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Graziela Botton

AVALIAÇÃO DE UM SISTEMA ADESIVO UNIVERSAL UTILIZADO COMO SELANTE DE FOSSAS E FISSURAS

Santa Maria, RS
2018

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Tese apresentada ao Curso de Doutorado do Programa de Pós-Graduação em Ciências Odontológicas, Área de Concentração em Odontologia, ênfase em Odontopediatria, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do título de **Doutor em Ciências Odontológicas**.

Orientadora: Profa. Dra. Rachel de Oliveira Rocha

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Rachel de Oliveira Rocha, Dra. (UFSM)
(Presidente/Orientadora)

Anelise Fernandes Montagner, Dra. (CNEC)

Carine Weber Pires, Dra. (FSG)

Marcela Marquezan, Dra. (UFSM)

Thiago Machado Ardenghi, Dr. (UFSM)

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DEDICATÓRIA

Com amor, aos meus pais, Nara e Ricardo.

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"Se cheguei até aqui foi porque me apoiei no ombro dos gigantes". (Isaac Newton)

Aos meus gigantes, agradeço...

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Eu não tenho paredes. Só tenho horizontes.

(Mário Quintana)

RESUMO

AVALIAÇÃO DE UM SISTEMA ADESIVO UNIVERSAL UTILIZADO COMO SELANTE DE FOSSAS E FISSURAS

AUTORA: Graziela Botton
ORIENTADORA: Rachel de Oliveira Rocha

A presente tese é composta por dois artigos científicos, cujo tema principal é o uso de sistemas adesivos na técnica de aplicação de selantes de fossas e fissuras. Artigo 1: *Are self-etch adhesive systems effective in the retention of occlusal sealants? A systematic review and meta-analysis*. O objetivo deste trabalho foi revisar sistematicamente a literatura de ensaios clínicos randomizados encontrados nas bases de dados PUBMED/MEDLINE, CENTRAL e ClinicalTrials.gov, até junho de 2015, para estabelecer se há diferença entre as taxas de retenção ao longo do tempo dos selantes oclusais aplicados com sistemas adesivos autocondicionantes ou com o condicionamento ácido prévio, com ou sem o uso de sistemas adesivos combinados. Dos 683 estudos potencialmente elegíveis, 10 foram selecionados para leitura completa e 5 incluídos na metanálise. Foi encontrada diferença significativa, favorecendo o grupo do condicionamento ácido. Este trabalho esclareceu que a retenção dos selantes de fossas e fissuras é maior ao longo do tempo quando aplicados no modo convencional, com condicionamento ácido prévio do esmalte, independente do uso de sistema adesivo combinado. Nenhum estudo incluído nessa revisão sistemática avaliou sistemas adesivos universais. Artigo 2: *Universal adhesive system in self-etch mode may not be a valid option for bonding resin-based fissure sealants*. Este estudo avaliou a resistência de união ao microcisalhamento (μSBS) do sistema adesivo Scothbond Universal (SBU), aplicado no modo autocondicionante, associado com o selante resinoso FluroShield (FLSH), ou como material único e avaliou também a sorção e solubilidade do SBU e do FLSH em solução aquosa. Foram preparados 42 terceiros molares hígidos e reunidos aleatoriamente em 6 grupos (n=7) de acordo com a) condição do esmalte: hígido ou desmineralizado e b) material: SBU+FLSH, SBU e FLSH. Após a realização do teste de μSBS os dados obtidos foram submetidos a Análise de Variância de dois fatores e teste de Tukey (α=0,05). O FLSH aplicado no modo convencional, com condicionamento ácido, apresentou maiores valores de resistência de união e a não houve diferença quanto a condição do esmalte. A sorção e solubilidade foram avaliadas de cordo com a ISO 4049:2009. Foram confeccionados 10 discos de cada material SBU e FLSH. Cada disco foi testado separadamente. Primeiro foram armazenados em um dissecador, depois foram imersos em água destilada, para novamente serem dissecados, em cada uma das três etapas foram pesados diariamente até alcançar massa constante (m1, m2 e m3). Os valores obtidos foram analisados pelo teste U de Mann-Whitney para avaliar as diferenças nas médias de sorção, solubilidade e real % de água absorvida (SPc%). O SBU apresentou maiores médias de sorção e solubilidade e a SPc % foi quase cinco vezes maior que no FLSH. Assim, o sistema adesivo universal no modo autocondicionante não é uma opção válida para aplicação de selantes de fossas e fissuras ou para ser utilizado como próprio selante, por apresentar menor resistência de união ao esmalte e sofrer maior deterioração quando exposto à água. Sugere-se como a melhor estratégia de aplicação de selantes de fossas e fissuras, o condicionamento ácido prévio do esmalte.

Palavras-chave: Selantes de Fossas e Fissuras. Adesivos Dentinários. Microcisalhamento. Esmalte Dentário. Absorção.

ABSTRACT

EVALUATION OF A UNIVERSAL ADHESIVE SYSTEM USED AS A PIT AND FISSURE SEALANT

AUTHOR: Graziela Botton
ADVISER: Rachel de Oliveira Rocha

This work is composed by two studies, whose main theme is the use of adhesive systems in pit and fissures sealants application technique. Manuscript 1: Are self-etch adhesive systems effective in the retention of occlusal sealants? A systematic review and meta-analysis. The aim of this study was to systematically review the literature of randomized clinical trials found in PUBMED/MEDLINE, CENTRAL and ClinicalTrials.gov databases up to June 2015 to establish whether there is a difference between the retention rates throughout time of occlusal sealants applied with self-etch adhesive systems or with prior acid etching, with or without the use of adhesive systems. From 683 potentially eligible studies, 10 were selected for full-text analysis and 5 were included in the meta-analysis. Statistically significant difference was found favoring the acid etching group. This study elucidated that the retention throughout time of pit and fissure sealants is higher when the application is in the conventional mode, with prior acid etching of the enamel, regardless of the use of adhesive system. No study included in this systematic review evaluated universal adhesive systems. Manuscript 2: Universal adhesive system in self-etch mode may not be a valid option for bonding resin-based fissure sealants. This study evaluated the microshear bond strength (μSBS) of the Scothbond Universal adhesive system (SBU) applied in self-etch mode combined with the resin-based sealant FluroShield (FLSH) or as a single material and also evaluated the SBU and FLSH water sorption and solubility. Forty-two third molars were randomly assigned in 6 groups (n = 7) according to a) enamel condition: sound or demineralized and b) material: SBU+FLSH, SBU and FLSH. The μSBS data were analyzed using two-way ANOVA and Tukey test (α=0.05). The FLSH applied in conventional mode, with prior acid etching, showed higher bond strength values and there was no difference in enamel condition. Sorption and solubility were evaluated according to ISO 4049:2009. Ten disk shaped specimens were prepared of each material (SBU and FLSH). Each disk was tested separately. At first, they were stored in a desiccator, after they were immersed in distilled water, so they were desiccated again. Specimens disk were weighed daily until achieving constant mass in each one of these three steps descripted above (m1, m2 and m3). The data were analyzed by the Mann-Whitney U test to assess the differences in average water sorption, solubility and real % absorbed water (SPc%) between the materials. SBU showed higher averages of water sorption and solubility and SPc% was almost five times higher than FLSH. Thus, universal adhesive system in self-etch mode is not a valid option for the use combined of pit and fissure sealants or as a sealant itself, because it shows lower bond strength to the enamel and it undergoes greater damage when exposed to water. It is suggested as the best strategy for the application of pit and fissure sealants, the prior acid conditioning of the enamel.

Keywords: Pit and Fissure Sealants. Dentin-Bonding Agents. Microshear. Dental Enamel. Absorption.

SUMÁRIO

1 INTRODUÇÃO

Os selantes de fossas e fissuras tem se mostrado um método efetivo de prevenção de lesões de cárie em molares decíduos e permanentes quando comparados à aplicação de verniz fluoretado e ao não uso de selantes (WRIGHT et al., 2016; AHOVUO-SALORANTA et al., 2017). Além do papel preventivo, os selantes também apresentam importante ação terapêutica no controle de lesões incipientes em esmalte, quando observa-se desmineralização inicial deste substrato (WRIGTH et al., 2016). Ainda, tem sido sugerida a eficácia dos selantes na contenção da progressão de lesões oclusais não cavitadas com envolvimento até terço médio de dentina (ALVES et al., 2017).

Vários são os materiais disponíveis para o selamento de fossas e fissuras e, dentre eles, os selantes resinosos fotopolimerizáveis são mais indicados por sua aplicação clínica mais rápida, com menor chance de integração de bolhas durante o procedimento (KÜHNISH et al., 2012), além de apresentarem superior longevidade na retenção (ZHANG et al., 2017). O procedimento padrão para aplicação dos selantes resinosos envolve o condicionamento do esmalte, com ácido fosfórico, precedendo a aplicação do selante (PEUTZFELDT; NIELSEN 2004). A manutenção do campo seco durante o procedimento é um grande desafio, especialmente quando da aplicação em molares em erupção, situação em que a contaminação por saliva ou fluido gengival é praticamente inevitável e existe grande dificuldade de isolamento absoluto do dente (NOGOURANI et al., 2012). No entanto, a efetividade dos selantes resinosos está relacionada à sua retenção (AHOVUO-SALORANTA et al., 2017) e o risco de perda está relacionado a maior chance de desenvolvimento de lesão de cárie (KÜHNISCH et al., 2012).

A aplicação de sistemas adesivos tem sido sugerida como passo operatório após o condicionamento ácido, antecedendo a aplicação do selante resinoso, com a finalidade de aumentar a retenção do material (BAGHERIAN et al., 2016). Em estudos laboratoriais, maiores valores de resistência de união ao esmalte são observados com a combinação de sistema adesivo e selante resinoso, em condições com ou sem contaminação por saliva após o condicionamento ácido (MESQUITA-GUIMARÃES et al., 2016).

Os sistemas adesivos autocondicionantes, desenvolvidos para simplificar os procedimentos de adesão, dispensam a etapa de lavagem e assim, trazem a vantagem de redução do tempo de aplicação, otimizando o uso em situações de pouca colaboração do paciente, além de manter o campo seco durante o procedimento, condição desejada para o sucesso na efetividade dos selantes de fossas e fissuras (PEUTZFELDT; NIELSEN, 2004), com essas

vantagens, estes adesivos foram sugeridos para o preparo do esmalte prévio à aplicação do selante (FEIGAL; QUELHAS, 2003; MAHER et al., 2013). Entretanto, os estudos realizados para comparar a retenção de selantes de fossas e fissuras com o esmalte condicionado previamente por sistemas adesivos autocondicionantes ou pelo método convencional de condicionamento ácido prévio à aplicação do selante revelaram resultados contraditórios. Alguns trabalhos encontraram maior retenção ao longo do tempo quando os selantes foram aplicados com o método convencional (BURBRIDGE et al., 2007; KARAMAN et al., 2013; AMAN et al., 2015), enquanto outros não encontraram diferença na retenção quando os selantes foram aplicados combinados aos adesivos autocondicionantes (FEIGAL; QUELHAS, 2003; MAHER et al., 2013).

