UNIVERSIDADE DE UBERABA

IVONE DE FÁTIMA LIMA CARDOSO

RUGOSIDADE E DESGASTE DE SUPERFÍCIE DE UM SELANTE DE FOSSAS E FISSURAS TERMOCROMÁTICO: INFLUÊNCIA DA EROSÃO E ABRASÃO

UBERABA – MG

2014

IVONE DE FÁTIMA LIMA CARDOSO

RUGOSIDADE E DESGASTE DE SUPERFÍCIE DE UM SELANTE DE FOSSAS E FISSURAS TERMOCROMÁTICO: INFLUÊNCIA DA EROSÃO E ABRASÃO

Dissertação apresentada ao programa de Mestrado em Odontologia da Universidade de Uberaba - UNIUBE, para a obtenção do Título de Mestre em Odontologia - Área de concentração em Biomateriais.

Orientadora: Profa. Dra. Maria Angélica Hueb de Menezes Oliveira

UBERABA – MG

2014

Catalogação elaborada pelo Setor de Referência da Biblioteca Central UNIUBE

Cardoso, Ivone de Fátima Lima.

C179r Rugosidade e desgaste de superfície de um selante de fossas e fissuras termocromático: influência da erosão e abrasão / Ivone de Fátima Lima Cardoso. – Uberaba, 2014.

29 f. : il. color.

Dissertação (mestrado) – Universidade de Uberaba. Programa de Mestrado em Odontologia, 2014.

Orientadora: Profª. Drª. Maria Angélica Huebi de Menezes Oliveira

1. Cáries dentárias - Prevenção. 2. Dentes - Erosão. 3. Dentes -

UNIVERSIDADE DE UBERABA

Pró-Reitoria de Pesquisa, Pós-Graduação e Extensão

Programa de Mestrado em Odontologia

Ata da Sessão Pública de defesa de dissertação para obtenção do título de Mestre em Odontologia, área de concentração em Biomateriais, a que se submeteu a aluna Ivone de Fátima Lima Cardoso – matrícula 6102826, orientada pelo Prof.ª Maria Angélica Hueb de Menezes Oliveira

Aos trinta e um dias do mês de março do ano de dois mil e quatorze, às 13 horas e 30 minutos, na sala 2C02 na Universidade de Uberaba, reuniu-se a Comissão Julgadora da defesa em epígrafe indicada pelo Colegiado do Programa de Mestrado em Odontologia da Universidade de Uberaba, composta pelos Professores Doutores: Maria Angélica Hueb de Menezes Oliveira - **Presidente**, Ailla Carla Rocha Acosta Lancellotti e Vinícius Rangel Geraldo Martins para julgar o trabalho da candidata Ivone de Fátima Lima Cardoso, apresentado sob o título: **"RUGOSIDADE E DESGASTE DE SUPERFÍCIE DE UM SELANTE DE FOSSAS E FISSURAS TERMOCROMÁTICO: INFLUÊNCIA DA EROSÃO E ABRASÃO".** A Presidente declarou abertos os trabalhos e agradeceu a presença de todos os Membros da Comissão Julgadora. A seguir a candidata dissertou sobre o seu trabalho e foi arguida pela Comissão Julgadora, tendo a todos respondido às respectivas arguições. Terminada a exposição, a Comissão reuniu-se e deliberou pelo seguinte resultado:

(X) **APROVADO**
( ) **REPROVADO** (anexar parecer circunstanciado elaborado pela Comissão Julgadora)

Para fazer jus ao título de MESTRE EM ODONTOLOGIA ÁREA DE CONCENTRAÇÃO BIOMATERIAIS, a versão final da dissertação, considerada aprovada devidamente conferida pela Secretaria do Mestrado em Odontologia, deverá ser entregue à Secretaria dentro do prazo de 30 dias, a partir da data da defesa. O aluno Aprovado que não atender a esse prazo será considerado Reprovado. Após a entrega do exemplar definitivo, o resultado será homologado pela Universidade de Uberaba, conferindo título de validade nacional aos aprovados. Nada mais havendo a tratar, O Senhor Presidente declara a sessão encerrada, cujos trabalhos são objeto desta ata, lavrada por mim, que segue assinada pelos Senhores Membros da Comissão Julgadora, pelo Coordenador do Programa de Mestrado em Odontologia da UNIUBE, com ciência do aluno. Uberaba, aos trinta e um dias do mês de março de dois mil e quatorze.

