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ENSINO E PROTOCOLO CLÍNICO DE REPARO DE RESTAURAÇÕES DE RESINA COMPOSTA

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Dissertação apresentada ao Programa de Pós-graduação em Odontologia da Universidade Federal do Rio Grande do Sul como requisito parcial para a obtenção do título de Mestre em Odontologia, Área de Concentração em Clínica Odontológica/Odontopediatria.

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RESUMO

A presente dissertação de mestrado é composta por dois artigos científicos. O primeiro deles, intitulado "Repair of resin composite restorations in primary teeth: current trends in school teaching in Brazil" visou investigar o perfil do ensino do reparo de restaurações de resina composta com falhas em dentes decíduos nos cursos de Graduação em Odontologia do Brasil. Para isso, um questionário relacionado ao ensino do reparo de restaurações de resina composta foi enviado por e-mail para 205 cursos com alunos cursando a Disciplina de Odontopediatria entre maio e setembro de 2019. Os dados obtidos foram submetidos à análise descritiva. A taxa de resposta foi de 43,4%. O reparo de restaurações de resina composta foi ensinado por 82% das instituições. As principais indicações de reparo foram preservação da estrutura dentária (95,9%) e redução do risco de complicações pulpares (71,2%). Em relação ao protocolo para reparo, poucas instituições (24,7%) têm recomendado o desgaste da porção da resina a ser reparada com brocas diamantadas (tratamento físico). Por outro lado, a maioria preconizou o condicionamento com ácido fosfórico, seguido da aplicação de sistema adesivo. Embora o ensino do reparo de restaurações de resina composta tem sido estabelecido nos cursos de Graduação em Odontologia no Brasil, não há consenso especialmente sobre o protocolo clínico para reparo. O segundo artigo intitulado "Silane coupling agents are beneficial for resin composite repair: A systematic review and meta-analysis of *in vitro* studies" avaliou se o silano combinado à aplicação de sistema adesivo aumenta a resistência de união de reparo de resina composta direta à base de metacrilato em comparação ao uso de sistema adesivo. A pesquisa bibliográfica foi realizada nas bases de dados PubMed/ MEDLINE, Scopus e Lilacs, sem restrição de ano de publicação e idioma. Dois revisores selecionaram independentemente os estudos, extraíram os dados e avaliaram o risco de viés. Meta-análises foram realizadas usando modelo de efeitos aleatórios comparando as médias de resistência de união e desvios padrão entre os tratamentos de superfície silano *plus* sistema adesivo e sistema adesivo (meta-análise global), e considerando análises de subgrupos (valores de resistência de união de reparo imediata e de degradação, tipo de silano – hidrolisado ou não hidrolisado e tipo de teste de resistência de união). As análises estatísticas foram realizadas no RevMan 5.3 considerando um nível de significância de 5%. De um total de 676 estudos potencialmente elegíveis, 81 foram selecionados para leitura na íntegra e 17 foram incluídos na revisão sistemática. Não houve diferença entre os grupos, considerando a resistência de união de reparo imediata e de degradação (p=0,12 e p=0,06, respectivamente). No entanto, a meta-análise global mostrou que o uso de silano previamente à aplicação de adesivo promoveu maiores valores de resistência de união de reparo (p=0,003). O efeito positivo do silano no protocolo de reparo foi maior quando da utilização de silanos não hidrolisados (tamanho do efeito: 7,30 IC95% -2,91-17,51). Uma significante diferença entre os grupos foi encontrada apenas para estudos que usaram o teste de microcisalhamento (p=0,02). Sendo assim, a aplicação de silano previamente ao sistema adesivo aumenta a resistência de união de reparo de resina composta direta à base de metacrilato.

Palavras-chave: Reparo de Restauração Dentária; Educação em Odontologia; Odontopediatria; Revisão Sistemática

ABSTRACT

The present master dissertation is composed by two scientific articles. The first one, entitled "Repair of resin composite restorations in primary teeth: current trends in school teaching in Brazil" aimed to investigate the teaching profile of the repair of resin composite restorations with failures in primary teeth among undergraduate dental courses in Brazil. For this, a questionnaire related to the teaching of the repair of resin composite restorations was e-mailed to 205 courses with students attending the Pediatric Dentistry Discipline between May and September 2019. Data obtained were submitted to descriptive analysis. The response rate was 43.4%. The repair of resin composite restorations was taught by 82% of the institutions. The main indications for repair were dental structure preservation (95.9%) and reduction in the risk of pulp complications (71.2%). Regarding the protocol for repair, few schools (24.7%) have recommended the grinding of the resin portion to be repaired with diamond burs (physical treatment). In the other hand, most advocated the conditioning with phosphoric acid, followed by the application of adhesive system. Although the teaching of the repair of resin composite restorations has been established in undergraduate dental courses in Brazil, there is no consensus especially about the clinical protocol for repair. The second article entitled "Silane coupling agents are beneficial for resin composite repair: A systematic review and meta-analysis of *in vitro* studies" evaluated if silane combined with adhesive system application improve the repair bond strength of direct methacrylate-based resin composites in comparison to use of adhesive alone. The literature search was undertaken through PubMed/MEDLINE, Scopus and Lilacs databases, without publication year and language restriction. Two reviewers independently selected studies, extracted data, and assessed the risk of bias. Meta-analyses were performed using the random effects model comparing the bond strength means and standard deviations between silane *plus* adhesive system and adhesive system surface treatments (global meta-analysis), and considering subgroup analyses (immediate and degradation repair bond strength values, type of silane – hydrolyzed or nonhydrolyzed, and type of bond strength test). Statistical analyses were performed using RevMan5.3 at a significance level of 5%. Of a total of 676 potentially eligible studies, 81 were selected for full-text analysis, and 17 were included in the systematic review. There was no difference between groups, considering immediate and degradation repair bond strength ($p=0.12$ and $p=0.06$, respectively). However, global meta-analysis showed that the use of silane prior to adhesive application produced higher repair bond strength values ($p=0.003$). The positive effect of the silane on the repair protocol was greater when nonhydrolyzed silanes were used (effect size: 7.30 95% CI 2.91-17.51). A significant difference between groups was found only for studies that used microshear bond strength test ($p=0.02$). Thus, the use of silane prior to adhesive system increases the bond strength repair of direct methacrylate-based resin composite.

Keywords: Dental Restoration Repair; Education, Dental; Pediatric Dentistry; Systematic Review

SUMÁRIO

1 INTRODUÇÃO

Restaurações adesivas são amplamente utilizadas em Odontopediatria. A taxa de falha anual de restaurações de resina composta em dentes decíduos varia entre 1,7 e 12,9% (CHISINI *et al.*, 2018). Fratura do dente e/ou da restauração e presença de lesão de cárie adjacente são os principais motivos de falhas em dentes posteriores (PEDROTTI *et al.*, 2017), enquanto que motivos estéticos, como alteração de cor, forma anatômica e pigmentação, levam à reintervenção de restaurações anteriores (DEMARCO *et al.*, 2015).

Frente à necessidade de reintervir em restaurações insatisfatórias, os clínicos podem optar pela substituição ou reparo da restauração. O reparo é uma abordagem minimamente invasiva que envolve a remoção da parte defeituosa da restauração, seguida pela restauração do defeito preparado (HICKEL, BRÜSHAVER, ILIE, 2013). Embora o reparo tenha sido tradicionalmente considerado como "*bad dentistry*", atualmente é considerado como "*estado de arte*". Isso porque tem sido evidenciado que o reparo pode aumentar a sobrevida das restaurações (RUIZ *et al.*, 2019), minimizando o risco de complicações pulpares e os custos do tratamento (GORDAN *et al.*, 2016), além de reduzir tempo clínico e o desconforto ao paciente. Neste contexto, a realização de reparo de restaurações parcialmente defeituosas é especialmente interessante em Odontopediatria.

Sabe-se que os dentistas são mais propensos a reparar restaurações que foram realizadas por eles e substituir restaurações realizadas por outros profissionais (GORDAN *et al.*, 2014). Ademais, os clínicos tendem a realizar a substituição quando a restauração está associada com fratura (GORDAN *et al.*, 2014). Não está claro na literatura se a lacuna entre a evidência científica e a prática clínica ainda existe em muitos países, nem mesmo se o reparo faz parte do currículo dos cursos de Odontologia e quais outros fatores (além do conhecimento) podem impactar na decisão dos profissionais em realizar reparos de restaurações parcialmente defeituosas.

Um levantamento realizado no Japão mostrou que a maioria das escolas (95%) aborda o reparo de restaurações com falhas como parte do ensino nos cursos de graduação e o principal motivo da indicação do reparo está associado a maior preservação de estrutura dentária (LYNCH *et al.*, 2013). Nos países escandinavos, o ensino do reparo de restaurações tem sido realizado nos primeiros anos do curso de graduação em Odontologia. Falta de experiência clínica com a técnica tem sido apontada como uma barreira para a implementação do seu ensino (BLUM *et al.*, 2012).

Embora o ensino de reparo de restaurações de resina composta com defeitos tem sido

incluído também nos currículos dos cursos de graduação em Odontologia no Canadá e Estados Unidos, o treinamento é geralmente teórico e não clínico (LYNCH *et al*., 2012). Uma recente revisão sistemática (KANZON *et al.*, 2018) demonstrou que a maioria dos cursos de Odontologia no mundo inclui o ensino de reparo de restaurações no currículo e que muitos dentistas estão cientes da indicação do reparo. Por outro lado, a proporção de reparos realizados ainda é baixa (KANZON *et al.*, 2018). É importante destacar que não se sabe o panorama de ensino do reparo de restaurações adesivas no Brasil.

Além disso, ainda não existe um protocolo padrão para tratamento da superfície da resina composta envelhecida previamente ao reparo. Tratamentos físicos, como asperização da superfície com pontas diamantadas, tem o objetivo de melhorar a união mecânica entre a resina envelhecida e a nova (reparo), enquanto que os agentes químicos, como uso de silano e/ou sistemas adesivos, são usados visando melhorar a união entre os materiais resinosos na interface adesiva (VALENTE *et al.*, 2016).

Silanos são moléculas organofuncionais que promovem a união entre dois materiais. Em procedimentos de reparo, essa molécula promove a união da fase inorgânica do substrato com a fase orgânica da resina do reparo (ÇAKIR *et al.*, 2018). Ademais, os silanos possuem maior capacidade de molhamento, facilitando a penetração do adesivo nos defeitos da superfície da resina composta (BRENDEKE; OZCAN, 2007). Assim, os silanos poderiam ser efetivos no aumento da resistência de união em reparos. Tem sido reportado que a associação de tratamentos de superfície físicos e químicos parece ser benéfica no aumento da resistência de união de reparo (VALENTE *et al.*, 2016).

A asperização de superfície com pontas diamantadas em alta rotação, seguida do condicionamento com ácido fosfórico e subsequente aplicação de sistema adesivo tem sido o protocolo clínico utilizado por mais de 80% dos dentistas para reparo de restaurações (VALENTE *et al.*, 2016). Diante da falta de evidência clínica, a compilação de resultados laboratoriais poderia elucidar se o silano é indispensável no protocolo de reparo.

Diante do exposto, no presente trabalho serão apresentados os artigos oriundos de duas investigações científicas. O primeiro deles, intitulado “Repair of resin composite restorations in primary teeth: current trends in school teaching in Brazil” visou investigar o perfil do ensino do reparo de restaurações de resina composta com falhas em dentes decíduos nos cursos de graduação em Odontologia do Brasil. O segundo artigo intitulado “Silane coupling agents are beneficial for resin composite repair: A systematic review and meta-analysis of *in vitro* studies” avaliou o efeito do uso do silano previamente à aplicação de sistema adesivo na resistência de união de reparo de resina composta em comparação ao uso

de sistema adesivo.

2 ARTIGO – Repair of resin composite restorations in primary teeth: current trends in school teaching in Brazil

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Original Research Report

Pediatric Dentistry

Repair of resin composite restorations in primary teeth: current trends in school teaching in Brazil

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Abstract

This study investigated the teaching of direct resin composite restoration repair in Pediatric Dentistry among undergraduate dental courses in Brazil. A questionnaire relating to the teaching of the management of defective resin composite restorations was developed and e-mailed to 205 undergraduate dental schools between May and September 2019. Data obtained were summarized using descriptive statistics. The response rate was 43.4%. Repair of resin composite restorations was taught by 82% participating schools. The most commonly reported indications for the teaching of the repair of resin composite restorations were dental structure preservation (95.9%) and reduction in the risk of pulp complications (71.2%). Regarding to techniques taught for surface treatments, few schools (24.7%) taught mechanical roughening of the existing resin composite restoration with diamond burs. On the other hand, 87.7% recommended the phosphoric acid etching of the exposed tooth and composite surfaces and 76.7% indicated adhesive application into prepared surface. The most commonly taught material for completing repairs was conventional resin composite. In conclusion, the teaching of the repair of failed resin composite restorations has been established in undergraduate dental courses in Brazil. However, there is no consensus especially related to clinical protocol for repair.

Descriptors: dental restoration failure; education, dental; pediatric dentistry; students, dental

Introduction

The simplistic approach of restoration replacement—"if in doubt, take it out"—increasingly is recognized by dentistry as unreasonably costly, since it sacrifices sound tooth tissue, and reduces the likelihood of continuing pulp vitality[1]. On the other hand, the repair (i.e. partial replacement of the restoration allowing preservation of that portion of the restoration that presents no clinical or radiographic evidence of failure) may increase the survival of resin composite restorations placed in both primary and permanent teeth[2,3], prolonging the tooth retention time. Therefore, it has been considered preferable, whenever possible, to perform a repair as an alternative to restoration replacement[4].

It has been shown that dentists who placed the original restoration are more likely to repair than replace an existing restoration, compared to a practitioner who is not the one who placed the defective restoration[5]. On the other hand, dentists tend to perform replacement when restoration is associated with fracture[5].

A survey conducted in Japan found that the teaching of repair of defective resin composite restorations is established within many Japanese dental schools, but there is no consensus regarding the repair protocol[6]. In Scandinavian countries, the teaching of repair of defective resin composite restorations has been included in their primary dental degree program. Lack of clinical experience for performing repair has been point as a barrier for the implementation of its teaching[7]. Although teaching repair of defective resin composite restoration repair has also been included in the didactic curriculum of most schools in Canada and United States, training is generally theoretical rather than clinical[8].

A recent systematic review[9] showed that while most dentists state to perform repairs and the majority of dental schools teach repairs, the proportion of truly repaired restorations is low. It is unclear if the gap between scientific evidence and clinical practice still exists in many countries, which were not included in this review, neither what further factors (beyond

knowledge) may affect dentists' decision towards repairs.

Repair of partially defective restorations is especially interesting in Pediatric Dentistry, because it is a more patient-friendly approach and reduces clinical time. Therefore, the aim of the present study was to investigate the teaching of direct resin composite restoration repair in Pediatric Dentistry among undergraduate dental courses in Brazil.

Methodology

This study was approved by the Ethics Committee for Research, Federal University of Rio Grande do Sul, Brazil (CAAE: 96425018.0.0000.5347).

Dental Schools

Undergraduate programs registered in the Federal Council of Dentistry and in the Ministry of Education and Culture (MEC) were potential participants in this study, totaling 469 institutions. An inclusion criterion was the possibility of contact by e-mail. A cover letter presenting the survey, following by a consent form together with questionnaire, was sent by e-mail to the person identified as being responsible for the delivery of Pediatric Dentistry teaching programs. E-mail addresses were requested from the course coordination by telephone or e-mail or were collected from electronic address of school or scientific paper.

Data Collection

A questionnaire, adapted from previous studies[6,8], regarding the teaching repair of partially defective resin composite restorations was used. The questionnaire included sixteen multiple choices, two free text questions and seven clinical cases (Figure 1). Information sought included the following: the teaching of resin composite repair techniques in their dental school program, the nature of this teaching, the reasons for including this teaching,

clinical indications for repair, views on the longevity of resin composite repairs and techniques taught for resin composite restoration repair. The respondents should inform the decision-making for each clinical case: no intervention, polishing, repair or replacement of the restoration.