Diante desses resultados contraditórios, o primeiro objetivo dessa tese foi conduzir uma revisão sistemática de literatura de estudos clínicos randomizados que compararam a retenção de selantes de fossas e fissuras combinados a sistemas adesivos autocondicionantes *versus* selantes aplicados após condicionamento ácido, combinados ou não a sistemas adesivos. A questão de pesquisa estabelecida foi "os sistemas adesivos autocondicionantes são efetivos quando comparados ao tradicional condicionamento ácido prévio à aplicação dos selantes de fossas e fissuras na retenção ao longo do tempo?".

Seguindo a tendência de simplificação, os adesivos universais, também chamados multi-modo, recebem essa denominação pela versatilidade de aplicação, que pode ser com condicionamento ácido prévio ou no modo autocondicionante (PERDIGÃO; LOGUERCIO, 2014; ISOLAN et al., 2014; McLEAN et al., 2015). Em recente revisão sistemática, a meta-análise mostrou maiores valores de resistência de união ao esmalte quando esses sistemas adesivos foram utilizados na estratégia com condicionamento ácido prévio, do que na estratégia autocondicionante (ROSA et al., 2015). Apesar disso, o sistema Scotchbond Universal é indicado pelo fabricante para o uso combinado ao selante de fossas e fissuras, dispensando o condicionamento ácido, ou seja, aplicado na estratégia autocondicionante.

Existem poucos estudos que investigaram a aplicação de um sistema adesivo utilizado como selante de fossas e fissuras. Os achados disponíveis são de um adesivo aplicado com condicionamento ácido prévio, comparando a um selante resinoso. Em avaliação de 30 meses, o sistema adesivo apresentou melhores resultados clínicos que o selante resinoso (GRANDE et al., 2000) e em 12 meses de acompanhamento, o sistema adesivo usado como selante, apresentou retenção semelhante a três selantes convencionais (BACA et al., 2007).

No melhor do nosso conhecimento, não encontramos estudos que avaliaram a resistência de união ao esmalte de um sistema adesivo universal combinado a um selante

resinoso, na estratégia autocondicionante, como sugere o fabricante, ou como material único para o selamento de fossas e fissuras oclusais, pensando na simplificação da técnica de aplicação de um selante de fossas e fissuras.

Dessa forma o segundo artigo desta tese, intitulado *Universal adhesive system in self-etch mode may not be a valid option for bonding resin-based fissure sealants*, teve como objetivo avaliar a resistência de união ao esmalte hígido e desmineralizado de um sistema adesivo universal no modo autocondicionante, utilizado em associação a um selante de fossas e fissuras ou como material único; bem como, comparar sorção e solubilidade destes materiais.

2 ARTIGO 1 - ARE SELF-ETCH ADHESIVE SYSTEMS EFFECTIVE IN THE RETENTION OF OCCLUSAL SEALANTS? A SYSTEMATIC REVIEW AND META-ANALYSIS

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REVIEW

Are self-etch adhesive systems effective in the retention of occlusal sealants? A systematic review and meta-analysis

GRAZIELA BOTTON[1], CAROLINE SONEGO MORGENTAL[2], MAITÊ MUNHOZ SCHERER[2], TATHIANE LARISSA LENZI[1], ANELISE FERNANDES MONTAGNER[1] & RACHEL DE OLIVEIRA ROCHA[3]

[1]Dental Science Graduate Program, Federal University of Santa Maria, Santa Maria, Brazil, [2]School of Dentistry, Federal University of Santa Maria, Santa Maria, Brazil, and [3]Departament of Stomatology, Federal University of Santa Maria, Santa Maria, Brazil

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Background. Occlusal sealants are an effective method for caries prevention, although the effectiveness of different application strategies has not been established yet.

Aim. This systematic review compared the retention rate of sealants placed on occlusal surfaces following the use of self-etch adhesive systems and traditional acid etching, with or without the application of adhesive system.

Design. Literature searching was carried out until June 2015 in PubMed/MEDLINE, CENTRAL, and ClinicalTrials databases selecting randomized clinical trials that evaluated self-etch adhesive systems associated with pit and fissure sealants in primary or permanent molars comprising retention as outcome. From 683 potentially eligible studies, 10 were selected for full-text analysis and 5 were included in the meta-analysis. Two reviewers independently selected the studies, extracted the data, and assessed the bias risk. Pooled-effect estimates were obtained by comparing the retention failure rate between groups (self-etch systems *vs* acid etching with or without adhesive systems).

Results. Significant difference was found between groups, favoring the control group (prior acid etching) ($P < 0.05$), which showed lower failure rate in the retention of occlusal sealants. High heterogeneity was found on the meta-analysis. Most trials showed good evidence strength.

Conclusions. Occlusal sealants applied with self-etch systems show lower retention throughout time than sealants applied in the conventional approach, regardless of the use of adhesive systems.

Introduction

The evidences supporting the use of pit and fissure sealants as an effective method for the prevention or control of occlusal caries are strong. There are randomized controlled trials and systematic reviews confirming the preventive effect of resin-based sealants on occlusal surfaces of molars[1–4].

The most common material used to sealing occlusal surfaces seems to be resin – or glass–ionomer cement – based[5,6]. Few studies are available confirming the effectiveness of other materials such as compomers[3]. The advantage of one type of sealant over another is still unclear[7,8] so ever, resin-based sealants are commonly considered as gold standard for sealant materials comparisons[3].

Resin-based sealants' effectiveness seems to be associated with the retention of sealant over time[8–10], although this criterion cannot be used as an endpoint for caries prevention[5]. In a systematic review, however, it was found that the risk of loss of retention of resin-based sealants was associated with the risk of caries occurrence[3]. A common factor associated with the reasons for resin-based retention loss is the lack of proper tooth isolation and enamel contamination by saliva before the sealant placement[11]. Therefore, the placement of adhesive systems prior to sealant application has been suggested to improve the

Correspondence to:
Rachel de Oliveira Rocha, Rua Floriano Peixoto, 1184 sala 211, Santa Maria, RS, Brazil 97015-373 + 55 55 3220 9266. E-mail: rachelrocha@smail.ufsm.br
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sealant retention[12–14] due to their hydrophilic characteristics.

Following the trend to reduce the number of steps and simplify the application technique, the self-etch adhesive systems present the advantage of eliminating the prior acid etching and rinsing steps, reducing not only the technique sensitivity, but also the time of application and, consequently, decreasing the chair time[15–17]. Based on this, self-etch adhesive systems may be an alternative for occlusal sealant especially in young children, where simplifications in the clinical procedures are warranted[18]. There are few comparisons on the effect of etch-and-rinse and self-etch systems on clinical performance of occlusal sealants, and the results are unclear. To the best of our knowledge, a systematic quantitative evaluation of the available evidence on the effectiveness of self-etch adhesive systems and traditional acid etch technique in fissure sealant placement has never been undertaken.

Thus, the aim of this study was to systematically review the literature for randomized clinical trials studies that compared the retention rate of sealants combined with self-etch adhesive systems versus sealants with prior application of phosphoric acid, with or without adhesive systems combined. The research question was as follows: Are self-etch adhesive systems effective in the retention of pit and fissure sealants in primary and permanent molars compared to conventional prior acid-etching approach?

Materials and methods

This systematic review was registered at the PROSPERO database (CRD42015016379) and was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement[19].

Search strategy and selection criteria

A comprehensive literature search was undertaken through Cochrane Central Register of Controlled Trials (CENTRAL) and MEDLINE via PubMed databases up to June 2015 with no publication year limit. The subject search used a combination of controlled vocabulary and text words based on the search strategy for the PubMed/MEDLINE database as described in Table 1.

A sensitive search strategy was adapted for the CENTRAL database ('self-etch adhesive' AND 'pit and fissure sealants'). To reduce

Table 1. Search strategy used in PubMed/MEDLINE.

	Search terms
N° 4	((((((((((((((((Pit[MeSH Terms] AND Fissure Sealants [MeSH Terms])) OR (Pit and Fissure Sealants)) OR (Pit and Fissure Sealant)) OR Sealant*) OR Dental Sealants) OR Tooth Sealants) OR Fissure Sealants) OR Sealants, Fissure) OR Sealants, Tooth) OR Sealants, Dental) OR Sealants, Pit Fissure) OR Fissure Sealants, Pit) AND self-etching adhesive*) OR self-etch adhesive*) OR self-etch primer*) OR self-etch) OR all-in-one) OR self-etch adhesive system*) OR self-etching) OR self-etching primer*) OR all-in-one adhesive*)) AND ((((((((((((((((Pit[MeSH Terms] AND Fissure Sealants[MeSH Terms])) OR (Pit and Fissure Sealants)) OR (Pit and Fissure Sealant)) OR Sealant*) OR Dental Sealants) OR Tooth Sealants) OR Fissure Sealants) OR Sealants, Fissure) OR Sealants, Tooth) OR Sealants, Dental) OR Sealants, Pit Fissure) OR Fissure Sealants, Pit) AND Phosphoric Acids[MeSH Terms]) OR Phosphoric Acids) OR phosphoric acid) OR etch-and-rinse) OR acid phosphoric*) OR acid etching) OR preliminary acid etching) OR prior acid etching) OR dental acid etching) OR Acid Etching, Dental[MeSH Terms]) OR Acid Etching, Dental) OR acids, phosphoric) OR etching, dental acid)) AND ((((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation [MeSH Terms] OR therapeutic use[MeSH Subheading]))))
N° 3	((((((((((((((Pit[MeSH Terms] AND Fissure Sealants[MeSH Terms])) OR (Pit and Fissure Sealants)) OR (Pit and Fissure Sealant)) OR Sealant*) OR Dental Sealants) OR Tooth Sealants) OR Fissure Sealants) OR Sealants, Fissure) OR Sealants, Tooth) OR Sealants, Dental) OR Sealants, Pit Fissure) OR Fissure Sealants, Pit) AND self-etching adhesive*) OR self-etch adhesive*) OR self-etch primer*) OR self-etch) OR all-in-one) OR self-etch adhesive system*) OR self-etching) OR self-etching primer*) OR all-in-one adhesive*
N° 2	((((((((((((((((Pit[MeSH Terms] AND Fissure Sealants [MeSH Terms])) OR (Pit and Fissure Sealants)) OR (Pit and Fissure Sealant)) OR Sealant*) OR Dental Sealants) OR Tooth Sealants) OR Fissure Sealants) OR Sealants, Fissure) OR Sealants, Tooth) OR Sealants, Dental) OR Sealants, Pit Fissure) OR Fissure Sealants, Pit) AND Phosphoric Acids [MeSH Terms]) OR Phosphoric Acids) OR phosphoric acid) OR etch-and-rinse) OR acid phosphoric*) OR acid etching) OR preliminary acid etching) OR prior acid etching) OR dental acid etching) OR Acid Etching, Dental[MeSH Terms]) OR Acid Etching, Dental) OR acids, phosphoric) OR etching, dental acid
N°1	(((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading]))

publication bias, unpublished documents were pursued through ClinicalTrials.gov ('pit and fissure sealants'). The results of searches of various databases were cross-checked to locate and eliminate duplicates.