Profa. Dra. Ailla Carla Rocha Acosta Lancellotti Ailla Lancellotti

Profª. Drª. Maria Angélica Hueb de Menezes Oliveira ________________

Prof. Dr. Vinícius Rangel Geraldo Martins ________________

Prof. Dr. Cesar Penazzo Lepri Cesar P. Lepri
Coordenador do Programa de Mestrado em Odontologia

Flávia Michele da Silva ________________
Secretária do Programa de Mestrado em Odontologia da UNIUBE

Ciência do Aluno: Ivone de Fátima Lima Cardoso

DEDICATÓRIA

Ao Hélio, meu esposo, pelo seu companheirismo, amor e apoio incondicionais. Aprendemos muito nesta caminhada conjunta, as lições de vida nos fortaleceram, alicerçando nossas vidas com respeito mútuo e amor sincero.

Aos nossos filhos Hélio César e Felipe, indispensáveis, sentido do infinito amor de nossas vidas, e, graças a Deus, maravilhosos!

Dedico este trabalho.

AGRADECIMENTOS

Agradeço,

Aos meus pais (*in memoriam*) pelo esforço, dedicação, exemplo e amor incondicional.

À toda minha família, minha essência, razão maior que me incentiva sempre, na busca da plena realização profissional e pessoal.

À minha orientadora

Maria Angélica, pela confiança, por ter aceito o desafio de me orientar, mesmo não me conhecendo; pela sabedoria, conferindo-me segurança e apoio, indispensáveis ao sucesso deste trabalho.

À Jaciara, Regina, Ailla e Fernando,

pela grande colaboração e participação, na realização deste trabalho.

À Fabiana,

Mais que uma amiga, que, com sabedoria e competência, sempre me ensinou e apoiou, com a rara qualidade do profissionalismo e doação desinteressados, e sempre disponível. Você é uma pessoa especial!

À Maria Elena e Horácio

Irmã e cunhado muito queridos, que tanto me ajudaram e apoiaram na busca desta conquista.

À Alessandra

Amiga, sempre disposta a ajudar, obrigada

Aos professores do curso, pelas contribuições essenciais na minha formação científica e profissional.

Resumo

O objetivo deste estudo foi avaliar os efeitos da erosão e abrasão relacionados ao desgaste e rugosidade de superfície de um selante com pigmento termocrômico de fossas e fissuras. Os selantes de fossas e fisuras à base de resina, Defense Chroma (Angelus), e FluroShield (Dentsply) foram manipulados e inseridos em uma matriz cilíndrica, de aço inoxidável e fotoativados por 20 segundos. Metade da superfície de cada amostra foi coberta com duas camadas de esmalte de unhas e cera.para escultura. Foram realizados 4 ciclos diários de imersão-agitação em refrigerante tipo cola (pH 2.6, 0.32ppmF, Coca-Cola Company), por 90 segundos cada. Após cada ciclo, as amostras eram lavadas com água destilada, secas em papel absorvente e imersas em saliva artificial até o próximo ciclo. As escovações foram realizadas 30 minutos após o primeiro e o último ciclo erosivo, com escova elétrica por 5 dias. As amostras foram analisadas por um perfilômetro 3D (Microscópio de Medição à Laser- LEXT OLS 4000- Olympus).Teste t de Student foi realizado para avaliar os valores de ($p<0,05$). Os ciclos erosivos e abrasivos promoveram alterações de superficie em ambos selantes. O selante Defense Chroma apresentou valores menores de rugosidade e desgaste de superfície e com diferenças estatisticamente significantes em relação ao FluroShield. O selante Defense Chroma apresentou menor desgaste e rugosidade de superfície, comparado ao FluroShield.

Palavras chaves: selantes de fossas e fissuras, erosão dentária, abrasão dentária

Sumário

Title: Surface Roughness and Wear of a Thermochromatic Pit and Fissure Sealant: Influence of Erosion and Abrasion

Short Title: Resin Sealant, erosion and abrasion

Authors:

Ivone de Fátima Lima Cardoso

Post-graduate student, Biomaterials Division, Uberaba University, Uberaba – MG, Brazil

Jaciara Miranda Gomes da Silva

Departament of Pediatric Clinics, Preventive and Community Dentistry, Dental School of Ribeirão Preto, University of São Paulo, Ribeirão Preto, SP, Brazil.

Regina Guenka Palma-Dibb

Departament of Restorative Dentistry, Dental School of Ribeirão Preto, University of São Paulo, Ribeirão Preto, SP, Brazil.

Ailla Carla Rocha Acosta Lancellotti

State University of Campinas, Departament of Restorative Dentistry, Piracicaba, SP, Brazil.