The survey was sent up to five times, from May 2019 to September 2019, fifteen days apart at a time, to those schools that did not answer. The database was updated as the new answers were received. Sampling unit was the course. When more than one questionnaire was answer by a course, it was drawn only one questionnaire representing the institution.

Data Analysis

Data were summarized using descriptive statistics.

Results

A flow diagram illustrates the application of questionnaire in Brazilian undergraduate courses (Figure 2). Completed responses were received from 89 of the 205 invited schools (response rate = 43.4%). Seventy-three schools (82%) reported that teaching repair of defective resin composite restorations is included in the Pediatric Dentistry curriculum. Among the schools that did not teach this technique in Pediatric Dentistry, six reported that teaching was done in Operative Dentistry discipline. Three did not include the teaching of this technique given a lack of available time within their curriculum, one school reported lack of agreement among professors and six schools did not indicate its reasons for not doing so.

All Brazilian regions were represented in this study (Table 1). Southeastern and southern regions showed greater representativeness, as well as, undergraduate courses of private institutions (64%). Survey results are shown in Table 2. Of those schools teaching the repair of resin composite restorations, their reported reasons for doing so were as follows:

minimally invasive approach (90.4%) and existing scientific evidence (38.4%). The majority of the schools (76.7%) said that teaching is based on theoretical and clinical activities. The most commonly reported indications for the teaching of the repair of resin composite restorations were: dental structure preservation (95.9%) and reduction in the risk of pulp complications (71.2%).

The defects in the restorations considered appropriate for repair rather than replacement by the largest number of schools included marginal defects, partial loss of restoration involving up to half of the surface and presence of active carious lesion involving dentin adjacent to the restoration. In addition, 86.3% of respondents reported that they were more likely to indicate repair of defective restorations in patients with difficult management and 54% them in primary teeth nearest the physiological exfoliation.

Regarding to techniques taught for surface treatments of existing resin composite restorations, few schools (24.7%) taught mechanical roughening of the existing resin composite restoration with diamond burs, including removal of the surface layer of material. On the other hand, the most schools (87.7%) recommended the phosphoric acid etching of the exposed tooth and resin composite surfaces and 76.7% of schools indicated adhesive application into prepared surface. The most commonly taught material for completing repairs was conventional resin composite. Finishing devices included finishing discs (65.8%), abrasive polishing tips (65.8%) and diamond finishing instruments (52.1%).

Respondents said that recall intervals based on individual caries risk were considered for monitoring of the repaired restorations through clinical exam and/or radiographic evaluation, and 54.9% of schools reported that the assessment of the restorations is based on personal judgment. In the evaluation of the clinical cases, more than half of respondents opted for repair the restorations performed in posterior teeth presenting form anatomic alteration or marginal gaps. However, respondents were more likely to indicate replacement

of fractured restorations. Moreover, most respondents (69.9%) opted for none intervention considering a restoration with subtle color and luster alteration placed in anterior primary tooth nearest to exfoliation. However, 43.8% them opted for repair a restoration with marginal discoloration and color change performed in anterior primary tooth even nearest to physiological exfoliation.

Discussion

This is the first survey the teaching of the repair of resin composite restorations in primary teeth in dental undergraduate schools in Brazil. As with all questionnaire-based surveys, risks exist in relation to the reliability of responses and the potential of nonresponse bias. Within this survey, a 43.4% response rate was achieved, similar to than the response rates in previous Brazilian questionnaire-based surveys in the dental literature[10,11]. It is important to note that previous surveys were conducted in countries with a limited number of schools, i.e., 12 Scandinavian schools[7] and UK and Irish dental schools[12]. In our study, 89 of the 205 schools completed responses.

Our results indicate that most undergraduate dental schools (82.0%) teach repairs of resin composite restorations performed in primary teeth. The tooth substance preservation and reduced risk of harmful effects on the pulp were the main reasons for repair teaching, in line with surveys conducted in undergraduate dental schools in Scandinavian[7], United Kingdom and Ireland[12], Japan[6], United States and Canada[8].

The majority of the schools reported that this teaching was based on theoretical and clinical activities. Previous surveys[7,8] have shown that repair teaching is generally theoretical rather than clinical. More experienced clinicians seem to be more aware of repair restorations and repaired more frequently while those with insufficient training or missing knowledge. Additionally, negative experience with repairs has been a barrier for performing repairs[9]. It is

not obvious in which clinical situation one must choose repair or replacement of defective restorations[13]. Nevertheless, the general consensus tends towards repair of restorations given its numerous advantages, not least including a minimally invasive approach to treatment and avoidance of unnecessary loss of tooth tissue and pulpal damage[9].

It has been evidenced that specific patient or tooth related aspects such as patient's age, caries risk, frequency of dental appointments, affected tooth, number of restoration's surfaces, size of defect, caries lesion depth may influence on dentists' repair behavior[9]. In our study, marginal defects, partial loss of restoration involving up to half of the surface and presence of active carious lesion involving dentin adjacent to the restoration were the main indicatives of repairs. Moreover, 47.9% respondents indicated repair facing active caries lesion in enamel adjacent to the restoration.

The diagnosis of recurrent caries is the main reason for the replacement of the restorations[14]. It has been shown that the presence of recurrent caries influences the re-intervention decision, leading to restoration replacement in most cases[15]. Although recurrent caries is histologically similar to primary caries, the clinical diagnosis for evaluating the presence of caries or staining around the restorations margins is a challenge for dentists and it is subjective most of times. Moreover, presence of demineralization around restoration margins, by itself, is not indicative of a restoration replacement[16].

Most schools reported that the evaluation of the restorations is based on personal judgment, which may lead to unnecessary re-intervention The use of standardized criteria such as USPHS[17] and FDI[16] could be useful for assessment of restorations placed by clinicians in their own practices. Also, dental students should be trained to use them as part of a clinical evaluation to determine whether a restoration can be maintained or whether it needs repair or replacement[16]. According to the FDI criteria[16], restorations with cavitation and suspected undermining caries localized and accessible may be repaired while restorations

with deep caries or exposed dentin, which is not accessible, must be replaced.

The majority of respondents reported that they were more likely to indicate repair of failed restorations placed in primary teeth nearest the physiological exfoliation or those performed in patients with difficult management. Overall, less than three years was considered an acceptable survival of repaired restorations. A retrospective study[2] showed that longevity of adhesive restorations placed in high–caries risk children up to 36 months was 34.8%. Conversely, the survival of repaired restorations up to 36 months reached 43.7%, evidencing that repair increases the survival of failed restorations in primary teeth[2].

Thus, although choice of repairing defective restorations may be even more beneficial for children with difficult management because it is a more simplified and less time-consuming technique, this approach may provide a benefit to all pediatric patients. In the evaluation of the clinical cases, it was possible to note that there was a tendency for opting for repair instead replacement of failed restorations placed in primary molars, except due fracture of the restoration. On the other hand, 43.8% of respondents opted for repair a restoration with marginal discoloration and color change in anterior primary tooth nearest to physiological exfoliation. Clinicians tend to intervene more for esthetic reasons even in situations where no intervention would be the best decision-making. Moreover, it has been well established that the treatment decision is also influenced by 'professional profile', some being more 'reactive' (do not act until the problem occurs) and others being more 'proactive'[18].

In our study, there was no consensus regarding the clinical protocol for repair. Few schools (24.7%) taught mechanical roughening of the existing resin composite restoration with diamond burs. This physical treatment has the ultimate goal to improve mechanical attachment between aged and new (repair) composite[19]. On the other hand, the majority of the schools recommended the application of phosphoric acid etching and adhesive system on

exposed tooth. It has been noted that use of physical and chemical surface treatments of aged dental composites seems beneficial for improving the repair bond strength of resin composite restorations[19].

It has been also suggested the use of silane coupling agent prior to adhesive application in the repair procedures[20-23]. Silanes promote the union of the inorganic phase of the substrate with the organic phase of the resin of the repair[24] and facilitate the penetration of the adhesive into surface defects due their higher surface wettability[25]. However, few Brazilian schools (6.8%) preconized the use of silane coupling agent before adhesive application.

Most schools taught repair techniques involving the application of conventional or flowable resin composite. Whilst flowable materials offer advantages, including ease of placement, they have a low filler loading[26]. Thus, flowable composites could be used for repairing few defects[4].

Facing the current scientific evidences, there is no gold standard protocol or materials established for treating the aged resin composite surfaces before repair. As such the repair protocol may vary according to clinical conditions. Phosphoric acid etching and application of an adhesive (an adhesive containing silane may be advantageous) is recommended for repair of marginal defects and the gaps can best be filled with flowable resin composite[4]. In cases of repair of restorations with chipping defects, bulk fracture, partial loss or severe wear, with failed resin composite surface, roughening of the existing resin composite restoration with diamond burs, acid etching, application of silane and adhesive and conventional resin composite is indicated[4]. When facing exposed enamel and dentin surfaces should be smoothened followed by etching with phosphoric acid and application of adhesive and resin composite. If no dentin and only enamel surfaces are involved a more hydrophobic bond instead of a dentin adhesive is preferable[4].

It is important to highlight that there is a need for randomized controlled long-term clinical trials to be able to give evidence based recommendation. Teaching of repair in dental school programs is desirable and it will lead to increased certainty to decision to repair failed restorations amongst future of undergraduate dental students. To enhance evidence-based management of defective restorations, guidelines towards when and how to repair should be established and reinforced.

Conclusion

The teaching of the repair of defective resin composite restorations has been established in undergraduate dental courses in Brazil. Such teaching is to be encouraged, as it is in the best interests of pediatric patients. It is suggested that standardized clinical criteria for helping in the decision-making for repair or replace defective restorations should be included in the curriculum and future researches should focus on establishing the optimal techniques for the repair of composite restorations.

References

1. Lynch CD, Blum IR, Frazier KB, Haisch LD, Wilson NHF. Repair or replacement of defective direct resin-based composite restorations. J Am Dent Assoc. 2012 Feb;143(2):157–63.

2. Ruiz LF, Nicoloso GF, Franzon R, Lenzi TL, de Araujo FB, Casagrande L. Repair increases the survival of failed primary teeth restorations in high–caries risk children: a university-based retrospective study. Clin Oral Investig. 2019 Apr. https://doi.org/10.1007/s00784-019-02899-9.

3. Casagrande L, Laske M, Bronkhorst EM, Huysmans MCDNJM, Opdam NJM. Repair may increase survival of direct posterior restorations – A practice based study. J Dent.

2017 Sep;64:30–6.

4. Hickel R, Brüshaver K, Ilie N. Repair of restorations – Criteria for decision making and clinical recommendations. Dent Mater. 2013 Jan;29(1):28–50.

5. Gordan V V, Riley J, Geraldeli S, Williams OD, Spoto JC, Gilbert GH., et al. The decision to repair or replace a defective restoration is affected by who placed the original restoration: Findings from the National Dental PBRN. J Dent. 2014 Dec;42(12):1528–34.

6. Lynch C, Hayashi M, Seow L, Blum I, Wilson N. The Management of Defective Resin Composite Restorations: Current Trends in Dental School Teaching in Japan. Oper Dent. 2013 Sep-Oct;38(5):497–504.

7. Blum IR, Lynch CD, Wilson NHF. Teaching of the repair of defective composite restorations in Scandinavian dental schools. J Oral Rehabil. 2012 Mar;39(3):210–6.

8. Lynch CD, Blum IR, Frazier KB, Haisch LD, Wilson NHF. Repair or replacement of defective direct resin-based composite restorations: contemporary teaching in U.S. and Canadian dental schools. J Am Dent Assoc. 2012 Feb;143(2):157–63.

9. Kanzow P, Wiegand A, Göstemeyer G, Schwendicke F. Understanding the management and teaching of dental restoration repair: Systematic review and meta-analysis of surveys. J Dent. 2018 Feb;69:1–21.

10. Paranhos MC., Pires CW., Lenzi TL., Casagrande L., Rocha R de O. Graduate and undergraduate teaching of primary tooth pulpectomy: A comparison among Brazilian dental schools. Pesqui Bras Odontopediatria Clin Integr. 2019 Sep;19(1):1–10.

11. Bergoli AD, Primosch RE, de Araujo FB, Ardenghi TM, Casagrande L. Pulp therapy in primary teeth--profile of teaching in Brazilian dental schools.J Clin Pediatr Dent. 2010 Winter;35(2):191-5.

12. Blum IR, Lynch CD, Wilson NHF. Teaching of direct composite restoration repair in undergraduate dental schools in the United Kingdom and Ireland. Eur J Dent Educ. 2012 Feb;16(1):e53–8.

13. Gordan V V, Riley JL, Rindal DB, Qvist V, Fellows JL, Dilbone DA, et al. Repair or replacement of restorations: A prospective cohort study by dentists in The National Dental Practice-Based Research Network. J Am Dent Assoc. 2015 Dec;146(12):895–903.

14. Demarco FF, Corrêa MB, Cenci MS, Moraes RR ON. Longevity of posterior composite restorations: not only a matter of materials. Dent Mater. 2012 Jan;28(1):87–101.

15. Ávila NM, Bottezini PA, Nicoloso GF, Araujo FB, Ardenghi TM, Lenzi TL, et al. Prevalence of defective restorations and factors associated with re-intervention in primary teeth: A retrospective university-based study. Int J Paediatr Dent. 2019 Sep;29(5):566–72.

16. Hickel R, Peschke A, Tyas M, Mjör I, Bayne S, Peters M, et al. FDI World Dental Federation - clinical criteria for the evaluation of direct and indirect restorations. Update and clinical examples. J Adhes Dent. 2010 Aug;12(4):259–72.

17. Bayne SC, Schmalz G. Reprinting the classic article on USPHS evaluation methods for measuring the clinical research performance of restorative materials. Clin Oral Investig. 2005 Dec;9(4):209–14.

18. Mjör IA, Toffenetti F. Secondary caries: a literature review with case reports. Quintessence Int. 2000 Mar;31(3):165–79.

19. Valente LL, Sarkis-Onofre R, Gonçalves AP, Fernández E, Loomans B, Moraes RR. Repair bond strength of dental composites: systematic review and meta-analysis. Int J Adhes Adhes. 2016 Sep;69:15–26.

20. Fornazari I, Wille I, Meda E, Brum R, Souza E. Effect of Surface Treatment, Silane, and Universal Adhesive on Microshear Bond Strength of Nanofilled Composite Repairs. Oper Dent. 2017 Jul-Aug;42(4):367–74.

21. Fawzy AS, El-Askary FS, Amer MA. Effect of surface treatments on the tensile bond strength of repaired water-aged anterior restorative micro-fine hybrid resin composite. J Dent. 2008 Dec;36(12):969–76.

22. Eliasson S, Tibballs J, Dahl J. Effect of Different Surface Treatments and Adhesives on Repair Bond Strength of Resin Composites After One and 12 Months of Storage Using an Improved Microtensile Test Method. Oper Dent. 2014 Sep-Oct;39(5):E206–16.

23. Kashi TJ, Erfan M, Rakhshan V, Aghabaigi N, Tabatabaei F. An *In Vitro* Assessment of the Effects of Three Surface Treatments on Repair Bond Strength of Aged Composites. Oper Dent. 2011 Nov;36(6):608–17.

24. Çakir N, Demirbuga S, Balkaya H, Karadaş M. Bonding performance of universal adhesives on composite repairs, with or without silane application. J Conserv Dent. 2018 May-Jun;21(3):263–8.

25. Brendeke J, Ozcan M. Effect of physicochemical aging conditions on the composite-composite repair bond strength. J Adhes Dent. 2007 Aug;9(4):399–406.

26. Baroudi K, Rodrigues JC. Flowable resin composites: A systematic review and clinical considerations. J Clin Diagnostic Res. 2015 Jun;9(6):ZE18-ZE24.

Table 1. Distribution by regions of the undergraduate dental courses.

Regions	Sent e-mails N	Answered Questionnaires N (%)
North	20	6 (6.7)
Northeast	45	18 (20.2)
Central-west	17	7 (7.9)
Southeast	76	30 (33.7)
South	47	28 (31.5)
Total	**205**	**89 (100)**

Table 2. Results regarding of questions presented in the survey.

