

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
FACULDADE DE ODONTOLOGIA

RAFAELA LUÍSA DA COSTA CARRARO

ESTRUTURA DENTÁRIA REMANESCENTE APÓS RESTAURAÇÃO OU
SELAMENTO DE LESÃO DE CÁRIE: ENSAIO CLÍNICO RANDOMIZADO DE 3-4
ANOS

Porto Alegre

2018

RAFAELA LUÍSA DA COSTA CARRARO

ESTRUTURA DENTÁRIA REMANESCENTE APÓS RESTAURAÇÃO OU
SELAMENTO DE LESÃO DE CÁRIE: ENSAIO CLÍNICO RANDOMIZADO DE 3-4
ANOS

Trabalho de Conclusão de Curso apresentado ao Curso de Graduação em Odontologia da Faculdade de Odontologia da Universidade Federal do Rio Grande do Sul, como requisito parcial para obtenção do título de Cirurgião-Dentista.

Orientadora: Marisa Maltz

Coorientadora: Vânia Fontanella

Porto Alegre

2018

CIP - Catalogação na Publicação

Carraro, Rafaela Luísa da Costa
Estrutura dentária remanescente após restauração ou
selamento de lesão de cárie: Ensaio clínico
randomizado de 3-4 anos / Rafaela Luísa da Costa
Carraro. -- 2018.

23 f.

Orientadora: Marisa Maltz.

Coorientadora: Vânia Fontanella.

Trabalho de conclusão de curso (Graduação) --
Universidade Federal do Rio Grande do Sul, Faculdade
de Odontologia, Curso de Odontologia, Porto Alegre,
BR-RS, 2018.

1. Cárie dentária. 2. Selante. 3. Restauração
dentária. 4. Radiografia dentária. I. Maltz, Marisa,
orient. II. Fontanella, Vânia, coorient. III. Título.

AGRADECIMENTOS

Agradeço aos meus pais que estiveram sempre presentes me apoiando e incentivando. Pai, obrigada pelas caronas nas segundas-feiras de manhã que me permitiam passar mais tempo em casa e pelos abraços carinhosos que me confortaram nas horas difíceis. Mãe, tuas orações chegaram até mim, teu exemplo me inspirou e motivou nessa caminhada e o teu colo foi essencial para me manter de pé.

À minha irmã Sabrina que me protegeu, me mimou e me ajudou em tudo o que eu precisei.

Às minhas amigas que deixaram meus dias mais alegres e que tornaram essa jornada mais leve e divertida.

À minha orientadora, que me concedeu o privilégio de aprimorar meus conhecimentos com sua larga experiência e competência.

À minha coorientadora, que me auxiliou e me tranquilizou com sua calma e paciência.

À Luana Alves, que mesmo à distância contribuiu muito para a realização desse trabalho.

À Maristela Machado, pelo carinho e pela revisão do trabalho.

À CNPq pela bolsa de iniciação científica e incentivo à pesquisa.

Enfim, agradeço a todas as pessoas que fizeram parte dessa etapa importante em minha vida.

RESUMO

Com o advento da odontologia minimamente invasiva, cada vez mais se buscam alternativas conservadoras para o tratamento de lesões de cárie, com o intuito de evitar o ciclo restaurador repetitivo e a perda do elemento dentário. Uma dessas alternativas é o selamento de lesões cariosas sem remoção prévia de tecido cariado. O objetivo deste estudo foi mensurar a perda de estrutura dentária radiograficamente visível decorrente da adoção de dois tipos de tratamento para o controle de lesões cariosas oclusais em dentes permanentes: (R) restauração convencional com remoção total da dentina cariada e (S) selamento de lesões de cárie sem remoção prévia de tecido cariado. Foram utilizados dados de ensaios clínicos randomizados controlados desenvolvidos previamente para comparar as duas terapias, em Porto Alegre (BR) e em Bruxelas (BE). No Grupo Porto Alegre, 49 pacientes foram divididos em 2 grupos: 26 receberam restauração e 23 receberam selante. Foram incluídos somente pacientes com radiografias de acompanhamentos com possibilidade de mensuração (sem sobreposição e correta angulação vertical e horizontal), Foram incluídos na amostra do presente estudo 17 pacientes no grupo restauração e 16 no grupo selante. No Grupo Bruxelas, 23 pacientes receberam os dois tratamentos (restaurador e selamento). Radiografias interproximais foram tomadas antes do tratamento, após 10-20 meses e após 25-46 meses. Foram avaliadas as seguintes medidas: maior profundidade e maior largura da lesão de cárie antes do tratamento; maior profundidade e maior largura da restauração após tratamento restaurador e maior profundidade e maior largura da área radiolúcida após selamento (programa Adobe Photoshop®). Onze radiografias foram avaliadas em triplicata e a reprodutibilidade das medições foi avaliada através do coeficiente de correlação intraclassa ($>0,84$). Foi realizado cegamento das radiografias em relação ao tempo da tomada radiográfica e ao local de origem. A normalidade dos dados foi verificada através do teste de Kolmogorov-Smirnov. A perda de tecido dentário radiograficamente visível (profundidade e largura) observada inicialmente e aquela decorrente da execução das duas terapias nos diferentes tempos foram comparadas utilizando o teste T independente. A profundidade e a largura das lesões cariosas iniciais (E1), e as restauradas/seladas após 10-20 meses (E2) e 25-46 meses (E3) foram comparadas entre si utilizando o teste T pareado. O nível de significância adotado foi de 5%. As lesões de cárie do grupo restaurador e do selado

apresentaram profundidade semelhante. Observou-se uma maior perda de estrutura dentária com o tratamento restaurador comparado ao selamento. Os resultados mostram que a terapia restauradora ao longo do tempo ocasionou perda de tecido dentário, aumento das medidas de profundidade e largura quando comparados ao E1. No grupo selante, não se observou progressão da lesão ao longo do tempo. O selamento de lesões cáries, sem remoção prévia de tecido cariado, é uma alternativa conservadora para o tratamento de lesões da cárie até metade externa de dentina, sendo capaz de preservar maior quantidade de tecido dentário comparado ao tratamento restaurador convencional. A restauração convencional é responsável por causar perda de tecido dentário, podendo fragilizar a estrutura dentária e comprometer a longevidade dental.