Fernando Carlos Hueb de Menezes

Professor, Biomaterials Division, Uberaba University, Uberaba, MG, Brazil

Maria Angélica Hueb de Menezes Oliveira

Professor, Biomaterials Division, Uberaba University, Uberaba. MG, Brazil

Corresponding author:

Prof. Maria Angélica Hueb de Menezes Oliveira

Avenida Nenê Sabino, 1801. Sala 2R02 - Bairro Universitário - CEP: 38.055-500. Uberaba – MG.

Phone: 55 (34) 3319 8958

Fax: 55 (34) 3314 8910

Email: angelica.hueb@uniube.br

Title: Surface Roughness and Wear of a Thermochromatic Pit and Fissure Sealant: Influence of Erosion and Abrasion

Short Title: Resin Sealant, erosion and abrasion

Abstract

Purpose: The purpose of this study was to assess the effects of erosion and abrasion related to wear and roughness of a thermochromatic pit and fissure sealant. Methods: The resin-based pit-and-fissure sealants Defense Chroma (Angelus) and FluroShield (Dentsply) were manipulated and inserted into a stainless steel cylindrical matrix and light cured for 20s. The specimen had half of its surface waterproofed with two layers of cosmetic nail polish and wax for sculpture. It was performed 4 cycles of immersion/stirring in cola-type soft drink (pH 2.6, 0.32 ppmF, Coca-Cola Company) over 90 s. Then the specimens were washed with distilled water, dried with absorbent paper and immersed in artificial saliva until the next cycle. Brushings were performed 30 min after the first and last erosive challenge cycle with an electric toothbrush during 5d. The specimens were analyzed with a 3D profilometer (3D Measuring Laser Microscope – LEXT OLS 4000 – Olympus).The Student’s t-test was used to evaluate the values ($p<0.05$).Results: The erosive/brushing cycles promote surface alterations in both sealants. Defense Chroma sealant presented the lower values of surface roughness and wear that were statistically significant different from the FluroShield. Conclusions: Defense Chroma sealant presented lower values surface roughness and wear compared to the FluroShield

Keywords: pit and fissure sealants, tooth erosion, tooth abrasion

Introduction

It has been observed through the last decades a worldwide decrease of prevalence and severity of dental caries disease[1] due to the adoption of preventive actions. It is known that the main responsible measure for that alteration in global panorama of dental caries was the use of fluoride by means of fluoridation of water of the public supply or its topical use, such as dentifrice, mouth rinses, varnishes and gels for professional use.[2] Although unquestionable, the effectiveness of the fluorides in reduction of caries lesions occurs mainly on the smooth surfaces. According to the exposed, 75% of dental caries are concentrated in 25% of the population[3] mainly on the occlusal surfaces of permanent molars, along pits and fissures.[4,5]

The main susceptibility of occlusal surfaces to the development of dental caries lesions is directly related to the complex and irregular morphology of pits and fissures which make it difficult the mechanical sanitation done by brushing. Thus, caution and special protection must be considered to occlusal surfaces, since they are eight times more prone to the development of dental caries lesion.[4-6]

Among all available preventive methods currently attempting to inhibit the development and progression of dental caries lesions on the occlusal surfaces - chiefly in patients ranked as high risk to the dental caries - arise the pits and fissures sealant application.[7,8]

According to the Scientific Council guidelines of American Dental Association, the resin-based sealants are the first choice material for occlusal sealing'. The use of glass ionomer would occur in conditions when technique with resin-based sealant would be impaired by the difficulty in achieving adequate salivary control and dry field isolation, as in the case of partially erupted teeth. Under these circumstances, the ionoméric materials are temporary, acting as fluoride reservoirs until the sealing technique with a resin-based material may be done definitively.[9,10] The pit and fissure sealing with a resin-based sealant reduced the incidence of dental caries lesions in children and teenagers about 86% after 1 year, 78.6% after 2 years and 58.6% after 4 years of its application.[9]

When used on the occlusal surface, sealants create a physical barrier micromechanically adhered to the enamel, which prevents the contact of microorganisms and its substrates with narrow and deep fissures and pits. However, the clinical success of sealants depends on its retention, resistance to wear, and also capability to keep a proper sealing along the sealant-enamel interface likewise. Resin-based sealants have been the most indicated materials.[9,10]

It is worth considering that the restorative materials are often subjected to the chemical, mechanical and thermal challenge in the oral environment. At this context, Dentistry evolves in attempting to create a sealant that presents better clinical performance than the common challenges in the oral cavity.

