with polyvinyl siloxane (Virtual, Ivoclar/Vivadent, Schaan, Liechtenstein), and the molds were pored with epoxy resin (Buehler, Lake Bluff, EUA). Following the polymerization of the epoxy resin, the dies were removed from the molds, coded and fixed in brass stubs, then gold coated with a sputter coater (Balzers-SCD 050; Balzers Union Aktiengeselischaft Furstentun, Liechtentein) for 180 seconds at 40 mA. They were then examined using electron microscopy (LEO 435 VP; Cambridge, England) operated at 20 Kv, by the same operator.

Microtensile Bond strength test (µTBS)

Each restored tooth was sectioned perpendicular to the bonded area to obtain beams with a transversal bonding area of approximately 1 mm^2 using a water-cooled diamond blade (Buehler Corporation, Enfield, USA) in a low speed saw machine (Isomet 1000, Buehler, Lake Bluff, USA). Each tooth generated an average of 3 beams, for a total of 18 beams per group. Within each sub-group each beam was fixed to the grips of a microtensile device using a cyanoacrylate adhesive (Odeme, Dental Ventures of America Inc., Corona, CA, USA) and the test was conducted in a testing machine (EMIC 3000, São José dos Campos, PR, Brazil) with a load cell of 50 kgf at a crosshead speed of 0.5 mm/min until failure. Bond strength values were calculated in MPa.

Finite element analysis

Two-dimensional finite element models were created following the study factors: composite type and substrate (enamel or dentin) (Figure 2). Two teeth from the experimental test (enamel and dentin gingival end) were longitudinally sectioned (Figure 2A). The teeth image were imported to an image processing and analysis software ImageJ (National Institute of Mental Health, Bethesda, EUA) (Figure 2B) for tracing outlines of the dental structures and root embedment. The obtained coordinates were transferred to the software MSC Marc/Mentat (MSC Software Co, Los Angeles, USA). Through these coordinates cubic-splines were created to get the right contour of the tooth structures (Figure 2C). Two models were created following the enamel (Figure 2D) and dentin gingival (Figure 2E) end and restored with composite resin. The element mesh was manually created using four-node isoparametric arbitrary quadrilateral plane-strain elements with reduced integration which is the element number 115 from the Marc/Mentat element library (Figure 2F). The nodes on the base of the root embedment were rigidly fixed in the X and Y directions (Figure 2F). A metallic load tip was modeled with the same dimensions as used in the mechanical cycling and a 100N load was applied. All materials were considered linear, isotropic and homogeneous and the mechanical properties (Elastic modulus, Poisson's ratio, and compressive and tensile strength were collected through literature review (Table 2). Each model was solved in Marc. Stresses at the adhesive interface were analyzed using modified Von Mises criteria. At the end of the load application, the stresses at the adhesive interface (composite/tooth) were collected at the selected interfacial nodes (Figure 2G and 2H). The mean stress at the interfacial nodes and standard deviation were calculated and correlated to the microtensile bond strength test.

Statistical Analysis

To evaluate whether there was a difference in the mean values for the composite resin, substrate variation (enamel and dentin), and cycling condition, three-way analysis of variance (ANOVA) was applied. When ANOVA indicated a statistically significant difference in the mean values of the dependent variable, the multiple comparisons Games-Howell test for heterogeneous variances was applied, since the Levene test showed heterogeneous variances among the analyzed factors. The significance level for all tests was set at $\alpha = 0.05$.

RESULTS

Micro tensile Bond strength test (μTBS)

The bond strength (μTBS) results are shown in the table 3 and graph 1. The three-way ANOVA test showed statistical differences among the conditions evaluated and a significant interaction between the composite resin type and the substrate as well as cycling conditions ($p<0.05$). The Games-Howell test demonstrated statistical differences among the composite resins. No statistical difference was found for Tetric N Ceram and Tetric Bulk fill before the thermo-mechanical cycling regardless the substrate type (dentin or enamel). Tetric N Ceram bond strength values were statistical superior than SonicFill ($p<0.05$). There was no statistical difference between Tetric Bulk Fill and SonicFill. Tetric N Ceram exhibited the higher bond strength values than the other composites after thermo-mechanical cycling and enamel substrate. Tetric Bulk Fill did not differ statistically from the SonicFill ($p<0.05$). On the other hand, for the dentin substrate after thermo-mechanical cycling there were no statistical differences between the composites.

Bond strength values were higher for the enamel substrate than the dentin substrate after and before the thermo-mechanical cycling regardless the composite type ($p<0.05$).

Stress: Finite Element Analysis

The results showed higher interfacial stress values for the dentin substrate regardless the composite type ($p<0.05$). On the other hand, lower interfacial stresses were observed for the enamel substrate. The higher stress values in the dentin interface could be related to the lowest bond strength values showed in the experimental μTBS test after the thermo-mechanical cycling. The highest interfacial stress were observed for the SonicFill composite (graph 2), on the other hand, the SonicFill composite exhibited the lowest μTBS (MPa), regardless the substrate (enamel and dentin). Tetric N Ceram exhibited a slightly higher interfacial stress value than Tetric bulk fill ($p<0.05$).

Scanning Electron Microscopy (SEM)

Illustrative SEM images, showing the interface quality, are shown in Figures 3 through 8. (the cracks are in consequence of the vacuum formed in scanning electron microscopy chamber).

DISCUSSION

In vitro testing of the of interfacial bond strength has long been performed in marginal sealing and μTBS studies is one of the most used tests and it has been stated that the test could predict the reliability of these bonds clinically.[24,25] Artificial aging thermal cycling and mechanical load cycling has been used to mimic oral environmental conditions, as well. [26] On the other hand scanning electron microscopy has also been used to show the integrity of the interface of composite to the tooth structures.[27]

The bond strength of the different composite resins on the different substrates showed some results statistically different and they were also partially affected by the thermo cycling, and these results rejected partially the null hypothesis of the study. In this sense some studies have shown similar outcomes that corroborate with the present ones.[28,29] For the enamel substrate all the composite resins studied presented bond strength values without statistically significant differences before and after thermo cycling. This could be explained by the stable properties of the enamel substrate [30] and the use of the two steps self-etching adhesive, once the same adhesion strategy was applied to all composites.[31] Regarding to dentin substrate, the same was observed where no statistically significant was found before and after the thermo mechanical cycling. However, this substrate showed lower bond strength values statistically significant compared to enamel in both situations, before and after the cycling (table 1). As dentin is a more variable substrate with much more moisture and difficulties to get a reliable bond,[32,33] even the hybrid layer was present; it was not comparable to the enamel results. It could be inferred that the adhesive itself played a more important role than the composites. Moreover, the SonicFill resulted in lower bond strength values in most situations compared to the other composite resins evaluated. This could be explained by the bubbles presented at the interface of this material compared to the others that was seen in scanning electron microscopy analyses (figures 6 and 7).

It has been shown that continuous and fast polymerization can cause an increase in discontinuity of the interface between composite resin and dental structure.[34,35] In the present study the photo-activation was performed the same way to all materials and the light was applied with the total intensity since the beginning of the process. As only the SonicFill composite resin showed discontinuity, it could be though that the polymerization was not the problem, once the others composites demonstrate a very good interface.