Palavras- chave: Selante. Restauração Dentária. Dentição Permanente. Radiografia Dentária.

ABSTRACT

With the advent of minimally invasive dentistry, more and more conservative alternatives are being sought for the treatment of caries lesions, in order to avoid the tooth repetitive restorative cycle leading to tooth loss. One of these alternatives is the sealing of carious lesions without previous removal of carious tissue. The objective of this study was to measure the radiographic loss of dental structure after two types of treatment for the control of occlusal carious lesions in permanent teeth: conventional restoration with total removal of carious dentin (RE) and sealing of caries lesions without removal of carious tissue (SE). Data from two randomized controlled clinical trials previously developed to compare these two therapies, in Porto Alegre (BR) and in Brussels (BE), were used. In the Porto Alegre Group, 49 patients were divided into 2 groups: 26 received restoration and 28 received sealant. Only patients with radiographic follow-up with possibility of measurements (without superposition and correct vertical and horizontal angulations) were included. Seventeen patients from the restoration group and 16 from the sealing group were included in the study sample. In the Brussels Group, 23 patients received both restorative and sealing treatments. Interproximal radiographs were taken before treatment, after 10-20 months and 25-46 months. The following measures were evaluated: greater depth and greater width of caries lesion before treatment; greater depth and width of the restoration after restorative treatment and greater depth and width of the radiolucent area after sealing (Adobe Photoshop® program). Eleven measurements were performed in triplicate and the reproducibility of the measurements was assessed by the intraclass correlation coefficient (> 0.84). Blinding of the radiographs was performed in relation to the time of radiographic taking and the place of origin. The normality of the data was verified through the Kolmogorov-Smirnov test. The loss of radiographically visible dental tissue (depth and width) observed initially and that resulting from the execution of the two therapies at different times were compared using the independent T test. The depth and width of the initial carious lesions (E1), and those restored/sealed after 10-20 months (E2) and 25-46 (E3) months were compared to each other using the paired T test. The level of significance was 5%. Caries lesions of the restorative and sealed groups presented similar depth. A greater loss of tooth structure was observed with the restorative treatment compared to the sealing. The results show that restorative therapy over time caused loss of

dentin tissue, increased depth and width measurements when compared to E1. In the sealant group, no progression of the lesion was observed over time. The sealing of carious lesions, without previous removal of carious tissue, is a conservative alternative for the treatment of caries lesions restricted to the outer half of dentin, being able to preserve a greater amount of dental tissue compared to conventional restorative treatment. The conventional restoration is responsible for causing loss of dental tissue, which can weaken dental structure and compromise dental longevity.

Keywords: Sealant. Dental Restoration. Permanent Dentition. Dental Radiography.

SUMÁRIO

1	INTRODUÇÃO	08
2	OBJETIVO	10
2.1	OBJETIVO GERAL	10
2.2	OBJETIVOS ESPECÍFICOS	10
3	ARTIGO	11
4	CONCLUSÃO	21
	REFERÊNCIAS	22

1 INTRODUÇÃO

Lesões cavitadas de cárie em superfície oclusal convencionalmente são tratadas com remoção total de tecido cariado e restauração. O dente, uma vez restaurado, começa a apresentar falhas no tratamento restaurador ao longo do tempo, acarretando na substituição da mesma restauração e outras tantas ao longo da vida do paciente. Cada troca é responsável por fragilizar a estrutura dentária até a sua perda. Esse processo foi descrito por Elderton (2003) como “ciclo restaurador repetitivo” e como “espiral da morte” por Qvist (2015), sendo responsável pela diminuição da vida útil do dente. Por estes motivos, tem-se buscado alternativas de tratamento visando à máxima preservação da estrutura dentária, incluindo as restaurações minimamente invasivas e o selamento de lesões cariosas (FRENCKEN et al., 2012).

Dentre os materiais utilizados para uma abordagem conservadora estão os selantes. Inicialmente, eram utilizados preventivamente em fóssulas e fissuras, criando uma barreira contra as ações dos metabólitos do biofilme (AHOUVUO-SALORANTA et al., 2008). A partir disso, estudos começaram a avaliar a ação dos selantes em cáries incipientes de cicatrículas e fissuras oclusais, entre eles, Handelman et al. (1976) que demonstrou uma ampla redução do número de microrganismos cariogênicos após o selamento. Esse efeito protetor e capaz de inativar o processo de cárie foi explicado por Theilade (1977), em um ensaio clínico que teve como objetivo avaliar o efeito do selamento na microflora das fissuras oclusais de molares humanos. Segundo o pesquisador, o efeito preventivo de cárie dos selantes pode ser atribuído à combinação de dois mecanismos: 1) diminuição do número de bactérias viáveis, e 2) falta de carboidratos fermentáveis suficientes para que as bactérias remanescentes acumulem ácido em concentrações cariogênicas. Resultados semelhantes foram encontrados em meta-análise publicada por Oong et al. (2008) avaliando o efeito de selantes sobre o nível de contaminação bacteriana em lesões cariosas.