It has been recently introduced on market by Angelus, a thermo chromatic resin-based sealant named Defense Chroma. However, there are few researches assessing its chemical properties, in order to rise enough funding for the clinical application. On the exposed, the purpose of this study was to assess the effects of erosion and abrasion related to wear and roughness of the Defense Chroma pit and fissure sealant.

Methods

Preparation of specimens

The pit-and-fissure sealants, FluroShield and Defense Chroma (Table 1) were manipulated according to the manufacturer's instructions and inserted into a stainless steel cylindrical matrix (3mm of intern diameter x 1.5mm of thickness/high), promoting the insertion in a single increment. Then the material was covered with an acetate strip. In order to compact the material and prevent void and bubble formation, a microscopic slide was placed over the sealant/matrix ensemble and a weight of 500g was placed over the microscopic slide for 30s.

After the insertion of the materials, the sealant was light cured for 20 s through the glass slide, producing specimens with smooth, highly flat surfaces. It was done 10 specimen for each material (n=10).

Later, the specimen had half of its surface waterproofed with two layers of cosmetic nail polish (Colorama Maybelline Ultra Duração; Cosbra Cosméticos LTDA., São Paulo, SP, Brazil), and wax for sculpture, being exposed only half of surface of the material to the erosive challenges and brushings. The nail/wax covering allowed control (reference area protected from the action of beverage and brushing) and experimental areas to be present in the same specimen.

Twenty four hour earlier the experiments, the specimen were immersed into solution which presents a mineral saturation degree similar to the saliva, as suggested in a previous study.[11] (methyl-*p*-hydroxybenzoate, 2.00 g/L; sodium carboxymethyl cellulose, 10.0 g/L; KCl, 0.625 g/L; $MgCl_2.6H_2O$, 0.059 g/L;

$CaCl_2.2H_2O$, 0.166 g/L; K_2HPO_4, 0.804 g/L; KH_2PO_4, 0.326 g/L; the pH was adjusted to 6.75 using KOH) and kept at 37ºC.

Erosive Challenge and Brushing Cycles

To the erosive challenge and brushing cycles, the specimens were fixed, per group, in 2 acrylic plates (Plexiglas) with super bonder.

It was performed 4 cycles of immersion/stirring in cola-type soft drink (pH 2.6, 0.32 ppm F, Coca-Cola Company) 90s/2h break/ 5d. After every cycle of immersion/ stirring, the specimens were washed with distilled-deionized water over 10s softly dried with absorbent paper, then immersed in artificial saliva until next cycle.

Brushings were performed 30min after the first and last erosive challenge cycle, summing 2 brushings within 6h break among them. Each brushing was performed with an electric soft bristle toothbrush (Colgate® Motion Multi-action, Colgate-Palmolive Ind. Com. LTDA, São Paulo, SP, Brazil), by the same operator. One solution (slurry) from the mixture of dentifrice and distilled water in proportion of 1:3 in weight, respectively, was injected between the specimen and the toothbrush, before the brushing movements. This solution was prepared earlier of its use in each brushing. Brushing was performed during 10s with a weight of 200g (~2N). After each brushing, the specimens were washed with distilled-deionized water for 10s, softly dried with absorbent paper, and then were maintained in artificial saliva until next cycle.

Erosive challenge and brushing cycles were performed during 5 days. The whole procedure was performed at room temperature The cola-based soft drink, the artificial saliva and the toothbrush heads were daily changed before the first cycle immersion of each day.

After 5 days, the specimens were kept in humidity until analysis start.

Assessment in 3D Profilometer

To the profilometry analysis, the nail polish was carefully removed from specimens by the use of cotton soaked in acetone solution (1:1). The specimens (experimental and control area) were analyzed with a 3D profilometer (3D Measuring Laser Microscope – LEXT OLS 4000 – Olympus).

The data of 3D profilometry of surface (vertical variation over surface), expressed in each one of them, were registered and treated with the software of analysis which is supplied with the device. This software generates axonometric colored pictures of the surface which are followed by a scale in which each color represents a depth level.

These pictures were used in order to analyze the linear, superficial and 3D measures of the topographical variation. By using the software of analysis, the axonometric pictures of each sample were analyzed in order to: 1 - get a better view of the extension and depth of degree caused by *erosion* + *brushing*, and 2 - observe whether there are differences in topographical profile among the different group of materials. The vertical length between the highest point and the lowest of the fragment shall be calculated by the software.