The inclusion criteria were as follows: (i) randomized clinical trials that evaluated the effectiveness of self-etch systems compared to acid-etching technique used before sealants in occlusal surfaces and (ii) articles published in English. The exclusion criteria were as follows: (i) no random or quasi-random allocation of study subjects, (ii) absence of a proper control group (acid-etching system), (iii) absence of retention as outcome, (iv) absence of similar follow-up for subjects of both groups evaluated in the same way. In case of studies reporting the same sample, we included those that presented more information.

It was not necessary to contact with authors to identify additional studies. If the full text was not available at databases, it was recovered through Bibliographic Commuting Program – Comut (comut.ibict.br/comut).

Retrieved titles and abstracts were independently reviewed by two authors (G.B. and R.O.R.) and selected for further review if they met the inclusion criteria. The interexaminer agreement was calculated (Kappa = 0.93), indicating excellent agreement. Same authors independently assessed full-text articles of the studies selected. Those studies that did not show any exclusion criteria were maintained. The reference lists of selected articles to this step were evaluated, and the full texts of potentially interesting studies to the research question were retrieved.

Any discrepancies were solved through discussion and consensus of a third reviewer (T.L.L.).

Data extraction

Two authors (G.B. and R.O.R.) assessed the selected publications using a standardized protocol, and the relevant data were recorded in a specific form in the Microsoft Office Excel 2007 software (Microsoft Corporation, Redmond, WA, USA). The following data were extracted: demographic setting (year, country), population characteristics and size, the brand and manufacturer of self-etch adhesive system, control material (phosphoric acid and additional adhesive, if applicable) and sealant, study design, type and numbers of teeth, mean age of participants, dentition (primary or permanent), details of intervention, type and number of operators, number of examiners, blinding, evaluation criteria and follow-up period. The retention of the sealants was recorded as success (total retention) or failure (partial or total loss). If studies reported the results as continuous scale, the data were dichotomized as described above. Moreover, only molars data were extracted from studies and it was selected data of follow-up period more similar among included studies. Therefore, in one study[17] with 48 months of follow-up, data of 12 months were retrieved for meta-analysis. It was not necessary contact with authors to search additional data.

Quality and bias risk assessment

Two reviewers (G.B. and T.L.L.) independently assessed the quality of the included trials by concerning the evidence strength. Criteria proposed by a previous systematic review with regard to minimum intervention approaches[20] were used, as described in Table 2. There was no disagreement observed between the evaluators (Kappa = 1.0).

Table 2. Quality score criteria for therapy articles[20].

Quality aspect	Criteria	Points
Study setting	*In situ*	1
	In vivo	2
Articles provide information on:	How samples were collected	1
	How examiners/patients were blinded	1
	How operators were trained or calibrated	1
	Examiner reliability	1
Sample dropout rate	30-20%	0
	10-19%	2
	<10%	3
Follow-up period	<1 year	0
	1 year	1
	>1 year	2

Strong evidence: 10–11.
Good evidence: 6–9.
Reasonable evidence: 0–5.

Statistical methods for the meta-analysis

The meta-analysis was conducted using Review Manager Software version 5.3 (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration) considering the random-effect model. Pooled-effect estimates were obtained by comparing the failure rate between groups (self-etch systems and acid-etching approach). A *P-value* ≤0.05 was considered statistically significant (*Z*-test). Statistical heterogeneity of the treatment effect (self-etch *vs* control – acid-etching technique) among studies was assessed using Cochran's Q-test, with a threshold *P-value* of 0.1, and the inconsistency I^2-test, in which values >50% were considered indicative of high heterogeneity.

Results

Search strategy

The search strategy identified 683 potentially relevant records and 681 remained after duplicates removal. After screening titles and abstracts, it was retrieved 9 full-text papers for more detailed information and 5 of these papers were excluded. Other study was identified in reference lists of related reviews. Two studies were excluded because reported data of the same sample in different papers[21,22]. In these cases, studies that reported data from the longer follow-up were considered[16,17]. One article was a retrospective study of chart review[23], one did not use acid-etching approach as control group[24], and another study used acid etching before self-etch system, without a proper group of comparison (only self-etch adhesive system)[25]. Finally, 5 papers met the eligibility criteria and were included in the review and meta-analysis[15–17,26,27]. Flowchart summarizes the process of studies selection (Fig. 1).

Study characteristics

The main characteristics of the papers included in the meta-analysis are summarized in Table 3. Each of the five studies was carried out in different countries: United States[15], Scotland[16], Turkey[17], Egypt[26], and Pakistan[27]. One study took place in a hospital and in a community dental service[16], three at universities[15,17,26], and one in a dental section of a hospital[27]. In all studies, the dental sealants were applied in places with complete dental unit. Sealants were applied using cotton rolls for tooth isolation procedure, and they were performed with a split-mouth design. Two studies did not inform the number and who placed the sealants[15,26]. Examiners were blinded during sealant evaluation in all studies.

Primary molars were considered in one study[26] and permanent molars in the other four[15–17,27]. In three studies, the materials were applied according to manufacturer's instructions[16,17,27], and in two studies that used the same self-etch adhesive system (Adper Prompt L-Pop), sealant and adhesive were light-cured together in the experimental group[15,26].

One study used only visual inspection as analysis instrument – sealant was opaque[27], two studies used mirror and probe[17,26], one study used photographic images of each tooth which were recorded on videotape using intraoral video camera[15] and another did not provide directly this information[16], but cited the study conducted by Deery *et al.*, 2001[28], which used visual inspection.

Regarding the evaluation criterion, one study used a dichotomous scale considering success as total retention and failure as partial or total loss[15], one study rated as complete retention, partial retention, or complete failure[27], and another used a similar scale that was completely sealant retained, partial loss, or total loss[17]. Even, two studies[16,26] assessed using Color Coverage Caries Sealant Evaluation System proposed by Deery *et al.*, 2001[28].

The shorter follow-up period was 6 months[27], and the longest was 48 months[17]. Two studies followed patients for 12 months[16,26] and one for 24 months[15].

Quality and risk of bias

The majority of the studies could be scored as good evidence[15,16,26,27]. Only one study showed strong evidence[17], as summarized in Table 4.

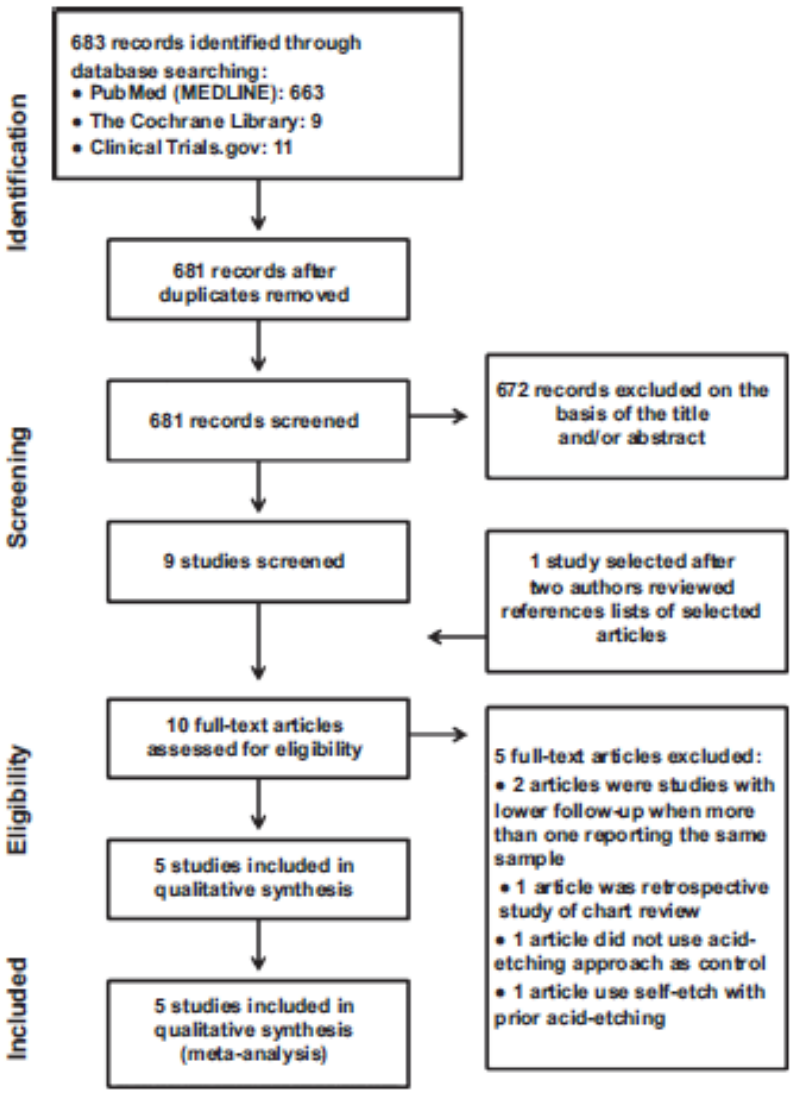

Fig. 1. Flowchart of studies selection according to PRISMA statement.

Meta-analysis

The values of Cochran's Q- and the Z-test were <0.05 showing statistically significant difference between groups, favoring the control group (acid-etching technique), which showed a lower failure rate in the retention of occlusal fissures sealants and the I^2-test was 85%. The meta-analysis results are presented in Fig. 2.

Discussion

Resin-based dental sealants can be used for caries prevention in at-risk, caries-free teeth[8] and as therapy for carious lesions limited to enamel – incipient caries[29]. Self-etch adhesive systems have been proposed as an alternative for sealant placement, especially when saliva isolation is difficult[18,26]. The long-term success of pit and fissure sealants is directly related to their retention rate[8–10]. Clinical trials involving children and teenagers are challenging to perform as for achieving long follow-up time, cooperation of parents is necessary[17]. Considering that sealing pits and fissures are important in caries prevention[8], the current study addressed an important question of which adhesive strategy should be used prior to sealant application to promote the highest longevity of the sealant based on results of randomized clinical trials.

Table 3. Detailed chart related to the studies included in the current systematic review.