Questions	**N (%)**
1. What is the definition of repair?	
Sealing the margins of a defective restoration	11 (15.1)
Polishing of the restoration for improve anatomical properties and surface	1 (1.4)
Add restorative material with or unprepared in the restoration and / or dental tissues	61 (83.6)
2. What is the reason (s) for including teaching the repair of failed resin composite restorations in the curriculum?	
Clinical experience	26 (35.6)
Existing scientific evidence	28 (38.4)
Information from case reports	3 (4.1)
Minimally invasive approach	66 (90.4)
3. How is teaching done?	
Theoretical and clinical activities	56 (76.7)
Only clinical activities	16 (21.9)
Theoretical activities (without clinical experience)	1 (1.4)
4. What criteria are used to assess the quality of restorations and the possibility of intervention?	
Personal judgment (clinical and radiographic examination)	40 (54.9)
United States Public Health Service (USPHS)	10 (13.7)
International Dental Federation (FDI)	21 (28.8)
Atraumatic Restorative Treatment (ART)	1 (1.4)
5. Mark the procedures / materials your school uses for repair	
Type of operative field isolation	
Relative isolation	5 (6.8)
Absolute isolation	20 (27.4)
Isolation will depend on case	48 (65.8)

Surface treatments of existing composite restorations	
Acid etching with phosphoric acid	64 (87.7)
Aluminum oxide abrasion	4 (5.5)
Acid etching with hydrofluoric acid	0 (0)
Mechanical roughening with diamond bur	18 (24.7)
No surface treatment	3 (4.1)
Materials utilized in the repair technique	
Dentine/enamel bonding agent	56 (76.7)
Flowable resin composite	47 (64.4)
Silane coupling agent	5 (6.8)
Bulk Fill resin composite	20 (27.4)
Conventional resin composite	57 (78.1)
Glass Ionomer Cement	26 (35.6)
Compomer	1 (1.4)
Resin sealant	1 (1.4)
Finishing techniques for repair	
Diamond finishing instruments	38 (52.1)
Abrasive polishing tips	48 (65.8)
Finishing discs	48 (65.8)
Tungsten carbide finishing instruments	8 (11)
Polishing paste	36 (49.3)
Scalpel blade	1 (1.4)
6. What is/are the clinical indication(s) for repair?	
Tooth substance preservation	70 (95.9)
Reduced risk of pulp complications	52 (71.2)
Reduced of clinical time	40 (54.8)
Reduced costs to the patient	29 (39.7)
Simplification of technique	35 (47.9)
7. Point out the reasons for repair of resin composite restorations in primary teeth:	
Active caries lesion in enamel adjacent to the restoration	35 (47.9)

Active caries lesion in dentin adjacent to the restoration	51 (69.9)
Inactive caries lesion in enamel (cavitated or not) adjacent to the restoration	7 (9.6)
Inactive caries lesion in dentin adjacent to the restoration	13 (17.8)
Marginal defects	65 (89)
Color change in anterior teeth	23 (31.5)
Color change in posterior teeth	4 (5.5)
Marginal pigmentation in anterior teeth	25 (34.2)
Marginal pigmentation in posterior teeth	5 (6.8)
Pigmentation of lingual/palatal surface restoration	0 (0)
Pigmentation of the occlusal surface restoration	1 (1.4)
Restoration pigmentation in the cervical region	1 (1.4)
Pigmentation of the restoration on proximal surface	0 (0)
Pigmentation involving more than one surface	3 (4.1)
Partial loss of restoration involving up to half surface	52 (71.2)
Abrasion / Attrition / Erosion	16 (21.9)
Large anterior (incisal) restoration fracture	21 (28.8)
Large anterior restoration fracture (proximal)	22 (30.1)
Large anterior restoration fracture (proximal / incisal)	22 (30.1)
Large posterior restoration fracture (occlusal)	27 (37)
Large posterior restoration fracture (proximal)	25 (34.2)

8. What is the acceptable survival of a repaired primary teeth restoration?

Up to one year	12 (16.4)
Less than three years	28 (38.4)
Three to five years	23 (31.5)
More than five years	10 (13.7)

9. Point out the factors that influence the indication of restoration repair in primary teeth.

Patient age	56 (100)
Early childhood patients	28 (46.7)
Patients with tooth nearest to physiological exfoliation	32 (53.3)
Length of stay of deciduous tooth in the arch	56 (100)

Beginning of the biological cycle	23 (46)
End of the biological cycle	27 (54)
Child behavior	48 (100)
Patients with difficult management	44 (86.3)
Collaborating patient	7 (13.7)

Clinical situations of composite restorations in primary teeth.	
10. Male patient, six-year old, presenting atypical restoration in the tooth #75.	
No intervention	16 (21.9)
Restoration polish	7 (9.6)
Restoration repair	41 (56.2)
Restoration replacement	9 (12.3)
11. Female patient, five-year old, with restorations in the teeth #54.	
No intervention	3 (4.1)
Restoration polish	2 (2.7)
Restoration repair	51 (69.9)
Restoration replacement	17 (23.3)
12. Female patient, five-year old, with restorations in the teeth #55.	
No intervention	2 (2.7)
Restoration polish	1 (1.4)
Restoration repair	57 (78.1)
Restoration replacement	13 (17.8)
13. Female patient, seven-year old, presenting occluso-proximal restoration in the teeth #54.	
No intervention	2 (2.7)
Restoration polish	0 (0)
Restoration repair	5 (6.8)
Restoration replacement	66 (90.4)
14. Female patient, seven-year old, presenting occluso-proximal restoration in the teeth #55.	

No intervention	42 (57.5)
Restoration polish	18 (24.7)
Restoration repair	4 (5.5)
Restoration replacement	9 (12.3)

15. Male patient, six-year old, with composite restoration in teeth #61.

No intervention	51 (69.9)
Restoration polish	20 (27.4)
Restoration repair	2 (2.7)
Restoration replacement	0 (0)

16. Male patient, six-year old, with composite restoration in teeth #62.

No intervention	19 (26)
Restoration polish	19 (26)
Restoration repair	32 (43.8)
Restoration replacement	3 (4.1)

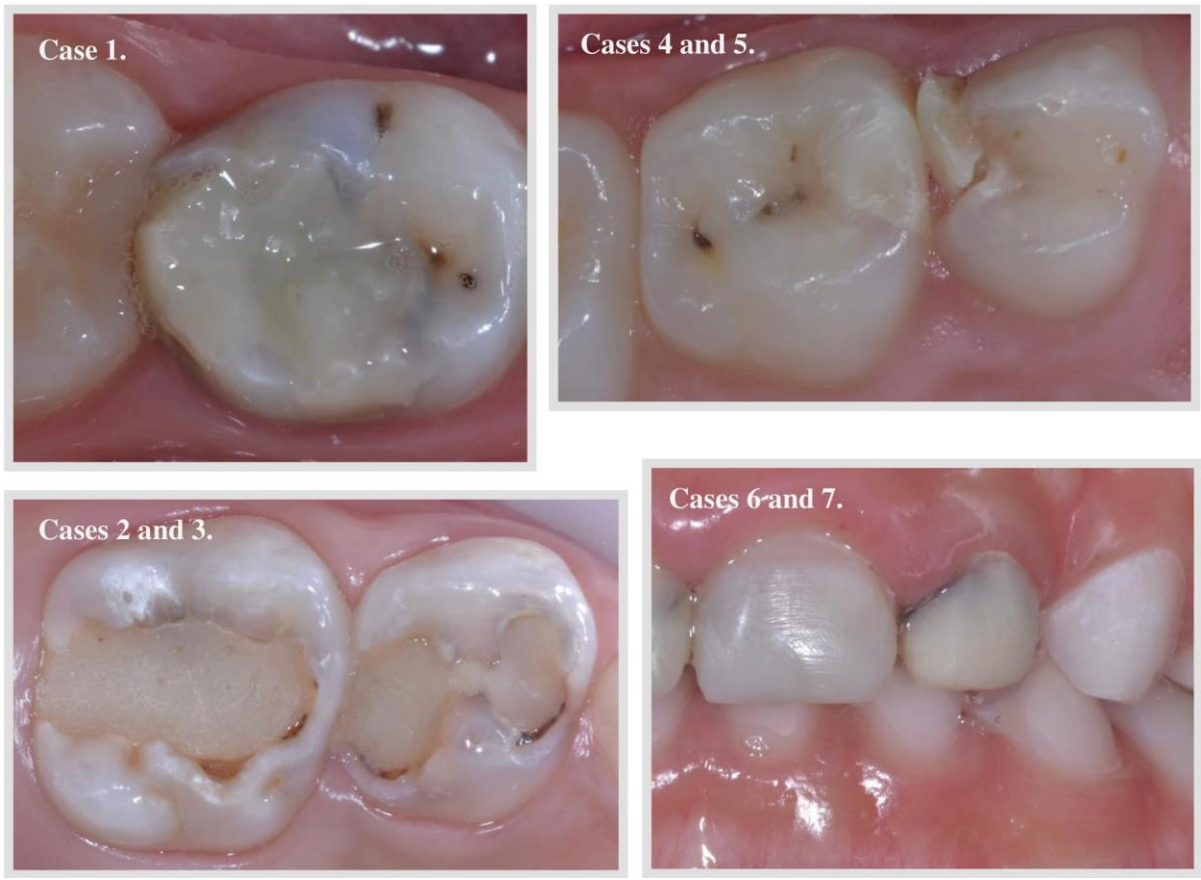

Figure 1. Clinical situations of resin composite restorations in primary teeth. Case 1. Male patient, six-year old, presenting atypical restoration in the tooth 75. Cases 2 and 3. Female patient, five-year old, with restorations in the teeth 54 and 55. Cases 4 and 5. Female patient, seven-year old, presenting occluso-proximal restoration in the teeth 54 and 55. Cases 6 and 7. Male patient, six-year old, with composite restoration in teeth 61 and 62.

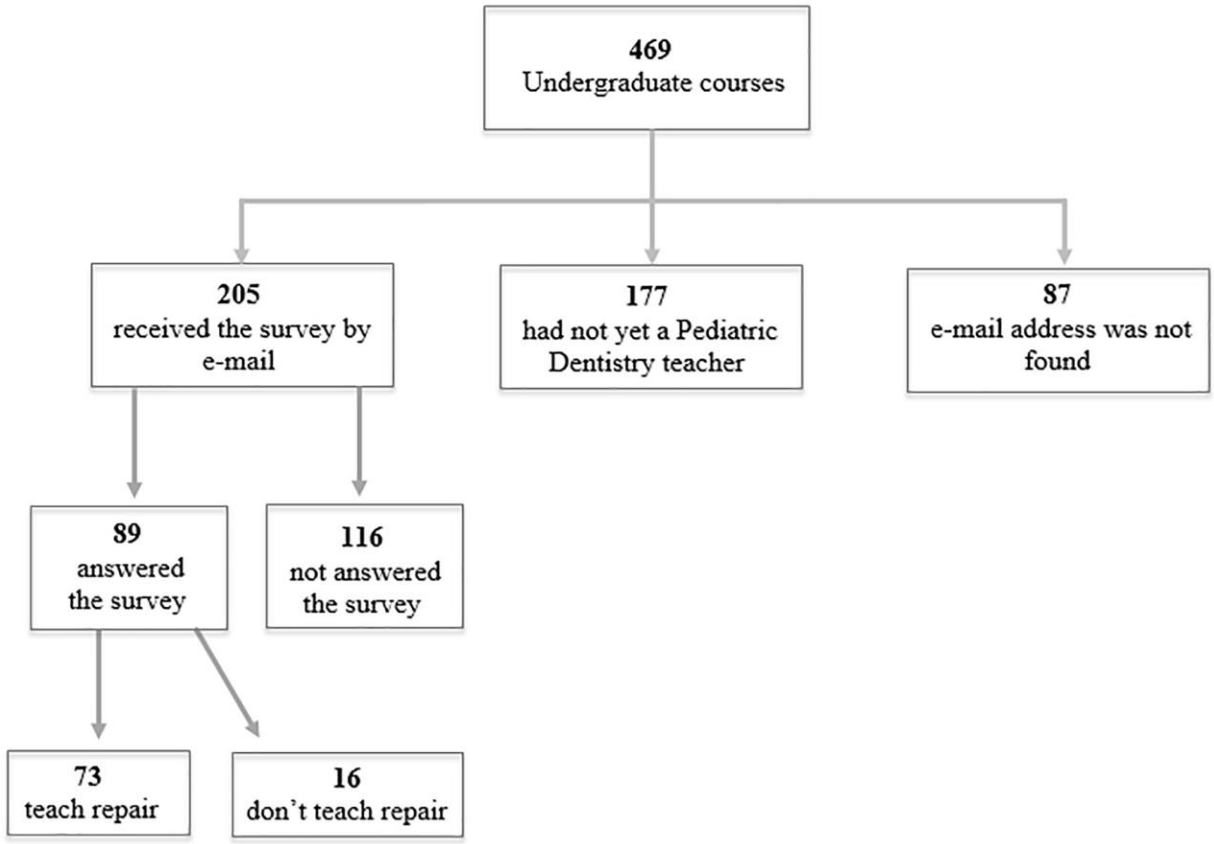

Figure 2. Flow-chart of questionnaire application in Brazilian undergraduate courses.

3 ARTIGO – Silane coupling agents are beneficial for resin composite repair: A systematic review and meta-analysis of *in vitro* studies

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Silane coupling agents are beneficial for resin composite repair: A systematic review and meta-analysis of *in vitro* studies

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Abstract

Purpose: This study aimed to systematically review the literature to determine if silane combined with adhesive application improve the repair bond strength of direct methacrylate-based resin composites in comparison to use of adhesive alone. **Materials and Methods:** Literature searching was carried out until September 2019 through PubMed/MEDLINE, Scopus and Lilacs databases with no publication year or language limits. Two reviewers independently selected the studies, extracted data and assessed the risk of bias. Meta-analyses were conducted using random effects model to calculate pooled mean differences between adhesive *versus* silane *plus* adhesive surface treatments (global meta-analysis), and considering subgroup analyses (immediate and degradation repair bond strength values, type of silane – hydrolyzed or nonhydrolyzed, and type of bond strength test). Statistical analyses were performed using RevMan5.3 at a significance level of 5%. **Results:** From 676 potentially eligible studies, 81 were selected for full-text analysis, and 17 were included in the systematic review. Global meta-analysis showed that the use of silane prior to adhesive application produced higher repair bond strength values (p=0.003). A higher mean difference (effect size: 7.30 95% IC -2.91-17.51) between groups was found when nonhydrolyzed silanes were used. . The type of bond strength test also showed a significant difference between groups, favoring the silane *plus* adhesive, only for studies that used the microshear bond strength test (p=0.02). The heterogeneity was high. Studies scored between medium and high risk of bias. **Conclusion:** An additional silane application step increases the repair bond strength of methacrylate-based resin composites.

Keywords: methacrylate functional silane; bond strength; repair; resin-based composites

Introduction

Dental restorations are usually placed due to caries or fracture[34] and resin composite is often the material of choice for restoring anterior and posterior teeth. In case of resin composite restoration failure, clinicians can decide for restoration replacement or repair. Repair is a minimally invasive treatment that involves removal of the defective part of the restoration, followed by restoration of the prepared defect[21]. Although repair was traditionally often considered as 'bad dentistry'[20], nowadays it is considered as state-of-art as it limits the size of the restorative intervention, reducing the risk for pulp complications and treatment costs[19,20].

Although it has been shown that repair may increase survival of posterior restorations[9,36], there is no gold standard protocol for treating the aged resin composite surfaces before repair. Physical treatments such as grinding with burs or air abrasion have the ultimate goal to improve mechanical attachment between aged and new (repair) resin composite, whereas chemical agents such as silane or adhesive agents are applied to improve chemical coupling between resin-based materials at the adhesive interface[41].