Após o entendimento do processo de desmineralização ocasionado pelos ácidos bacterianos no tecido dentário e sua progressão, aliado a observações clínicas, radiográficas e microbiológicas sobre a eficácia de selantes sobre pequenas lesões de cárie em fissuras oclusais, ensaios clínicos começaram a avaliar a

efetividade desse tipo de tratamento para lesão mais extensas, atingindo dentina. Em estudo de 10 anos de acompanhamento, Mertz-Fairhurst et al. (1998) mostraram que lesões de cárie até metade externa de dentina não progrediram com o uso de selamento sem remoção de tecido cariado. Confirmando esses achados, trabalhos recentes mostraram que essa paralisação somente é efetiva enquanto os selantes permanecem intactos e bem adaptados, exigindo que o paciente cumpra regularmente follow-ups para controlar a ocorrência de falhas clínicas dos selantes (ALVES et al., 2017; BAKHSHANDEH; QVIST; EKSTRAND, 2012; QVIST et al., 2017).

Os resultados destes estudos demonstraram que podem ser incluídos nos critérios de indicação de selamento dentes com lesões pequenas e médias em dentição permanente jovem. Assim, o tratamento restaurador tradicional pode ser adiado por vários anos ou até mesmo evitado, melhorando, assim, a saúde bucal de adolescentes e adultos jovens (QVIST et al., 2017).

Apesar dos resultados positivos em relação à progressão de cárie com o uso de selante encontrados até o presente momento, ainda não existe literatura que avalie ao longo do tempo a extensão de lesões de cárie tratadas com selamento sem remoção de tecido cariado assim como não há dados sobre a quantidade de tecido dentário sadio removido durante o preparo de uma restauração convencional.

2 OBJETIVO

2.1 OBJETIVO GERAL

O objetivo deste estudo foi mensurar a perda de estrutura dentária radiograficamente visível decorrente da adoção de dois tipos de tratamento para o controle de lesões cárias oclusais em dentes permanentes: (R) restauração convencional com remoção total da dentina cariada e (S) selamento de lesões de cárie sem remoção prévia de tecido cariado.

2.2 OBJETIVOS ESPECÍFICOS

- a) Comparar a perda de tecido dentário resultante do selamento de lesão de cárie ao longo do tempo (10-20 e 25-46 meses de acompanhamento);
- b) Comparar a perda de tecido dentário resultante do tratamento restaurador convencional ao longo do tempo (10-20 e 25-46 meses de acompanhamento);
- c) Comparar as duas terapias (selamento de lesão de cárie e restauração convencional) no que concerne à perda de tecido dentário ao longo do tempo (10-20 meses e 25-46 meses de acompanhamento).

3 ARTIGO

Remaining dental structure after restoration or sealing of occlusal carious lesion: a 3-4-year randomized clinical trial

Rafaela Luísa da Costa Carraro¹, Vânia Fontanella² Joana Cristina Carvalho³, Luana Severo Alves⁴,
Marisa Maltz¹

¹ Federal University of Rio Grande do Sul, Department of Social and Preventive Dentistry, Faculty of Odontology, Porto Alegre, RS, Brazil;

² Federal University of Rio Grande do Sul, Department of Surgery and Orthopedics, Faculty of Odontology, Porto Alegre, RS, Brazil;

³ Catholic University of Louvain, Faculty of Medicine and Dentistry, Brussels, Belgium;

⁴ Federal University of Santa Maria, Department of Restorative Dentistry, School of Dentistry, Santa Maria, RS, Brazil.

Running head: Remaining dental structure after restoration or sealing of occlusal caries

*Corresponding Author

Marisa Maltz

Universidade Federal do Rio Grande do Sul

Department of Social and Preventive Dentistry

Faculty of Odontology

Ramiro Barcelos 2492

Porto Alegre, Rio Grande do Sul, 1118, Brasil

Tel: (51) 33085247

Fax: (51) 33085189

E-mail: marisa.maltz@gmail.com

Keywords: Sealant. Dental Restoration. Permanent Dentition. Dental Radiography

1 **1. Abstract**

2 The objective of this study was to measure the radiographic loss of dental structure after two types
3 of treatment for the control of occlusal carious lesions in permanent teeth: conventional restoration
4 with total removal of carious dentin (RE) and sealing of caries lesions without removal of carious
5 tissue (SE). Data from two randomized controlled clinical trials were used (Porto Alegre [BR] n=49
6 patients and Brussels [BE], n=23 patients). Final sample was: RE=40 and SE=39 teeth. Interproximal
7 radiographs were taken at baseline (E1), 10-20 (E2) and 25-46 months (E3). The measures evaluated
8 were: greater depth and width of caries lesion (Adobe Photoshop® program). The intraclass
9 correlation coefficient of the reproducibility was > 0.84. Blinding of the radiographs was performed
10 (time of radiographic taking and the place of origin). The loss of radiographically visible dental tissue
11 measured initially and after the therapies at different times were compared (T test). The depth and
12 width at E1, E2 and E3 were compared (paired T test). Caries lesions of the RE and SE presented
13 similar measurements. A greater loss of tooth structure was observed in RE compared to SE. The
14 results show that restorative therapy over time caused loss of dental tissue, increased depth and
15 width measurements when compared to E1. In the SE, no progression of the lesion was observed
16 over time. The sealing of carious lesions is an alternative for the treatment of caries lesions restricted
17 to the outer half of dentin, being able to preserve dental tissue compared to conventional restorative
18 treatment.

19

20 **2. Introduction**

21 The conventional restorative treatment of caries lesions is based on the total removal of carious
22 tissue and restoration. The restoration fails over time, demanding multiple replacements throughout
23 the patient life, weakening the dental structure, and, ultimately, decreasing tooth longevity. This
24 process was described by Elderton [2003] as the “repetitive restorative cycle” and as the “death
25 spiral” by Qvist [2015]. In this context, conservative treatments aiming at the maximum preservation
26 of the dental structure have been proposed [FRENCKEN et al., 2012].