The manufacturer claims that the SonicFill composite resin system, have a depth of cure of 5 mm. It has a specific handpiece that provides sonic energy at different intensities that facilitates the placement of the composite resin. As the sonic energy is applied through the handpiece, the built-in modifier causes the viscosity to decrease (up to 87%) during the insertion of the composite resin. [36] When the sonic energy is interrupted, the composite resin returns to a more viscous state, suitable for sculpturing. The manufacturer claims that this helps to fill a large cavity without bubbles. Nevertheless, the restorative procedure with the SonicFill system seems more difficult and even an operator with skills could have difficulties to control the flow of the material using the ultrasonic device.[36] Furthermore, for practitioners that are still beginners, a very careful training should be done before performing clinical restorations.

The finite element analysis shows that the dentin substrate has higher interfacial stress compared to enamel. This higher stress values in the dentin interface could be correlated to the lowest bond strength values showed in the experimental μTBS test after the thermo-mechanical cycling. The highest interfacial stress was observed for the SonicFill composite, on the other hand, the SonicFill composite exhibited the lowest μTBS (MPa), regardless the substrate (enamel and dentin). Tetric N Ceram exhibited a higher interfacial stress value than Tetric bulk fill. The stress values could be explained by the mechanical dissimilarity between enamel and dentin.[37, 38]

However, for both substrates if adhesion is not strong enough, gap and interfacial discontinuity will be formed which will lead to failure of the restorative procedure in service, such as fractures and secondary caries.[39, 40] Thus, it seems worth to say that dentin substrate would have more problem in its lifetime regardless to the composite resin evaluated. On the other hand, it is known that placement techniques are important factors in modifying the shrinkage stresses and the magnitude of the stress is mediated by the modulus of elasticity of the composite resin, its ability to relieve these stresses, its conversion rate and the compliance applied by adhesion to the walls of the cavity. However, volumetric shrinkage during polymerization of components in combination with effective adhesion to rigid dental tissues results in strain transfer and internal deformation of the walls of the restored tooth. In this viewpoint I could be implied that the Bulk fill materials are pretty reliable, even compared to the conventional ones, however, the technique of insertion of the SonicFill composite is much more concerning if the practitioner is not enough trained.

CONCLUSIONS

Despite the limitations of this in vitro study, it can be concluded that:

1. Thermo mechanical cycling influenced the bond strength of composite resin to enamel and dentin;
2. Enamel resulted in bond strength values higher compared to dentin for all composite resin evaluated;
3. The dentin substrate showed higher stress values compared to enamel; and
4. The Sonic technique showed bubbles and discontinuity higher than the incremental and bulk fill techniques.

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Table 1. Composite Materials Used in This Study and Their Composition [a]

Product	Manufacturer	Base resin	Filler (wt/vol%)
Tetric N-Ceram	Ivoclar Vivadent, Schaan, Liechtenstein	Bis-GMA, Bis-EMA, UDMA	81/57
Tetric N-Ceram Bulkfill	Ivoclar Vivadent, Schaan, Liechtenstein	Bis-GMA, Bis-EMA, UDMA	77/55
SonicFill	Kerr, West Collins, Orange, CA, USA	Bis-GMA, TEGDMA, EBPDMA	83/68

[a] Composition of base resin and filler content are from manufacturer's information.

Abbreviations: BIS-GMA, bisphenol A dimethacrylate; BIS-EMA, bisphenol A polyethylene glycol diether dimethacrylate; UDMA, urethane dimethacrylate; TEGDMA, triethyleneglycol dimethacrylate; EBPADMA, ethoxylated bisphenol A dimethacrylate.

Table 2: Mechanical properties applied for dental materials and structures.

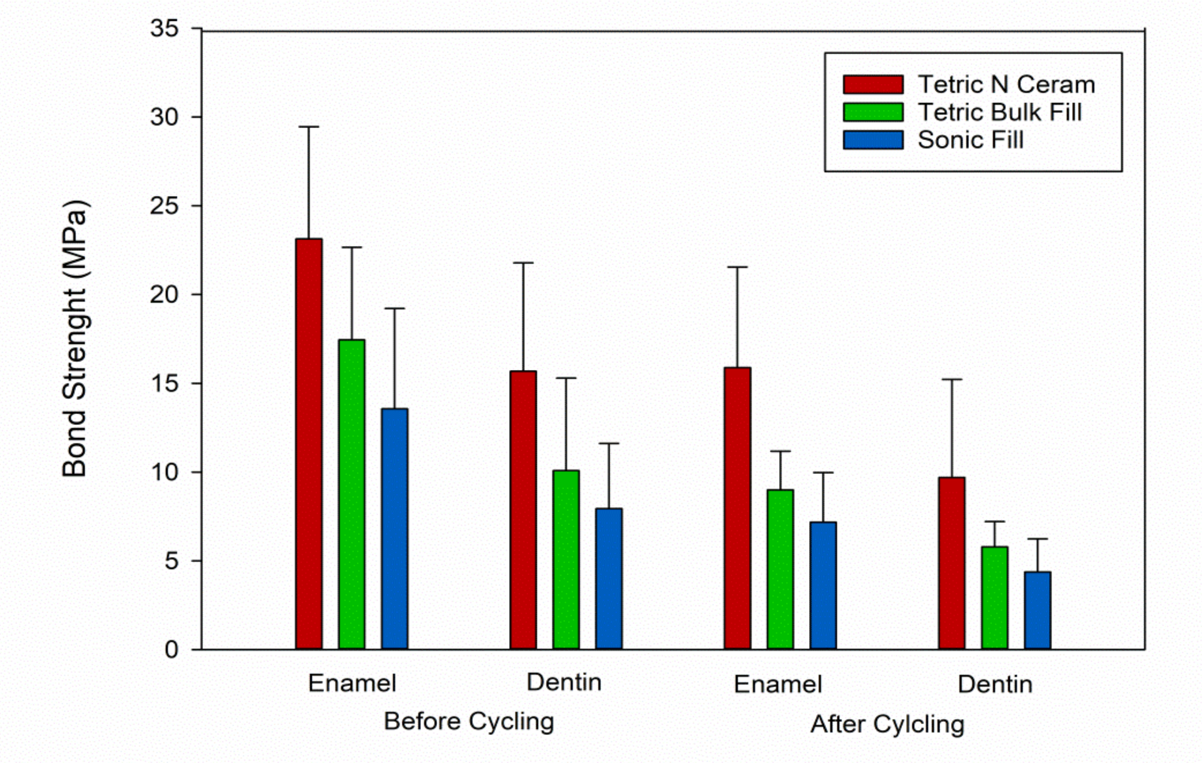
Structure	Elastic Modulus (MPa)	Poisson's ratio	Compressive Strength (MPa)	Tensile Strength (MPa)
Enamel	84.100	0.30	384.0	10.3
Dentin	18.600	0.30	297.0	98.7
PDL (polyether)	50	0.45	-	-
Polystyrene resin	13.500	0.31	-	-
Tetric-N-Ceram	10.800	0.24	224.0	63.3
Tetric-N-Ceram Bulk Fill	5.300	0.24	267.24	39.5
SonicFill	8.600	0.24	254.0	77.6

Table 3: Bond strength (MPa) (Mean and Standard deviation (SD)) of the composite resins evaluated in different substrates before and after thermo-mechanical cycling.

