

Do Different Isolation Methods Influence the Survival Rates of Occlusoproximal Atraumatic Restorations in Primary Molars? A Systematic Review and Meta-Analysis

João Gilberto Duda¹, Ana Cláudia Rodrigues Chibinski², Juliana Larocca de Geus³, Denise Stadler Wambier², Alessandra Reis² and Letícia Maíra Wambier^{1*}

¹Positivo University, Curitiba, Paraná, Brazil

²State University of Ponta Grossa, Paraná, Brazil

³Paulo Picanço Faculty, Brazil

***Corresponding Author:** Letícia Maíra Wambier, Positivo University, Curitiba, Paraná, Brazil.

Received: September 25, 2021; **Published:** March 28, 2022

Abstract

Aim: A systematic review was performed to evaluate the survival rates of occlusoproximal atraumatic restorations (ART) in primary molars using two methods of isolation of the operative field (rubber dam and cotton rolls/saliva ejector).

Methods: Seven databases were searched for randomized clinical trials comparing the use of different isolation techniques (rubber dam and cotton rolls/saliva ejector) for ART restorations with follow-up equal to or longer than 6 months. The Cochrane risk of bias tool was used to assess the quality of the studies and GRADE for the quality of the evidence.

Results: 687 articles were identified. Three remained in the qualitative synthesis; two were judged to be at unclear and one at high risk of bias. The studies from which the information could be extracted were included for meta-analysis. The survival rate at six-month follow-up was 1.1 (95% confidence interval [CI] = 0.85 to 1.42; $p = 0.46$), and the survival rate at 24 months follow-up was 1.50 (95% CI = 0.87 to 2.56; $p = 0.14$). The quality of the evidence was judged very low.

Conclusion: There is no evidence of superiority of one isolation method over other when longevity of occlusoproximal restorations is considered. Notwithstanding, the low quality of the evidence demands further well-designed trials on the topic to corroborate this finding.

Keywords: Systematic Review; Dental Atraumatic Restorative Treatment; Rubber Dams; Cotton Rolls; Primary Molars

Introduction

Nowadays, Atraumatic Restorative Treatment (ART) is one of the most used protocols for caries treatment in children due to its inherent characteristics of being atraumatic and minimally invasive [1]. The main characteristics of ART restoration are the selective removal of carious dentin with manual instruments, which enable greater conservation of tooth substrate and enhance the chance of maintaining teeth vitality in deep cavities [1-3]. By avoiding noise, vibration of low and high speed drills [4] and the tingling caused by the infiltrative anesthesia [5], ART restorations favor the control of child behavior [6].

Longitudinal studies have reported high success rates of ART technique in occlusal cavities [7-10]. However, the same does not occur in cavities that involves multiple faces [10,11]. After a follow-up period of two years, a systematic review showed longevity rates of 93% (95% CI 91% to 94%) for occlusal restorations and 62% (95% CI 51% to 73%) for occlusoproximal cavities [7]. This is a difficulty to overcome for ART restorations [11-14].

Several factors can influence the success rate of the ART restorations, such as lack of operator training [15,16], difficulty in handling and inserting the glass ionomer cements (GIC) [9,17] and also the increased possibility of material fracture in restorations that involves proximal surfaces [18,19]. In addition, in occlusoproximal restorations, the restorative material must be well accommodated in the gingival cavity wall to prevent infiltration and fracture of the restoration [13,20,21].

In the original protocol of the ART, it was recommended that the restorations should be carried out using cotton rolls isolation [1]. Although this can be easily and quickly accomplished in occlusal cavities, the same does not occur for occlusoproximal cavities. In proximal restorations, that require matrix and wedge adaptation and a longer operative time, the control of the moisture could be more challenging [16,22]. Additionally, visual access to the proximal cavity is also restricted [23].

Given that, some clinical trials attempted to investigate if the type of the isolation method could have an influence on the survival rates of ART restorations [22-24]. These studies concluded that the isolation method does not influence the survival rates of ART restoration success; however, given that most of these individual clinical trials have a low statistical power [22], we cannot rule out the fact that the authors did not detect a significant and important clinical difference due to their low sample sizes.

The great advantage of a meta-analysis over individual randomized clinical trials is that the former has a higher statistical power for any measure of interest, as opposed to a less precise measure derived from a single study. Additionally, a systematic process can evaluate the risk of bias of these studies.

Purpose of the Study

The purpose of this systematic review was to answer the following research question: Is the survival rates of ART restorations in class II cavities of primary molars performed with rubber dam isolation higher than those performed with cotton roll/ saliva ejector in children?

Materials and Methods

Protocol and registration

This study protocol was registered in the PROSPERO database (CRD42016033834) and the recommendations of the PRISMA statement were followed for the report of this study [28]. This study was accomplished from April to June of 2021.

Information sources and search strategy

The controlled vocabulary (MeSH terms) and free keywords in the search strategy were defined based on the PICOS question:

1. Population (P): Primary molars in children.
2. Intervention (I): Rubber dam isolation.

3. Comparison (C): Cotton roll/saliva ejector for isolation.
4. Primary outcome (O): Survival rates of proximal ART restorations.
5. Study design (S): Randomized clinical trials.