27 Sealing of caries lesions has shown to be an alternative to conventional restorative treatment in
28 order to preserve dental tissue. The reduction of bacterial counts and lesion arrestment are observed
29 after different periods of sealing [HANDELMAN et al., 1976; THEILADE et al., 1977; OONG et al.,
30 2008].

31 Clinical, radiographic, and microbiological observations on the efficacy of sealing small occlusal
32 carious lesions lead to clinical trials evaluating the effectiveness of sealing cavitated dentine lesions
33 reaching the outer half of dentin thickness. In a 10-year follow-up study, Mertz-Fairhurst et al. [1998]
34 showed similar restoration survival of conventional amalgam restoration compared to the sealing of
35 cavitated lesions without removal of carious tissue. Bakhshandeh, Qvist, and Ekstrand [2012] have
36 recently shown that the sealing is only effective while the sealants remain intact and well adapted.
37 After 7 years of observation, resin restorations had a success rate of 91% and sealants of 37%, with
38 an annual failure rate of 1.1% for restorations and 8.3% for sealants [QVIST, V. et al, 2017]. Even
39 though at the beginning of the study all the lesions were referred to restorative treatment, after 7
40 years of follow-up, half of the sealed teeth did not require resin restoration. Alves et al. [2017], in a
41 recent randomized clinical trial after 3-4 year, observed success rates of 76% and 94% for sealants
42 and restorations, respectively. This study also showed that the sealing of carious lesions is able to
43 control the caries process, despite the need for regular follow-ups to control sealant retention.

44 In conjunction, the results of these clinical trials showed that small and medium-size cavitated lesions
45 could be arrested through sealing, not needing dental caries removal and restoration. Thus, the
46 traditional restorative treatment can be postponed for several years or even avoided, thus increasing
47 the tooth survival [QVIST et al., 2017].

48 Despite the positive results regarding caries progression found so far, there is still no long-term
49 evaluation of the amount of dental tissue lost due to the placement of a conventional restoration
50 compared to the sealing of carious lesion.

51

52 **3. Materials and Methods**

53 This study arises from two randomized controlled clinical trials, one in Porto Alegre (BR) and another
54 in Brussels (BE), evaluating two different therapies for the treatment of occlusal carious lesions in
55 permanent teeth: sealant, without previous carious tissue removal (SE); or restoration (RE), with
56 total removal of carious dentin. All carious lesions required restorative treatment due to the
57 presence of a cavity with no possibility of biofilm control. Interproximal radiographs were used to
58 evaluate the maximum depth of the lesions, which was located up to the outer half of the dentin.

59 Seventy-two patients aged from 8-43 years (median 19 years), 49 under treatment at the Faculty of
60 Odontology, Federal University of Rio Grande do Sul, Brazil and 23 patients under treatment at the
61 Saint-Luc University Hospital, Brussels were included in the sample. The recruitment phase lasted 12
62 months in Porto Alegre and 72 months in Brussels. The study protocols were approved by the Ethics
63 Committees of the Federal University of Rio Grande do Sul, Brazil (Protocol number 01/08) and of the
64 Catholic University of Louvain, Belgium (Protocol number 340320097.77). Study protocols followed
65 the STROBE guidelines [VANDENBROUCKE et al., 2014].

66 **Sample**

67 Porto Alegre sample consisted of 54 teeth randomly assigned to the sealant group (n=28) or
68 restoration group (n=26). The Brussels patients (23) had at least one tooth assigned to the sealant
69 group (n=24) and one to the restoration group (n=23). Radiographs were taken at baseline, and at
70 follow-up periods of 10 to 20 months and 25 to 46 months. Only patients with radiographic follow-up
71 with possibility of measurements (without superposition and correct vertical and horizontal
72 angulations) were included.

73

74 **Interventions**

75 The intervention has been previously described (ALVES et al., 2017). Briefly, the occlusal surface was
76 cleaned with a pumice/water slurry and Robinson bristle brushes. Local anesthesia was performed
77 prior to the installation of the rubber dam. Then, the teeth were randomly assigned to SE or RE
78 groups.

79 In the SE group, sealant was placed directly over the carious dentine, no previous caries removal or
80 any invasive technique was performed. The cavity was conditioned with 37% phosphoric acid gel for
81 30 seconds, followed by cavity washing and drying; the sealant material (Fluroshield,
82 Caulk/Dentsply®, Rio de Janeiro, Brazil) was applied on the occlusal caries with an exploratory probe
83 and light-cured for 20s.

84 In the RE group, after complete removal of carious dentin according to the clinical hardness criteria,
85 enamel and dentin were conditioned with 37% phosphoric acid gel for 30s in enamel and 15s in
86 dentine, followed by cavity washing and drying. Excite Adhesive (Ivoclar-VivaDent®, São Paulo, Brazil)
87 was applied on the enamel and dentin cavity walls and the teeth were restored with light-cured
88 composite resin (Tetric Ceram Ivoclar-VivaDent®, São Paulo, Brazil) following the incremental
89 technique.

90

91 **Radiographic evaluation**

92 Radiographs were taken at baseline, and at the follow-up periods of 10-20 months and 25-46
93 months. Standard interproximal radiographs were obtained using a positioner (Jon®, São Paulo,
94 Brazil). The digital radiographs were obtained with phosphor storage plates with VistaScan Perio
95 (Bietigheim-Bissingen, Durr Dental, Germany) and Astex Odontomax (São Paulo, Brazil) radiographic
96 apparatus operating at 70 kVp, 7 mA, 30 cm focal distance and exposure time of 0.6 seconds. Storage
97 plates were read using the VistaScan system (Dürr Dental®, Bietigheim-Bissingen, Germany)
98 immediately after exposure. The images were exported using dbWin®4 software, subsequently
99 displayed on the monitor screen for radiographic measurement. All radiographs received the "Caries
100 2" program filter before being exported in order to standardize brightness and contrast.