Study	Feigal, Quelhas[15]	Burbridge *et al.*[16]	Karaman *et al.*[17]	Maher *et al.*[26]	Aman *et al.*[27]
Year	2003	2007	2013	2013	2015
Country	USA	Scotland	Turkey	Egypt	Pakistan
Setting	University	Dental Hospital and Community Dental Service Clinics	University	University	Dental section of a hospital
Self-etch system	Prompt L-Pop (3M ESPE, St. Paul, MN, USA)	Xeno III (Dentsply, Germany)	Futurabond NR (Voco, Cuxhaven, Germany)	Adper Prompt L-Pop (3M ESPE, St. Paul, MN, USA)	Adper Easy One (3M ESPE, St. Paul, MN, USA)
Control group	Phosphoric acid gel	37% phosphoric acid + Prime and Bond (Dentsply, Germany)	Phosphoric acid gel + Solobond M (Voco, Cuxhaven, Germany)	35% phosphoric acid (Scotchbond Etchant, 3M ESPE, St. Paul MN, USA)	37% phosphoric acid + Adper Single Bond 2 (3M ESPE, St. Paul, MN, USA)
Sealant	Delton (Dentsply Caulk, Milford, DE, USA)	Opaque Delton (Dentsply, Germany)	Grandio Seal (Voco, Cuxhaven, Germany)	Climpro (3M ESPE, St. Paul, MN, USA)	Climpro (3M ESPE, St. Paul, MN, USA
Study design	Split mouth	Split mouth	Split mouth	Split mouth	Split mouth
n (molars)	18	50	64	45	91
Mean age	7–13 years (mean 10.5)	5–13 years (mean 9.15)	18–21 years (mean 20)	4–6 years (mean 5.18 ± 0.83)	6–16 years (mean 12.7 ± 2.9)
Dentition	Permanent	Permanent	Permanent	Primary	Permanent
Isolation	Cotton roll and saliva ejector	Cotton roll and saliva ejector	Cotton roll and saliva ejector	Cotton roll and saliva ejector	Cotton roll and saliva ejector
Manufacturer's instructions	Sealant and adhesive were light-cured together in the experimental group	Followed manufacturer's instructions	Followed manufacturer's instructions	Sealant and adhesive were light-cured together in the experimental group	Followed manufacturer's instructions
Operator (Type, Number)	Not related	7 dentists and therapists (3 dental surgeons/3 dental hygienists/1 dental therapist) (received written and verbal training)	4 calibrated dentists	Not related	2 clinicians (received training)
Examiner (Number, Blinded)	Two/blinded (3 in case of disagreements)	One/blinded	2 calibrated/blinded (different of operators)	One	Two/blinded
Analysis instrument	Photographic images of each tooth were recorded on video tape/intraoral video camera (AcuCam, New Image Industries, Franklin Park, IL, USA)	Visual inspection	Dental explorer and a mirror	Visual inspection – only the mirror (probe in case of doubt)	Visual inspection (opaque sealant)
Evaluation criteria	Failure (total/partial loss) or success – review clinical observations and photographic images at the time of treatment were recorded	Color Coverage Caries Sealant Evaluation System	Completely retained, partial loss, total loss	Color Coverage Caries Sealant Evaluation System	Complete retention; partial retention; complete failure

	24 months		12 months		12 months		12 months		6 months	
Follow-up period analyzed	**SE**	**TE**	**SE**	**TE**	**SE**	**TE**	**SE**	**TE**	**SE**	**TE**
Results Retention rates %										
Success: total retention	61%	61%	0%	26.3%	17.2%	87.5%	51%	64%	28.6%	58.2%
Failure: total or partial loss	39%	39%	100%	73.7%	82.8%	12.5%	49%	36%	71.4%	41.8%

SE, self-etch adhesive system, TE, total etch – conventional approach.

Table 4. Quality score for evidence of studies[20].

Quality aspect	Criteria	Feigal, Quelhas[15]	Burbridge *et al.*[16]	Karaman *et al.*[17]	Maher *et al.*[26]	Aman *et al.*[27]
Study setting	*In situ* *In vivo*	2	2	2	2	2
Articles provide Information on	How samples were collected	1	1	1	1	1
	How examiners/ patients were blinded	1	1	1	Not related	1
	How operators were trained or calibrated	Not related	1	1	Not related	1
	Examiner reliability	Not related	1	1	Not related	1
Sample dropout rate	30–20% 10–19% <10%	3	0	3	3	2
Follow-up period	1 year >1 year	2	1	2	1	0
Total evidence		9 Good	7 Good	11 Strong	7 Good	8 Good

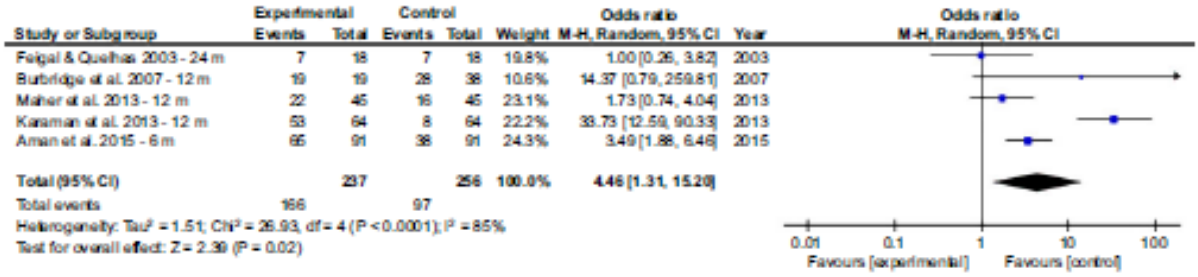

Fig. 2. The pooled estimate (OR; 95% CI) for failure rate in the retention of occlusal fissure sealants.

Therefore, this pioneering systematic review compared the retention rate of fissures sealants placed on occlusal surfaces following the use of the self-etch adhesives and phosphoric acid-etching technique.

The present study was able to summarize the clinical data on different bonding approaches used for occlusal sealant application and showed that the retention of occlusal fissure sealants is higher when applied after prior phosphoric acid etching. The higher failure rates when using self-etch systems prior sealants may be related to the pH aggressiveness of these materials, because mild or ultra-mild self-etch primers may insufficiently etch the enamel, resulting in deficient resin penetration into enamel[17,27]. The acidity of self-etch systems is lower than that of phosphoric acid, so these materials do not etch the enamel as effectively as phosphoric acid, especially sound enamel[30]. In the studies that used Prompt L-Pop[15] and Adper Prompt L-Pop[26], considered as strong self-etch systems (pH approximately 1), there were no differences in sealant retention using self-etch adhesive or a conventional phosphoric acid-etching technique. As the composition and pH of materials directly affect the adhesive performance, this should be taken into account when extrapoling the results. Considering the global analysis, however, it can be evidenced that self-etch system could not be the ideal approach prior to pit and fissure sealants.

Retention was assessed considering failure as any sealant loss, regardless of the amount[15]. The data for meta-analysis were extracted from primary studies in a dichotomous manner, being success as total retention and failure as any amount of sealant loss, partial, or total. Moreover, only data from molars were included in the analysis, both from primary and permanent teeth, because

that bond strength to sound enamel of both dentitions has been shown similar[31].

Further, the analysis pooled the results of follow-up periods closer among the clinical trials in an attempt to do not jeopardize any study with longer follow-up, because higher rates of retention failures were noted in shorter follow-up. The more frequent follow-up time on selected studies was 12 months[16,17,26], which seems a suitable shorter time for the evaluation of pits and sealants.

This systematic review searched studies that compared retention rates when self-etch adhesive systems or phosphoric acid etch – with or without adhesive layer intermediate – were used before sealant application. Considering that few studies were retrieved in this review, the results obtained should be carefully considered, because some trials used a small sample[15] or showed a high dropout[16]. The small number of trials available still may be related with publication bias, as negative or similar results probably cannot have been published.

Furthermore, this systematic review did not cover any study comparing universal adhesive applied as self-etch mode with etch-and-rinse system. Manufacturers' instructions of the universal adhesive systems suggest the use their before sealants, without prior acid etching. Considering this aspect, randomized controlled clinical trials assessing universal adhesives prior pit and fissure sealants could be interesting to be conducted out.

The literature search was made in three databases. In Cochrane Central Register of Controlled Trials (CENTRAL) were found 10 records, which were two contemplating the inclusion criteria; however, they were duplicates with records selected by MEDLINE via PubMed[15,25]. Even in ClinicalTrials.gov was found a record performed in 2009, but it was documented as 'unknown', that is not available updated data. Nevertheless, the full text was recovered by MEDLINE via PubMed[27]. So, it is suggested that for this systematic review, a search performed only in MEDLINE via PubMed database could have been enough to assess the included studies, at last the Scopus of this database covers a wide range of scientific journals[32]. Additionally, to select only studies in English, depending on the studied subject, may represent a limitation; however, previous studies did not find evidence of bias in meta-analysis caused by language restrict[33,34].

The only parameter considered was sealant retention. It was not possible to assess the caries prevention because there were few studies that also mentioned this outcome[16,17]. Moreover, in one study, that failed sealants were repaired during the 12 months follow-up[16], and in another, it was not observed caries development throughout the 48 months follow-up[17].

It has been demonstrated that the risk of loss of complete retention of sealant materials is associated with the risk of caries occurrence for resin-based sealants but not for glass–ionomer cement (GIC) sealants[35]. It can be attributed to the presence of GIC particles in bottom of fissures, maintaining its preventive effect even when the sealant is lost[36].

Recently, a study suggests that the total loss of the sealant retention appears not to be a valid predictor for clinical outcome[37]. In this systematic review, we considered as insuccess both partial and total loss of sealant. This is because the partial loss of the resin sealant may result in a site retentive of biofilm, increasing the risk to caries. In this sense, comparisons of bonding strategies for placing occlusal sealants may provide more useful information for clinical evidence-based decision making. Further large sized randomized control trials, investigating the clinical efficacy of resin-based fissures sealants applied under different approaches, should investigate retention and caries occurrence as outcomes.

One study showed data only from those participants whose results were known, without dropout[16]. The impact of similar decision was evaluated at previous meta-analysis, and no change in the overall significance was shown[38]. This same study showed dropout of 37%, usually an exclusion criterion of systematic reviews, but the authors considered that there was no reason to think that patients who failed to re-attend had different outcome of the assessed patients[16]. Despite these methodological faults, this study was classified as good evidence and then was kept for meta-analysis.

It is valid to assume that the included studies were conducted in countries with different culture and caries prevalence, avoiding the studies' polarization. Although some investigations were performed at community dental service and others at university, all procedures were made following controlled conditions, without influence in the studies' outcome.

In the pooled studies, some methodological conditions ranged considerable: it was evaluated primary[26] and permanent molars[15–17,27], and a high variation of the mean age of the patients among the studies (5.18 up to 20 years old) was observed. Only two of the five studies used the same evaluation criteria – Color Coverage Caries Sealant Evaluation System[16,26]. High variation was also noted on number and professional qualifications, and some studies did not report this information. Besides, despite had been pooled the follow-up more similar among studies, 3 assessed 12 months[16,17,26], one 6 months[27], and another 24 months[15]. All these differences may have influenced for a high heterogeneity. Moreover, the high variation in the odds ratio may be due to the greater differences in failure rates in the studies, comparing experimental and control groups. The percentage of failures in experimental groups was 100% in one study and 82% in the other, whereas low failure rates were observed for respective control groups.