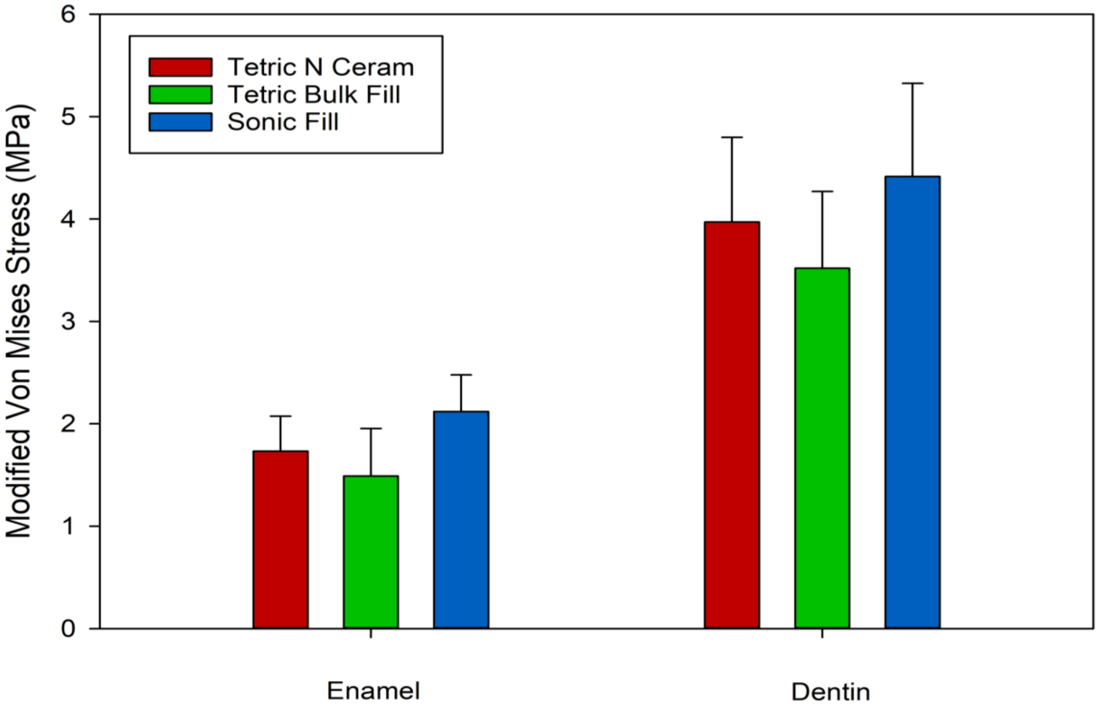
Composite type	Micro tensile Bond strength (MPa)							
	Before thermo-mechanical cycling				After thermo-mechanical cycling			
	Enamel		Dentin		Enamel		Dentin	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Tetric N Ceram	23.13aA	6.32	15.68aB	6.10	15.88aA	5.67	9.70aB	5.52
Tetric Bulk Fill	17.45abA	5.21	10.08abB	5.21	9.00bcA	2.18	5.79aB	1.42
SonicFill	13.55bA	5.66	7.94bB	3.67	7.18cA	2.79	4.37aB	1.87

* Means followed by the same lowercase letters within each column and uppercase letters within the row indicate no statistical difference at the 95% confidence level ($p < 0.05$), based on Games-Howell's multiple parametric comparison test for heterogeneous variances.

Graph 1: Bond strength of the composite resins evaluated in enamel and dentin with fatigue and without fatigue for the composite resins evaluated (Mean and standard deviation)



Graph 2: Interfacial stresses by modified Von Mises (MPa) after 100N load application.



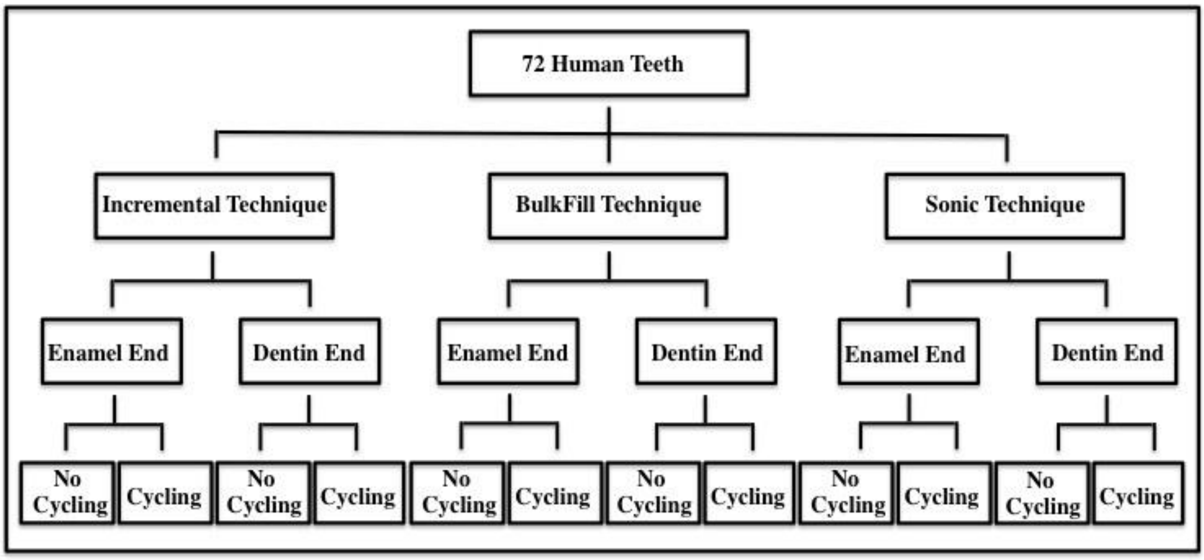


Figure 1. Teeth divided into 12 groups in agreement with the different restorative techniques, thermal/mechanical cycling, and interfacial characteristics of dental substrates.