101 Before the measurements, each experimental tooth was cut out from the radiograph, so that the
102 examiner could not identify whether the radiograph was from the baseline or from the follow-ups
103 (10-20 months and 25-46 months). In addition, the examiner was also blinded in regards to the place
104 of origin of the radiographs (Brazil or Brussels), to the experimental group (baseline radiographs),
105 and to the different follow-up periods.

106 Adobe Photoshop CC® version 2017 1.1 (Adobe Systems, San Jose, CA, USA) was used for analysis.
107 The measurements were performed according to a previously described and validated method
108 [BAKHSHANDEH; EKSTRAND and QVIST, 2011]. Some images required the geometric alignment due
109 to small differences in the projection angles, and the same software was used for correction. For this
110 purpose, a reference point was positioned in a clearly distinguishable structure, such as the enamel

111 cement line (ECL), which was defined as a landmark in both images. Three different measures were
 112 taken, as described below.

113

114 *Greater depth and greater width of caries lesion before treatment (Fig 1a)*

115 Initially, a line was drawn at the ECL, in the mesio-distal direction, separating the coronary portion
 116 from the root. Next, the deepest point and the most superficial point of the lesion were demarcated.
 117 When it was not possible to identify the most superficial dentine point (in case of cavity), it was
 118 estimate, and the most superficial dentine point from the cusp not affected by the lesion was
 119 considered. Then, a line perpendicular to the ECL was drawn, joining the two already demarcated
 120 points. The relative dentin depth of the lesion, designated RD, was expressed as a percentage of the
 121 total length of the coronary dentin. The larger portions of the lesion were marked with two points,
 122 and a parallel line from ECL passing through the points was drawn. The relative dentine width of the
 123 lesion, designated RW, was expressed as a percentage of the total width of the ECL.

124

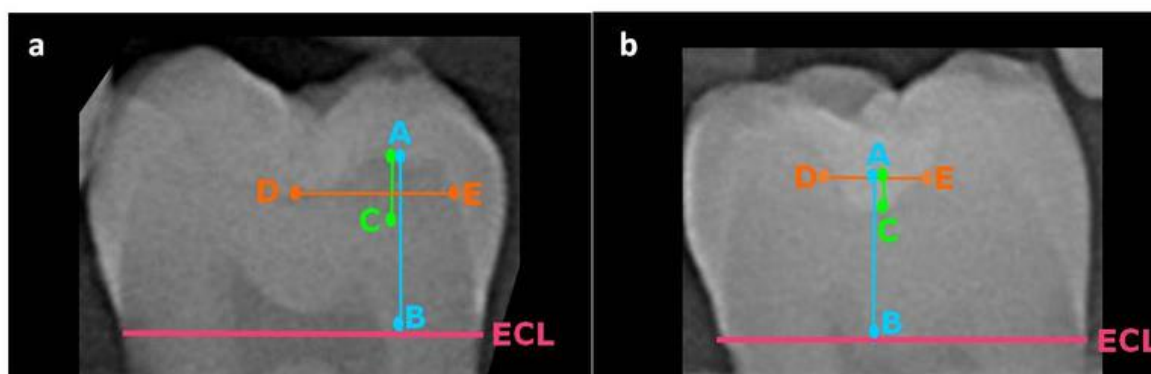
125 *Greater depth and greater width of radiolucent area after sealing (Fig 1a)*

126 The measurement of caries lesions after sealing was performed according to the description of the
 127 measurements of greater depth and greater width of the caries lesion before treatment, expressed
 128 above.

129

130 *Greater depth and width of restoration after restorative treatment (Fig 1b)*

131 Initially, a line was drawn at the ECL in the mesio-distal direction, separating the coronary portion
 132 from the root. Then, the deeper and the most superficial point of the restoration were demarcated.
 133 To estimate this more superficial point, the highest point of dentin at the cusp not affected by the
 134 lesion was considered. Then, a line perpendicular to the ECL was drawn, joining the two already
 135 demarcated points. The relative dentin depth of the restoration, designated RDR, was expressed as a
 136 percentage of the total length of the coronary dentin. The larger portions of the restoration were
 137 marked with two points, and a parallel line from ECL passing through the points was drawn. The
 138 relative dentine width of the restoration, designated RWR, was expressed as a percentage of the
 139 total width of the ECL.



140

141 **Fig. 1. a:** Illustration of measurements of dentinal depth and width of occlusal caries lesions in
 142 radiographic images. ECL: enamel-cement line; A-B: Total depth of dentin; A-C: Depth of carious
 143 lesion; D-E: Width of carious lesion. **b:** Illustration of measurements of dentinal depth and width of
 144 restoration in occlusal carious lesions in radiographic images. ECL: enamel-cement line. A-B: Total
 145 depth of dentin; A-C: Depth of restoration; D-E: Width of restoration.

146 **Calibration and reproducibility**

147 The examiner (RC) performed the repeated measurement of 11 radiographs of occlusal caries lesions
148 involving the outer half of dentin not included in the study. Measures were taken in triplicates for
149 each tooth with a minimum time interval of one week.

150 The same examiner performed all the measurements (baseline and follow-ups). The measurements
151 were repeated 3 times for each tooth with a minimum time interval of one week.

152

153 **Statistical analysis**

154 The reproducibility of the measurements was assessed by the intraclass correlation coefficient (ICC).
155 The mean of the three measurements was calculated and used in the data analysis. The normality of
156 the data was verified through the Kolmogorov-Smirnov test. The loss of radiographically visible
157 dental tissue (depth and width) observed at baseline (cariou lesion) and that resulting from the
158 execution of the two therapies at different periods were compared using the independent T test. The
159 depth and width of the initial carious lesions (E1), and those restored/sealed after 10-20 months (E2)
160 and 25-46 months (E3) were compared to each other using the paired T test. The level of significance
161 was 5%.