A previous systematic review[41] assessed the influence of physical and/or chemical surface treatments on the repair bond strength of methacrylate-based resin composites. It was shown that silane coupling agents seem to play a minor role in improving repair potential compared to adhesive agents. However, both chemical treatments were compared with physical treatment involving grinding of resin composite surfaces with burs or abrasive papers, i.e., there was no comparison of repair bond strengths between silane combined with adhesive in comparison with the use of an adhesive alone.

It has been shown that clinicians prefer to follow the same procedure for both placing and repairing a restoration[41]. The use of burs, followed by acid etching and application of a bonding agent, appeared to be used by over 80% of clinicians as a pretreatment for the old

resin composite for repair[41]. Pooled *in vitro* data might help elucidating whether silane treating the resin composites surfaces before repair is indispensable. Furthermore, several factors may play a role related to the application of silane coupling agents such as type of silane (hydrolyzed or nonhydrolyzed), and the service life of defective composite restoration to be repaired.

Therefore, this systematic review and meta-analysis aimed to evaluate the effect of the use of silane prior to adhesive application on repair bond strength of direct methacrylate-based resin composites in comparison to the use of adhesive alone.

Materials and Methods

This study was carried out according to the Cochrane Handbook[22] and reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[26]. The following research question was formulated to address the literature and outline the search strategy: Does silane *plus* adhesive application improve the repair bond strength of direct methacrylate-based resin composites in comparison to the use of adhesive alone?

Search Strategy

A comprehensive literature search was undertaken through PubMed/MEDLINE, Scopus and Lilacs databases. The last search was carried out in September 2019 to identify studies that could be considered. The subject search used a combination of controlled vocabulary and text words based on the search strategy for the PubMed/MEDLINE database as follow:

((((((Composite Resins[MeSH Terms]) OR Composite Resin*) OR Resin* Composite) OR Composite*) AND Silane)) AND ((((((((((((Repair bond strength) OR Bond strength) OR Tensile strength[MeSH Terms]) OR Tensile strength) OR Shear strength[MeSH Terms]) OR

Shear strength) OR Tensile) OR Shear) OR Microtensile) OR Microtensile bond strength) OR Microshear) OR Microshear bond strength) OR Repair*)

A sensitive search strategy was adapted for the Scopus and Lilacs databases. The results of searching the various databases were cross-checked to locate and eliminate duplicates. No publication year or language limits were considered.

Selection, Inclusion and Exclusion Criteria

The titles and abstracts of all identified studies were carefully assessed by two independent reviewers (T.L.L. and L.T.M.), and selected based on the inclusion criterion: *in vitro* studies that assessed the influence of the silane application on the repair bond strength of resin composites. If consensus was not reached, the abstract was set aside for further evaluation. The references of all selected studies were manually searched for further relevant studies that could fulfill the inclusion criteria.

The full texts of all studies that full-filled the inclusion criteria for eligible papers were then reviewed independently by the same reviewers considering the following exclusion criteria: (1) did not compare silane *plus* adhesive application with adhesive alone; (2) did not evaluate the repair bond strength of direct methacrylate-based resin composite; (3) did not use the same adhesive system in both experimental groups; (4) use of unusual bond strength test (e.g. flexural strength); (5) did not store the dental resin composite for more than 24h before repair or subject to mechanical loading or/and thermocycling for age the resin composite; and (6) did not provide mean bond strength data, in megapascals (MPa) and respective standard deviation. For studies that did not report the precise bond strength values and that showed the results in graphs or figures, corresponding authors were contacted 3 times by e-mail, with 2 weeks interval, if any information was missing. If no information was provided, the study was excluded from the systematic review.

Additionally, the resin composite surface could have been left untreated or ground with dental burs, SiC abrasive papers, or similar abrasives. Studies that used other types of surface treatment such as use of hydrofluoric acid and air abrasion were excluded. Grinding was considered because intraorally the resin composite surfaces are commonly prepared with burs before repair. Abrasive papers were considered acceptable grinding treatment since their granulometry resembles the granulometry of diamond burs[41]. Any disagreements in the eligibility criteria were solved by discussion and consensus by a third reviewer (L.C.). The eligibility of studies between the authors showed excellent agreement, with a kappa score of 0.91.

Data Extraction

The data extraction was performed by means a standardized sheet in Microsoft Office Excel (Microsoft Corporation, Redmond, WA, USA). For each paper, the following data were systematically extracted: publication details (title, authors, country and year), study methodology (sample size, aging protocol of dental composite, silane, adhesive system and resin composite evaluated, bond strength test, time of storage before test) and outcome information (mean bond strength (MPa) and standard deviation).

Risk of Bias Assessment

Two authors (T.L.L. and L.T.M.) independently evaluated the risk of bias of each included study considering a score described in previous systematic reviews of *in vitro* studies[38,41]. The following parameters were considered: randomization of specimens, materials used according to manufacturers' instructions, description of sample size calculation, blinding of the operator of the testing machine and use of storage method able to age the composite before repair. If the authors reported the parameter, the paper received a "yes" for that specific parameter; if it was not possible to find the information, the paper

received a “no”. Papers that reported 1 or 2 items were classified as having a high risk of bias, 3 or 4 as medium risk, and 5 as low risk. Disagreements between the reviewers regarding the classification of risk of bias were resolved by consensus.

Data Analyses

For the meta-analyses, the pooled effect estimates were obtained by comparing bond strength means from silane *plus* adhesive *versus* adhesive groups, as well as considering the subgroups, according to the time storage before testing – immediate or degradation repair bond strength, type of silane – hydrolyzed or nonhydrolyzed, and type of bond strength test. For studies that evaluated several adhesive systems or resin composites, the values were extracted and one mean was calculated by a formula according to the Cochrane Statistical Guidelines[22], to obtain a single sample size, mean and standard deviation values for both groups. In the selected studies, only the data of interest were extracted to be analyzed in the meta-analyses.

When storage time of the specimens before testing was until 30 days we considered the bond strength values as immediate repair bond strength, while degradation repair bond strength was considered when specimens were submitted to thermocycling or stored in water for at least 6 months. The statistical differences between-groups were performed in Review Manager (RevMan version 5.3 software, Cochrane Collaboration, Copenhagen, Denmark, 2014) using a random effect method. Statistical significance was defined as a P-value ≤ 0.05 (Z test). The amount of specimens was considered as the amount of experimental units. Statistical heterogeneity among studies was assessed *via* the Cochran Q test, with a threshold p value of 0.1, and inconsistency (I^2).

Results

Search and Selection

Figure 1 depicts a flowchart summarizing the selection process for studies according to the PRISMA statement[26]. The search strategy identified 676 potentially relevant records excluding duplicates. The first screening resulted in 81 studies remained for full-text reading. Finally, 17 papers were included in the systematic review and meta-analysis.

Descriptive Analysis

Table 1 shows descriptive extracted data from the included studies in the review. Papers were published between the years 1997 and 2019, with only one study[7] published before 2000. In this collection, 16 methacrylate-based resin composites were used, being Filtek Supreme Ultra (3M ESPE, St Paul, USA), Filtek Z250 (3M ESPE, St Paul, USA) and Clearfil AP-X (Kuraray, Osaka, Japan) the most frequent ones. Nine commercially available silanes were evaluated, being the most of them classified as hydrolyzed. Monobond S (Ivoclar Vivadent, Schaan, Liechtenstein) was the silane more frequently tested in the included studies.

Furthermore, 12 adhesive systems were evaluated, and the two-step self-etch system Clearfil SE Bond (Kuraray, Osaka, Japan) was the most tested. Two silane-containing universal adhesives were tested. Two studies[14,18] tested Scotchbond Universal Adhesive (3M ESPE, St. Paul, USA), and one study[3] evaluated the Clearfil SE One (Kuraray, Osaka, Japan).

The majority of the studies used static storage method in water for aging dental resin composites prior to repair procedures, while only four studies[13-15,23] combined water storage with thermocycling, and two studies[10,30] used only thermocycling method. Additionally, two studies[23,39] performed aging before bond strength test through thermocycling. Shear bond

strength was the most common used test (47.1%), followed by microshear (23.5%) and microtensile (17.6%).

Risk of Bias

From the 17 studies included in this review, 10 scored high [1,3,5,7,12,16,18,24,30,39] and 7 scored medium[2,4,10,13-15,23] risk of bias (Table 2). The item that most frequently received "No" in the analysis was description of sample size calculation, and only one study[2] reported the presence of a blinded operator to experimental condition during the bond strength test. Nine studies[1-3,5,7,12,16,18,24] did not use an appropriate storage method to age the composite before repair, and the randomization of specimens was not performed in 5 studies[1,3,12,16,39].

Meta-Analyses

The meta-analyses were performed considering the global analysis and considering subgroup analyses according to the storage time before testing (immediate and degradation repair bond strength), type of silane (hydrolyzed and nonhydrolyzed) and type of bond strength test.

The results of the global meta-analysis of repair bond strength are presented in Figure 2. There was no difference between groups, considering immediate and degradation repair bond strength (p=0.12 and p=0.06, respectively). High heterogeneity was observed for both subgroups. However, in the global analysis, there was a significant difference between groups, showing evidence that use of silane previously to adhesive application produced higher repair bond strength values (p=0.003). The heterogeneity was also found high (I^2 = 98%).

Use of nonhydrolyzed silanes combined with adhesive application promoted higher mean difference (effect size: 7.30 95% IC -2.91-17.51) in comparison with the use of adhesive alone (Figure 3). The heterogeneity was high (I^2=97%).

Subgroup analyses according to type of bond strength test (Figure 4) showed a significant difference between groups, favoring the silane *plus* adhesive, only for studies that used the microshear bond strength test (p=0.02). A high heterogeneity was observed (I^2=97%).

Discussion

This systematic review was designed to determine if the application of a silane coupling agent is a necessary clinical step for the repair protocol. One often alleges that laboratory bond-strength testing cannot predict clinical effectiveness of dental materials. Despite this, mechanical tests are valuable tools to report the effect of different adhesive protocols on the bond strength values. Global meta-analysis showed that use of silane prior to adhesive application resulted in higher repair bond strength of resin composites when compared to the use of adhesive alone (effect size: 5.06 95% IC 1.81-6.30).

Silanes are organofunctional molecules that promote the union between two materials. In dentistry, a bifunctional molecule called 3-methacryloxypropyl-trimethoxysilane (MPS) is frequently used. MPS silanes consist of, on one side, a methacrylate group that can react with the intermediate adhesive and resin composites, and, on the other side, a reactive silanol group that can form siloxane bonds with the alumina and/or silica present on the air-abraded or etched substrate surfaces[27]. In repair procedures, this molecule promotes the union of the inorganic phase of the substrate with the organic phase of the resin composite of the repair[8]. Furthermore, silanes have a higher surface wettability, facilitating the penetration of the adhesive into surface defects[6], and consequently, are beneficial in the increasing repair bond strength.

It has been evidenced that the application of physical *plus* chemical surface treatments of aged resin composite improves the repair bond strength[41]. Removing the superficial layer from an old resin composite and roughening with at least a diamond bur are necessary to

obtain micromechanical retention. Also, the chemical adhesion of silane with resin composite depends upon availability of silica at the surface (i.e. glass particles). Since grinding with burs or SiC abrasive papers was performed before repair in the most studies included, it was expected that the silica content at the aged resin composite was sufficient to promote chemical bonding of silane with resin composite.

The degradation of dental resin composites upon storage is also able to break filler-polymer bonds[17], allowing surface loss of glass particles. Nevertheless, it should be highlighted that the number of studies included in the analysis was relatively low, mainly those that evaluated degradation repair bond strength of resin composites. There is no aging protocol that is considered gold standard for mimicking the aging of dental resin composites that occurs in the oral environment. However, it seems that some studies used an aging protocols unlikely to be aged the resin composites properly, i.e., stored the resin composites in water for less than 6 mo[1-3,5,7,12,16,18,24]. Thus, these storage protocols defined as short in this review may have resulted in less or no effect of the silanes in the repair protocol. It may be attributed to the presence of many still available free radicals and monomers that resulted in a more or less 'incremental filling technique', instead of a real repair technique on better polymerized 'old' composite.

Failures prone to be repaired are expected to happen in the medium or long-term clinical service of restorations[11]. In this sense, the "immediate" repair bond strength results found in this review are likely less representative for the clinical situations. Also, in another study it has been shown that recently cured resin composites are more reactive than aged ones due the presence of free radicals and monomers available to improve the bonding to dental resin composite upon repair[35]. Future studies on the repair bond strength of resin composites should be performed on resin composite samples that have been subjected to prolonged degradation protocols to increase clinical relevance.

There were wide variety of materials tested in the included studies with predominance of a two-step self-etch system (Clearfil SE Bond, Kuraray) and a silane coupling agent (Monobond S (Ivoclar Vivadent, Schaan, Liechtenstein). Although the two-step self-etch adhesive system dispenses previous acid conditioning step, three studies[13,14,23] used phosphoric acid previously to application of Clearfil SE Bond in the applied repair protocol. Etching with phosphoric acid promotes the removal of grinding debris from resin composite surface[28], and might also enhance the reactivity between the silica or zirconia surface and silane coupling agent[28]. Moreover, this adhesive system relies on the presence of 10-MDP that also may improve the repair bond strength of resin composites. This functional monomer is also known for its ability to bond chemically to calcium of the dental structure and oxide groups (such as SiO_2, Al_2O_3, ZrO_2) of the resin composites to be repaired, making the adhesive interface more resistant to biodegradation[42].

Silane coupling agents are available in two types, either hydrolyzed or nonhydrolyzed. The hydrolyzed silanes are already activated. They are applied before the adhesive system, or alternatively, are included in universal adhesives such as Scotchbond Universal Adhesive (3M ESPE) and Clearfil One (Kuraray). The nonhydrolyzed silane has to be activated first with an acid, usually an acidic monomer such as MDP requiring either mixing of 2 components (Bisco) before the silane is applied or by mixing the silane into the self-etching primer (Clearfil SE Bond) or adhesive resin (Clearfil PhotoBond)[27].

Subgroup analysis according to the type of silane found a higher mean difference (effect size: 7.30 95% IC -2.91-17.51) between silane *plus* adhesive and adhesive groups when nonhydrolyzed silanes were used. Hydrolyzed silane solutions may have a relatively short shelf life and gradually become less reactive after opening of the bottle, preventing optimal adhesion[29]. Further studies are necessary to evaluate if the use of a silane-containing universal adhesive would eliminate the silane application for direct composite repair.

High heterogeneity was found in all statistical analyses carried out. Considering the methodological variability among studies, heterogeneity is unavoidable. All included studies had a medium or high risk of bias. This finding seems to be usual in systematic reviews of laboratorial studies[25,32,37]. Lack of information about sample size calculation, randomization and blinding of the operator of the test machine are the main reasons for this, and should be carefully considered in further *in vitro* studies. Another important issue, not included on bias risk assessment, is related to the experimental unit used for statistical purposes, especially when multiple measurements are done in the same tooth as in micro-tests. Although micro-tests are preferable nowadays[31], few included studies [1,3,4,13,14,18,23] performed microtensile or microshear tests.

Although the meta-analysis considering the type of bond strength test evidenced that there was a tendency of better results when using silane, a significant difference between groups was observed only for studies that used the microshear bond strength test ($p=0.02$). Though a great diversity in laboratory testing of adhesive materials exists, validity of these tests can be improved by application of standardized protocols in test methodology.

Finally, for the dental practitioner, the review results suggest that the use of a separate, preferably a nonhydrolized silane, would lead to better results when repairing dental composites intra-orally. However, clinical proof of this supposed beneficial effect has still to be delivered. Clinical studies on routine repair[9,33,36] only used routine bonding techniques (acid etching *plus* adhesive) for the repaired restoration surfaces which might be quite sufficient for low-risk repair sites like when an occluso-proximal cavity receives a new box due to secondary decay. Therefore, a clinical trial on routine repair protocols including variables as silane and adhesive types would be most essential to establish their clinical relevance.

Conclusion

Within the limitations of this systematic review and meta-analysis, even though high heterogeneity was detected, the results of this review suggest that the implementation of an additional silane application step (preferably non-hydrolyzed silane) could improve the repair bond strength of direct methacrylate-based resin composites.