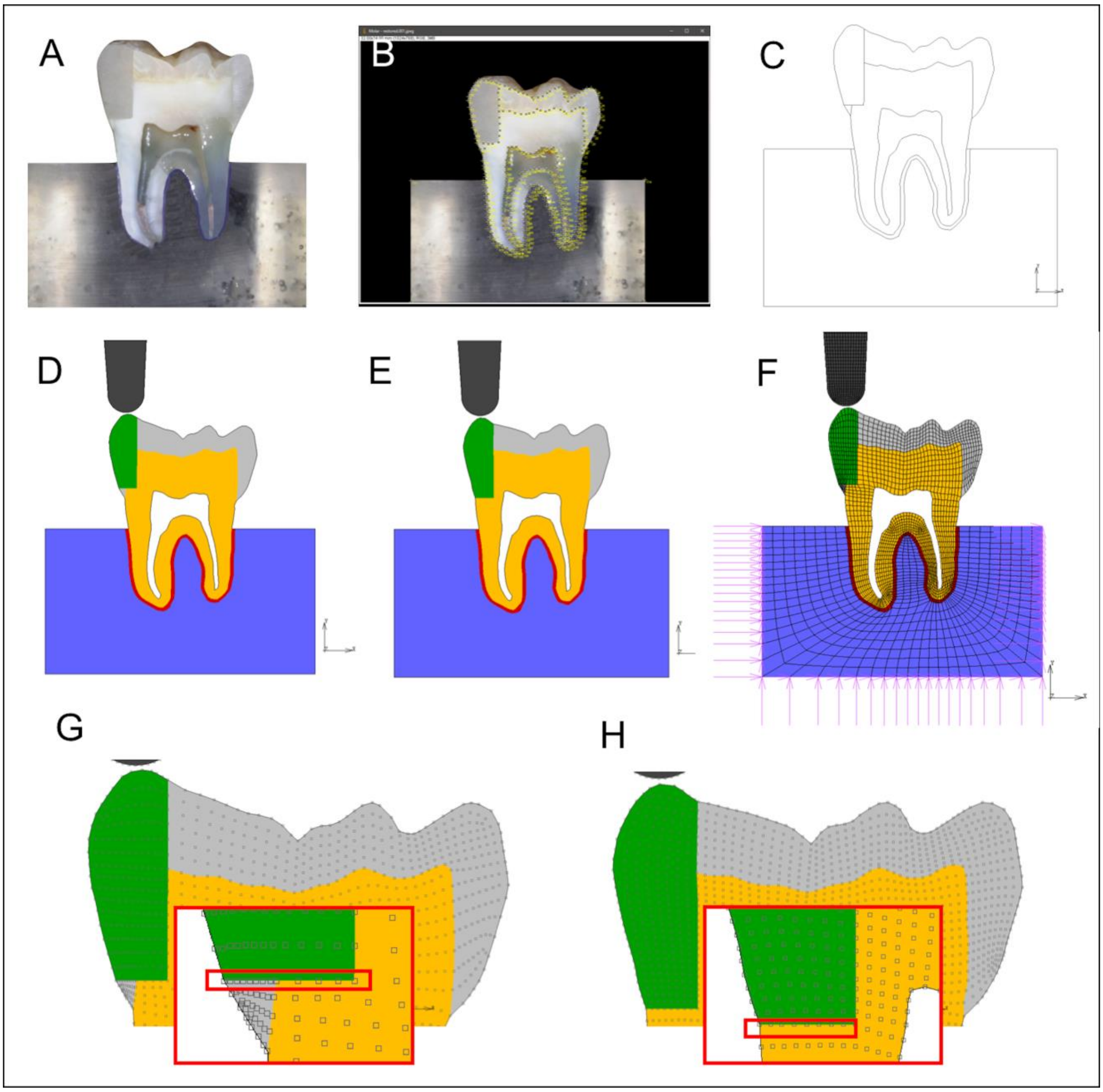


Figure 2. Two-dimensional finite element analysis. (A) Longitudinal cross-section of the selected tooth with enamel gingival end; (B) coordinate points imported to the imageJ; (C) cubic splines created of the tooth structure and root embedment; (D) two-dimensional model of the enamel gingival end model; (E); two-dimensional model of the dentin gingival end model; (F) Finite element mesh and fixed displacements at X and Y axis; (G and H) interfacial nodes selected for stress analysis.

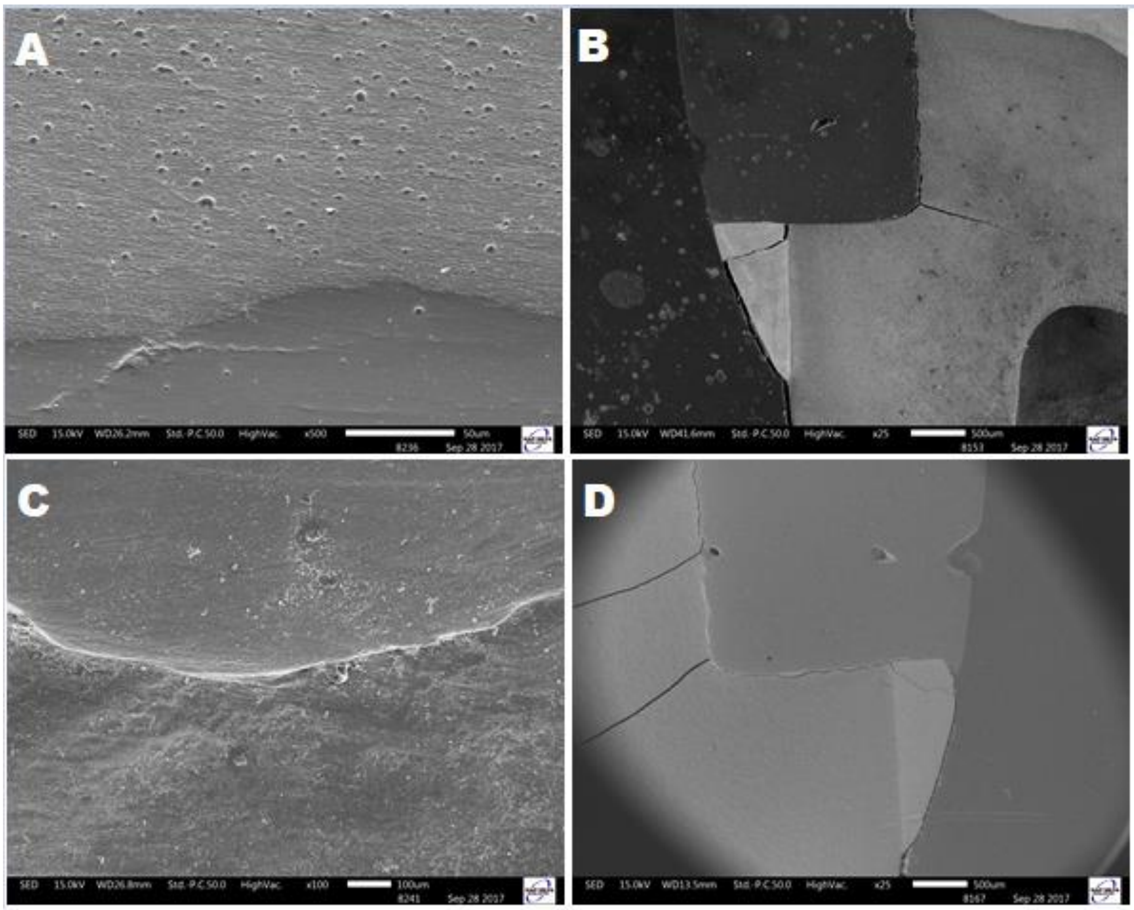


Figure 3. Scanning electron microscopy of the interface between Tetric-N-Ceram composite resin and enamel end. A (500x) and B (25x) showing the interface before the thermo mechanical cycling. A is external marginal view and B lateral view. C (100x) and D (25x) show the interface after thermo mechanical, being C external marginal view and D lateral view.