162

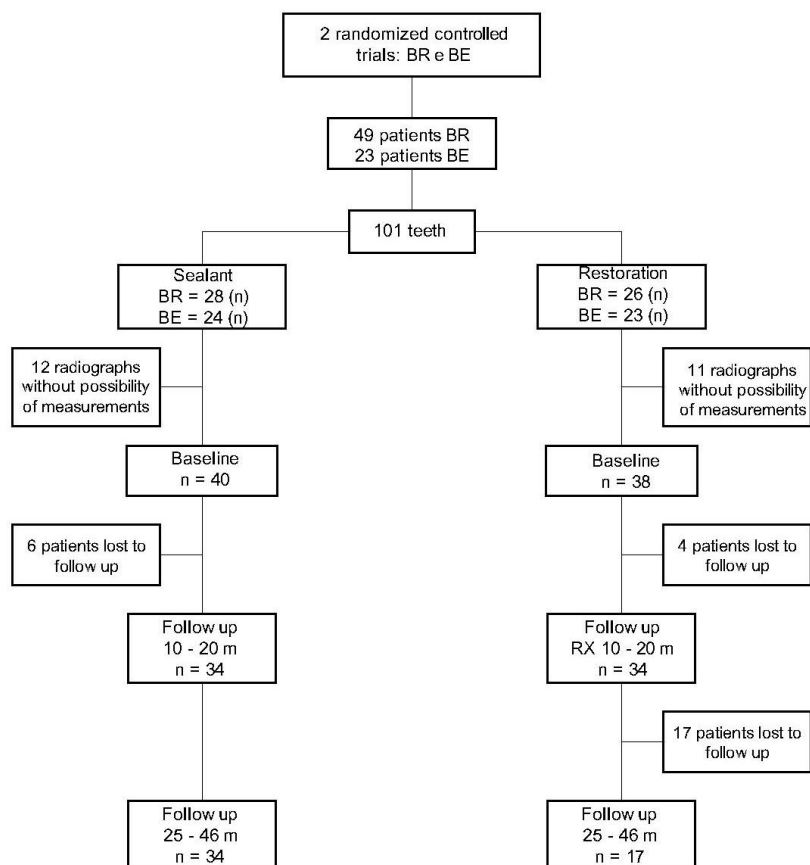
163 **4. Results**

164 The reproducibility of the measurements was considered high for all measurements ($ICC \geq 0.84$).

165 Figure 2 illustrates the flowchart of the study. In the SE group, 12 radiographs without possibility of
166 measurements were detected and excluded. After 10 to 20 months, 6 patients were lost to follow-
167 up. Thus, the sample of the SE group consisted of 40 initial radiographs, 34 radiographs after 10 to 20
168 months, and 34 after 25 to 46 months. In the RE group, 11 radiographs without possibility of
169 measurements were detected and excluded. Four patients were lost to follow-up after 10 to 20
170 months recall, whereas 17 patients were lost after 25 to 46 months. Totalizing 38 initial radiographs
171 included, 34 at 10 to 20 months follow-up and 17 at 25 to 46 months follow-up.

172 Table 1 shows the depth and width measurements of the initial caries lesions (baseline) and after
173 treatment (follow-up at 10-20 months and at 25-46 months). At baseline, all lesions had similar depth
174 and width measurements. Restorative treatment resulted in significantly loss of dental tissue in
175 depth and width. No increase in lesion depth and width was observed between the 10-20 months
176 and the 25-46 months follow up periods. Sealing of caries lesion resulted in no further tissue loss.
177 Similar radiolucent areas were observed at baseline and at the follow-up periods. Conventional
178 restorative treatment resulted in greater loss of dentin tissue in depth and width compared to the
179 sealing of carious lesions.

180



181

182 **Fig. 2.** Flowchart of the study.

183

184 **Table 1** - Relative depth and width of occlusal caries lesions (baseline), restorations and sealed
 185 lesions at 10-20 mouths and 25-46 mouths follow up periods (mean% \pm SD and p value).

	Depth			Width		
	Baseline	10-20	25-46	Baseline	10-20	25-46
Restorations	43,36 ^{Aa} (\pm 11,41)	60,84 ^{Ab} (\pm 18,3)	61,61 ^{Ab} (\pm 12,82)	45,64 ^{Aa} (\pm 16,11)	51,36 ^{Aab} (\pm 16,82)	55,14 ^{Ab} (\pm 18,38)
Sealant	42,60 ^{Aa} (\pm 12,82)	41,71 ^{Ba} (\pm 10,63)	41,51 ^{Ba} (\pm 11,33)	43,47 ^{Aa} (\pm 12,49)	43,05 ^{Ba} (\pm 14,25)	43,76 ^{Ba} (\pm 12,00)

Different upper case letters indicate a statistically significant difference in the comparison of the two therapies (columns, independent T-test). Different lowercase letters indicate a statistically significant difference in the comparison of the same therapy over time (lines, paired T-test) ($p < 0.05$).

186

187 **5. Discussion**

188 The present study investigated the long-term loss of dental tissue due to the placement of a
189 conventional restoration compared to the sealing of carious lesion. The results demonstrated that
190 conventional restorations with total carious dentin removal are responsible for greater loss of dental
191 tissue compared with the sealing of the lesions without removal of carious tissue.