Clinical Relevance: Clinicians are advised to apply silane as an additional step prior to adhesive application when repairing failed resin composite restorations.

References

1. Acharya G, Manjunath M. The effect of surface treatments and bonding regimens on microtensile bond strengths of repaired composite: An in vitro study. J Conserv Dent 2012; 15, 383-387.

2. Al-Asmar AA, Hatamleh KS, Hatamleh M, Al-Rabab'ah M. Evaluating various preparation protocols on the shear bond strength of repaired composite. J Contemp Dent Pract 2017;18: 182–187.

3. Alqarni D, Nakajima M, Hosaka K, Ide K, Nagano D, Wada T, Ikeda M, Mamanee T, Thanatvarakorn O, Prasansuttiporn T, Foxton R, Tagami J. The repair bond strength to resin matrix in cured resin composites after water aging. Dent Mater J 2018;38:233-340.

4. Andrade AP, Shimaoka AM, de Carvalho RCR. Composite resin repairs: what is the most effective protocol? Braz Dent Sci 2017;99-109.

5. Bonstein T, Garlapo D, Donarummo J, Bush PJ. Evaluation of varied repair protocols applied to aged composite resin. J Adhes Dent 2005;7:41–9.

6. Brendeke J, Ozcan M. Effect of physicochemical aging conditions on the composite-composite repair bond strength. J Adhes Dent 2007;9:399-406.

7. Brosh T, Pilo R, Bichacho N, Blutstein R. Effect of combinations of surface treatments and bonding agents on the bond strength of repaired composites. J Prosthet Dent 1997;77: 122–126.

8. Çakir N, Demirbuga S, Balkaya H, Karadaş M. Bonding performance of universal adhesives on composite repairs, with or without silane application. J Conserv Dent 2018; 21:263-268.

9. Casagrande L, Laske M, Bronkhorst EM, Huysmans MCDNJM, Opdam NJM. Repair may increase survival of direct posterior restorations – A practice based study. J Dent 2017;64: 30–36.

10. Cho S, Rajitrangson P, Matis B, Platt J. Effect of Er,Cr:YSGG Laser, Air Abrasion, and Silane Application on Repaired Shear Bond Strength of Composites. Oper Dent 2013;38: E58–E66.

11. Demarco FF, Corrêa MB, Cenci MS, Moraes RR, Opdam NJ. Longevity of posterior composite restorations: not only a matter of materials. Dent Mater 2012;28:87–101.

12. El-Askary FS, El-Banna AH, van Noort R. Immediate vs delayed repair bond strength of a nanohybrid resin composite. J Adhes Dent 2012;14:265–274.

13. Eliasson S, Tibballs J, Dahl J. Effect of Different Surface Treatments and Adhesives on Repair Bond Strength of Resin Composites After One and 12 Months of Storage Using an Improved Microtensile Test Method. Oper Dent 2014;39:E206–E216.

14. Eliasson ST, Dahl JE. Effect of curing and silanizing on composite repair bond strength using an improved micro-tensile test method. Acta Biomater Odontol Scand 2017:3,21–29.

15. Eren D, Doğan CA, Bektaş ÖÖ. Effect of Different Surface Treatments and Roughness on the Repair Bond Strength of Aged Nanohybrid Composite. Photobiomodul Photomed Laser Surg 2019;37:473–482.

16. Fawzy AS, El-Askary FS, Amer MA. Effect of surface treatments on the tensile bond

strength of repaired water-aged anterior restorative micro-fine hybrid resin composite. J Dent 2008;36:969–976.

17. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater 2006;22:211–222.

18. Fornazari I, Wille I, Meda E, Brum R, Souza E. Effect of Surface Treatment, Silane, and Universal Adhesive on Microshear Bond Strength of Nanofilled Composite Repairs. Oper Dent 2017;42:367–374.

19. Gordan VV, Riley J, Geraldeli S, Williams OD, Spoto JC, Gilbert GH, National Dental PBRN Collaborative Group. The decision to repair or replace a defective restoration is affected by who placed the original restoration: Findings from the National Dental PBRN. J Dent 2014;42:1528–1534.

20. Gordan VV, Riley JR, Rindal DB, Qvist V, Fellows JL, Dilbone DA, Brotman SG, Gilbert GH, National Dental PBRN Collaborative Group. A prospective cohort study by dentists in The National Dental Practice-Based Research Network. J Am Dent Assoc 2015;146:895–903.

21. Hickel R, Brüshaver K, Ilie N. Repair of restorations – Criteria for decision making and clinical recommendations. Dent Mater 2013;29:28–50.

22. Higgins JPT, G.S. (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.2. 2009 [updated September 2009].

23. Joulaei M, Bahari M, Ahmadi A, Savadi Oskoee S. Effect of Different Surface Treatments on Repair Micro-shear Bond Strength of Silica- and Zirconia-filled Composite Resins. J Dent Res Dent Clin Dent Prospects 2012;6:131–137.

24. Kashi TJ, Erfan M, Rakhshan V, Aghabaigi N, Tabatabaei F. An *In Vitro* Assessment of the Effects of Three Surface Treatments on Repair Bond Strength of Aged Composites. Oper Dent 2011;36:608–617.

25. Lenzi TL, Gimenez T, Tedesco TK, Mendes FM, Rocha RO, Raggio DP. Adhesive systems for restoring primary teeth: a systematic review and meta-analysis of in vitro studies. Int J Paediatr Dent 2016;26:364–375.

26. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med 2009:6, e1000100.

27. Loomans B, Özcan M. Intraoral Repair of Direct and Indirect Restorations: Procedures and Guidelines. Oper Dent 2016;41:S68–S78.

28. Loomans BAC, Vivan Cardoso M, Roeters FJM, Opdam NJM, De Munck J, Huysmans MCDNJM, Van Meerbeek B. Is there one optimal repair technique for all composites? Dent Mater 2011;27:701–709.

29. Matinlinna JP, Lung CYK, Tsoi JKH. Silane adhesion mechanism in dental applications and surface treatments: A review. Dent Mater 2018;34:13–28.

30. Melo MA, Moysés MR, Santos SG, Alcântara CE, Ribeiro JC. Effects of different surface treatments and accelerated artificial aging on the bond strength of composite resin repairs. Braz Oral Res 2011;25:485–491.

31. Mine A, Van Ende A, Van Meerbeek B, Cardoso MV, Van Landuyt KL, Peumans M, Poitevin A, De Munck J. Meta-analytical Review of Parameters Involved in Dentin Bonding. J Dent Res 2011;91:351–357.

32. Montagner AF, Sarkis-Onofre R, Pereira-Cenci T, Cenci MS. MMP Inhibitors on Dentin Stability. J Dent Res 2014;93:733–743.

33. Opdam NJM, Bronkhorst EM, Loomans BAC, Huysmans MCDNJM. Longevity of repaired restorations: A practice based study. J Dent 2012;40:829–835.

34. Opdam NJM, van de Sande FH, Bronkhorst E, Cenci MS, Bottenberg P, Pallesen U,

Gaengler P, Lindberg A, Huysmans MCDNJM, van Dijken JW. Longevity of posterior composite restorations: a systematic review and meta-analysis. J Dent Res 2014;93:943–949.

35. Pospíšil J, Horák Z, Kruliš Z, Nešpůrek S, Kuroda S. Degradation and aging of polymer blends I. Thermomechanical and thermal degradation. Polym Degrad Stab 1999;65:405–414.

36. Ruiz LF, Nicoloso GF, Franzon R, Lenzi TL, de Araujo FB, Casagrande L. Repair increases the survival of failed primary teeth restorations in high–caries risk children: a university-based retrospective study. Clin Oral Investig. 2019.

37. Sarkis-Onofre R, Skupien JA, Cenci MS, Moraes RR, Pereira-Cenci T. The role of resin cement on bond strength of glass-fiber posts luted into root canals: a systematic review and meta-analysis of in vitro studies. Oper Dent 2014:39:E31-44.

38. Soares FZM, Follak A, da Rosa LS, Montagner AF, Lenzi TL, Rocha RO. Bovine tooth is a substitute for human tooth on bond strength studies: A systematic review and meta-analysis of in vitro studies. Dent Mater 2016;32:1385-1393.

39. Staxrud F, Dahl JE. Silanising agents promote resin-composite repair. Int Dent J 2015; 65:311–315.

40. Staxrud F, Tveit AB, Rukke HV, Kopperud SE. Repair of defective composite restorations. A questionnaire study among dentists in the Public Dental Service in Norway. J Dent 2016;52:50–54.

41. Valente LL, Sarkis-Onofre R, Gonçalves AP, Fernández E, Loomans B, Moraes RR. Repair bond strength of dental composites: systematic review and meta-analysis. Int J Adhes Adhes 2016;69:15–26.

42. Yoshida Y, Yoshihara K, Nagaoka N, Hayakawa S, Torii Y, Ogawa T, Osaka A, Van Meerbeek B. Self-assembled Nano-layering at the Adhesive interface. J Dent Res 2012;91: 376–81.

Table 1. Descriptive data from included studies in systematic review.

Author, Year, Country	Composite Resin	Aging method before repair	Silane	Type of Silane	Adhesive System	MDP in Adhesive	Type of Adhesive	Bond Strength Test	N	Time and aging method before test
Eren; Dogna; Bektas., 2019[15] Turkey	Filtek Z550 (3M ESPE)	Water at 37°C 24h Thermocycled 5-55°C - 5000 cycles	Bis-Silane (Bisco)	2 components nonhydrolyzed	Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch	Shear	8	Water at 37°C 24h
Alqarni et al., 2018[3] Japan	Filtek Supreme Ultra (3M ESPE)	Water at 37°C 1 week and 1 month	Clearfil Porcelain Bond Activator (Kuraray)	1 component nonhydrolyzed	Clearfil One (Kuraray)	Yes	One-step self-etch (Universal)	Microshear	2	Water at 37°C 24h
	Estelite Sigma Quick (Tokuyama Dental) Beautifil II (Shofu) Clearfil AP-X (Kuraray)									
Al-Asmar et al., 2017[2] Jordan	Filtek Z350 XT (3M ESPE)	Water at 37°C 6 weeks	RelyX Ceramic Primer (3M ESPE)	1 component hydrolyzed	Adper Single Bond Plus (3M ESPE)	No	One-step Etch-and-rinse	Shear	22	Water at 37°C 2 weeks
Andrade; Shimaoka; Carvalho., 2017[4] Brazil	Filtek Z250 (3M ESPE)	Water at 37°C 6 months	Monobond S (Ivoclar Vivadent)	1 component hydrolyzed	Adper Single Bond Plus (3M ESPE)	No	One-step Etch-and-rinse	Microshear	10	Water at 37°C 24h
					Clearfil tri-S Bond (Kuraray)	Yes	One-step self-etch			
					Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch			

Eliasson e Dahl, 2017[14] Iceland	Filtek Supreme Ultra (3M ESPE)	Water at 37°C 2 weeks Thermocycling 5-55°C - 5000 cycles	Silane Porcelain Primer (Bisco)	2 components nonhydrolyzed	Adper Scotchbond Multi-Purpose (3M ESPE)	No	Two-step Etch-and-rinse	Microtensile	16	Water for 6 months + Thermocycled 5000 times
					Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch			
					One-step Plus (Bisco)	No	One-step Etch-and-rinse			
					Scotchbond Universal Adhesive (3M ESPE)	Yes	One-step self-etch Universal			
Fornazari et al., 2017[18] Brazil	Filtek Supreme Ultra (3M ESPE)	Water at 37°C 14 days	RelyX Ceramic Primer (3M ESPE)	1 component hydrolyzed	Heliobond (Ivoclar Vivadent)	No	One-step Etch-and-rinse	Microshear	12	Water at 37°C 48h
			Monobond Plus (Ivoclar Vivadent)	1 component hydrolyzed	Scotchbond Universal Adhesive (3M ESPE)	Yes	One-step self-etch (Universal)			
Staxrud and Dahl, 2015[39] Norway	Filtek Supreme Ultra (3M ESPE)	Water at room temperature for one year	Bis-Silane (Bisco)	2 components nonhydrolyzed	Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch	Shear	10	Thermocycled (5000 cycles/5–55 °C)
		Water for 60 days							22	
Eliasson et al., 2014[13] Iceland	Tetric Evo Ceram (Ivoclar Vivadent)	Water 2 weeks Thermocycling 5-55°C - 5000 cycles	Bis-Silane (Bisco)	2 components nonhydrolyzed	AdheSE One (Ivoclar Vivadent)	No	Two-step self-etch	Microtensile	4	Water + Thermocycling (5000 times) for one month and 12 months
					Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch			
					Adper Scotchbond Multi-Purpose (3M ESPE)	No	Two-step Etch-and-			

							rinse			
Cho et al., 2013[10] USA	Point 4 (Kerr)	Thermocycling 6-51°C - 5000 times	Silane (Ultradent)	1 component hydrolyzed	OptiBond Solo Plus (Kerr)	No	One-step Etch-and-rinse	Shear	10	Water at 37°C 24h
Acharya and Manjunath, 2012[1] India	Esthet X HD (Dentsply)	Water at 37°C 14 days	RelyX Ceramic Primer (3M ESPE)	1 component hydrolyzed	Adper Single Bond Plus (3M ESPE)	No	One-step Etch-and-rinse	Microtensile	5	24h
El-Askary et al., 2012[12] Egypt	Grandio Caps Shade (Voco)	Water at room temperature 1 month	Monobond S (Ivoclar Vivadent)	1 component hydrolyzed	Solobond Plus (Voco)	No	Two-step Etch-and-rinse	Tensile	10	Water at room temperature 24h and 1 month
Joulaei et al., 2012[23] Iran	TPH Spectrum (Dentsply)	Water at 37°C 24h Thermocycled 5-55°C - 5000 cycles	Silane (Ultradent)	1 component hydrolyzed	Margin Bond (Coltène)	No	One-step Etch-and-rinse	Microshear	3	Thermocycled 5-55°C for 1000 cycles
	Filtek Z250 (3M ESPE)				Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch			
					Adper Single Bond Plus (3M ESPE)	No	One-step Etch-and-rinse			
Melo et al., 2011[30] Brazil	Charisma (Heraeus Kulzer)	ASTM-G-53 machine - 4 h of exposure to UV-B at 60 °C and 4 h of condensation at 60 °C, 192 h.	Silane (Dentsply)	2 components nonhydrolyzed	Excite (Ivoclar Vivadent)	No	One-step Etch-and-rinse	Shear	16	Water at 37 ± 2 °C 24h
Kashi et al., 2011[24] Iran	Clearfil AP-X (Kuraray)	Water at 37 °C 3 weeks	Clearfil Porcelain Bond Activator (Kuraray)	1 component nonhydrolyzed	Clearfil SE Bond (Kuraray)	Yes	Two-step self-etch	Shear	15	Water at 37°C 1 week and 6 months
Fawzy et al., 2008[16] Egypt	Gradia anterior (GC Corporation)	Water at 37°C 30 days	Monobond S (Ivoclar	1 component hydrolyzed	Excite (Ivoclar Vivadent)	No	One-step	Tensile	8	Water at 37°C 24h

			Vivadent)				Etch-and-rinse			
Bonstein et al., 2005[5] Canada	Vit-L-escence (Ultradent)	Water at 37°C ± 2°C for 24h for 20 days.	Monobond S (Ivoclar Vivadent)	1 component hydrolyzed	Excite (Ivoclar Vivadent)	No	One-step Etch-and-rinse	Shear	20	10 min
Brosh et al., 1997[7] Israel	Pertac-hybrid (Espe)	Water at 37°C 14 days	Scotch Prime - Ceramic Primer (3M ESPE)	1 component hydrolyzed	Enamel Bond (Ultradent)			Shear	20	Water at 37°C + Thermocycled for 300 cycles at 5-55°C 14 days.

Table 2. Assessment of the risk of bias of included studies in the systematic review.