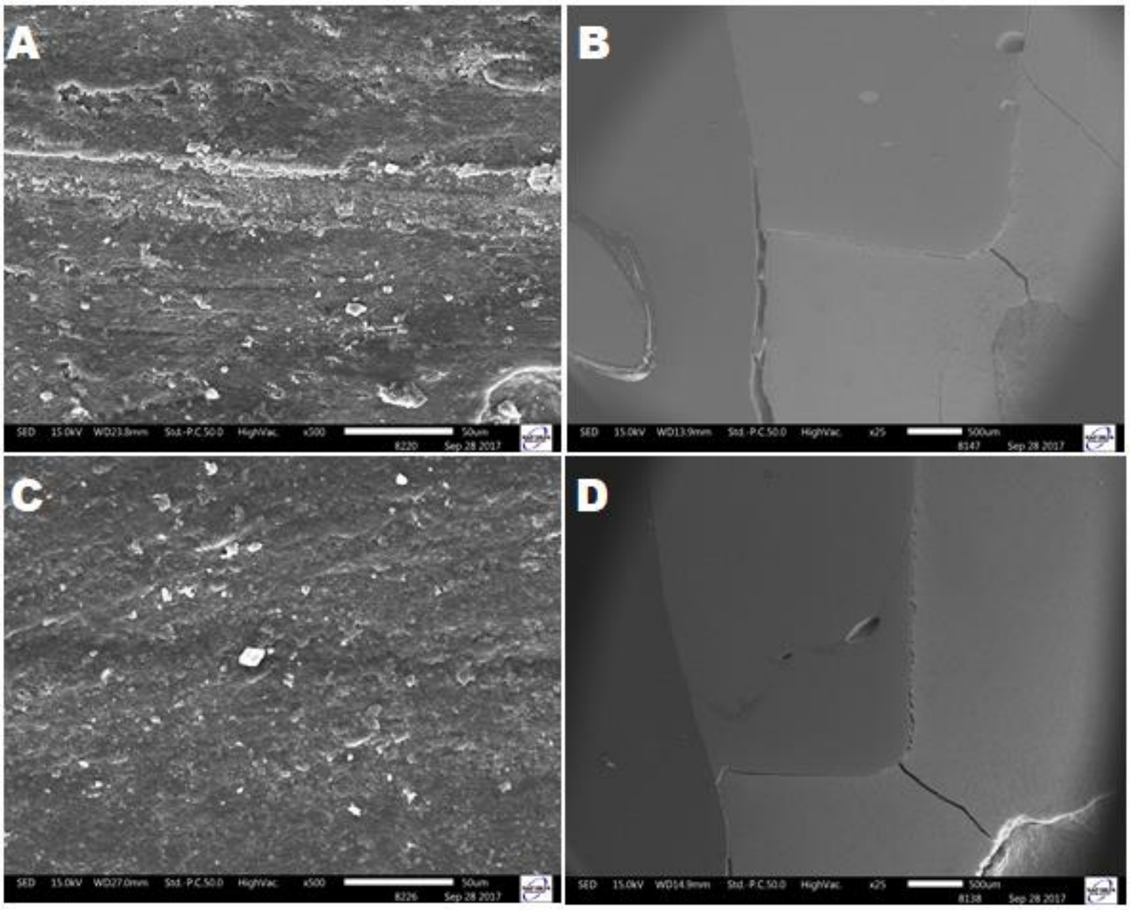


Figure 4. Scanning electron microscopy of the interface between Tetric-N-Ceram composite resin and dentin end. A (500x) and B (25x) showing the interface before the thermo mechanical cycling. A is external marginal view and B lateral view. C (100x) and D (25x) show the interface after thermo mechanical, being C external marginal view and D lateral view.

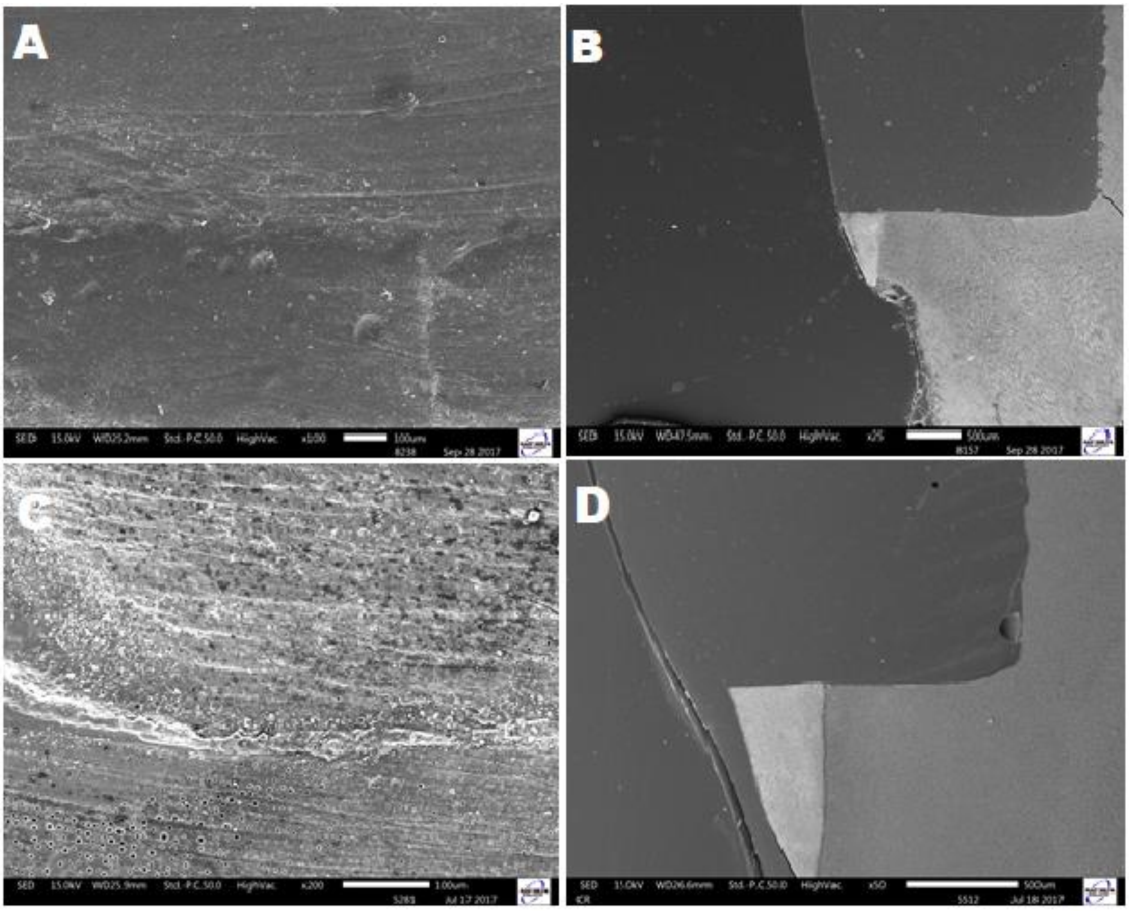


Figure 5. Scanning Electron Microscopy of the adhesive interface between Tetric-N-Ceram Bulk-Fill composite resin in enamel end. A (100x) and B (25x) show the interface before thermo mechanical cycling, being A an external interface view and B a lateral view. C (100x) and D (25x) show the interface after thermo mechanical cycling, being C a external interface view and D a lateral view