For each specimen, 2 images with a magnification of 217x were captured and scanned. One image was used to the surface wear analysis (Rv) and showed a ~200µm width strip of the reference area. The experimental area filled the rest of the picture. The other image had captured only the experimental area and allowed the material surface roughness analysis (Ra).

The Student's t-test was used to evaluate the values ($p<0.05$).

Results

The data analysis showed that the erosive challenge/brushing cycles promote surface alterations in both sealants: Defense Chroma (Figures 1 and 2) and FluroShield (Figures 3 and 4).

Regarding the surface roughness, Defense Chroma presented the lower values that were statistically significant different from the FluroShield. FluroShield showed statistically significant higher surface wear compared to the Defense Chroma sealant (Table 2).

Discussion

The clinical evidences of use of sealant as an efficient preventive method increased the number of materials for that purpose, such as the recent resin-based pit and fissure sealant analyzed in this research. The Defense Chroma presents the ability to change its color at temperatures below 31^{o}C, giving the advantage of easy detection concerning its retention and possible failures in periodic returns. According to the manufacturer, this material control can be accomplished applying a jet of air or water over it. In the present study we observed this characteristic, still having the advantage of remaining undetectable when the temperature increases, giving aesthetic so desired by patients nowadays.

Additionally, this material is based in fluoride what may reduce the susceptibility to the demineralization processes caused by acid challenges on the margins of the material.[13] In the current investigation Defense Chroma was chosen for the comparison with a resin-based sealant, which also presents fluoride and load particles in its composition, besides of clinical evidences of its efficiency on occlusal dental caries control.[14]

Acids from the diet, medications, gastro esophageal reflux and the action of salivary enzymes are responsible for the chemical challenges in the oral cavity, causing an increase roughness in surface of restorative and preventive materials.

The increase roughness in surface gives greater accumulation of cariogenic biofilm, providing the initial process of demineralization of caries on the margins of the sealant material.[15] Moreover, these materials become susceptible to the wear caused by daily brushing, changing outline and color. These cumulative effects over time influence the clinical performance of this material.[16]

Erosion, attrition and abrasion processes rarely occur alone. These events can occur simultaneously and the abrasion of eroded surfaces corresponds to the process between interaction of oral substrates and oral structures. Thus, several studies have investigated the effects of brushing on the eroded surfaces, as well as preventive measures for these changes.[17] Shellis et al.[18] argue about discussions and consensus regarding the methodologies on erosion research, concluding that only research models involving erosive and abrasive challenges can be considered models for evaluating superficial tooth wear. Therefore, in this study the cycles of erosive and abrasive challenges were performed simultaneously so that the wear and roughness of the sealants could be evaluated.

At this investigation the cola-type soft drink was chosen for its high erosion potential, due to a low pH index and low concentrations of calcium fluoride, since it simulates clearer the daily erosive events that occur in the oral cavity.[17] The length of erosive cycle varies from in vitro studies between 15s and 40min, with no consensus in the literature, despite the knowledge that these events *in vivo* do not last more than a few min. However, the choice of the time of erosive challenge will be dependent on factors such as the used erosive agent and the substrate/material assessed.[17,18] The erosion cycle time in this study was determined in a pilot study.

The cycling models are used in an attempt to simulate *in vitro* what occurs in clinical conditions in the oral cavity. As in the present research, artificial saliva is commonly used as a remineralizing solution, but studies show the difficulty to reproduce by artificial formulations what occurs in the oral cavity.[17,18]

Regarding brushing, in the present study the protocol of a smaller number of brushing in relation to the number of erosive challenges per day was used, following other authors in previous works[19,20] considering that this methodology would simulate clinically how people usually brush their teeth twice a day, and not after each erosive challenge. The brushing length time of 10s was determined in a pilot stud, for it is the minimum time able to promote detectable superficial changes by the method of evaluation. The force of brushing used was 2N. Wiegand and Attin[17] recommend a force of brushing of 1.5 to 2 N for electrical brushes. The ISO 14569-1 82007 suggests 0.5-2.5N of force, and according to Shellis et al.[18] a force of 2N is a good recommendation.

The features of the particles that make the resinous composites are related to the physical/mechanical properties of this materials.[21] Borges et al.[22] noticed that the FluroShield sealant has particles with irregular shapes and sizes in its composition. In addition to it, according to some authors[23] the wear would begin with water absorption that diffuses through the resinous matrix in the spaces between the particles and the pores, and other defects increased by the low pH of the oral cavity acidic. So, this biodegradation of materials would depend on its hydrolytic stability, which is related to the composition of the resinous matrix and polymerization reactions of the material.[16]

Therefore, the minor profile of wear and lower roughness in surface presented by the Defense Chroma compared to the FluroShield sealant may relies on differences of the materials composition, interrelation, size and shape of the particles. Moreover, in this study the microscopic images showed the presence of air bubbles, especially for FluroShield sealant, that were probably exposed by the brushing process, since in the preparation of the specimens the bubbles were imperceptible. These findings could also explain the better performance of the Defense Chroma sealant in this assessment.