Study	Random	Materials	Sample size	Blinding	Aging method before repair	Bias risk
Acharya and Manjunath, 2012[1]	No	No	No	No	No	High
Al-Asmar et al., 2017[2]	Yes	Yes	No	Yes	No	Medium
Alqarni et al., 2018[3]	No	Yes	No	No	No	High
Andrade; Shimaoka; Carvalho, 2017[4]	Yes	Yes	No	No	Yes	Medium
Bonstein et al., 2005[5]	Yes	Yes	No	No	No	High
Brosh et al., 1997 [7]	Yes	Yes	No	No	No	High
Cho et al., 2013[10]	Yes	Yes	No	No	Yes	Medium
El-Askary et al., 2012[12]	No	Yes	No	No	No	High
Eliasson e Dahl, 2017[14]	Yes	Yes	No	No	Yes	Medium
Eliasson et al., 2014[13]	Yes	Yes	No	No	Yes	Medium
Eren; Dogna; Bektas, 2019[15]	Yes	Yes	No	No	Yes	Medium
Fawzy et al., 2008[16]	No	Yes	No	No	No	High
Fornazari et al., 2017[18]	Yes	Yes	No	No	No	High
Staxrud and Dahl, 2015[39]	No	Yes	No	No	Yes	High
Joulaei et al., 2012[23]	Yes	Yes	No	No	Yes	Medium
Kashi et al., 2011[24]	Yes	Yes	No	No	No	High
Melo et al., 2011[30]	Yes	No	No	No	Yes	High

Random: randomization of specimens; materials: materials used according to manufacturers' instructions; sample size: description of sample size calculation; blinding: blinding of the operator of the testing machine; aging method before repair: use of storage method able to age the composite before repair.

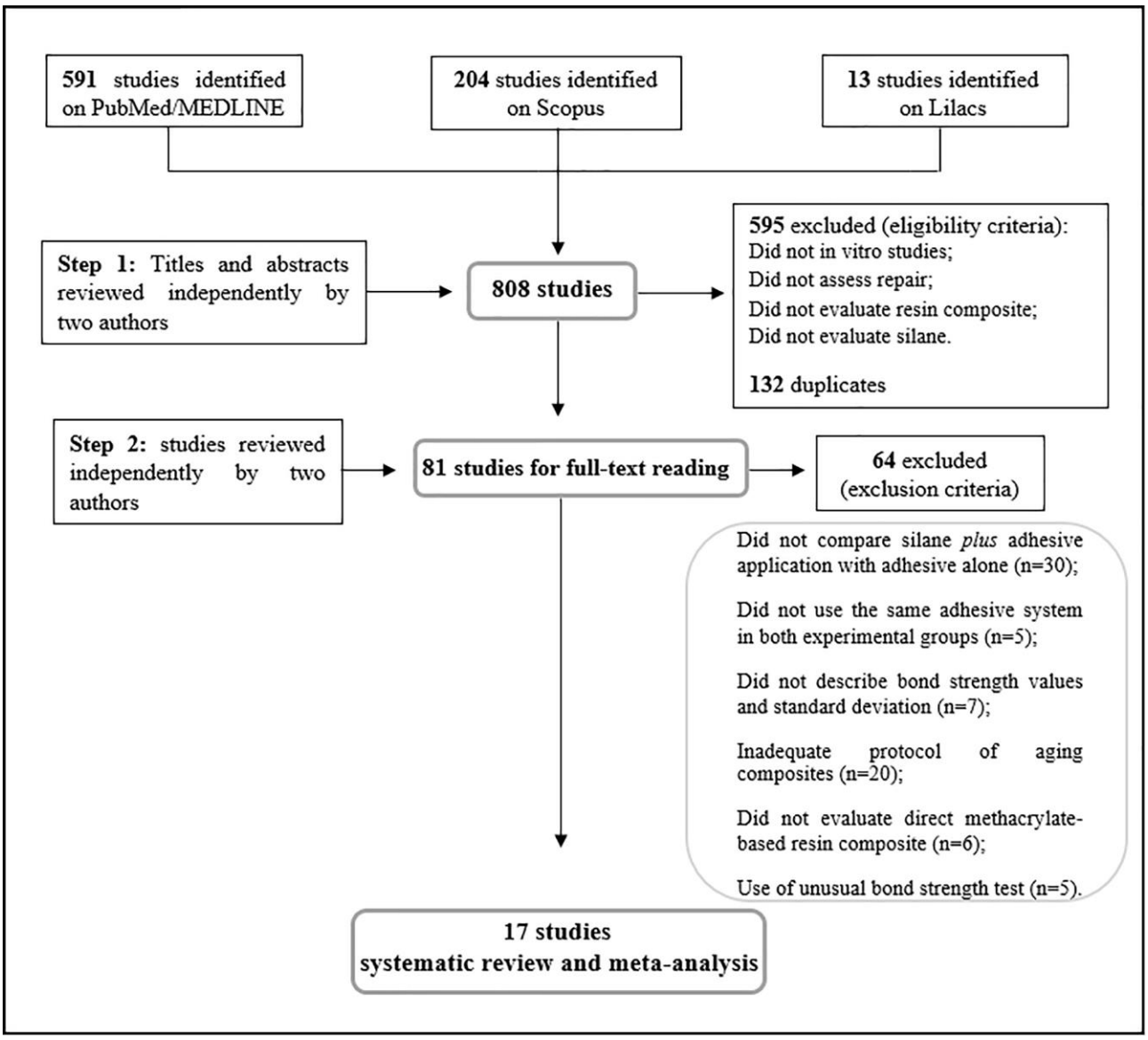

Figure 1. Flowchart diagram of study selection according to PRISMA statement.

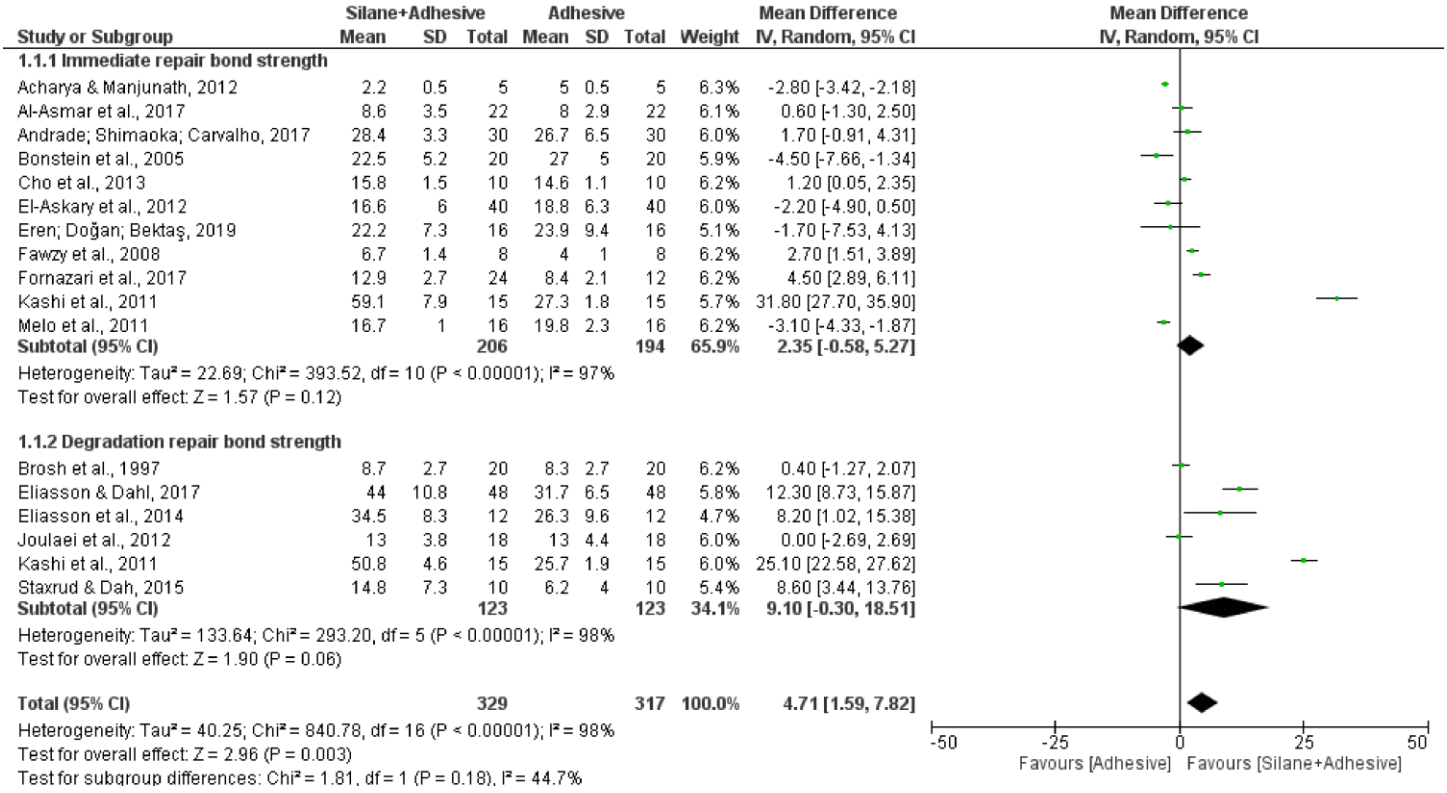

Figure 2. Summary findings of the meta-analyses comparing the repair bond strength of silane *plus* adhesive *versus* adhesive before repair.

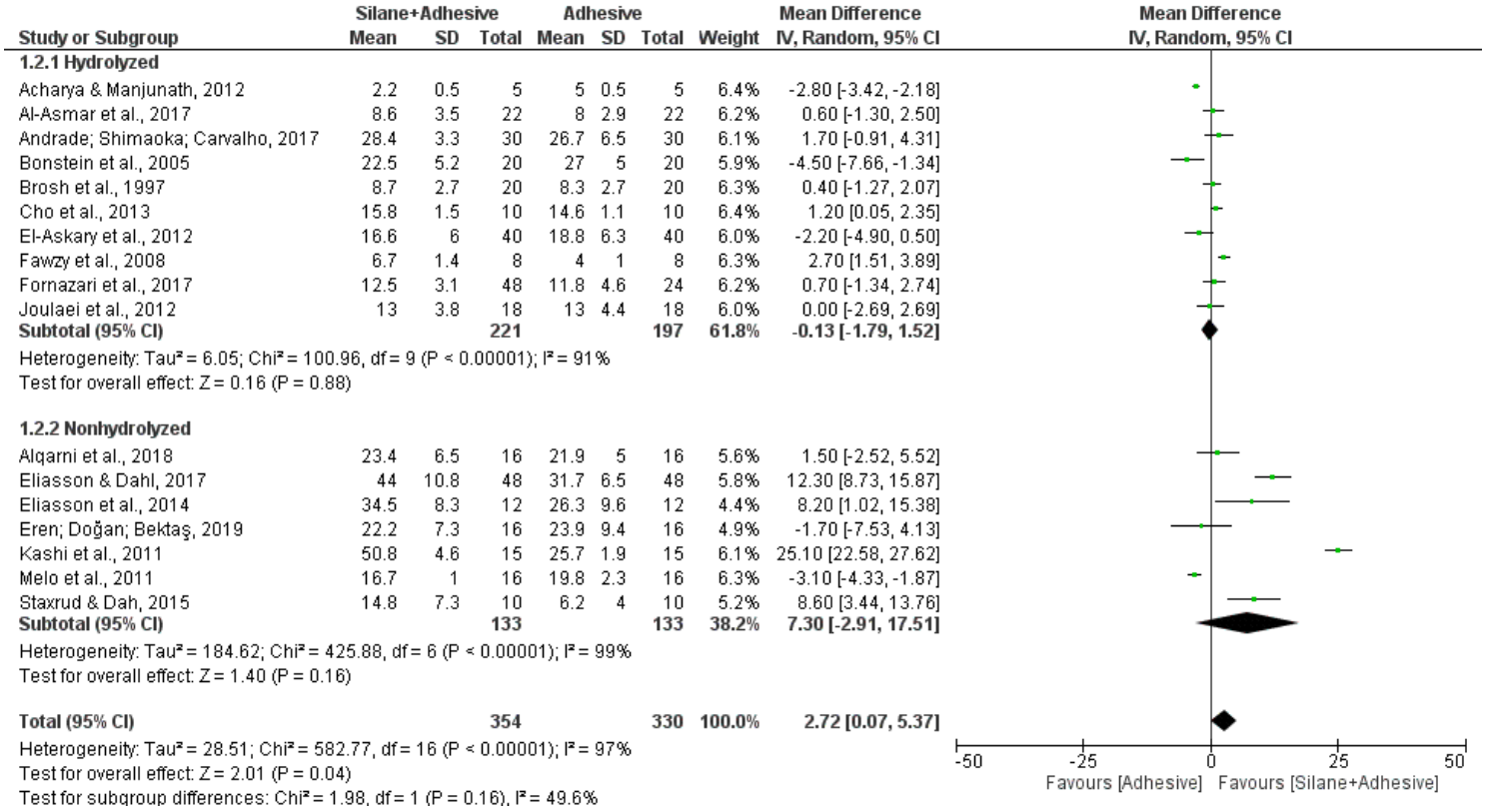

Figure 3. Subgroup analyses according to the type of silane.

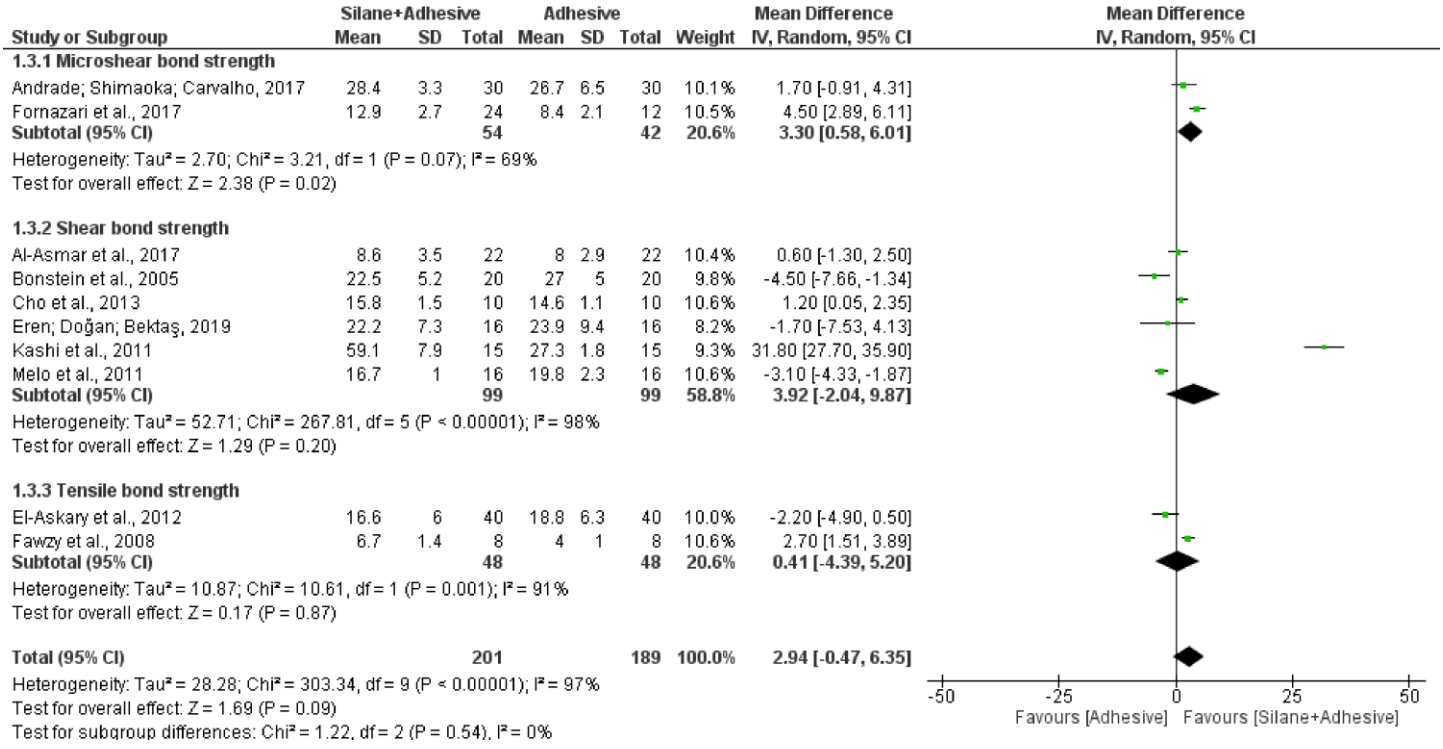

Figure 4. Subgroup analyses according to the type of bond strength test.