We searched the electronic databases MEDLINE via PubMed, Scopus, Web of Science, the Latin American and Caribbean Health Sciences Literature database (LILACS), the Brazilian Library in Dentistry (BBO) and the Cochrane Library (Table 1). The search strategy was firstly developed for PubMed and then modified for the other databases to identify eligible studies.

Pubmed= 312			
#1 dental caries[MeSH Terms]) OR tooth, deciduous[MeSH Terms]) ORdental cavity preparation[MeSH Terms]) ORdental marginal adaptation[MeSH Terms]) OR molar[MeSH Terms]) OR “primary teeth”[Title/Abstract]) OR “primary tooth”[Title/Abstract]) OR “deciduous dentition”[Title/Abstract]) OR “primary dentition”[Title/Abstract]) OR “deciduous tooth”[Title/Abstract]) OR primary molar*[Title/Abstract]) OR dental cavit*[Title/Abstract]) OR “dentin carious”[Title/Abstract])	#2 dental atraumatic restorative treatment[MeSH Terms]) OR glass ionomer cements[MeSH Terms]) OR “atraumatic restorative treatment”[Title/Abstract]) OR ART[Title/Abstract]) OR ART technique*[Title/Abstract]) OR ART restoration*[Title/Abstract]) OR ART sealant*[Title/Abstract]) OR IRT[Title/Abstract]) OR “interim restorative technique”[Title/Abstract]) OR “ART approach”[Title/Abstract]) OR “dental restoration”[Title/Abstract]) OR “minimal intervention”[Title/Abstract]) OR ionomer[Title/Abstract]) OR “partial caries removal”[Title/Abstract])	#3 saliva[MeSH Terms]) OR rubber dams[MeSH Terms]) OR cotton fiber[MeSH Terms]) OR “saliva contamination”[Title/Abstract]) OR “rubber dam”[Title/Abstract]) OR “cotton rolls”[Title/Abstract]) OR “isolation methods”[Title/Abstract]) OR “tooth isolation”[Title/Abstract])	#4 (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized controlled trials[mh] OR random allocation[mh] OR double-blind method[mh] OR single-blind method[mh] OR clinical trial[pt] OR clinical trials[mh] OR (“clinical trial”[tw]) OR ((singl*[tw] OR doubl*[tw] OR trebl*[tw] OR tripl*[tw]) AND (mask*[tw] OR blind*[tw])) OR (placebos[mh] OR placebo*[tw] OR random*[tw] OR research design[mh:noexp] OR comparative study[pt] OR evaluation studies as topic[mh] OR follow-up studies[mh] OR prospective studies[mh] OR control*[tw] OR prospective*[tw] OR volunteer*[tw]) NOT (animals[mh] NOT humans[mh]))
#1 AND #2 AND #3 AND 4			
Scopus= 349			
#1 (TITLE-ABS-KEY (“dentin carious”) OR TITLE-ABS-KEY (“dental caries”) OR TITLE-ABS-KEY(“dental cavit*”) OR TITLE-ABS-KEY (“dental marginal adaptation”) OR TITLE-ABS-KEY (molar) OR TITLE-ABS-KEY (“primary t??th”) OR TITLE-ABS-KEY (“deciduous dentition”) OR TITLE-ABS-KEY (“primary dentition”) OR TITLE-ABS-KEY (“deciduous t??th”) OR TITLE-ABS-KEY (“primary molar*”))	#2 TITLE-ABS-KEY (“glass ionomer cement*”) OR TITLE-ABS-KEY (“atraumatic restorative treatment”) OR TITLE-ABS-KEY (art) OR TITLE-ABS-KEY (“art technique*”) OR TITLE-ABS-KEY (“art restoration*”) OR TITLE-ABS-KEY (“art sealant*”) OR TITLE-ABS-KEY (irt) OR TITLE-ABS-KEY (“interim restorative technique”) OR TITLE-ABS-KEY (“art approach”) OR TITLE-ABS-KEY (“dental restoration”) OR TITLE-ABS-KEY (“minimal intervention”) OR TITLE-ABS-KEY (ionomer) TITLE-ABS-KEY (“partial caries removal”))	#3 (TITLE-ABS-KEY (saliva) OR TITLE-ABS-KEY (“rubber dam*”) OR TITLE-ABS-KEY (“cotton fiber”) OR TITLE-ABS-KEY (“saliva contamination”) OR TITLE-ABS-KEY (“cotton rolls”) OR TITLE-ABS-KEY (“isolation methods”) OR TITLE-ABS-KEY (“tooth isolation”) AND (LIMIT-TO (SUBJAREA , “DENT”))	