192 Cavitated lesions are usually treated by total removal of carious tissue in order to remove bacteria
193 that invade the tissue and to prevent lesion progression, thus increasing the longevity of the
194 restorations and maintaining pulp vitality [SCHWENDICKE, 2018]. Even with advances and
195 modifications in restorative materials, they have a limited longevity, requiring replacements over
196 time. Once a restoration has been performed, the tooth enters in a cycle of multiple replacements
197 over time that will compromise the survival of the dental element [ELDERTON, 2003]. In a meta-
198 analysis of prospective studies, Beck et al. [2015] concluded that the mean annual failure rate of class
199 I and class II resin restorations in posterior teeth is 1.68%, and that it increases over time.
200 Ástvaldsdóttir et al. [2015] in a systematic review including 8 articles published between 2005 and
201 2013, demonstrated that 1 in every 100 restorations should be replaced annually, and that the
202 survival rate of the restorations decreases over time. The highest chance of failure occurs from the
203 age of 62 months. Restoration replacement is, therefore, a common procedure in general dental
204 practice, being responsible for increasing the loss of tooth structure at each procedure, leading to
205 tooth weakening [ÁSTVALDSDÓTTIR, 2015]. Each restoration replacement makes the cavity larger
206 and the restoration more complex, time-consuming, and costly than the initial one. Consequently,
207 with a greater number of faces involved, it will have a shorter longevity, and may have a deleterious
208 effect on the pulp leading to endodontic treatment. Thus, the restorative cycle causes long-term
209 detrimental consequences for dental health [QVIST 2015]. In this sense, the sealing of carious lesions
210 could be an alternative to conventional restoration by avoiding the tooth insertion in the "repetitive
211 restorative cycle".

212 For many years, it was believed that caries lesion control was only possible through complete
213 removal of carious tissue and restoration. However, dental caries is a result of an imbalance in the
214 remineralization and demineralization process, due to the access of the bacteria to a substrate. Thus,
215 sealing of carious lesions would be able to control bacterial proliferation and arrest disease
216 progression [ALVES et al. 2017; QVIST et al. 2018; FONTANE and INNES, 2018]. This protective effect
217 able to inactivate the caries process was studied by Theilade [1977] in a clinical trial that aimed to
218 evaluate the effect of sealing on the microflora of non cavitated human molar occlusal fissures. The
219 author concluded that, the preventive effect of caries on sealants may be due to the lack of
220 fermentable carbohydrates for the remaining bacteria to accumulate acid in cariogenic
221 concentrations and consequently decrease the number of viable bacteria. A meta-analysis evaluating
222 the effect of fissure sealants of occlusal surface with no clinical cavity on the level of bacterial
223 contamination confirmed these previous results [OONG et al., 2008]. Clinical studies have also
224 demonstrated the possibility of arresting the progression of cavitated lesions after cavity sealing
225 [MERTZ-FAIRHURST et al., 1998, BAKHSHANDEH, et al., 2012, ALVES et al. 2017, QVIST et al., 2017].
226 Thus, the application of resin sealant on cavitated occlusal carious lesions with radiolucent image
227 restricted to the outer half of dentin can avoid the removal of carious tissue prior to the conventional
228 restoration. Although sealants may have a higher fracture rate than restorations and that a
229 conventional restorative treatment may be necessary in the future, it is possible to assume that
230 tooth longevity will be greater due to the postponement of a more invasive approach
231 [BAKHSHANDEH, et al., 2012, ALVES et al., 2017, QVIST et al, 2017].

232 The present study demonstrated that sealing carious lesions resulted in greater preservation of
233 dental structure, that is, maintenance of the size of the lesion calculated through the greater width

234 and depth. The restorative treatment increased the loss of dental tissue, which can increase the
235 fragility of the tooth, and, consequently, its useful life.

236

237 **8. Acknowledgement**

238 The study was supported by the Brazilian National Council of Technological and Scientific
239 Development (CNPQ), Ivoclar/Vivadent (São Paulo, Brazil) and Caulk/ Dentsply (Rio de Janeiro,
240 Brazil).

241

242

243

244

9. References

- Ahovuo-Saloranta A, et al. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. *Cochrane Database Syst. Rev.* 2008 Oct;(4).
- Alves LS. et al. A randomized clinical trial on the sealing of occlusal carious lesions: 3-4-year results. *Braz Oral Res.* 2017 Jun;31: 1-8.
- Ástvaldsdóttir A. et al. Longevity of posterior resin composite restorations in adults – A systematic review. *J Dent.* 2015 Aug;43(8): 934-954.
- Bakhshandeh A, Qvist V, Ekstrand KR. Measurement of histological and radiographic depth and width of occlusal caries lesions: a methodological study. *Caries Res.* 2011 Oct;45(6): 547-555.
- Bakhshandeh A, Qvist V, Ekstrand KR: Sealing occlusal caries lesions in adults referred for restorative treatment: 2–3 years of follow-up. *Clin Oral Investig.* 2012;16: 521–529.
- Beck F. et al. Survival of direct resin restorations in posterior teeth within a 19-year period (1996-2015): A meta-analysis of prospective studies. *Dent Mater.* 2015 Aug;31(8):958-985.
- Elderton, RJ. Preventive (evidence-based) approach to quality general dental care. *Med Princ Pract.* 2003;12(1):12-21.
- Fontana, M. Nicola Innes N. Sealing Carious Tissue Using Resin and Glass-Ionomer Cements. In: SCHWENDICKE F, FRENCKEN J, INNES N (Ed). *Caries Excavation: Evolution of Treating Cavitated Carious Lesions.* Basel: Karger, 2018. vol 27,p.103-112.
- Frencken JE. et al. Minimal intervention dentistry for managing dental caries. A review. *Int. Dent. J.* 2012 Oct;62(5): 223-243.
- Handelman SL, Washburn F, Wopperer P: Twoyear report of sealant effect on bacteria in dental caries. *J Am Dent Assoc.* 1976;93: 967–970.
- Mertz-Fairhurst EJ, Curtis JW Jr, Ergle JW, Rueggeberg FA, Adair SM: Ultraconservative and cariostatic sealed restorations: results at year 10. *J Am Dent Assoc.* 1998;129: 55–66.
- Oong EM, Griffin SO, Kohn WG, Gooch BF, Caufield PW: The effect of dental sealants on bacteria levels in caries lesions: a review of the evidence. *J Am Dent Assoc.* 2008;139: 271–278.
- Qvist V., Borum MK, Møller KD, Andersen TR, Blanche P, Bakhshandeh A. Sealing Occlusal dentin caries in permanente molars: 7-years results of a randomized controlled trial. *Epidemiol Res.* 2017 Jan; 2(1): 73-86.
- Qvist V: Longevity of restorations: ‘the death spiral’; in Fejerskov O, Nyvad B, Kidd E (eds): *Dental Caries: The Disease and Its Clinical Management.* Hoboken, Wiley-Blackwell, 2015, p. 387–401.
- Schwendicke F. Removing Carious Tissue: Why and How?. In: Schwendicke F, Frencken J, Innes N (Ed). *Caries Excavation: Evolution of Treating Cavitated Carious Lesions.* Basel: Karger, 2018. vol 27, p. 56–67.
- Theilade E, Fejerskov O, Migasena K, Prachyabrued W. Effect of fissure sealing on the microflora in occlusal fissures on human teeth. *Arch Oral Biology.* 1977; 22(4): 251-259.
- Vandenbroucke, JP et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *Epidemiology.* 2007 Nov; 6: 805-835.