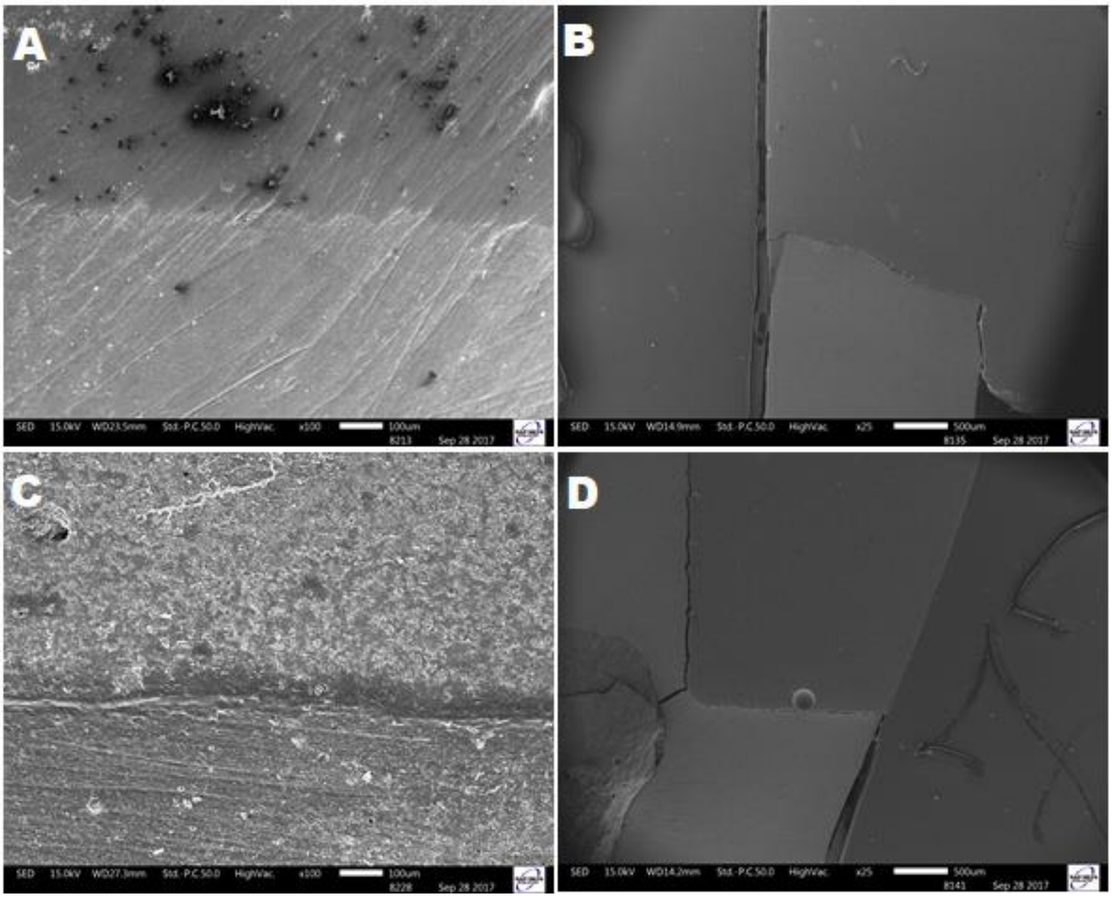


Figure 6. Scanning Electron microscopy of the Interface between composite resin Tetric-N-Ceram Bulk-Fill in dentin end. A (100x) and B (25x) show the interface before thermo cycling, being A an external interface view and B a lateral view. C (100x) and D (25x) the interface after thermo cycling, being C an external interface view and D a lateral view.

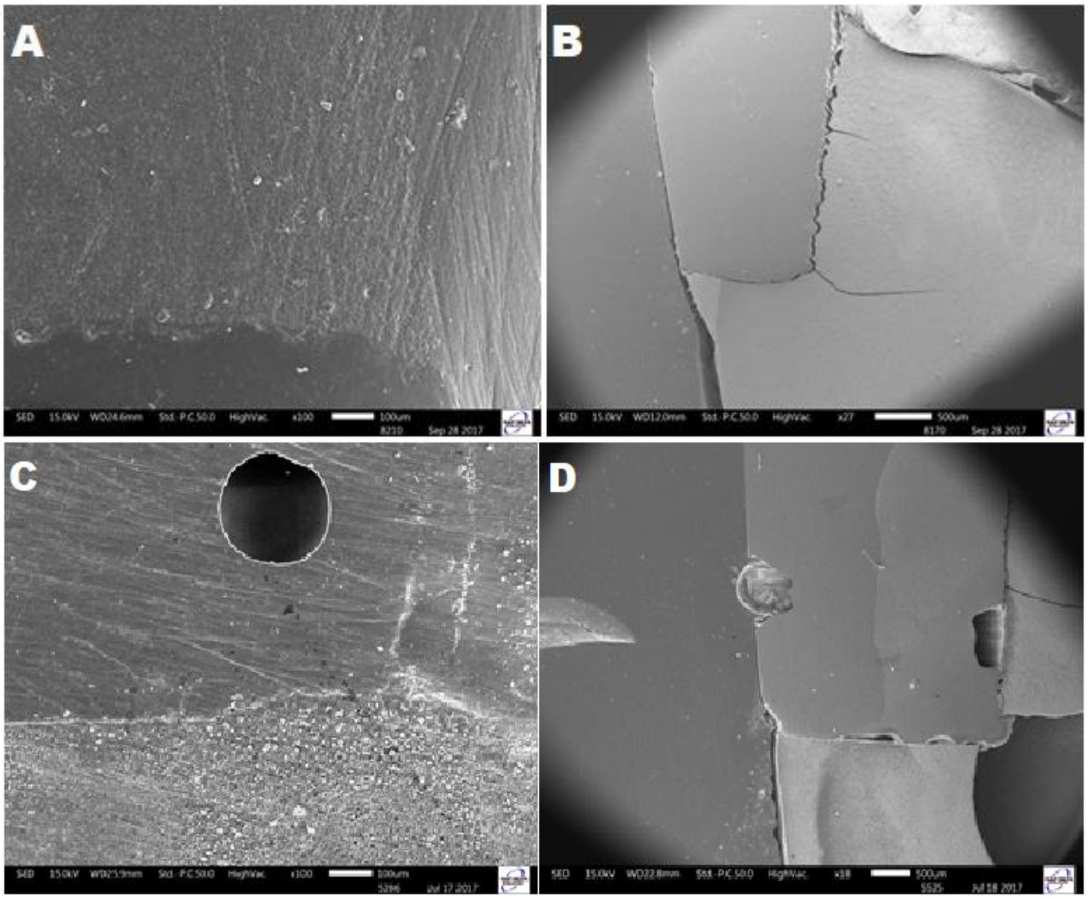


Figure 7. Scanning Electron microscopy of the Interface between composite resin SonicFill in enamel end. A (100x) and B (27x) show the interface before thermo cycling, being A a external interface view and B a lateral view. (100x) And D (25x) the interface after thermo cycling, being C an external interface view and D a lateral view.