#1 AND #2 AND #3		
Web of Science- 85		
#1 TOPIC: ("dent* cari*") OR TOPIC: ("deciduous t??th") OR TOPIC: ("dental cavit*") OR TOPIC: ("dental marginal adaptation") OR TOPIC: ("molar") OR TOPIC: ("primary t??th") OR TOPIC: ("deciduous dentition") OR TOPIC: ("primary dentition") OR TOPIC: ("primary molar\$")	#2 TOPIC: ("glass ionomer cement\$") OR TOPIC: ("atraumatic restorative treatment") OR TOPIC: ("art") OR TOPIC: ("art technique\$") OR TOPIC: ("art restoration\$") OR TOPIC: ("art sealant\$") OR TOPIC: ("irt") OR TOPIC: ("interim restorative technique\$") OR TOPIC: ("art approach") OR TOPIC: ("dental restoration\$") OR TOPIC: ("minimal intervention") OR TOPIC: ("ionomer") OR TOPIC: ("partial caries removal")	#3 TOPIC: ("saliva") OR TOPIC: ("rubber dam\$") OR TOPIC: ("cotton fiber") OR TOPIC: ("saliva contamination") OR TOPIC: ("cotton roll\$") OR TOPIC: ("isolation method\$") OR TOPIC: ("t??th isolation")
#1 AND #2		
Lilacs and BBO= 51		
#1 (MH:"dental caries " OR MH:"tooth, deciduous" OR MH:"dental cavity preparation" OR MH:"dental marginal adaptation" OR MH: molar OR "primary teeth" OR "dentes primários " OR "dientes de leche" OR "primary tooth" OR "dente decíduo" OR "diente primario" OR "deciduous dentition" OR "dentição decídua" OR "dentición temporal" OR "primary dentition" OR "deciduous tooth" OR "diente de leche" OR "primary molar" OR "molar decíduo" OR "primary molars" OR "molares decíduos" OR "molares primarios" OR "dental cavities" OR "cavidades dentais" OR "cavidades dentales" OR "dental cavity" OR "cavidade dental" OR "cavidad dental" OR "dentin carious" OR "cárie de dentina" OR "caries dentinaria")	#2 (MH:"dental atraumatic restorative treatment" OR MH:"glass ionomer cements" OR "atraumatic restorative treatment" OR "tratamento restaurador atraumático" OR "restauración atraumática" OR "tratamiento restaurador atraumático" OR ART OR TRA OR "ART technique" OR "técnica ART" OR "técnica TRA " OR "ART techniques" OR " técnicas ART" OR " técnicas TRA" OR "ART restoration" OR "restauração ART" OR "restauración TRA" OR "restauración ART" OR "ART restorations" OR "restaurações ART" OR "restauraciones TRA" OR "restauraciones ART" OR "ART sealant" OR "ART selante" OR "ART sellante" OR "TRA sellante" OR "ART sealants" OR "ART selantes" OR "TRA sellantes" OR "ART sellantes" OR IRT OR "interim restorative technique" OR "técnica restauradora provisória" OR "técnica restauradora provisional" OR "ART approach" OR "abordagem ART" OR "enfoque TRA" OR "enfoque ART" OR "dental restoration" OR "restauração dentária" OR "restauración dental" OR "minimal intervention" OR "mínima intervenção" OR "minima intervención" OR ionomer OR ionómero OR ionómero OR "partial caries removal" OR "remoção parcial de cárie" OR "remoción parcial de caries")	#3 (MH: saliva OR MH:"rubber dams" OR MH:"cotton fiber" OR "saliva contamination" OR "contaminação com saliva" OR "contaminación con saliva" OR "cotton rolls" OR "rolos de algodão" OR "rollos de algodón" OR "isolation methods" OR "métodos de isolamento" OR "métodos de aislamiento" OR "tooth isolation" OR "isolamento dental" OR "aislamiento dental" OR "aislamiento dentario")

#1 AND #2 AND #3		
Cochrane Library = 35		
<p>#1 MeSH descriptor: [Dental caries] explode all trees</p> <p>#2 MeSH descriptor: [Tooth, deciduous] explode all trees</p> <p>#3 MeSH descriptor: [Dental cavity preparation] explode all trees</p> <p>#4 MeSH descriptor: [Dental marginal adaptation] explode all trees</p> <p>#5 MeSH descriptor: [Molar] explode all trees</p> <p>#6 #1 OR #2 OR #3 OR #4 OR #5</p> <p>#7 primary near t*th: ti,ab,kw or “deciduous dentition”:ti,ab,kw or “primary dentition”:ti,ab,kw or deciduous t*th:ti,ab,kw(Word variations have been searched)</p> <p>#8primary near molar*:ti,ab,kw or dental near cavit*:ti,ab,kw or “dentin carious”:ti,ab,kw(Word variations have been searched)</p> <p>#9#6 OR #7 OR #8</p>	<p>#1 MeSH descriptor: [Dental atraumatic restorative treatment] explode all trees</p> <p>#2 MeSH descriptor: [Glass ionomer cements] explode all trees</p> <p>#3 #1 OR #2</p> <p>#4“Atraumatic restorative treatment”:ti,ab,kw or ART:ti,ab,kw or ART near technique*:ti,ab,kw or ART near restoration*:ti,ab,kw or ART near sealant*:ti,ab,kw(Word variations have been searched)</p> <p>#5 IRT:ti,ab,kw or “interim restorative technique”:ti,ab,kw or “ART approach”:ti,ab,kw or “dental restoration”:ti,ab,kw or “minimal intervention”:ti,ab,kw(Word variations have been searched)</p> <p>#6 ionomer:ti,ab,kw or “partial caries removal”:ti,ab,kw(Word variations have been searched)</p> <p>#7 #3 OR #4 OR #5 OR #6</p>	<p>#1 MeSH descriptor: [Saliva] explode all trees</p> <p>#2 MeSH descriptor: [Rubber dams] explode all trees</p> <p>#3 MeSH descriptor: [Cotton fiber] explode all trees</p> <p>#4 #1 OR #2 OR #3</p> <p>#5 “saliva contamination”:ti,ab,kw or “isolation methods”:ti,ab,kw or tooth near isolation:ti,ab,kw(Word variations have been searched)</p> <p>#6 #4 OR #5</p>
#9 AND #7 AND #6		

Table 1: Electronic databases and search strategy.