Despite of the high heterogeneity, concerning quality of evidence, all selected studies showed a good strength of evidence[20]. In all studies, the operators' blinding was not possible due to the different adhesive protocols prior sealant application. Nevertheless, it was reported that the evaluators were blinded, except in one study[26]. Further, training of operators is an essential step for considering reliable a clinical trial and three studies reported operators' training[16,17,27]. Future clinical studies should take into consideration methodological parameters related to the training of the operators, evaluation criteria, and follow-up period aiming to reduce the bias risk.

Based on the present findings, sealants applied in the conventional manner, with prior acid etching, present superior retention throughout time than the occlusal sealants combined with self-etch systems, which could give support for clinicians for the best option for occlusal sealant application.

Why this paper is important to paediatric dentists

- The pediatric dentists must be aware that nowadays, it is preferable to use acid-etching technique for ensuring the long-term success of occlusal fissure sealants.

Conflict of interest

The authors declare no conflict of interests.

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3 ARTIGO 2 - UNIVERSAL ADHESIVE SYSTEM IN SELF-ETCH MODE MAY NOT BE A VALID OPTION FOR BONDING RESIN-BASED FISSURE SEALANTS

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Universal adhesive system in self-etch mode may not be a valid option for bonding resin-based fissure sealants

Graziela Botton
Professor
Department of Stomatology, Federal University of Santa Maria, Brazil
Rua Marechal Floriano Peixoto, 1184, 97015-270, Santa Maria, RS, Brazil
Contribution to the paper: Performed the experiments, execution and article writing.

Lucas Saldanha da Rosa
Undergraduate student, Federal University of Santa Maria, Brazil
Rua Marechal Floriano Peixoto, 1184, 97015-270, Santa Maria, RS, Brazil
Contribution to the paper: Performed the experiments

Fabio Zovico Maxnuck Soares
Professor
Department of Restorative Dentistry, Federal University of Santa Maria, Brazil
Rua Marechal Floriano Peixoto, 1184, 97015-270, Santa Maria, RS, Brazil
Contribution to the paper: Contribution substantially to discussion, proofread the manuscript.

Rachel de Oliveira Rocha
Associate Professor
Department of Stomatology, Federal University of Santa Maria, Brazil
Rua Marechal Floriano Peixoto, 1184, 97015-270, Santa Maria, RS, Brazil
Contribution to the paper: Idea, contribution substantially to discussion, proofread the manuscript.

Corresponding author:
Rachel de Oliveira Rocha
Rua Floriano Peixoto, 1184 sala 211
Santa Maria, RS, Brazil
+55 55 3220 9266
rachelrocha@smail.ufsm.br

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Universal adhesive system in self-etch mode may not be a valid option for bonding resin-based fissure sealant

ABSTRACT

Purpose: The aims of this study were a) to evaluate the microshear bond strength (μSBS) of a universal adhesive system (Scotchbond Universal Adhesive - SBU) used in self-etch mode, beneath a resin-based fissure sealant (FluroShield - FLSH) or as a single sealant material to sound and demineralized enamel; and b) to compare the water sorption and solubility of these materials.

Materials and Methods: Forty-two third molars were randomly assigned in 6 groups (n=7) according to the enamel condition (sound and demineralized) and material (SBU+FLSH; SBU and FLSH/prior acid etching). Composite cylinders (0.72 mm^2) were built up on unground enamel and tested (μSBS) after 24h water storage. Ten disk shaped specimens were prepared of each material (SBU and FLSH) and water sorption and solubility were evaluated according to ISO 4049:2009. μSBS data (MPa) were analyzed using two-way ANOVA and Tukey's post-hoc test and the water sorption and solubility values by the Mann-Whitney U test (α=0.05).

Results: The FLSH applied with prior acid etching, resulted in highest μSBS values ($p<0.000$), regardless the enamel condition ($p=0.410$). SBU showed higher water sorption ($p<0.000$) and solubility ($p<0.000$) than FLSH.

Conclusion: The universal adhesive system in self-etch mode may not be a valid option for bonding fissure sealants considering the lower bond strength to enamel, regardless its condition, and the more water intake (sorption and solubility) than a resin-based fissure sealant.

INTRODUCTION

Fissure sealants are an effective method for the prevention and arresting occlusal carious lesions in primary and permanent molars.[45] Its effectiveness depends on the retention over the time,[1] forming a physical barrier to avoid biofilm accumulating on occlusal fissures and therefore, preventing carious lesions.

Traditionally, fissure sealing procedure enclose resin-based sealants with prior enamel acid etching.[32] However, inadequate enamel acid etching and, consequently, poor sealant retention can contribute to caries development. The insufficient enamel acid etching may be related to the aprismatic and more highly mineralized enamel of newly erupted molars.[24,44] Therefore, long acid conditioning and several other enamel preparations have been suggested to overcome this.[6]

The aspiration to use an adhesive system in fissure sealant protocol is to attempt to improve the sealant retention.[46] According to the results of a recently published systematic review, adhesive systems used beneath fissure sealants had a positive effect on retention rates and, consequently, on occlusal caries prevention.[7]

The self-etch adhesive systems present the advantage of eliminating the prior acid etching and rinsing steps, consequently, simplifying the application technique[32] and make the procedure more user-friendly. Thus, the use of self-etch adhesives prior to the placement of fissure sealants has proved to be a very attractive alternative. However, insufficient etching pattern of the self-etch adhesives on enamel and, consequently, low bond strength values and poor sealant retention have been found in laboratory[21] and clinical studies.[46] A recent systematic review of a randomized clinical trials compared the retention rates of occlusal sealants placed after the use of self-etch adhesive systems and traditional acid etching, with or without the application of adhesive system, and found that the sealants applied after enamel acid etching, regardless of the use of adhesive systems, showed higher retention rates throughout time than sealants applied with self-etch systems.[10]

Nevertheless, Scothbond Universal Adhesive, a universal adhesive system, is indicated by the manufacturer to the application, in self-etch mode, prior to the application of the resin-based sealant. Despite the mild pH (2.7),[33] the presence of 10-MDP (10-methacryloxydecyl dihydrogen phosphate) and methacrylate-modified polyalkenoic acid copolymer[30] in this adhesive system can result in similar etching pattern[18] and also, to a chemical interaction between functional monomers and hydroxyapatite,[42,43] justifying the manufacturer directions.

Although a systematic review of in vitro studies showed that the best protocol for sound enamel adhesion by universal adhesives is with the prior phosphoric acid etching,[33] a few studies [5,26] have been evaluated this universal adhesive system in self-etch mode beneath resin-based fissure sealants.

Furthermore, in the clinical situation, fissure sealants are likely to be applied on demineralized occlusal enamel, with a lower amount of minerals, higher porosity[12], and enlargement of the intercrystalline spaces.[35] Demineralized enamel seems negatively influence on the bond strength of adhesive systems,[3,39] even so, this kind of substrate has not been considered in fissure sealants evaluations.

Therefore, the primary objective of this study was to evaluate the bond strength of a universal adhesive system used in self-etch mode, beneath a fissure sealant or as a single sealant material to sound and demineralized enamel. The second objective was to compare the water sorption and solubility of a universal adhesive system and a resin-based sealant. The null hypotheses considered were: (1) bond strength of universal adhesive system used in self-etch mode would be similar to resin-based sealant with prior acid etching; (2) bond strength to sound and demineralized enamel would be similar; (3) a universal adhesive system and the resin-based sealant would have similar water sorption and solubility.

MATERIALS AND METHODS

Bond Strength Test

Tooth Selection and Preparation

Forty-two caries-free, human third molars (Ethics Committee Approval) were cleaned and disinfected in 0.5% aqueous chloramine-T solution at 4º C until thirty days. The root portion of each tooth was removed and the crowns were sectioned parallel to the longitudinal axis in the mesiodistal direction using a diamond disk in a cutting machine (Labcut 1010, Extec; Enfield, CT, USA), resulting in two sections, buccal and lingual with unground enamel, for each tooth. The sections of each tooth were randomly on website Random.org (Randomness and Integrity Services Ltd) assigned in one of the 6 experimental groups (n=7).

Experimental Design

This in vitro study considered 6 experimental groups of combinations of two enamel conditions - sound or artificially demineralized; and three combinations of two materials - resin-based sealant FluroShield (DENTSPLY, Petropolis, RJ, Brazil) with prior acid etching; Scotchbond Universal Adhesive (3M ESPE; St Paul, MN, USA) in self-etch mode beneath resin-based sealant FluroShield; and Scotchbond Universal Adhesive in self-etch mode as a sealant material. The outcomes were bond strength to unground enamel and sorption and solubility of both materials in distilled water.

Enamel Demineralization - Artificial Caries Induction

Artificially demineralized enamel was created by artificial caries induction with a pH-cycling model. The sections of each tooth were covered with two layers of acid-resistant nail polish (Colorama, Maybelline; São Paulo, SP, Brazil) except on experimental surfaces. Sections were individually subjected to 14 cycles of immersion for 8 hours in 10 ml of demineralizing solution (2.2 mM CaCl2, 2.2 mM NaH2PO4, 50 mM acetic acid with adjusted pH of 4.5) and for 16 hours in the same volume of remineralizing solution (1.5 mM CaCl2, 0.9 mM NaH2PO4, 0.15 mM KCl with adjusted pH of 7.0) for 14 days.[39,40] A digital pHmeter (Digimed, DM22; ServMed Analítica; Guarulhos, SP, Brazil) was used to confirm the pH of the solutions before each pH cycle. De- and remineralizing solutions were renewed every cycle.

Bonding and Restorative Procedures

The sections of each tooth were glued with cyanoacrylate to PVC rings completed with acrylic resin (JET Clássico®, São Paulo, SP, Brazil). Specimens were prepared with prior acid etching for FluroShield – in which phosphoric acid was applied for 30 s prior to the application of the resin-based material and in self-etch mode, ie, without phosphoric acid etching, when Scotchbond Universal Adhesive was used beneath the FluroShield or as a sealant material. All bonding procedures were carried out by a single trained operator and in accordance with the manufacturer's recommended application protocol (Table 1).

Adhesive system and resin-based sealant were applied on unground enamel in delimited areas (acid-resistant double-faced adhesive tape (3M, Scotch; Sumaré, SP, Brazil), perforated by a rubber-dam punch),[36] and starch tubes (Renata, Pastifício Selmi, Londrina, PR, Brazil),[38]

with an internal diameter of 0.96 mm and a height of 1.0 mm, were carefully positioned over adherent delimited areas followed by the light curing the adhesive system for 20 s in two FluroShield groups - in etch-and-rinse mode and Scotchbond Universal Adhesive beneath the FluorShield - and for 10 s in Scotchbond Universal Adhesive as single material (Emitter B, Schuster, Santa Maria, RS, Brazil) with a light output of at least 1250 mW/cm^2. A resin composite (Filtek Z350, 3M ESPE, St Paul, MN, USA; shade A1) was placed into the starch tubes and light cured for 20 s, resulting in at least 3 cylindrical specimens per each tooth.