Aforementioned, the resin-based sealants analyzed showed surface alterations after the erosive/abrasive challenges. Kantovitz et al.[24] reported that the FluroShield sealant did not presented change roughness in surface after immersion in citric acid, which according to the authors, is a function of the relation between the resinous matrix and the filler particles of this material (small and silanized). The findings of superficial change observed in this study for the sealants may be due to the association of the erosive cycle with brushing. Still, the non contact profilometer 3D LEXT OLS 4000 used in the present study allows a precise surface analysis since the microscope's laser beam has a resolution of 0.4 µm, which provides an accurate detection of even mild surface alterations.[25]

The Defense Chroma sealant, newly released up to this study, had never been assessed concerning its surface wear and roughness properties after the mechanical and chemical challenges. The lack of reported studies using the same methodology and materials tested in the present study is a limitation to stating a reliable comparison with outcomes of previous investigations. To our knowledge there is no paper assessing Defense Chroma properties. Simonsen and Neal[10] highlighted the need for significant technological advances in preventive dental materials, such as in the field of adhesives and ionomeric restorative materials.

It was observed that the Defense Chroma sealant presents a higher wear resistance and a lower surface roughness compared to a resin-based sealant which has proved clinical applicability (control). Accordingly, the Defense Chroma sealant shows favorable features in preventing dental caries lesions on the occlusal surface since its lower roughness could prevent the accumulation of cariogenic biofilm as well as changes in the material outline and color. However, researches must be done so it is possible to assess other properties of this material, as well as its clinical performance in the oral cavity.

At last, it is considered that the pit and fissure sealant technique should be indicated considering: the individual caries-risk and activity assessment, the specific parameters of the occlusal anatomy and in the patient collaboration. However, despite all the preventive benefits of this technique are already established in the literature, this method is still underused worldwide.

Conclusions

The following conclusions can be drawn:

1. The resin-based sealants analyzed showed surface alterations after the erosive/abrasive challenges;
2. Defense Chroma sealant presented lower surface roughness and wear compared to the FluroShield.

References

1. Narvai PC, Frazão P, Roncalli AG, Antunes JL. Dental caries in Brazil: decline, polarization, inequality and social exclusion. Rev Panam Salud Publica 2006;19(6):385-93.
2. Lussi A, Hellwig E, Klimek J. Fluorides - mode of action and recommendations for use. Schweiz Monatsschr Zahnmed 2012;122(11):1030-42.
3. Macek MD, Heller KE, Selwitz RH, Manz MC. Is 75 percent of dental caries really found in 25 percent of the population? J Public Health Dent 2004;64(1):20-5.
4. Maltz M, Barbachan e Silva B, Carvalho DQ, Volkweis A. Results after two years of non-operative treatment of occlusal surface in children with high caries prevalence. Braz Dent J 2003;14(1):48-54.

5. Wang JD, Chen X, Frencken J, Du MQ, Chen Z. Dental caries and first permanent molar pit and fissure morphology in 7- to 8-year-old children in Wuhan, China. Int J Oral Sci 2012;4(3):157-60.
6. Bohannan H. Caries distribution and the case for sealants. J Public Health Dent. 1983;33:200-4.
7. Mickenautsch S, Yengopal V. Caries-preventive effect of glass ionomer and resin-based fissure sealants on permanent teeth: an update of systematic review evidence. BMC Res Note. 2011; 28(4):22.
8. Ahovuo-Saloranta A, Forss H, Walsh T, Hiiri A, Nordblad A, Mäkelä M, Worthington HV. Sealants for preventing dental decay in the permanent teeth (Review). Cochrane Database Syst Rev 2013; 28(3).
9. Beauchamp J, Caufield PW, Crall JJ, Donly K, Feigal R, Gooch B, Ismail A, Kohn W, Siegal M, Simonsen R. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc 2008;139(3):257-68.
10. Simonsen RJ, Neal RC. A review of the clinical application and performance of pit and fissure sealants. Aust Dent J 2011;56(1):45-58.
11. Amaechi BT, Higham SM, Edgar WM. Factors influencing the development of dental erosion in vitro: enamel type, temperature and exposure time. J Oral Rehabil 1999;26:624-30.
12. Rock WP, Potts AJ, Marchment MD, Clayton-Smith AJ, Galuszka MA. The visibility of clear and opaque fissure sealants. Br Dent J 1989;67:395-396.
13. Kantovitz KR, Pascon FM, Correr GM, Borges AFS, Uchoa MNS, Puppin-Rontani RM. Inhibition of mineral loss at the enamel/sealant interface of

fissures sealed with fluoride-and non-fluoride containing dental materials in vitro. Acta Odontol Scand 2006 Nov;64(6):376-83.