We also hand-searched the reference lists of all primary studies for additional relevant publications and investigated the related article links for each primary study in the PubMed database. No restrictions on publication date or languages were involved, but only studies with a follow-up equal to or higher than 6 months were included in this revision.

Abstracts of the annual conference of the International Association for Dental Research (IADR) and its regional divisions (1990 - 2015) were searched. The grey literature was explored using the database System for Information on Grey Literature in Europe (SIGLE). Dissertations and theses were searched using the ProQuest Dissertations and Theses Full Text data bases and the Periódicos Capes Theses database.

To locate unpublished and ongoing trials, the following clinical trials registries were searched: Current Controlled Trials (www.controlled-trials.com), International Clinical Trials Registry Platform (<http://apps.who.int/trialsearch/>), the ClinicalTrials.gov (www.clinicaltrials.gov), Rebec (www.rebec.gov.br) and EU Clinical Trials Register (<https://www.clinicaltrialsregister.eu>).

Eligibility criteria

We included randomized clinical trials (RCTs) with parallel or split-mouth designs in humans that compared the use of rubber dam versus cotton roll/saliva ejector for isolation of the operative field in primary molars for ART restorations. Full-text versions of the papers that meet the eligibility criteria were retrieved for further assessment and data extraction.

RCT studies were excluded if: 1) deciduous teeth were restored with composite resin or amalgam; 2) permanent molars instead of deciduous teeth were restored using the ART technique.

Study selection and data collection process

The articles were selected by title and abstracts according to the described eligibility criteria. Articles appearing in more than one database were considered once. Full-text articles were obtained when there was insufficient information in the title and abstract to make a clear decision.

Subsequently, full-text articles were acquired, and two reviewers (L.M.W. and J.L.G.) classified those that met the inclusion criteria. To handle such a large number of studies, we created an ID for each eligible study, combining first author and year of publication. Relevant information about the study design, participants, interventions and outcomes were extracted using customized extraction forms by three authors (L.M.W., J.L.G. and A.R.) (Table 2 and 3).

Study ID	Study design	Country	Subjects' age mean ± SD [range] (years)	Number of male subjects [%]	Number of patients/ number of restorations [drop-outs]	Number of restorations per group (% jaw/man-dible)	Caries removal method	Acid used/ application time	Material restored used by group	Study settin-gs	Opera-tor(n)	Examiner (n)	Outcomes evaluated	
													Evalua-tioncrite-ria	Follow-u-pperiod
Bres-ciani 2002	Multiple restora-tions	Brazil (Bauru, SP)	n.r. [4-6]	n.r. [n.r.]	38/ 59 [n.r./ 3 restorations]	RD - 45 CR - 14 (n.r.)	Hand instrumen-ts (spoon excavators)	Polyacrylic acid ^b - 10 s	Ketac-Mo-lar ^a	Schools	Dentists (2)	Dentists (3)	Modified ART cri-teria	6 mth
Car-valho 2010	Parallel	Brazil (João Pes-soa and Campi-nas)	6.3 ± n.r. [6-7]	128 [55.2]	232/ 232 [48 children/ 77 restorations]	RD - 115 CR - 117 (39.7/ 60.4)	Hand instrumen-ts (spoon excavators)	Liquid part of the GIC diluted - 15 s	Fuji TM IX ^c	Schools	Calibrated dental stu-dents (4)	n.r. (8)	ART cri-teria	6, 12, 18 and 24 mths
Kemoli 2010	Multiple restora-tions	Kenya (Ma-chakos district)	7.4 ± 0.9 [6-8]	n.r. [n.r.]	804 / 804 [156 children/ restoration]	RD - 404 CR - 397 (30.4/ 69.6)	Hand instrumen-ts (spoon excavators)	Diluted mixing-liquid (Fuji) or the manufactur-er's conditioner - 15 s	Fuji TM IX ^c Ketac-Molar Easy mix ^d Ketac-Mo-lar Aplicap ^e	Schools	Pediatric dentists and dental students (7)	Postgradua-tepediatric students(2)	ART cri-teria	12, 18 and 24 mths

Table 2: Summary of the studies selected for this systematic review.

ID: Identification; SD: Standard Deviation; n.r.: Not Reported; mth: Months; RD: Rubber Dam; CR: Cotton Rolls/ Saliva Ejector. Modified ART criteria: 0 to 4 (0- restoration present, without substitu-tion; 1- present, requiring replacement; 2- Not present, other treatment present; 3- Not present the restoration; 4- Not present, tooth extracted/exfoliated. ART criteria: 0 to 9 (0- restoration was present and good; 1- Present, marginal defects ≤ 0.5 mm in depth; 2- Present with marginal defects > 0.5 mm deep; 3- Not present, restoration almost or completely disappeared; 4- Not present, other restoration present; 5- Not present, tooth extracted/exfoliated; 6- Present, general wear over the restoration of > 0.5 mm at the deepest point; 7- Present, general wear over the restoration of > 0.5 mm at the deepest point; 8- Un-diagnosable; 9- Presence of secondary caries in relation to restoration.