Microshear Bond Strength Test (μSBS)

The bonded specimens were stored in distilled water at 37°C for 24 h and then the starch tubes were removed under a gentle water stream, resulting in cylindrical specimens with a cross-sectional area of approximately 0.72 mm^2. Specimens were examined under a stereomicroscope at 40X magnification (Stereo Discovery V20, Carl Zeiss do Brazil Ltda., Rio de Janeiro, RJ, Brazil), for checking interfacial gaps, bubble inclusion, or other defects that required the exclusion and replacement of the cylindrical specimens test.

The specimens test were immediately subjected to μSBS using a universal testing machine (EMIC DL 1000 - Equipment and Systems Ltda; São Jose dos Pinhais, PR, Brazil). A thin steel wire (0.20 mm diameter) was used to make a loop between the load cell projection and the composite cylinder test, nearest to the adhesive interface. The cylinder was kept in line with the center of the load cell and the wire loop was parallel to the direction of load cell application and to the bonding interface. A shear load was applied at a crosshead speed of 1.0 mm/min until failure occurred. The fracture load was recorded and the bond strength was expressed in MPa. All these steps were carried out by a single blinded trained operator.

Failure Mode Analysis

After testing, all debonded specimens were observed by a blinded examiner under a stereomicroscope (Stereo Discovery V20, Carl Zeiss do Brazil Ltda., Rio de Janeiro, RJ, Brazil) at 40X magnification to determine the failure mode and to classify as two types: (1) cohesive failures within enamel or composite and (2) interfacial or adhesive failure.[41] Two representative specimens for each experimental group were prepared for failure mode evaluation under scanning electron microscope (SEM) to confirm the failure mode. The samples were dehydrated in ascending concentrations of ethanol (50%, 75%, and 95% for 5 min each, and 100% for 3

h)[27] and kept in vacuum for 24 h. Subsequently, they were gold sputter coated (JEOL A110, Jeol Inc Tec, Tokyo, Japan) and operated in the secondary electron mode at 10 kV voltage.

Water Sorption and Solubility

Specimen Preparation

Sorption and solubility evaluation were performed according to ISO 4049:2009. Ten disk-shaped specimens (15.0 mm in diameter x 1.0 mm in thickness) were prepared using a metal mould for each tested material.

For Scotchbond Universal Adhesive, 10 drops of adhesive system were applied in a dappen dish and the solvent was evaporated by an air-blown at 20 cm distance for 5 seconds. Then a micropipette (Digipet, Curitiba, PR, Brazil) was used to dispense the adhesive system directly into the metal mold. The disks were light cured for 80 seconds (Led Olsen, Olsen Ind. E Com S/A, Palhoça, SC, Brazil, 800 mW / cm^2) on the top and for 80 seconds on the opposite side.

FluroShield disks were obtained applying the material directly into the metal mold and the light curing was performed in the same manner as described above. Disks were assigned in two groups (n=10) according to the materials.

Measurement of Sorption and Solubility

Specimens disks were stored separately in a desiccator containing dehydrated silica gel at 37±1°C. The disks were weighed daily in an analytical balance, accurate to 0.001 mg (Coleman, Santo André, SP, Brazil) until reached a constant mass (three days of no weight change) (m1). The thickness and diameter of each disc were measured at two points with a digital caliper (Zaas Precision Amatools, Piracicaba, SP, Brazil) and volume (V) was calculated in mm^3.

Therefore the disks were individually placed in sealed vials containing 10 ml of distilled water at 37±1°C. On the first day, the disks were weighed after 4 and 24 hours. After the disks were weighed after 7, 14, 30, 60, 90, 120, 150 and 180 or until reaching a constant mass (m2). After weighing, the specimens were again placed in the desiccator containing dehydrated silica gel and transferred to an oven at 37±1°C. Then, weighed daily until obtaining a constant mass as described above (m3).

Sorption (WS) and solubility (SL) were calculated using the following formulae (in mg/mm^3), respectively:

WS = m2 - m3 / V and SL = m1 - m3 / V

Where m1: initial mass (mg) of the specimen (the mass of the disk after first dissection); m2: maximum sorption (mg) of the specimen (the mass of the disk in the absorption equilibrium); m3: final mass (mg) of the specimen (the mass of the disk after dissected again); V is the volume (mm^3) of the specimen.[2]

The actual percentage amount of water absorbed (SPc%) was obtained using the formulae: SPc% = m2-m1/m1.

Statistical Analysis

The experimental unit in the current study was the tooth, so μSBS values of specimens from the same tooth were averaged for statistical purposes. The mean μSBS for every test group was expressed as the average of the 7 teeth used per group. The sample size was at the start of the study, assuming a mean difference of 20% among groups, and expecting a variation coefficient of 20%, a minimum of 6 teeth per group was required to achieve a power of 0.8 and an α-error probability of 5%. The specimens that failed prior to the test were considered premature failures and they were not included in the bond strength calculation.

The Kolmogorov-Smirnov test confirmed distribution of bond strength data. The μSBS means were analyzed with two-way ANOVA (enamel condition vs material) and Tukey's post-hoc test ($\alpha = 0.05$). Statistical analyses were performed using Minitab software (Minitab Inc., State College, PA, USA). The failure mode was evaluated descriptively.

The non-parametric sorption and solubility values were analyzed by Mann-Withney U test to assess the differences in average water sorption, solubility and SPc% of the materials. The significance level was set at 0.05 and analysis was used to compare pairwise differences between adhesives in water sorption and solubility. The analysis was performed using Minitab software (Minitab Inc., State College, PA, USA).

RESULTS

Microshear Bond Strength

The microshear bond strength means and standard deviations for all experimental groups are presented in Table 2, as well as the number of specimens tested and pre-test failures (ptf) for each group. The ANOVA showed a significant effect for the factor 'material' ($p < 0.000$; $F = 17.83$) but not to the factor 'enamel condition' ($p = 0.410$; $F = 0.69$) as well as the cross-product interaction 'enamel condition *vs* material' ($p = 0.756$; $F = 0.28$) (Table 3).

FluroShield applied with previous acid etching (conventional sealant technique) resulted in highest μSBS values than FluroShield combined with Scotchbond Universal Adhesive in a self-etch mode (Tukey's test; $p = 0.001$) and Scotchbond Universal Adhesive (in a self-etch mode) (Tukey's test; $p < 0.000$) used as a single sealant material. All specimens showed interfacial failures, regardless material, and enamel condition. Representative SEM images of specimens bonded to sound and demineralized enamel with all adhesives are presented in Fig 1.

The number of pre-test failures was lower than 2% of the total number of tested specimens, as shown in Table 2.

Water Sorption and Solubility

The mean and standard deviation of water sorption, solubility and the percentage amount of water absorbed by the materials at the end of the storage period (180 days) are presented in Table 4. Scotchbond Universal Adhesive showed the higher means of water sorption ($p < 0.000$) and solubility ($p < 0.000$) than FluroShield. The actual percentage amount of water absorbed (SPc%) by Scotchbond Universal Adhesive was almost 5x higher than that absorbed by FluroShield ($p < 0.000$).

DISCUSSION

Selective enamel etching is an advice strategy prior to the application of universal adhesive systems to improve the bond strength values to enamel.[33] Nevertheless, the use of self-etch adhesive systems prior to the sealant application is still controversial. The present study investigated the enamel bond strength of a universal bonding agent in the self-etch mode used

prior to the application of fissure sealant and as a single sealant material. One study has been reported the use of multimode one-bottle universal adhesives on enamel to enhance fissure sealant retention used in etch-and-rinse mode[23], although the use is suggested by some manufacturers in self-etch mode. The results of the present study indicated that the bond strength values promoted by the universal adhesive in the self-etch mode were statistically lower than those obtained with the resin-based sealant with previous enamel acid etching. Therefore, the first null hypothesis that there would be no difference in bond strength among experimental groups must be rejected.

Two recently published systematic reviews[7,10] have shown the etch-and-rinse mode is preferable for the application of resin-based sealants and one of them reported that the use of adhesive systems beneath fissure sealants can improve retention rates[7]. The main reason for this is the poor micro-mechanical interlocking obtained in non-etched enamel when self-etch adhesives are used.[17] Even though the retention rates of self-etch adhesives were lower than those of etch-and-rinse systems as stated in these previous studies, the universal adhesive system evaluated in the presented study was not considered in these systematic reviews. Moreover, it could be assumed that the presence of both 10-MDP (10-methacryloxydecyl dihydrogen phosphate) and methacrylate-modified polyalkenoic acid copolymer,[30] although the mild pH (2.7) of Scotchbond Universal Adhesive,[33] can promote more intense and pronounced etching pattern[18] and chemical interaction between functional monomers and hydroxyapatite[42,43] leading to similar bond strength values to etch-and-rinse approach as pointed in an earlier study.[28] However, the results of the present study clearly showed an inferior performance of the resin-based sealant applied after universal adhesive in self-etch mode as well as the use of the adhesive system alone.

The simplified bonding steps and the combined total etch-and-rinse and self-etch approaches are the expectation for the universal adhesives. In fissure sealant application, the use of Scotchbond Universal Adhesive in self-etch mode, as proposed by the manufacturer, could be advantageous to improve sealant retention with user-friendly application protocol, eliminating the rinsing and drying steps. The application of Scotchbond Universal Adhesive in etch-and-rinse mode prior the sealant was not evaluated because the Scotchbond Universal Adhesive manufacturer indicates the application of this adhesive system combined with a resin-based sealant in the self-etch mode. Previous studies[14,34] assumed that the use of an adhesive prior to sealant application is advantageous since the presence of hydrophilic monomers could have a moisture-chasing effect,[46] especially where saliva contamination takes place. However, in general, universal adhesives in self-etch mode are not equally effective on ground enamel as

in etch-and-rinse mode[33]. This in vitro study used natural and unground enamel surfaces, corresponding to the clinical situation, with outer hypermineralized aprismatic enamel layer,[16] which have a significant influence on bond strength,[11] as also found in our results.

Even in this study, bonding to demineralized enamel was also evaluated, and contrary to previous studies,[3,39] enamel that underwent mineral loss prior to adhesive or sealant procedures did not influence on bond strength values. A possible explanation for this could be the different tested adhesive systems[39] and the use of unground permanent enamel as a substrate.[3] Thus, the second null hypothesis that similar bond strength to sound and demineralized enamel would be found must not be rejected. This result can be considered favorable in clinical situations when the sealants are indicated for the control of incipient lesions.[45] Still, the same protocol of application of pit and fissure sealants can be used for prevention and control of caries lesions.