14. Raucci-Neto W, de Castro-Raucci LM, Lepri CP, Faraoni-Romano JJ, da Silva JM, Palma-Dibb RG. Nd:YAG laser in occlusal caries prevention of primary teeth: a randomized clinical trial. Lasers Med Sci 2013 Aug 17. [Epub ahead of print]
15. Ninawe N, Ullal NA, Khandelwal V. A 1-year evaluation of fissure sealants on permanent first molars. Contemp Clin Dent 2012;3(1): 54-9.
16. de Paula AB, Fucio SB, Ambrosano GM, Alonso RC, Sardi JC, Puppin-Rontani RM. Biodegradation and abrasive wear of nano restorative materials. Oper Dent 2011;36(6):670-7.
17. Wiegand A, Attin T. Design of erosion/abrasion studies-insights and rational concepts. Caries Res 2011;45 Suppl 1:53-9.
18. Shellis RP, Ganss C, Ren Y, Zero DT, Lussi A. Methodology and models in erosion research: discussion and conclusions. Caries Res 2011;45 Suppl 1:69-77.
19. Magalhães AC, Wiegand A, Rios D, Hannas A, Attin T, Buzalaf MA. Chlorhexidine and green tea extract reduce dentin erosion and abrasion in situ. J Dent 2009;37(12):994-8.
20. Wiegand A, Hiestand B, Sener B, Magalhães AC, Roos M, Attin T. Effect of TiF4, ZrF4, HfF4 and AmF on erosion and erosion/abrasion of enamel and dentin in situ. Arch Oral Biol 2010;55(3):223-8.
21. Marghalani HY. Effect of filler particles on surface roughness of experimental composite series. J Appl Oral Sci 2010;18(1):59-67.

22. Borges BC, Bezerra GV, Mesquita J de A, Silva TR, Alves-Júnior C, Pinheiro IV, Braz R, Montes MA. Filler morphology of resin-based low-viscosity materials and surface properties after several photoactivation times. Acta Odontol Scand 2013;71(1):215-22.
23. Sarkar NK. Internal corrosion in dental composite wear. J Biomed Mater Res 2000;53(4):371-80.
24. Kantovitz KR, Pascon FM, Correr GM, Alonso RC, Rodrigues LK, Alves MC, Puppin-Rontani RM. Influence of enviromental conditions on properties of ionomeric and resin sealant materials. J Appl Oral Sci 2009;17(4):294-300.
25. Derceli JR, Faraoni-Romano JJ, Palma-Dibb RG. Dental erosion analysis using confocal microscopes. http://www.qualitydigest.com/inside/metrology-article/dental-erosion-analysis-using-confocal-microscopes.html 2013.

Tables

Table 1 – Resin-based sealants used in this study

Material	Composition
Defense Chroma (Angelus Ind. Produtos Odontológicos AS, Londrina, PR, Brazil)	Bis-GMA, Modified urethane,Tegdma Barium aluminum borosilicate, Tetra-acrylic Ester, Phosphoric acid Sodium fluoride, N-Methyl diethanolamine and Camphorquinone
FluroShield (Dentsply Ind. Com., Rio de Janeiro, RJ, Brazil)	Bis-GMA, Modified urethane, Tegdma Tetra-acrylic Ester, Phosphoric acid, Barium aluminum borosilicate glass, Sodium Fluoride, N-Methyl diethanolamine and Camphorquinone

Table 2 – Surface wear and roughness means (µm) and standard deviations of the groups

Sealant	Surface wear	Surface roughness
Defense Chroma	2.31 (±0.70)**a**	0.86 (±0.23)**a**
FluroShield	3.18 (±0.84)**b**	1.16 (±0.29)**b**

Different letters (a,b) indicate statistically significant difference at 5%.

Figure legends

Figure 1 – Axonometric image of Defense Chroma eroded/abraded surface. Left side: corresponding reference area. Right side: corresponding eroded area.