^aKetac-Molar®, 3M ESPE, Seefeld, Alemanha.

^bDurelon®,3M ESPE, Seefeld, Alemanha.

^cFujiTM IX®, GC, Europe.

Study ID	Isolation method	Survival rate by follow-up. Number of successful restorations/ total number of restorations	Secondary caries. Number of events/ Total number of restorations
Bresciani 2002	RD	6 mths: 29/45	6 mths: n.r./59
	CR	6 mths: 6/14	
Carvalho 2010	RD	6 mths: 76/115	24 mths: n.r./115
		12 mths: 55/63	
		18 mths: 32/43	
		24 mths: 24/27	
	CR	6 mths: 74/117	24 mths: n.r./117
		12 mths: 42/63	
		18 mths: 24/31	
		24 mths: 13/17	
Kemo-li2010	RD	*24 mths: 124/280	*24 mths: 48/404
	CR	*24 mths: 75/ 322	*24 mths: 84/397

Table 3: Summary of the results reported in the included studies in this systematic review.

ID: Identification; SD: Standard Deviation; n.r.: Not Reported; mth: Months; RD: Rubber Dam; CR: Cotton Rolls/ Saliva Ejector. *This information was obtained by e-mail contact with the author.

When there were multiple reports of the same study (i.e. reports with different follow-ups), data from all reports were extracted directly into a single data collection form to avoid overlapping data. The collection form was pilot tested using a sample of study reports to ensure that the criteria were consistent with the research question.

Risk of bias in individual studies

Quality assessments of the included trials were evaluated by two independent reviewers (L.M.W. and J.L.G.), using the Cochrane Collaboration tool for assessing risk of bias in randomized trials [29]. The assessment criteria contained six items: sequence generation, allocation concealment, blinding of the outcome assessors, incomplete outcome data, selective outcome reporting, and other possible sources of bias. During data extraction and quality assessment, any disagreements between the reviewers were resolved through discussion, and if needed, by consulting a third reviewer (A.R.).

For each aspect of the quality assessment, the risk of bias was scored following the recommendations described in the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0 (<http://handbook.cochrane.org>). The judgment for each entry consisted of recording “yes” (low risk of bias), “no” (high risk of bias) or “unclear” (either lack of information or uncertainty over the potential for bias).

We considered three out of the six domains in the Cochrane risk of bias tool as key domains [29]. At the study level, studies were judged to be at “low” risk of bias if they were judged as low risk in the key domains sequence generation, allocation concealment and evaluator blinding. If one or more key domains were classified as at “unclear” risk of bias, the study was considered to be at “unclear” risk and if at least one domain was judged as “high” risk of bias, the study as a whole was judged as at “high” risk of bias.

Summary measures and synthesis of the results

Data from eligible studies were dichotomous (number of survived restoration at different follow-ups). Only studies classified as at “low” or at “unclear” risk of bias in the key domains entered into the meta-analysis. We calculated the risk ratio and the 95% confidence interval (CI).

The random-effects models were employed. Heterogeneity was assessed using the Cochran Q test and I² statistics. All analyses were conducted using Revman 5.3 (Review Manager ver. 5.3, The Cochrane Collaboration, Copenhagen, Denmark). No subgroup analysis was performed.

Quality of the evidence using the grading of recommendations

The quality of the evidence was graded for each outcome across studies (body of evidence) using the Grading of Recommendations: Assessment, Development and Evaluation (GRADE) (<http://www.gradeworkinggroup.org/>) to determine the overall strength of evidence for each meta-analysis. The GRADE approach is used to contextualize or justify intervention recommendations with four levels of evidence quality, ranging from high to very low.

The GRADE approach begins with the study design (RCTs or observational studies) and then addresses five reasons (risk of bias, imprecision, inconsistency, indirectness of evidence, and publication bias) to possibly rate down the quality of the evidence (1 or 2 levels) and three to possibly rate up the quality (large effect; management of confounding factors; dose-response gradient). Each one of these topics was assessed as “no limitation”; “serious limitations” and “very serious limitations” to allow categorization of the quality of the evidence for each outcome into high, moderate, low, and very low. The “high quality” suggests that we are very confident that the true effect lies close to the estimate of the effect. On the other extreme “very low quality” suggests that we have very little confidence in the effect estimate and the estimate reported can be substantially different from what it was measured.

Results

Study selection

After the database screening and removal of duplicates, 687 studies were identified (Figure 1). After title screening, 44 studies remained. This number was reduced to 14 after examination of the abstracts and their full texts were assessed to check eligibility. Among them, 11 were excluded because they: 1) did not perform ART restorations [30-32], 2) did not use rubber dam isolation method [33-36], 3) were *in vitro* studies [37] and 4) were studies with overlapping data [16,38,39].