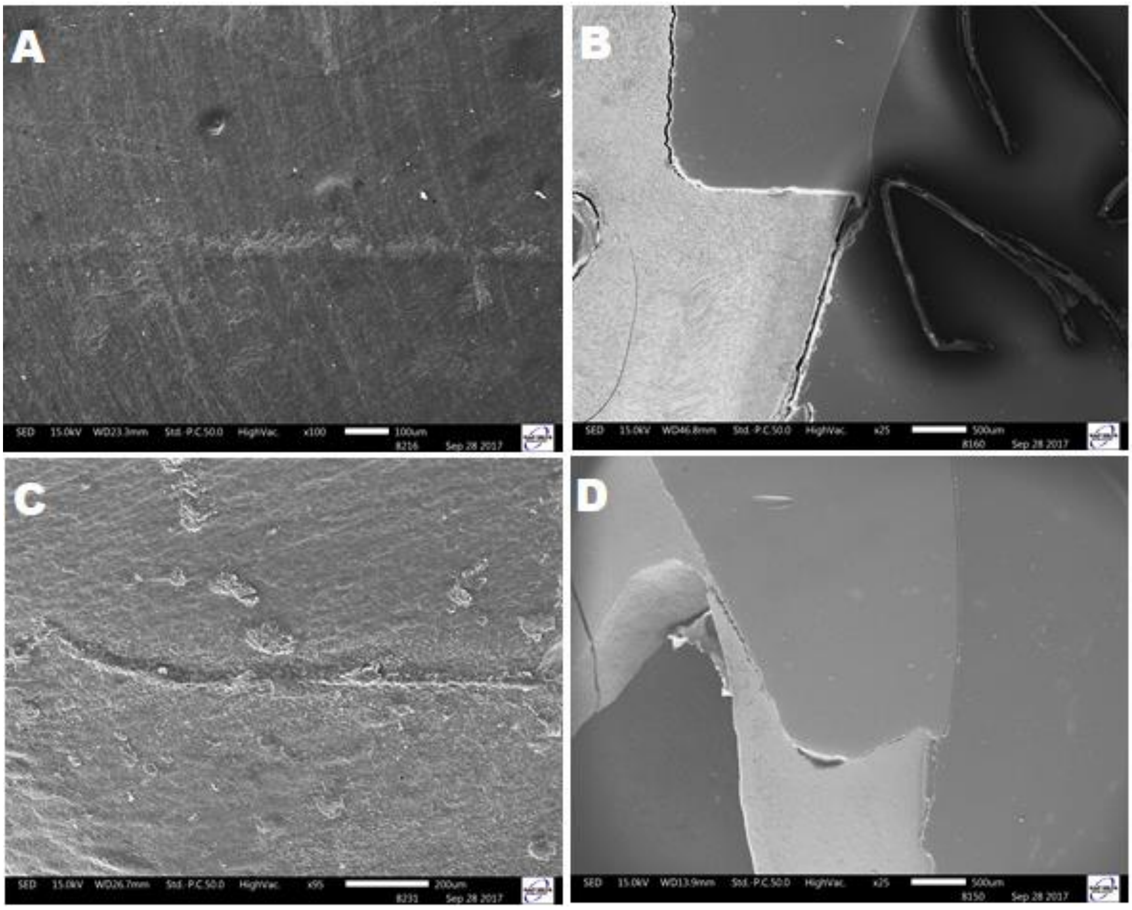


Figure 8. Scanning Electron microscopy of the Interface between composite resin SonicFill in dentin end. A (100x) and B (27x) show the interface before thermo cycling, being A an external interface view and B a lateral view. (100x) And D (25x) the interface after thermo cycling, being C an external interface view and D a lateral view.

4 Conclusão

Apesar das limitações deste estudo in vitro, pode-se concluir que a ciclagem térmica e mecânica influenciou a resistência de união da resina composta ao esmalte e à dentina; o esmalte resultou em valores de resistência de união superiores em relação à dentina para todas as resinas compostas avaliadas; a dentina mostrou maiores valores de tensão em relação ao esmalte e a técnica Sonic mostrou bolhas e descontinuidades maiores do que as técnicas incremental e Bulk Fill.

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Anexos

ANEXO A. NORMAS DE PUBLICAÇÃO DA REVISTA OPERATIVE DENTISTRY

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- 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 upon acceptance through quality control. This may take up to 7 days. If you do not receive such an acknowledgement, please check your author homepage at http://jopdent.allentrack.net if the paper does not appear there please resend 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 and/or .doc(x) files.

Manuscript Type Requirements

All Manuscripts

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.

AUTHOR INFORMATION must include:

- full name of all authors
- complete mailing address for each author

- valid email address for each author
- degrees (e.g. DDS, DMD, PhD)
- affiliation (e.g. Department of Dental Materials, School of Dentistry, University of Michigan)

MENTION OF COMMERCIAL PRODUCTS/EQUIPMENT must include:

- full name of product
- full name of manufacturer
- city, state and country of manufacturer

MANUSCRIPTS must be provided as Word for Windows files. Files with the .doc and .docx extensions are accepted.

TABLES may be submitted as either Word (.doc and .docx) or Excel (.xls and .xlsx) files. All tables must be legible, with fonts being no smaller than 7 points. Tables have the following size limitations: In profile view a table must be no larger than 7 x 9 inches; landscape tables should be no wider than 7 inches. It is the Editor's preference that tables not need to be rotated in order to be printed, as it interrupts the reader's flow.

ILLUSTRATIONS, GRAPHS AND FIGURES must be provided as **TIFF** or high resolution **JPEG** files with the following parameters:

- **line art** (and tables that are submitted as a graphic) must be sized with the short edge being no shorter than 5 inches. It should have a minimum resolution of 600 dpi and a maximum resolution of 1200 dpi. This means the shortest side should be no smaller than 3000 pixels.
- **gray scale/black & white figures** must be sized with the short edge being no shorter than 5 inches. It should have a minimum resolution of 300 dpi and a maximum of 400 dpi. This means the shortest side should be no smaller than 1500 pixels.
- **color figures and photographs** must be sized with the short edge being no shorter than 3.5 inches. It should have a minimum resolution of 300 dpi and a maximum of 400 dpi. This means that the shortest side should be no smaller than 1050 pixels.

Other Manuscript Type – Additional Requirements

CLINICAL TECHNIQUE/CASE STUDY MANUSCRIPTS must include as part of the narrative:

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

LITERATURE AND BOOK REVIEW MANUSCRIPTS must include as part of the narrative:

- 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 and will not be published
- references (see below)

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.

9. References that contain Crossref.org's DOIs (Digital Object Identifiers) should always be displayed at the end of the reference as permanent URLs. The prefix http://dx.doi.org/ can be appended to the listed DOI to create this URL. i.e. http://dx.doi.org/10.1006/jmbi.1995.0238

Reference Style Guide

- 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
- Journal Article with DOI: SA Feierabend, J Matt & B Klaiber (2011) A Comparison of Conventional and New Rubber Dam Systems in Dental Practice. Operative Dentistry 36(3) 243-250, http://dx.doi.org/10.2341/09-283-C

Author Rights

Authors of accepted manuscripts will be given access to a .pdf of their published version.

Author acceptance letters give the right to the author to make unlimited prints of the manuscript. Authors may not share the electronic file. Those authors who are required to post a copy of their manuscript to a University, or Government repository due to professional or funding contract stipulations, may do so after receipt of the article as stated above; and after notifying Operative Dentistry, Inc. (at editor@jopdent.org) of their intent to post, and to what repository it will be posted, as well as the URL at which it will appear. Authors may post their articles to their own professional website as well. Any electronic postings should contain the appropriate copyright statements as listed in this manual (under “copyright”).