Active application on enamel has been suggested to improve the bonding efficacy of self-etch adhesives, so as done in the present study, although no improvement was found on bonding to enamel in this study as pointed in earlier studies.[19,25] In the same way, the effect of the use of hydrophobic resin coating, that has been suggested to improve the bonding performance and the degree of conversion of universal adhesives, mostly in self-etch strategy[29] was not seen in the present study, even in the group FluroShield combined with Scotchbond Universal Adhesive.

In conventional fissure sealant group (FluroShield) the acid etching was performed for thirty seconds, minimum etching time suggested by the manufacturer, and adopted in this study in order to simulate the clinical situation with reduced chair time. This etching time was sufficient to obtain superior bond strength values than both self-etch groups (FluroShield combined with Scotchbond Universal Adhesive and Scotchbond Universal Adhesive alone).

The low values of water sorption and solubility were found in both tested materials but statistically significant higher water sorption and solubility values were found to Scotchbond Universal Adhesive. The third null hypothesis that both materials would have similar water sorption and solubility must be rejected. This finding was expected because Scotchbond Universal Adhesive is a simplified adhesive system that exhibits hydrophilic groups in its composition - HEMA, 4-META, and 10-MDP, phosphate monomer, more hydrophilic and prone to water sorption, differently from FluroShield that contains only Bis-GMA. It clearly seems, considering the SPc% values, that were almost 5x higher for Scotchbond Universal Adhesive. These values also could explain the negative values of solubility found for evaluated materials. The water absorbed could not be extracted by a drying process, even though in

accordance with ISO specification and became within the resin matrix.[8,20,31] Thus, the final mass of specimens was higher than the initial ones. The water bound to polymer network could have a plasticizing effect reducing material mechanical properties and as clinical consequences, a compromised long-term retention of fissure sealant.[9] Whereas a previous study investigated the use of an adhesive system as sealant alone,[15] we supposed that Scotchbond Universal Adhesive could be used as single fissure sealant with the advantage of simplified application of self-etch mode, however its hydrophilic components resulted in higher water absorption/adsorption as pointed by sorption and solubility values, which in clinical situation may result in unwanted degradation.

In vitro tests are important issues to predict the clinical performance of dental materials[9,37] including fissure sealants. Therefore, this study attempted to carefully maintain the characteristics found clinically, respecting the manufacturer's protocols for both tested materials and the use of unground enamel as substrate. Besides that, the microshear bond strength test was used since it allows to obtain several specimens from a single tooth,[4] providing more interfacial failures than other methods,[13] especially with brittle substrates such as enamel.

Although adhesive systems beneath fissure sealants had a significant effect on retention rates and in caries prevention,[7] the use of a universal adhesive system in self-etch mode should be carefully considered due to significantly lower bond strength values found in this study. Therefore, the results of this study are only valid to the evaluated universal adhesive and further studies are needed to refute this finding to other universal systems.

Under the conditions of this study, the following conclusion can be made:

The use of the universal adhesive system in the self-etch mode in fissure sealant protocol decrease the bond strength to enamel, regardless if used under resin-based fissure sealant or as the sealant itself.

The universal adhesive system undergoes more water intake (sorption and solubility) than a resin-based fissure sealant.

The universal adhesive system in self-etch mode may not be a valid option for bonding fissure sealants.

Clinical relevance: Lower bond strength values were found with Scotchbond Universal Adhesive beneath resin-based sealant or as a sealant material when applied in self-etch mode, which suggests that enamel acid etching is the preferred mode prior to the application of resin-based sealants.

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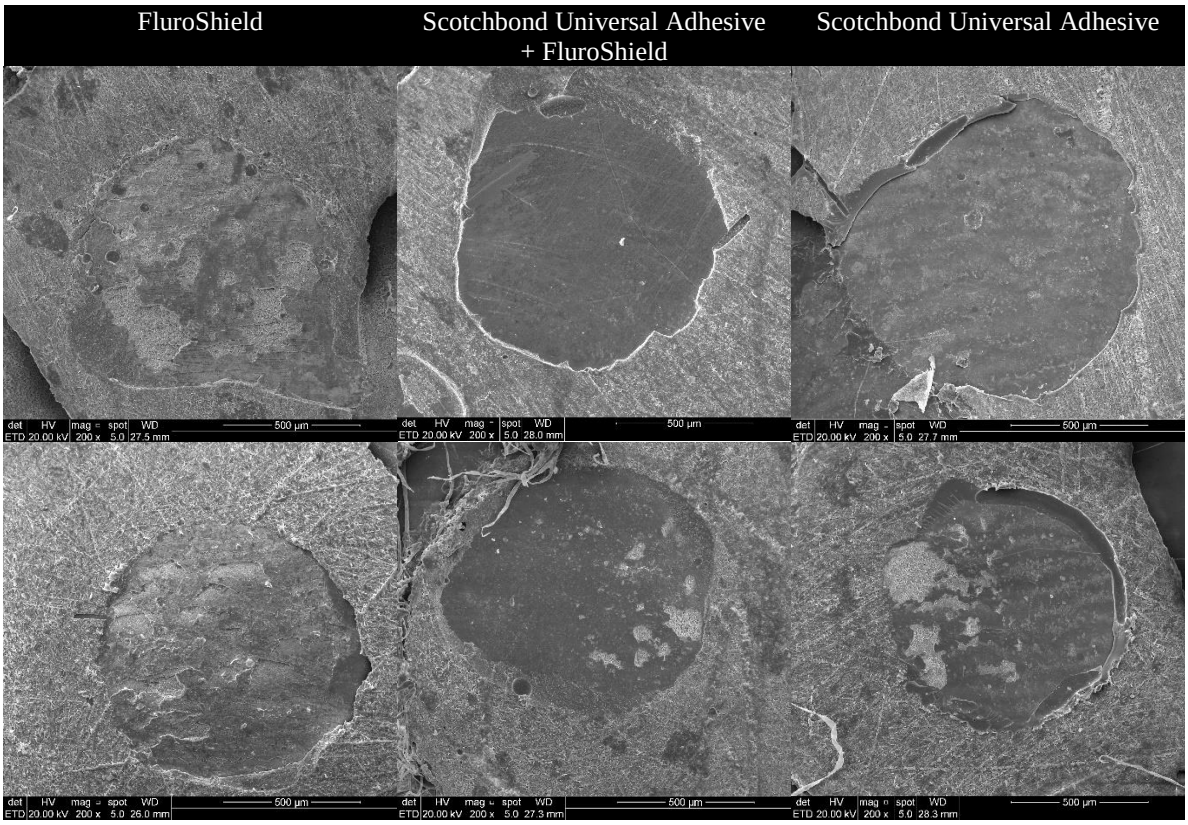

Fig. 1. Representative SEM images (200 x) of specimens bonded to sound (A) and demineralized (B) enamel.

Table 1
Materials used in the study.

Material test	Manufacturer	Lot. No.	pH	Composition	Application mode*
Condac 37®	FGM; (Joinville, SC, Brazil)	120815 2017AUG	<1	Phosphoric acid gel 37%	- Apply tooth conditioner gel for 30 seconds.** - Remove tooth conditioner gel with spray of water / air for at least 15 seconds and dry with air.
FluroShield®	Dentsply; (Petropolis, RJ, Brazil)	115336H	-	NCO Monomer, Nupol Bis GMA, TEGDMA, Penta, N-methyl Diethylamine, BHT, 2_n methacrylate, camphorquinone, Cervit T 1000, Silanized Barium, sodium fluoride, Cabosil TS 720 and Titanox 3328.	- Dispense the sealant with a brush. - Light-cure the sealant for 20 seconds.
Scothbond Universal Adhesive®	(3M/ESPE St. Paul, MN, EUA)	1508500365	2.7	MDP phosphate monomer, dimethacrylate resins, HEMA, methacrylate-modified polyalkenoic acid copolymer, filler, ethanol, water, initiators, silane	- Apply the adhesive for 20s with vigorous agitation. - Gently air thin for 5 s. - Light cure for 10 s.
Scothbond Universal Adhesive ® beneath FluroShield®		1508500365 115336H	2.7 -		- Apply the adhesive onto the tooth surface and rub or scrub the surface to be sealed for 20 s. - Gently air thin for 5 s. - Apply the sealant, and light cure both materials simultaneously for 20 seconds.***

MDP: 10-methacryloyloxydecyl-dihydrogen-phosphate; bis-GMA: bisphenyl-glycidyl methacrylate; HEMA: 2-hydroxyethyl methacrylate. *According to the manufacturers' instructions. ** According the FluroShield manufacturers' instructions. *** According to the Scothbond Universal manufacturers' instructions.

Table 2
Microshear bond strength (MPa) means (standard deviation) [specimens tested/ptf] for all experimental groups.

Material	Enamel condition	
	Sound	Demineralized
FluroShield (ER)	20.2(5.0) [26/0]	19.9(4.5) [25/0]
Scotchbond Universal Adhesive (SE) + FluroShield	13.3(4.3) [27/1]	14.9(4.2) [29/1]
Scotchbond Universal Adhesive (SE)	10.1(2.0) [23/0]	11.9(3.4) [25/1]

Table 3
µSBS means (standard deviation) for sealant material, irrespective of the enamel condition.

Material	**MPa**
FluroShield	20.0 (4.6)^{A}
Scotchbond Universal Adhesive + FluroShield	14.1 (4.2)^{B}
Scotchbond Universal Adhesive	11.0 (2.9)^{B}
Superscript letters indicate significant differences ($p < 0.05$)	

Table 4

Means and standard deviations of water sorption (WS), solubility (SL) and the percentage amount of water absorbed (SPc%) for each material.

Material	**WS***	**SL***	**SPc%**
FluroShield	0.07 (0.01)^{A}	-1.34 (0.15)^{A}	4.85 (0.12)^{A}
Scotchbond Universal Adhesive	0.25 (0.03)^{B}	- 0.90 (0.1)^{B}	23.41 (0.22)^{B}

Superscript letters indicate significant differences ($p < 0.000$) between rows.
* mg/mm^3

4 DISCUSSÃO

Os selantes de fossas e fissuras apresentam importante papel preventivo e terapêutico no controle das lesões de cárie em molares decíduos e permanentes (WRIGHT et al., 2016; AHOVUO-SALORANTA et al., 2017). Os selantes resinonsos apresentam superior longevidade, quando o desfecho é a retenção (ZHANG et al., 2017) a qual depende da adesão do material ao esmalte dentário. A técnica convencional de aplicação dos selantes resinosos, exige o condicionamento prévio do esmalte com ácido fosfórico, seguido da aplicação do material (PEUTZFELDT; NIELSEN 2004). Entretanto a aplicação de sistemas adesivos tem sido sugerida para melhorar a retenção (MESQUITA-GUIMARÃES et al., 2016; BAGHERIAN et al., 2016). Visando a simplificação da técnica, os sistemas adesivos autocondicionantes trazem vantagens como a eliminação das etapas de condicionamento do esmalte, lavagem e secagem, proporcionando além da facilidade na aplicação, a manutenção do campo seco e a redução no tempo de atendimento, condições desejáveis na clínica odontopediátrica (PEUTZFELDT; NIELSEN 2004; NOGOURANI et al., 2012; MAHER et al., 2013).