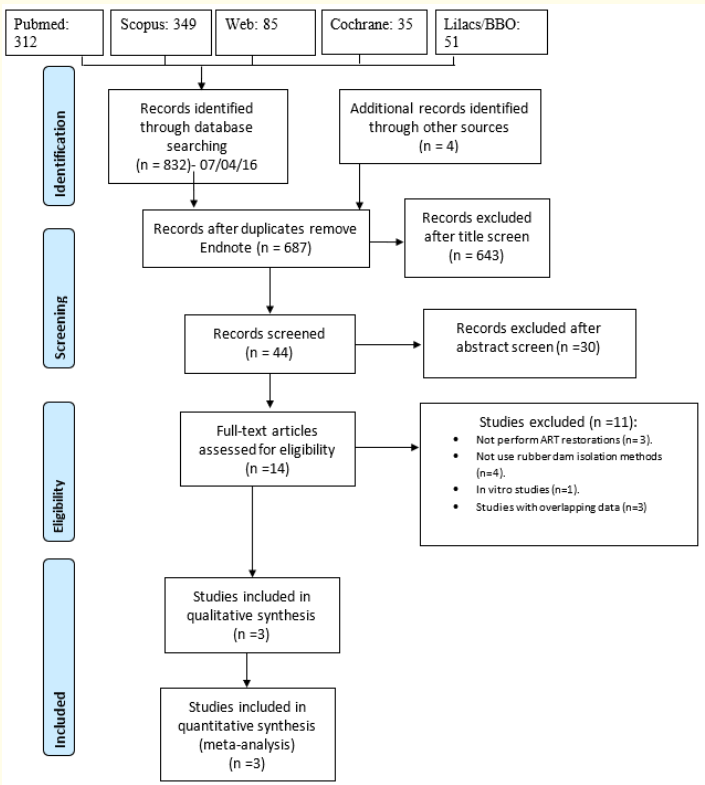


Figure 1: Flow diagram of study.

Characteristics of included articles

The characteristics of the three selected studies are listed in table 2 and 3. Two studies [22,24] performed multiple restorations per participant and only one study [23] used the parallel design. In two out of the three studies, the ART restorations were performed in Brazil [22,23] while the other was performed in Kenya [24].

The number of children included in the primary studies ranged from 804 to 38 and the number of ART restorations ranged from 804 to 59. The mean age of all the participants included in the clinical trials was approximately 6 years; however, this information was not reported in one study [22]. The percentage of males was 55% in one study [23] but this information was not reported in two studies [22,24].

The number of restorations performed with rubber dam ranged from 45 to 404 and the number of restorations performed with cotton rolls ranged from 14 to 397. The percentage of restoration performed in the lower arch ranged from 30% to 39% and in the upper arch ranged from 60% to 69%. This information was not reported in one study [22].

The ART restorations were performed at schools in all included clinical trials [22-24]. In all these studies, caries lesion was removed with hand instruments (spoon excavators). All included studies performed dentin conditioning: one study [22] used polyacrylic acid for 10s and two studies [23,24] used the diluted liquid of the glass ionomer cement for 15s.

The restorations were performed by two dentists in one study [22], by four calibrated dental students [23] or by seven evaluators among pediatric dentists and dental students [24]. In one study [22] the authors used Ketac Molar as restorative material, in the other study [23], the authors employed used Fuji™ IX and in the last one [24], the authors used more than one restorative material (Fuji™ IX, Ketac-Molar Easy mix and Ketac-Molar Aplicap).

The follow-up period of restorations ranged from 6 to 24 months and the restorations were evaluated by three dentists in one study [22], by eight examiners in one study [23] or by two postgraduate pediatric students in another study [24]. The evaluation criteria used for assessment of the restoration was not the same. In one study [22], the authors used the modified ART criteria with scores ranging from 0 to 4 while in the other two studies [23,24] the original ART criteria with scores ranging from 0 to 9 was employed.

The development of secondary caries lesions in the restorations was 6.7% in one study [23] for both isolation methods, and 16% in another study [24]. One study did not report this information [22].

Assessment of the risk of bias

The assessment of the risk of bias of the included studies is presented in figure 2. Some full-text studies did not report the method of randomization and how the allocation concealment was done. Blinding was adequately described in these studies. These three items were the key domains of the current systematic review.

	Adequate sequence generation?	Allocation concealment?	Blinding?	Incomplete outcome data addressed?	Free of selective reporting?
Bresciani., et al. 2002	?	?	+	+	+
Carvalho., et al. 2010	+	?	+	-	+
Kemoli., et al. 2010	+	?	+	+	+

Figure 2: Summary of the risk of bias assessment according to the Cochrane Collaboration tool.

In the key domains of the Cochrane risk of bias tool, none of these studies [22-24] were judged as at “low” risk of bias; therefore at the study level, the studies were considered to be at “unclear” risk of bias.

Meta-analysis

All meta-analyses were performed on studies classified as being at “unclear” risk of bias in the key domains and from which the information could be extracted.

Survival rate at six month follow up

This analysis was based on two studies [22,23]. The risk ratio was 1.1 with a 95% confidence interval of 0.85 to 1.42 (p = 0.46). We did not gather evidence to support that the use of rubber dam and cotton rolls affect the survival rates of ART restorations at six months (Figure 3). The data were not heterogeneous (chi² test p = 0.28; I² = 15%; Figure 3).