4 CONCLUSÃO

Com base nas investigações científicas apresentadas nessa dissertação, pode-se concluir que:

O ensino do reparo de restaurações de resina composta com falhas em dentes decíduos tem sido implementado no currículo dos cursos de Graduação em Odontologia do Brasil. Todavia, não há consenso entre os cursos especialmente acerca do protocolo clínico para reparo.

A aplicação prévia de silano (preferencialmente não hidrolisado) aumenta a resistência de união de reparo de restaurações de resina composta direta à base de metacrilato. Sendo assim, esse passo operatório deveria ser incorporado ao protocolo clínico de reparo.

REFERÊNCIAS

BLUM I. R.; LYNCH, C. D.; WILSON, N. H. F. Teaching of the repair of defective composite restorations in Scandinavian dental schools. **Journal of Oral Rehabilitation**, v. 39, n. 3, p. 210-216, 2012.

BRENDEKE, J.; OZCAN, M. Effect of physicochemical aging conditions on the composite-composite repair bond strength. **The Journal of Adhesive Dentistry**. v. 9, n. 4, p. 399-406, 2007.

CHISINI, L. *et al*. Restorations in primary teeth: a systematic review on survival and reasons for failures. **International Journal of Paediatric Dentistry**, v. 28, n. 2, p. 123–139, 2018.

DEMARCO, F. F. *et al*. Anterior composite restorations: A systematic review on long-term survival and reasons for failure. **Dental Materials**, v. 31, n. 10, p. 1214–24, 2015.

GORDAN, V.V. *et al*. Repair or replacement of restorations: a prospective cohort study by dentists in The National Dental PBRN. **Journal of the American Dental Association**, v. 146, n. 12, p. 895-903, 2016.

GORDAN, V. V. *et al*. The decision to repair or replace a defective restoration is affected by who placed the original restoration: Findings from the National Dental PBRN. **Journal of Dentistry**, v. 42, n. 12, p. 1528–1534, 2014.

HICKEL, R.; BRÜSHAVER, K.; ILIE, N. Repair of restorations – Criteria for decision making and clinical recommendations. **Dental Materials**, v. 29, n. 1, p. 28–50, 2013.

KANZOW, P. *et al*. Understanding the management and teaching of dental restoration repair: Systematic review and meta-analysis of surveys. **Journal of Dentistry**, v. 69, p. 1–21, 2018.

LYNCH, C. D. *et al.* Repair or replacement of defective direct resin-based composite restorations: contemporary teaching in U.S. and Canadian dental schools. **Journal of the American Dental Association**, v. 143, n. 2, p. 157-163, 2012.

LYNCH, C. D. *et al.* The management of defective resin composite restorations: current trends in dental school teaching in Japan. **Operative Dentistry**, v. 38, n. 5, p.497-504, 2013.

ÇAKIR, N. *et al*. Bonding performance of universal adhesives on composite repairs, with or without silane application. **Journal of Conservative Dentistry**, v. 21, n. 3, p. 263-268, 2018.

PEDROTTI, D. *et al.* Survival and associated risk factors of resin-based composite restorations in primary teeth: A clinical, retrospective, university-based study. **Pediatric Dentistry**, v. 39, n. 4, 2017.

RUIZ, L. *et al*. Repair increases the survival of failed primary teeth restorations in high–caries risk children: a university-based retrospective study. **Clinical Oral Investigations**, 2019.

VALENTE, L. L. *et al*. Repair bond strength of dental composites: systematic review and meta-analysis. **International Journal of Adhesion and Adhesives**, v. 69, p. 15–26, 2016.

ANEXO A – Aprovação do Comitê de Ética em Pesquisa

UFRGS - PRÓ-REITORIA DE PESQUISA DA UNIVERSIDADE FEDERAL DO RIO GRANDE DO

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Panorama do ensino de reparo de restaurações com falhas em dentes decíduos nos cursos de Graduação e Pós-Graduação em Odontologia do Brasil

Pesquisador: Tathiane Larissa Lenzi

Área Temática:

Versão: 3

CAAE: 96425018.0.0000.5347

Instituição Proponente: Faculdade de Odontologia

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.115.070

Apresentação do Projeto:

Trata-se de um projeto de pesquisa do PPG-Odontologia, área de concentração Clínicas Odontológicas/Odontopediatria.

Objetivo da Pesquisa:

Investigar o ensino do reparo de restaurações com falhas em dentes decíduos nos cursos de graduação e pós-graduação em Odontologia do Brasil.

Avaliação dos Riscos e Benefícios:

Atendendo a recomendação do CEP, os autores modificaram o TCLE, onde agora aparece o texto: "Você poderá sentir algum desconforto pelo tempo dedicado ao preenchimento do questionário ou por ter seus métodos de ensino avaliados." Essa alteração também foi incluída no cadastramento do projeto na PB, atendendo à solicitação do CEP. (SOLICITAÇÃO ATENDIDA)

Comentários e Considerações sobre a Pesquisa:

Este estudo transversal visa investigar o ensino de reparo de restaurações de resina composta com falhas em dentes decíduos nos cursos brasileiros de Graduação e Pós-Graduação em Odontopediatria, registrados no Conselho Regional de Odontologia (CRO) e credenciados pelo Ministério da

Endereço: Av. Paulo Gama, 110 - Sala 317 do Prédio Anexo 1 da Reitoria - Campus Centro
Bairro: Farroupilha **CEP:** 90.040-060
UF: RS **Município:** PORTO ALEGRE
Telefone: (51)3308-3738 **Fax:** (51)3308-4085 **E-mail:** etica@propesq.ufrgs.br

Educação (MEC). Para isso,
um questionário contendo dez perguntas de múltipla escolha e duas perguntas de texto livre será enviado por e-mail para os responsáveis pela Disciplina de Odontopediatria das 315 instituições credenciadas, sendo 245 cursos de Graduação e 70 cursos de Pós Graduação – Stricto e Lato Sensu. Os endereços de email serão obtidos através da coordenação dos cursos, da página dos mesmos ou ainda em artigos publicados envolvendo os docentes. As questões incluirão informações relacionadas ao ensino do reparo de restaurações de resina composta insatisfatórias, o método de ensino (teórico e/ou clínico), as razões para o ensino, indicações clínicas do reparo, percepções sobre a sobrevida de reparos com resina composta e técnicas indicadas para a realização de reparo. Uma carta de apresentação e o Termo de Consentimento Livre e Esclarecido serão enviados em anexo no e-mail. O questionário será enviado por até quatro vezes, com intervalos de quinze dias entre cada envio. Os dados obtidos nos questionários serão tabulados em uma tabela no programa Microsoft Office Excel e submetidos à análise estatística descritiva (frequências absolutas e relativas).

Considerações sobre os Termos de apresentação obrigatória:
Cálculo ou justificativa para o tamanho de amostra: a pedido do CEP, os pesquisadores esclareceram que a amostragem será do tipo censo. (SOLICITAÇÃO ATENDIDA)
Instrumento de coleta de dados: apresentado e em condições de aprovação.
Orçamento: apresentado e em condições de aprovação
Cronograma: apresentado e em condições de aprovação
TCLE: adequado.

Conclusões ou Pendências e Lista de Inadequações:
O parecer é favorável à aprovação do projeto.

Considerações Finais a critério do CEP:
Aprovado.

Continuação do Parecer: 3.115.070

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1204466.pdf	10/01/2019 19:46:43		Aceito
Projeto Detalhado / Brochura Investigador	PROJETO.docx	01/11/2018 16:22:48	Tathiane Larissa Lenzi	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE.docx	01/11/2018 16:22:37	Tathiane Larissa Lenzi	Aceito
Outros	Termo_compromisso.docx	21/08/2018 17:19:24	Tathiane Larissa Lenzi	Aceito
Folha de Rosto	Folha_rosto.pdf	21/08/2018 17:11:31	Tathiane Larissa Lenzi	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

PORTO ALEGRE, 17 de Janeiro de 2019

Assinado por:
MARIA DA GRAÇA CORSO DA MOTTA
(Coordenador(a))

ANEXO B – Normas do periódico Brazilian Oral Research

ISSN 1807-3107 *online version*

INSTRUCTIONS TO AUTHORS

Mission, scope, and submission policy

Brazilian Oral Research - BOR (online version ISSN 1807-3107) is the official publication of the *Sociedade Brasileira de Pesquisa Odontológica* - SBPqO (the Brazilian division of the International Association for Dental Research - IADR). The journal has an Impact Factor™ of 0.937 (Institute for Scientific Information - ISI), is peer-reviewed (double-blind system), and its mission is to disseminate and promote an information interchange concerning the several fields in dentistry research and/or related areas with gold open access.

BOR invites the submission of original and review manuscripts and papers in the following typology: Original Research (complete manuscript or Short Communication), Critical Review of Literature, Systematic Review (and Meta-Analysis) and Letters to the Editor. All submissions must be exclusive to.

Manuscripts and all corresponding documentation should be exclusively submitted through ScholarOne Manuscripts™ via the online submission link (http://mc04.manuscriptcentral.com/bor-scielo).

The evaluation process of manuscript's scientific content will only be initiated after meeting of all the requirements described in the present Instructions for Authors. Any manuscript that does not meet these requirements will be returned to the corresponding author for adaptations.

Important: Once having been accepted on their scientific merit, all manuscripts will be submitted for grammar and style revision as per the English language. Contact BOR by bor@sbpqo.org.br to get information about the recommended translation companies.The authors should forward the revised text with the enclosed revision certificate provided by the chosen editing company. **Linguistic revisions performed by companies that do not provide the mentioned certificate will not be accepted.** As an exception, this rule does not apply when one of the authors is a native English speaker.

Presentation of the manuscript

The manuscript text should be written in English and provided in a digital file compatible with "Microsoft Word" (in DOC, DOCX, or RTF

format).

All figures (including those in layouts/combinations) must be provided in individual and separate files, according to recommendations described under the specific topic.
Photographs, micrographs, and radiographs should be provided in TIFF format, according to the recommendations described under the specific topic.

Charts, drawings, layouts, and other vector illustrations must be provided in a PDF format individually in separate files, according to the recommendations described under the specific topic.

Video files may be submitted as per the specifications, including the author's anonymity (for purposes of evaluation) and respect for the patient's rights.

Important: ScholarOne™ allows upload of a set of files up to 10 MB. In case the video file exceeds this size, it is possible to leave information about the link to access the video. The use of patients' initials, names, and/or registry numbers is prohibited in the reproduction of clinical documentation. The identification of patients is prohibited. An informed consent statement, signed by the patient, concerning the use of his/her image should be provided by the author(s) when requested by **BOR**. The Copyright legislation in force must be respected and the source cited when the manuscript reproduces any previously published material (including texts, charts, tables, figures, or any other materials).

Title page (compulsory data)

- This must indicate the specialty* or research field focused on in the manuscript.

*Anatomy; Basic Implantodontology and Biomaterials; Behavioral Sciences; Biochemistry; Cariology; Community Dental Health; Craniofacial Biology; Dental Materials; Dentistry; Endodontic Therapy; Forensic Dentistry; Geriatric Dentistry; Imaginology; Immunology; Implantodontology – Prosthetics; Implantodontology – Surgical; Infection Control; Microbiology; Mouth and Jaw Surgery; Occlusion; Oral Pathology; Orthodontics; Orthopedics; Pediatric Dentistry; Periodontics; Pharmacology; Physiology; Prosthesis; Pulp Biology; Social/Community Dentistry; Stomatology; Temporomandibular Joint Dysfunction.

- Informative and concise title, limited to a maximum of 110 characters, including spaces.
- Names of all authors written out in full, including respective telephone numbers and email addresses for correspondence. We recommend that authors collate the names present in the Cover Letter with the profile created in ScholarOne™, to avoid discrepancies.
- The participation of each author must be justified on a separate page, which should meet the authorship and co-authorship criteria adopted by the International Committee of Medical Journal Editors, available at http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-

contributors.html
- Data of institutional/professional affiliation of all authors, including university (or other institution), college/program, department, city, state, and country, presented according to internal citation norms established by each author's institution. Verify that such affiliations are correctly entered in ScholarOne™.

Abstract: This should be presented as a single structured paragraph (but with no subdivisions into sections) containing the objective of the work, methodology, results, and conclusions. In the System if applicable, use the Special characters tool for special characters.

Keywords: Ranging from 3 (three) to 5 (five) main descriptors should be provided, chosen from the keywords registered at http://decs.bvs.br/ or http://www.nlm.nih.gov/mesh/MBrowser.html (no synonyms will be accepted).

Main Text

Introduction: This should present the relevance of the study, and its connection with other published works in the same line of research or field, identifying its limitations and possible biases. The objective of the study should be concisely presented at the end of this section.

Methodology: All the features of the material pertinent to the research subject should be provided (*e.g.*, tissue samples or research subjects). The experimental, analytical, and statistical methods should be described in a concise manner, although in detail, sufficient to allow others to recreate the work. Data from manufacturers or suppliers of products, equipment, or software must be explicit when first mentioned in this section, as follows: manufacturer's name, city, and country. The computer programs and statistical methods must also be specified. Unless the objective of the work is to compare products or specific systems, the trade names of techniques, as well as products, or scientific and clinical equipment should only be cited in the "Methodology" and "Acknowledgments" sections, according to each case. Generic names should be used in the remainder of the manuscript, including the title. Manuscripts containing radiographs, microradiographs, or SEM images, the following information must be included: radiation source, filters, and kV levels used. Manuscripts reporting studies on humans should include proof that the research was ethically conducted according to the Helsinki Declaration (*World Medical Association,* http://www.wma.net/en/30publications/10policies/b3/). The approval protocol number issued by an Institutional Ethics Committee must be cited. Observational studies should follow the STROBE guidelines (http://strobe-statement.org/), and the check list must be submitted. Clinical Trials must be reported according to the CONSORT Statement standard protocol (http://www.consort-statement.org/); systematic reviews and meta-analysis must follow the PRISMA (http://www.prisma-statement.org/), or Cochrane protocol (http://www.cochrane.org/).

Clinical Trials

Clinical Trials according to the CONSORT guidelines, available at www.consort-statement.org. The clinical trial registration number and the research registration name will be published along with the article.

Manuscripts reporting studies performed on animals must also include proof that the research was conducted in an ethical manner, and the approval protocol number issued by an Institutional Ethics Committee should be cited. In case the research contains a gene registration, before submission, the new gene sequences must be included in a public database, and the access number should be provided to BOR. The authors may use the following databases:

- GenBank: http://www.ncbi.nlm.nih.gov/Genbank/submit
- EMBL: http://www.ebi.ac.uk/embl/Submission/index.html
- DDBJ: http://www.ddbj.nig.ac.jp

Manuscript submissions including microarray data must include the information recommended by the MIAME guidelines (Minimum Information About a Microarray Experiment: http://www.mged.org/index.html) and/or itemize how the experimental details were submitted to a publicly available database, such as:

- ArrayExpress: http://www.ebi.ac.uk/arrayexpress/
- GEO: http://www.ncbi.nlm.nih.gov/geo/

Results: These should be presented in the same order as the experiment was performed, as described under the "Methodology" section. The most significant results should be described. Text, tables, and figures should not be repetitive. Statistically relevant results should be presented with enclosed corresponding p values.

Tables: These must be numbered and cited consecutively in the main text, in Arabic numerals. Tables must be submitted separately from the text in DOC, DOCX, or RTF format.

Discussion: This must discuss the study results in relation to the work hypothesis and relevant literature. It should describe the similarities and differences of the study in relation to similar studies found in literature, and provide explanations for the possible differences found. It must also identify the study's limitations and make suggestions for future research.