Diante de resultados contraditórios encontrados, quanto a retenção ao logo do tempo, de selantes aplicados no método convencional ou combinados aos sistemas adesivos autocondicionantes (FEIGAL; QUELHAS, 2003; BURBRIDGE et al., 2007; MAHER et al., 2013; KARAMAN et al., 2013; AMAN et al., 2015), surgiu a primeira questão de pesquisa dessa tese: “Os sistemas adesivos autocondicionantes são eficazes na retenção de selantes de fossas e fissuras em molares decíduos e permanentes em comparação com a abordagem convencional de condicionamento ácido prévio?”

Assim, na revisão sistemática ***“Are self-etch adhesive systems effective in the retention of occlusal sealants? A systematic review and meta-analysis”*** (BOTTON et al., 2015) foram analisados ensaios clínicos randomizados que compararam as taxas de retenção de selantes aplicados em superfícies oclusais após o uso de sistemas adesivos autocondicionantes ou na técnica convencional com condicionamento ácido, com ou sem a aplicação de sistema adesivo combinado. Os resultados mostraram menor retenção ao longo do tempo dos selantes oclusais aplicados após o uso de sistemas adesivos autocondicionantes. Esses achados foram corroborados por outra revisão sistemática (BAGHERIAN et al., 2016) publicada logo em seguida, que recomenda o uso de sistemas adesivos sob selantes oclusas, preferencialmente, aqueles aplicados na estratégia com condicionamento ácido.

A relevância do resultado encontrado está no esclarecimento de que o método convencional se mostrou o mais eficaz na retenção dos selantes de fossas e fissuras. Isto é, ao logo do tempo os adesivos autocondicionantes apresentam menor retenção, propriedade fundamental à efetividade dos selantes (AHOVUO-SALORANTA et al., 2017). É sugerido que a maior taxa de falha dos selantes aplicados com adesivos autocondicionantes pode estar associada a menor agressividade do pH desses sistemas adesivos, comparado ao ácido fosfórico utilizado no modo convencional de aplicação dos selantes de fossas e fissuras. Isso porque, a reduzida acidez dos sistemas autocondicionantes resulta em um padrão de condicionamento menos pronunciado que o condicionamento com ácido fosfórico, especialmente em esmalte não instrumentado (PASHLEY; TAY, 2001).

Assim, considerando os resultados desta revisão sistemática, fica evidente que os sistemas adesivos autocondicionantes não seriam a estratégia ideal de aplicação antes dos selantes de fossas e fissuras, apesar da simplificação na técnica oferecida por esses materiais. No entanto, nesta revisão sistemática não foram incluídos estudos que tenham avaliado a aplicação de um sistema adesivo universal no modo autocondicionante, comparado ao modo convencional prévio ao selante, pois não foram encontrados estudos com esse delineamento.

Apesar de ser recomendado o condicionamento ácido do esmalte quando do uso de sistemas adesivos universais, (ROSA et al., 2015, McLEAN et al., 2015), o fabricante do Scotchbond Universal indica a aplicação do produto no modo autocondicionante, combinado ao selante. No entanto, no melhor do nosso conhecimento, não encontramos trabalhos avaliando o uso desse sistema adesivo combinado ao selante resinoso, aplicado no modo autocondicionante e ficou clara a necessidade de realizar essa avaliação.

Ainda, com os achados de um sistema adesivo, aplicado como material único de selante de fossas e fissuras, porém com condicionamento ácido prévio, apresentando melhores resultados clínicos que os selantes convencionais em avaliações de 12 e 30 meses (GRANDE et al., 2000; BACA et al., 2007), e a ausência de avaliação de um sistema adesivo universal aplicado no modo autocondicionante como material único para selamento de fossas e fissuras, pensando na simplificação da técnica de aplicação dos selantes de fossas e fissuras, observou-se a necessidade dessa avaliação.

A proposta de um estudo em avaliar a possibilidade de uso de um sistema adesivo universal como selante de fossas e fissuras parece ser original e de relevância clínica, pois propõe a simplificação da técnica de aplicação, eliminando etapas críticas à manutenção do campo operatório seco, condição fundamental para a retenção e consequentemente à eficácia do selante, e ainda, a redução de tempo clínico, desejável em odontopediatria. Entretanto, diante

da possibilidade do uso desse sistema adesivo como material único para o selamento de fossas e fissuras, observou-se também a necessidade de avaliar a sorção e solubilidade do Scotchbond Universal comparado ao selante resinoso, pois esse sistema, ficaria sujeito a degradação na cavidade bucal.

Assim, o segundo artigo desta tese, intitulado ***"Universal adhesive system in self-etch mode may not be a valid option for bonding resin-based fissure sealants"***, avaliou a resistência de união ao microcisalhamento do sistema adesivo Scotchbond Universal, aplicado no modo autocondicionante, combinado ao selante resinoso FluroShield e como material único, comparado ao FluroShield aplicado no modo convencional, com condicionamento ácido prévio, em esmalte hígido e desmineralizado, e ainda, a sorção e solubilidade do Scotchbond Universal e do FluroShield em solução aquosa. Foram encontrados menores valores de resistência de união do SBU combinado, ou não, ao selante resinoso. Esses achados vão ao encontro dos de estudos anteriores que encontraram também menores valores de resistência de união do sistema adesivo universal aplicado no modo autocondicionante ao esmalte (ROSA et al., 2015; McLEAN et al., 2015). Além dos menores valores de resistência de união ao esmalte, a quantidade real de água absorvida pela SBU foi quase 5 vezes maior do que a absorvida pelo FLSH. Os resultados encontrados nesse trabalho suportam o fato de que o SBU poderia apresentar significativa degradação, caso usado como material único no selamento de fossas e fissuras. Ainda, os resultados encontrados quanto a resistência de união, mostram-se contrários à orientação do fabricante.

Neste estudo, optou-se ainda, pela avaliação no substrato desmineralizado, pois os selantes de fossas e fissuras são indicados à paralização de lesões incipientes (WRIGHT et al., 2016), e estudos anteriores apontam menores valores de resistência de união de sistemas adesivos ao esmalte desmineralizado, dadas as diferentes características desse substrato comparado ao esmalte hígido (TEDESCO et al., 2014; ANTONIAZZI et al., 2016). A condição do substrato não influenciou de forma significativa nos valores de resistência de união, em oposição aos achados de estudos anteriores (TEDESCO et al., 2014, ANTONIAZZI et al., 2016), possivelmente pelo emprego de esmalte não abrasionado, mais próximo da condição clínica. Esse resultado pode ser considerado como favorável, tendo em vista a indicação terapêutica dos selantes de fossas e fissuras, quando são aplicados em lesões de esmalte (WRIGHT et al., 2016).

Portanto, nessa tese, são apontadas considerações importantes sobre a aplicação de selantes de fossas e fissuras. Tendo em vista que a retenção e a longevidade dos selantes estão relacionadas à eficácia destes (AHOVUO-SALORANTA et al., 2017), é desejável o melhor

desempenho na adesão ao esmalte, que parece ser dependente do uso do condicionamento ácido prévio a aplicação dos selantes.

5 CONCLUSÃO

Fundamentado nos resultados apresentados pelas investigações realizadas nessa tese, conclui-se que:

- Selantes de fossas e fissuras apresentam maior retenção ao longo do tempo quando aplicados no método convencional, com condicionamento ácido prévio, independente do uso de sistema adesivo, quando comparados aos selantes aplicados combinados aos adesivos autocondicionantes. Considerando-se que a retenção dos selantes de fossas e fissuras está relacionada a efetividade desse método preventivo e terapêutico às lesões de cárie, permite-se sugerir que a estratégia recomendada para a aplicação dos selantes é a do condicionamento ácido prévio do esmalte.
- O sistema adesivo universal, aplicado no modo autocondicionante combinado ou não aos selantes de fossas e fissuras, promove menores valores de resistência de união ao microcisalhamento e ainda, apresenta pior desempenho na avaliação de sorção e solubilidade em meio aquoso, do que o selante resinoso. Assim, o sistema adesivo universal no modo autocondicionante não é uma opção válida para aplicação de selantes de fossas e fissuras, independente do uso combinado ao selante ou como material único.

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ANEXO A – NORMAS PARA PUBLICAÇÃO NO PERIÓDICO JOURNAL OF ADHESIVE DENTISTRY

GUIDELINES FOR AUTHORS

The Journal of Adhesive Dentistry is a bi-monthly journal that publishes scientifically sound articles of interest to practitioners and researchers in the field of adhesion to hard and soft dental tissues. The Journal publishes several types of peer-reviewed original articles:

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2. Submission via e-mail as a PC-word document (wintonowycz@quintessenz.de). Illustrations can be attached in any format that can be opened using Adobe Photoshop, (TIF, GIF, JPG, PSD, EPS etc.) or as Microsoft PowerPoint Documents (ppt). No paper version required but high resolution photographs or illustrations should be sent to the editorial office.
3. One paper copy of the manuscript plus a floppy diskette or CD-ROM (mandatory) containing a PC-word file of the manuscript text, tables and legends.

Figures should be included on the disk if possible in any format that can to be opened using Adobe Photoshop, (TIf, GIf, JPG, PSD, EPS etc.) or as a Microsoft PowerPoint Document (ppt)

Illustrations that cannot be sent electronically will be scanned at the editorial office so that they can be sent to reviewers via e-mail along with the manuscript to expedite the evaluation process. Resubmitted manuscripts should also be submitted in the above manner. Please note that supplying electronic versions of your tables and illustrations upon resubmission will assure a faster publication time if the manuscript is accepted.

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MANUSCRIPT PREPARATION

• The Journal will follow as much as possible the recommendations of the International Committee of Medical Journal Editors (Vancouver Group) in regard to
preparation of manuscripts and authorship (Uniform requirements for manuscripts submitted to biomedical journals. Ann Intern Med 1997;126: 36-47).

• **Title page.** The first page should include the title of the article (descriptive but as concise as possible) and the name, degrees, job title, professional affiliation, contribution to the paper (e.g., idea, hypothesis, experimental design, performed the experiments in partial fulfillment of requirements for a degree, wrote the manuscript, proofread the manuscript, performed a certain test, consulted on and performed statistical evaluation, contributed substantially to discussion, etc.) and full address of all authors. Phone, fax, and e-mail address must also be provided for the corresponding author, who will be assumed to be the first listed author unless otherwise noted. If the paper was presented before an organized group, the name of the organization, location, and date should be included.

• **3-8 keywords.**

• **Structured abstract.** Include a maximum 250-word structured abstract (with headings *Purpose, Materials and Methods, Results, Conclusion*).

• **Introduction.** Summarize the rationale and purpose of the study, giving only pertinent references. Clearly state the working hypothesis.

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