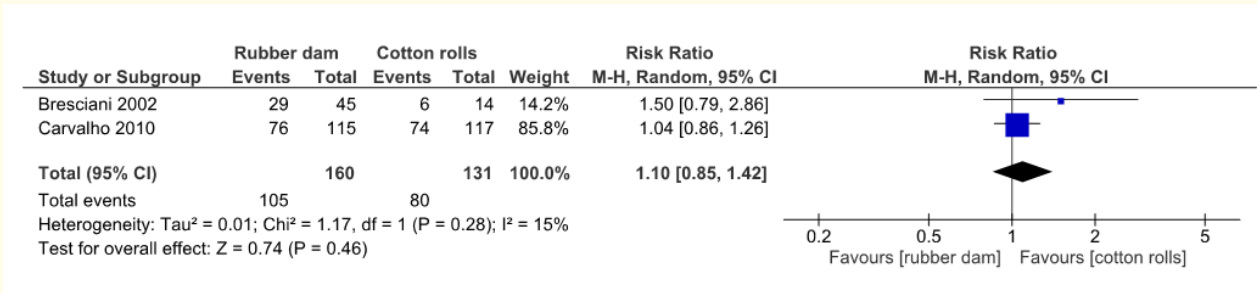


Figure 3: Forest plots of the survival rate of ART restorations at six-month follow-up.

Survival rate at twenty-four month follow up

This analysis was based on two studies [23,24]. The risk ratio was 1.50 with a 95% confidence interval of 0.87 to 2.56 (p = 0.14). We did not gather evidence that the use of rubber dam and cotton rolls affect the survival rates of ART restorations at 24 months (Figure 4). The data were heterogeneous (chi² test p = 0.005; I² = 88%; Figure 4).

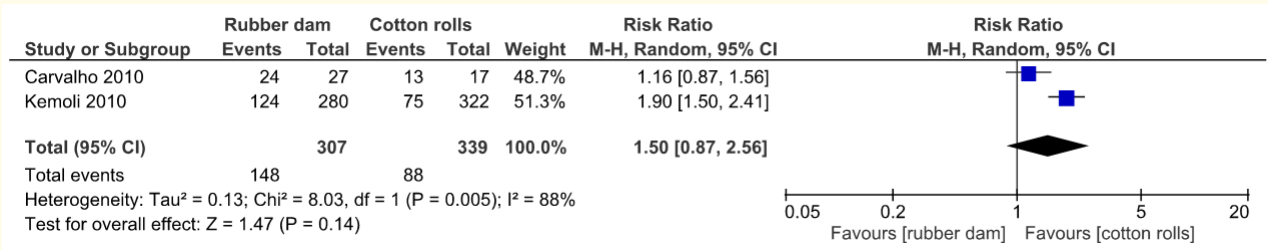


Figure 4: Forest plots of the survival rate of ART restorations at twenty-four month follow-up.

Assessment of the quality of evidence

In the summary-of-findings table (Table 4), the meta-analysis was graded as moderate in the quality of evidence for pain relief. The reasons for downgrading the evidence were that the RCTs are at “unclear” risk of bias and presence imprecision with a high 95% confidence interval, which does not exclude important harm or benefit.

Rubber dam isolation compared to cotton roll/ saliva ejector for isolation for occlusoproximal restorations (ART)					
Patient or population: Primary molars in children					
Intervention: Rubber dam isolation					
Comparison: Cotton roll/ saliva ejector for isolation					
Outcomes	Nº of participants (studies) Follow up	Certainty of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with [comparison]	Risk difference with [intervention]
Survival rates of occlusoproximal restorations - 6 months	291 (2 RCTs)	⊕○○○ VERY LOW ^{a,b}	RR 1.10 (0.85 to 1.42)	611 per 1000	61 more per 1000 (92 fewer to 256 more)
Survival rates of occlusoproximal restorations - 24 months	646 (2 RCTs)	⊕○○○ VERY LOW ^{a,b,c}	RR 1.50 (0.87 to 2.56)	437 per 1000	218 more per 1000 (57 fewer to 681 more)
*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). CI: Confidence interval; RR: Risk ratio					
GRADE Working Group grades of evidence					
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect					
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different					
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect					
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect					

Table 4: Summary of findings table.

Explanations:

- a. The included studies were judged to be at unclear or high risk of bias.
- b. The optimal information size criterion was not met and the CI included appreciable benefit and harm.
- c. There is heterogeneity that cannot be explained.

Discussion

The main idea behind using of rubber dam for ART restorations was to improve the accessibility and visibility of the operative field. Additionally, rubber dam reduces contamination during the insertion of the restorative material in the cavity and the first minutes during the initial setting reaction of the glass ionomer cement [40,41]. Some authors considered that these factors could play an important role

on the longevity of the class II ART restorations and the use of rubber dam isolation could be a way to improve the survival rates of these restorations [24].

In the pursuit of a clear response to this topic, we carried out the present systematic review. Our search strategy comprised the term ART (atraumatic restorative treatment), but also expressions like IRT (interim restorative treatment), minimal intervention and partial caries removal. Since the main subject of this study was a modification of the ART technique protocol, our search strategy was broadened, in order to identify all the papers that compared the longevity of high viscosity glass ionomer cement restorations with selective removal of soft carious dentine tissue [42] performed under rubber dam isolation and cotton rolls and saliva ejector.