Figure 2 – Linear image of Defense Chroma eroded/abraded surface. Left side: corresponding reference area. Right side: corresponding eroded area.

Figure 3 – Axonometric image of FluroShield eroded/abraded surface. Left side: corresponding reference area. Right side: corresponding eroded area.

Figure 4 – Linear image of FluroShield eroded/abraded surface. Left side: corresponding reference area. Right side: corresponding eroded area.

Figures

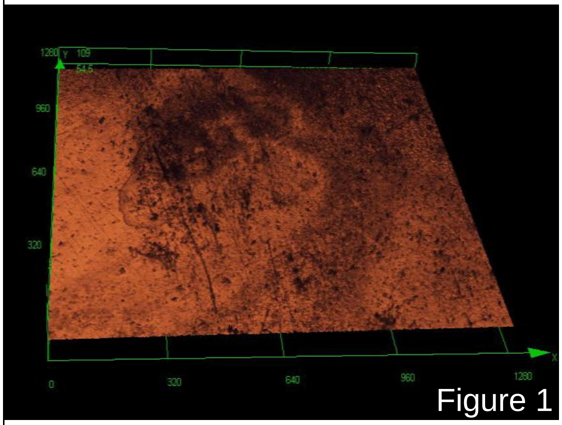

Figure 1

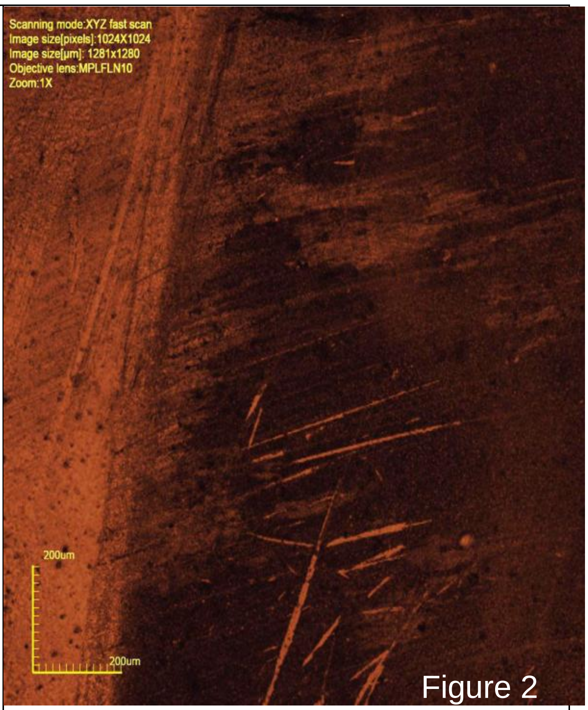

Figure 2

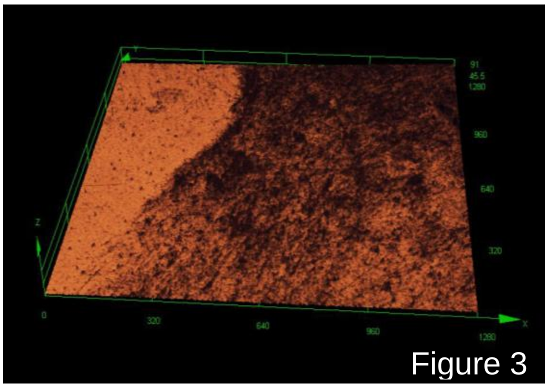

Figure 3

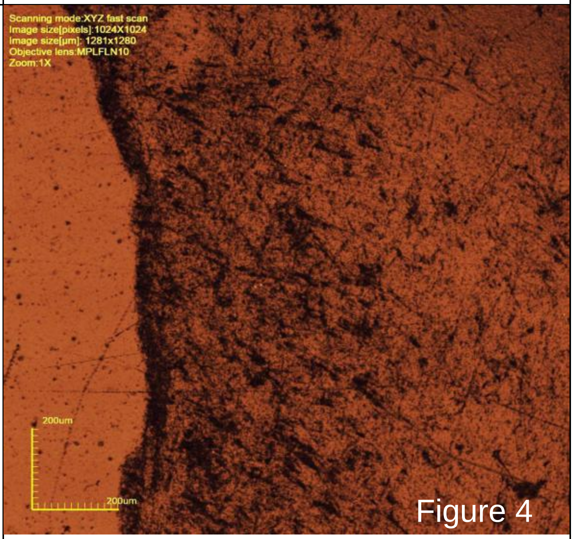

Figure 4