Conclusions: These must be presented in a concise manner and be strictly based on the results obtained in the research. Detailing of results, including numerical values, etc., must not be repeated.

Acknowledgments: Contributions by colleagues (technical assistance, critical comments, etc.) must be given, and any bond between authors and companies must be revealed. This section must describe the research funding source(s), including the corresponding process numbers.

Plagiarism

BOR employs a plagiarism detection system. When you send your manuscript to the journal it may be analyzed-not merely for the repetition of names/affiliations, but rather the sentences or texts used.

References: Only publications from peer-reviewed journals will be accepted as references. Unfinished manuscripts, dissertations, theses, or abstracts presented in congresses will not be accepted as references. References to books should be avoided.

Reference citations must be identified in the text with superscript Arabic numerals. The complete reference list must be presented after the "Acknowledgments" section, and the references must be numbered and presented in Vancouver Style in compliance with the guidelines provided by the International Committee of Medical Journal Editors, as presented in Uniform Requirements for Manuscripts Submitted to Biomedical Journals (http://www.ncbi.nlm.nih.gov/books/NBK7256/). The journal titles should be abbreviated according to the List of Journals Indexed in Index Medicus (http://www.ncbi.nlm.nih.gov/nlmcatalog/journals). The authors shall bear full responsibility for the accuracy of their references.

Spelling of scientific terms: When first mentioned in the main text, scientific names (binomials of microbiological, zoological, and botanical nomenclature) must be written out in full, as well as the names of chemical compounds and elements.

Units of measurement: These must be presented according to the International System of Units (http://www.bipm.org or http://www.inmetro.gov.br/consumidor/unidLegaisMed.asp).

Footnotes on the main text: These must be indicated by asterisks and restricted to the bare minimum.

Figures: Photographs, microradiographs, and radiographs must be at least 10 cm wide, have at least 500 dpi of resolution, and be provided in TIFF format. Charts, drawings, layouts, and other vector illustrations must be provided in a PDF format. All the figures must be submitted individually in separate files (not inserted into the text file). Figures must be numbered and consecutively cited in the main text in Arabic numerals. Figure legends should be inserted together at the end of the text, after the references.

Characteristics and layouts of types of manuscripts

Original Research

Limited to 30,000 characters including spaces (considering the introduction, methodology, results, discussion, conclusion, acknowledgments, tables, references, and figure legends). A maximum of 8 (eight) figures and 40 (forty) references will be accepted. The abstract can contain a maximum of 250 words.

Layout - Text Files

- Title Page
- Main text (30,000 characters including spaces)
- Abstract: a maximum of 250 words
- Keywords: 3 (three)-5 (five) main descriptors
- Introduction
- Methodology
- Results
- Discussion
- Conclusion
- Acknowledgments
- Tables

- References: maximum of 40 references
- Figure legends

Layout - Graphic Files

- Figures: a maximum of 8 (eight) figures, as described above.

Short Communication
Limited to 10,000 characters including spaces (considering the introduction, methodology, results, discussion, conclusion, acknowledgments, tables, references, and figure legends). A maximum of 2 (two) figures and 12 (twelve) references will be allowed. The abstract can contain a maximum of 100 words.

Layout - Text Files

- Title page
- Main text (10,000 characters including spaces)
- Abstract: a maximum of 100 words
- Descriptors: 3 (three)-5 (five) main descriptors
- Introduction
- Methodology
- Results
- Discussion
- Conclusion
- Acknowledgments
- Tables
- References: a maximum of 12 references
- Figure legends

Layout- Graphic Files

- Figures: a maximum of 2 (two) figures, as described above.

Critical Review of Literature
The submission of this type of manuscript will be performed only by invitation of the BOR Publishing Commission. All manuscripts will be submitted to peer-review. This type of manuscript must have a descriptive and discursive content, focusing on a comprehensive presentation and discussion of important and innovative scientific issues, with a limit of 30,000 characters including spaces (considering the introduction, methodology, results, discussion, conclusion, acknowledgments, tables, references, and figure legends). It must include a clear presentation of the scientific object, logical argumentation, a methodological and theoretical critical analysis of the studies, and a summarized conclusion. A maximum of 6 (six) figures and 50 (fifty) references is permitted. The abstract must contain a maximum of 250 words.

Layout- Text Files

- Title page
- Main text (30,000 characters including spaces)
- Abstract: a maximum of 250 words
- Keywords: 3 (three)-5 (five) main descriptors
- Introduction
- Methodology
- Results

- Discussion
- Conclusion
- Acknowledgments
- Tables
- References: maximum of 50 references
- Figure legends

Layout - Graphic Files

- Figures: a maximum of 6 (six) figures, as described above.

Systematic Review and Meta-Analysis
While summarizing the results of original studies, quantitative or qualitative, this type of manuscript should answer a specific question, with a limit of 30,000 characters, including spaces, and follow the Cochrane format and style (www.cochrane.org). The manuscript must report, in detail, the process of the search and retrieval of the original works, the selection criteria of the studies included in the review, and provide an abstract of the results obtained in the reviewed studies (with or without a meta-analysis approach). There is no limit to the number of references or figures. Tables and figures, if included, must present the features of the reviewed studies, the compared interventions, and the corresponding results, as well as those studies excluded from the review. Other tables and figures relevant to the review must be presented as previously described. The abstract can contain a maximum of 250 words.

Layout - Text Files

- Title page
- Main text (30,000 characters including spaces)
- Abstract: a maximum of 250 words
- Question formulation
- Location of the studies
- Critical Evaluation and Data Collection
- Data analysis and presentation
- Improvement
- Review update
- References: no limit on the number of references
- Tables

Layout - Graphic Files

- Figures: no limit on the number of figures

Letter to the Editor

Letters must include evidence to support an opinion of the author(s) about the scientific or editorial content of the BOR, and must be limited to 500 words. No figures or tables are permitted.

Copyright transfer agreement and responsibility statements

The manuscript submitted for publication must include the Copyright Transfer Agreement and the Responsibility Statements, available in the online system and mandatory.

CHECKLIST FOR INITIAL SUBMISSION

- Title Page file (in DOC, DOCX, or RTF format).
- Main text file (Main Document, manuscript), in DOC, DOCX, or RTF format.
- Tables, in DOC, DOCX, or RTF format.
- Declaration of interests and funding, submitted in a separate document and in a PDF format. (if applicable)
- Justification for participation of each author, provided in a separate document and in a PDF format.
- Photographs, microradiographs, and radiographs (10 cm minimum width, 500 dpi minimum resolution) in TIFF format. (http://www.ncbi.nlm.nih.gov/pmc/pub/filespec-images/)
- Charts, drawings, layouts, and other vector illustrations in a PDF format.
- Each figure should be submitted individually in separate files (not inserted in the text file).

Publication fees

Authors are not required to pay for the submission or review of articles.

EXAMPLES OF REFERENCES

Journals

Goracci C, Tavares AU, Fabianelli A, Monticelli F, Raffaelli O, Cardoso PC, et al. The adhesion between fiber posts and root canal walls: comparison between microtensile and push-out bond strength measurements. Eur J Oral Sci. 2004 Aug;112(4):353-61.

Bhutta ZA, Darmstadt GL, Hasan BS, Haws RA. Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence. Pediatrics. 2005;115(2 Suppl):519-617. doi:10.1542/peds.2004-1441.

Usunoff KG, Itzev DE, Rolfs A, Schmitt O, Wree A. Nitric oxide synthase-containing neurons in the amygdaloid nuclear complex of the rat. Anat Embryol (Berl). 2006 Oct 27. Epub ahead of print. doi: 10.1007/s00429-006-0134-9

Walsh B, Steiner A, Pickering RM, Ward-Basu J. Economic evaluation of nurse led intermediate care versus standard care for post-acute medical patients: cost minimisation analysis of data from a randomised controlled trial. BMJ. 2005 Mar 26;330(7493):699. Epub 2005 Mar 9.

Papers with Title and Text in Languages Other Than English
Li YJ, He X, Liu LN, Lan YY, Wang AM, Wang YL. [Studies on chemical constituents in herb of Polygonum orientale]. Zhongguo Ahong Yao Za Zhi. 2005 Mar;30(6):444-6. Chinese.

Supplements or Special Editions
Pucca Junior GA, Lucena EHG, Cawahisa PT. Financing national policy

on oral health in Brazil in the context of the Unified Health System. Braz Oral Res. 2010 Aug;24 Spec Iss 1:26-32.

Online Journals
Barata RB, Ribeiro MCSA, De Sordi M. Desigualdades sociais e homicídios na cidade de São Paulo, 1998. Rev Bras Epidemiol. 2008;11(1):3-13 [cited 2008 Feb 23]. Available from: http://www.scielosp.org/pdf/rbepid/v11n1/01.pdf.

Books
Stedman TL. Stedman's medical dictionary: a vocabulary of medicine and its allied sciences, with pronunciations and derivations. 20th ed. Baltimore: Williams & Wilkins; 1961. 259 p.

Books Online
Foley KM, Gelband H, editors. Improving palliative care for cancer [monograph on the Internet]. Washington: National Academy Press; 2001 [cited 2002 Jul 9]. Available from: http://www.nap.edu/books/0309074029/html/.

Websites
Cancer-Pain.org [homepage on the Internet]. New York: Association of Cancer Online Resources, Inc.; c2000 [cited 2002 Jul 9]. Available from: http://www.cancer-pain.org/.

Instituto Brasileiro de Geografia e Estatística [homepage]. Brasília (DF): Instituto Brasileiro de Geografia e Estatística; 2010 [cited 2010 Nov 27]. Available from: http://www.ibge.gov.br/home/default.php.

World Health Organization [homepage]. Geneva: World Health Organization; 2011 [cited 2011 Jan 17]. Available from: http://www.who.int/en/

ANEXO C – Normas do periódico The Journal of Adhesive Dentistry

The 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:

1. ***Clinical and basic science research reports*** – based on original research in adhesive dentistry and related topics.
2. ***Reviews topics*** – on topics related to adhesive dentistry
3. ***Short communications*** – of original research in ad-hesive dentistry and related topics. Max. 4 printed pages, including figures and references (max. characters 18,000). High priority will be given to the review of these papers to speed publication.

4a. ***Invited focus articles*** – presenting a position or hypothesis on a basic science or clinical subject of relevant related topics. These articles are not intended for the presentation of original results, and the authors of the articles are selected by the Editorial Board.

4b. ***Invited commentaries*** – critiquing a focus article by addressing the strong and weak points of the focus article. These are selected by the Editorial Board in consultation with the focus article author, and the focus article and the commentaries on it are published in sequence in the same issue of the Journal.

5. ***Invited guest editorials*** – may periodically be solicited by the Editorial Board.
6. ***Proceedings of symposia, workshops, or conferences*** – covering topics of relevance to adhesive dentistry and related topics.
7. ***Letters to the Editor*** – may be submitted to the editor-in-chief; these should normally be no more than 500 words in length.

SUBMISSION INSTRUCTIONS

Submission of manuscripts in order of preference:

Submission via online submission service (www.manuscriptmanager.com/jadd). Manuscript texts should be uploaded as PC-word files with tables and figures preferably embedded within the PC-word document. A broad range of file formats are acceptable. No paper version required but high resolution photographs or illustrations should be sent to the editorial office (see below). Online submissions are automatically uploaded into the editorial office's reviewer assignment schedule and are therefore processed immediately upon upload.

Mailing address:
Quintessenz Verlags-GmbH
The Journal of Adhesive Dentistry
Ifenpfad 2–4, D–12107 Berlin, Germany

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.

Review/editing of manuscripts. Manuscripts will be reviewed by the editor-in-chief and at least two reviewers with expertise within the scope of the article. The publisher reserves the right to edit accepted manuscripts to fit the space available and to ensure conciseness, clarity, and stylistic consistency, subject to the author's final approval.
Adherence to guidelines. Manuscripts that are not prepared in accordance with these guidelines will be returned to the author before review.

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.
- **Materials and Methods.** Present materials and methods in sufficient detail to allow confirmation of the observations. Published methods should be referenced and discussed only briefly, unless modifications have been made. Indicate the statistical methods used, if applicable.
- **Results.** Present results in a logical sequence in the text, tables, and illustrations. Do not repeat in the text all the data in the tables or illustrations; emphasize only important observations.
- **Discussion.** Emphasize the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other material given in the Introduction or Results section. Relate observations to other relevant studies and point out the implications of the findings and their limitations.
- **Acknowledgments.** Acknowledge persons who have made substantive contributions to the study. Specify grant or other financial support, citing the name of the supporting organization and grant number.
- **Abbreviations.** The full term for which an abbreviation stands should precede its first use in the text unless it is a standard unit of measurement.
- **Trade names.** Generic terms are to be used whenever possible, but trade names and manufacturer should be included parenthetically at first mention.
- **Clinical Relevance.** Please include a very brief (2 sentences or 3 lines) clinical relevance statement.

REFERENCES

- **All references must be cited** in the text, according to the alphabetical and numerical reference list.
- **The reference list** should appear at the end of the article, in alphabetical and numerical sequence.
- **Do not include unpublished data** or personal communications in the reference list. Cite such references parenthetically in the text and include a date.
- **Avoid using abstracts** as references.
- **Provide complete information** for each reference, including names of all authors. If the reference is part of a book, also include title of the chapter and names of the book's editor(s).

Journal reference style:

1. Turp JC, Kowalski CJ, Stohler CS. Treatment-seeking patters of facial pain patients: Many possibilities, limited satisfaction. J Orofacial Pain 1998;12:61–66.

Book reference style:

1. Hannam AG, Langenbach GEJ, Peck CC. Computer simulations of jaw biomechanics. In: McNeill C (ed). Science and Practice of Occlusion. Chicago: Quintessence, 1997:187–194.

ILLUSTRATIONS

- All illustrations must be numbered and cited in the text in order of appearance.
- Submitted figures should meet the following minimum requirements:
  – High-resolution images should have a width of 83 mm and 300 dpi (for column size).
  – Graphics (bar diagrams, schematic representations, drawings) wherever possible should be produced in Adobe Illustrator and saved as AI or EPS files.
  – All figures and graphics should be separate files – not embedded in Word or Power Point documents.

Upon article acceptance, high-resolution digital image files must be sent via one of the following ways:

1. As an e-mail attachment, if the files are not excessively large (not more than 10 MB), to our production department
2. Online File Exchange Tool: Please send your figures with our Online File Exchange Tool. This web tool allows you to upload large files (< 500 MB) to our server. Please archive your figures with a maximum size of 500 MB first. Then upload these archives with the following link: http://files.qvnet.de/JAD/, password: IAAD. Please name the archive with your name and article number so we can identify the figures.

Line drawings – Figures, charts, and graphs should be professionally drawn and lettered large enough to be read after reduction. Good-quality computer-generated laser prints are acceptable (no photocopies); also provide electronic files (eps, ai) if possible. Lines within graphs should be of a single weight unless special emphasis is needed.
Legends – Figure legends should be grouped on a separate sheet and typed double-spaced.

TABLES

- Each table should be logically organized, on a separate sheet, and numbered consecutively.
- The title and footnotes should be typed on the same sheet as the table.

MANDATORY SUBMISSION FORM

The Mandatory Submission Form, signed by all authors, must accompany all submitted manuscripts before they can be reviewed for publication. Electronic submission: scan the signed form and submit as JPG, TIF or PDF file.

PERMISSIONS & WAIVERS

- Permission of author and publisher must be obtained for the direct use of material (text, photos, drawings) under copyright that does not belong to the author.
- Waivers must be obtained for photographs showing persons. When such waivers are not supplied, faces will be masked to prevent identification. For clinical studies the approval of the ethics committee must be presented.

PAGE CHARGE

The first 8 printed pages in an article are free of charge. For excess pages, the charge is €140 per printed page. The approximate number of characters on a printed page is approximately 6,800. Please also consider the number and size of illustrations.

Autor: Quintessenz Verlags-GmbH, 2018. Disponível em: <https://jad.quintessenz.de/index.php?jid=&doc=authorguidelines_jad>. Acesso em: 09 de outubro de 2019.