Reviewers and the Reviewer Board

The list of current Reviewer Board Members will be printed in issue 6 of each volume in a manner that will allow the reviewer to remove the pages for use in professional folders.

Reviewer Board members serve as the primary source for peer review of submitted manuscripts, and are invaluable to us. In order to be as efficient as possible for everyone, Reviewers are required to update the online review system with current email address, areas of interest, and dates when unavailable for review. Every effort is made to limit review requests of new manuscripts. It will be assumed that members who repeatedly fail to respond with acceptance or regrets to requests for review will be removed from the Reviewer Board. Should a reviewer's circumstance change to where they are no longer able or willing to review, we request that a notice be sent to our offices at editor@jopdent.org.

Reviewer Board Members can expect to be asked to review to completion no more than 6 (original) manuscripts a year, and to participate in the annual Reviewer Board Meeting, whether in person, or by proxy. The following items apply to all reviewers for Operative Dentistry:

- Jopdent must have a CV and current email address on file – the CV is due by the last day of September in the year in which the reviewer completed a review (in order to be recognized in issue 6). It should be updated by the reviewer upon any significant change.
- To be considered for the RB, a reviewer must have 3 or more published articles in internationally recognized journals in which the reviewer was either a corresponding author or 1st author on at least one article.
- A reviewer with "no response" for every request made in a calendar year will be dropped from the RB.
- A reviewer who completed 0 reviews in a calendar year citing, "time constraints" will be removed from the Reviewer Board. Inopportune requests can be prevented by having reviewer availability dates current.
- A reviewer who cites, "conflict of interest" to either decline or withdraw from a review will not be charged for a declined review.

Conflicts of Interest

OpDent believes in the free market and that it is in the best interest of the profession for the market to give back generously to those groups who promote continuing education of those professionals. There must be clear guidelines and expectations however, so that the goodwill and generosity of the Market do not taint the educational activities with bias, real or imagined. To this end we have adopted the following policies and guidelines.

Commercialism

To those who **advertise** in any medium at any activity where Operative Dentistry, Inc. is acting as the administrative authority for continuing education, whether as sole authority, or in joint sponsorship, the following guidelines must be observed:

1. Program topic selection will be based on perceived needs for professional information and not for the purpose of endorsing specific commercial drugs, materials, products, treatments, or services.
2. Funds received from commercial sources in support of any educational programs shall be unrestricted and the planning committee of said program shall retain exclusive rights regarding selection of presenters, instructional materials, program content and format, etc.
3. Promotional material or other sales activities are not allowed in the area of instruction, neither in the lecture hall/operatory nor in close proximity to the doors of said areas.

Commercial Support

To those who provide monetary support for any activity where Operative Dentistry, Inc. is acting as the administrative authority for continuing education, whether as sole authority, or in joint sponsorship, the following guidelines must be observed:

1. Program topic selection will be based on perceived needs for professional information and not for the purpose of endorsing specific commercial drugs, materials, products, treatments, or services.
2. Funds received from commercial sources in support of any educational programs shall be unrestricted and the planning committee of said program shall retain exclusive rights regarding selection of presenters, instructional materials, program content and format, etc.
3. Any and all commercial support received shall be acknowledged in program announcements, brochures, and in the on-site program book. This announcement may

not be located on any page, or facing page, of the book announcing program speakers, or program evaluations.

4. Commercial support shall be limited to:
    a. The payment of reasonable honoraria;
    b. Reimbursement of presenters' out-of-pocket expenses; and
    c. The payment of the cost of modest meals or social events held as part of an educational activity.
5. When the Provider supports presenters, support shall be limited to:
    a. The payment of reasonable honoraria; and
    b. Reimbursement of presenters' out-of-pocket expenses.

Full Disclosure

To those who present at any activity where Operative Dentistry, Inc. is acting as the administrative authority for continuing education, whether as sole authority, or in joint sponsorship, the following guidelines must be observed:

1. All presentations should promote improvements in oral healthcare and not specific drugs, devices, services, or techniques.
2. Any media shown to the participants should be free from advertising, trade names, or product messages (except as applies in guideline #3).
3. Presenters shall avoid recommending or mentioning any specific product by its trade name, using generic terms whenever possible. When reference is made to a specific product by its trade name, reference shall also be made to competitive products.

Conflict of Interest

A Conflict of interest may be considered to exist if a presenter, author or reviewer for an OpDent CDE activity is directly affiliated with or has a direct financial interest in any organization(s) that may be co-supporting a course/manuscript, or may have a direct interest in the subject matter of the presentation/manuscript.

The intent of this policy is not to prevent a speaker with an affiliation or financial interest from making a presentation, or submitting a manuscript. It is intended that any potential conflict be identified openly so that the participants in the CDE have the full disclosure of the facts so that they may form their own judgments about the presentation/manuscript.

To those who participate at any activity where Operative Dentistry, Inc. is acting as the administrative authority for continuing education, whether as sole authority, or in joint sponsorship, the following guidelines should be understood:

Presenter

Speakers/presenters at any CE activity will be required to disclose any potential bias towards commercial supporters, or any other commercial entity that will be mentioned in their presentation.

Author

Authors of every accepted manuscript will be required to disclose any potential bias towards commercial supporters, or any other commercial entity that will be mentioned in their manuscript.

Reviewer

Reviewers of manuscripts will be required to disclose any potential bias towards commercial supporters, or any other commercial entity that is mentioned in the manuscripts they are asked to review. Should a conflict arise, the reviewer is obligated to withdraw themselves as reviewers of the manuscript, and OpDent will select a new reviewer.

Faculty Posting:

Faculty postings are available from OpDent for a $175.00USD flat fee which covers up to 250 words and free logo placement if one is provided. Each additional 50 words is charged at $50.00USD per unit, and each additional issue for which you would like the posting to run is charged at $50.00USD as well.

OpDent reserves the right to refuse any posting.

ANEXO B. PARECER COMITÊ DE ÉTICA EM PESQUISA

UNIVERSIDADE DE UBERABA - UNIUBE

Plataforma Brasil

COMPROVANTE DE ENVIO DO PROJETO

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Efeito da ciclagem mecânica, térmica e indução de cárie nas características interfaciais, resistência de união e distribuição de tensão entre diferentes resinas compostas e substrato dental

Pesquisador: Gilberto Antonio Borges

Versão: 1

CAAE: 56019916.8.0000.5145

Instituição Proponente: SOCIEDADE EDUCACIONAL UBERABENSE

DADOS DO COMPROVANTE

Número do Comprovante: 042446/2016

Patrocionador Principal: Sociedade Educacional Uberabense

Informamos que o projeto Efeito da ciclagem mecânica, térmica e indução de cárie nas características interfaciais, resistência de união e distribuição de tensão entre diferentes resinas compostas e substrato dental que tem como pesquisador responsável Gilberto Antonio Borges, foi recebido para análise ética no CEP Universidade de Uberaba - UNIUBE em 12/05/2016 às 14:03.