4 CONCLUSÃO

O presente estudo demonstrou que o selamento das lesões de cárie causou uma maior preservação da estrutura dentária, ou seja, manutenção do tamanho da lesão calculada através da maior largura e profundidade. O tratamento restaurador resultou em maior perda de tecido dentário, o que pode aumentar a fragilidade do dente e, conseqüentemente, diminuir sua vida útil.

REFERÊNCIAS

- AHOVUO-SALORANTA, A., et al. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. **Cochrane Database Syst. Rev.**, Oxford, v. 8, no. 4, Oct. 2008.
- ALVES, L. S. et al. A randomized clinical trial on the sealing of occlusal carious lesions: 3-4-year results. **Braz Oral Res.**, São Paulo, v. 31, p. 1-8, Jun. 2017.
- ÁSTVALDSDÓTTIR, A. et al. Longevity of posterior resin composite restorations in adults – A systematic review. **J Dent.**, England, v. 43, no. 8, p. 934-954, Aug. 2015.
- BAKHSHANDEH, A.; QVIST, V.; EKSTRAND, K. R. Measurement of histological and radiographic depth and width of occlusal caries lesions: a methodological study. **Caries Res.**, Basel, v. 45, no. 6, p. 547-555, 2011.
- BAKHSHANDEH, A.; QVIST, V.; EKSTRAND, K. R. Sealing occlusal caries lesions in adults referred for restorative treatment: 2-3 years of follow-up. **Clin Oral Investig.**, Berlin, v. 16, no. 2, p. 521-529, Apr. 2012.
- BECK, F. et al. Survival of direct resin restorations in posterior teeth within a 19-year period (1996-2015): A meta-analysis of prospective studies. **Dent Mater.**, Copenhagen, v. 31, no. 8, p. 958-985, Aug. 2015.
- ELDERTON, R. J. Preventive (evidence-based) approach to quality general dental care. **Med Princ Pract.**, Bristol, v. 12, no. 1, p. 12-21, 2003.
- FONTANA, M.; INNES, N. Sealing Carious Tissue Using Resin and Glass-Ionomer Cements. In: SCHWENDICKE, F.; FRENCKEN, J.; INNES, N. (Ed). **Caries Excavation: Evolution of Treating Cavitated Carious Lesions**. Basel: Karger, 2018. v. 27, p. 103-112.
- FRENCKEN J. E. et al. Minimal intervention dentistry for managing dental caries. A review. **Int. Dent. J.** London, v. 62, no. 5, p. 223-243, Oct. 2012.
- HANDELMAN, S. L.; WASHBURN F.; WOPPERE, P. Two-year report of sealant effect on bacteria in dental caries. **J Am Dent Assoc.**, Chicago, v. 93, no. 5, p. 967-970, Nov.1976.
- MERTZ-FAIRHUST E. J. et al. Ultraconservative and cariostatic sealed restorations: results at year 10. **J Am Dent Assoc.**, Chicago, v. 129, no. 1, p. 55-66, Jan. 1998.
- OONG, E. M. et al. The effect of dental sealants on bacteria levels in caries lesions: a review of the evidence. **J Am Dent Assoc.** Chicago, v. 139, no. 3, p. 271-278, Mar. 2008.
- QVIST, V. Longevity of restorations: 'the death spiral'. In: FEJERSKOV, O.; NYVAD, B.; KIDD, E. (Ed.). **Dental caries: The disease and its clinical management**. 3rd ed. West Sussex: Wiley-Blackwell, 2015. cap. 21, p. 337–350.

QVIST, V. et al. Sealing Occlusal dentin caries in permanente molars: 7-years results of a randomized controlled trial. **Epidemiol Res.**, v. 2, no. 1, p. 73-86, Jan. 2017.

SCHWENDICKE, F. Removing Carious Tissue: Why and How? In: SCHWENDICKE, F.; FRENCKEN, J.; INNES, N. (Ed.). **Caries Excavation: Evolution of Treating Cavitated Carious Lesions**. Basel: Karger, 2018. v. 27, p. 56–67.

THEILADE, E. et al. Effect of fissure sealing on the microflora in occlusal fissures on human teeth. **Arch Oral Biology.**, Oxford, v. 22, no. 4, p. 251-259, 1977.

VANDENBROUCKE, J. P. et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. **Epidemiology.**, Cambridge, v. 18, no. 6, p. 805-835, Nov. 2007.