Although the authors have used the term for ART restorations with rubber dam isolation, perhaps a more appropriate term was adhesive restoration with partial removal of decayed tissue. There is an extensive discussion in the literature regarding the term used for caries removal, such as removal of carious tissue, selective removal, stepwise removal and nonselective removal of carious tissue [43-45].

The primary included studies for this systematic review reported no significant difference in the success rates of class II restorations performed with rubber dam isolation and cotton rolls/ saliva ejector [22,23]. These data were confirmed in the meta-analysis. Although all selected papers reported proper blinding procedures [46-48], which means that no performance bias were incorporated in the outcome measurements [29], the other key domains were classified as at “unclear” risk of bias, which reduces the reliability in these primary study results.

The poorly randomization scheme and allocation concealment descriptions impaired the evaluation of these domains, the reason of why they were classified as at “unclear” risk of bias at the study level. This prevented us from evaluating the existence of selection biases. One could have contacted the study investigators, but this procedure may lead to overly positive answers [29], the reason why the authors were not contacted to answer about this items. We just contacted with one author [24] to obtain the data of 24 months of follow-up of the restorations.

Looking at the overall follow-up rates after 6 months of class II ART restorations in the primary studies from this systematic review, we observed that they ranged from 64.1% [47] to 74.35% [46] and after 24 months we observed that they ranged from 32.1% [23] to 30.8% [24].

The described rates are similar to those reported in a meta-analysis after one year of follow up of ART restorations [49]. Based on that, we can assume that the lower survival rates of class II ART restorations as well as the high heterogeneity at 24 months of the survival data could be related to other factors apart from isolation technique, such as the type of material used [40,50], the operator’s skill [41], the extension of the cavities [3,39] and the tooth type at which restorations were placed [51].

Another influential factor is that such restorations are usually done outside the clinical environment, such as adapted classrooms or church halls [1,19], where working condition is more challenging [12,15]. The non-ideal patient positioning, the reduced lighting and visibility conditions and the time spent on washing and drying the cavity with cotton pellets [51,52]. All these factors tend to increase the working time and the risk of saliva contamination [22,23].

The restorative material must be well accommodated in the gingival cavity wall to prevent infiltration and subsequent fracture of the restoration [1,53]. The studies selected for these systematic review presented little information about the method used to insert the GIC in the cavity. The use of encapsulated GIC with their own application device, as well as the use of Centrix syringes [22,54] may contribute to a better adaptation, avoiding the incorporation of air bubbles in the restorative material [9,12,53]. Another important step that can help the material adaptation to the cavity walls is the “finger printing”, which was reported as part of the ART protocol in only two studies [46,47].

The most common failures reported for ART restorations that involve more than one surface is the total loss of the restoration and fracture, usually attributed to material properties [20,55,56]. The choice of high viscosity glass ionomer cement as restorative material can contribute to overcome this type of failure in mechanical and physical properties of the restorations [11,57], as suggested by some authors [19,58].

A way to improve retention of the ART restoration is by conditioning the tissue before the insertion of the GIC [1]. The primary studies used different products and concentrations for this conditioning step, such as polyacrylic acid [22] or the liquid of the GIC cement diluted in water [23,24].

In summary, the present systematic review showed that there is limited evidence to support that the survival rates of ART restoration can be influenced by the two isolation methods. In view of the limited available evidence and the “unclear” risk of bias of the included studies, we encourage the conduction of further investigations, especially randomized controlled trials, testing alternative strategies to increase the longevity of Class II ART restorations.

Conclusion

Rubber dam isolation did not yield higher survival rates of Class II ART restoration in primary molars; however due to the few studies available in the literature and their “unclear” risk of bias, further investigations using the two isolation techniques should be performed.

Conflict of Interest and Source of Funding Statement

The authors have no conflict of interest to disclose. No external funding, apart from the support of the authors’ institution, was available for this study

Ethics Declarations

This paper does not contain any research with human participants or animal performed by any of the authors.

Bibliography

1. Frencken JE., *et al.* “Atraumatic restorative treatment (ART): rationale, technique, and development”. *Journal of Public Health Dentistry* 56.3 (1996): 135-140.
2. Frencken JE. “Evolution of the the ART approach: highlights and achievements”. *Journal of Applied Oral Science – SciELO* 17 (2009): 78-83.
3. Jiang M., *et al.* “Factors affecting success rate of atraumatic restorative treatment (ART) restorations in children: A systematic review and meta-analysis”. *Journal of Dentistry* 104 (2020): 103526.
4. Schriks MC and Van Amerongen WE. “Atraumatic perspectives of ART: psychological and physiological aspects of treatment with and without rotary instruments”. *Community Dentistry and Oral Epidemiology* 31.1 (2003): 15-20.
5. Van Bochove JA and Van Amerongen WE. “The influence of restorative treatment approaches and the use of local analgesia, on the children’s discomfort”. *European Archives of Paediatric Dentistry* 7.1 (2006): 11-16.
6. Simon AK., *et al.* “Does atraumatic restorative treatment reduce dental anxiety in children? A systematic review and meta-analysis”. *European Journal of Dentistry* 9.2 (2015): 304-309.

7. De Amorim RG., *et al.* "Survival of atraumatic restorative treatment (ART) sealants and restorations: a meta-analysis". *Clinical Oral Investigations* 16.2 (2012): 429-441.
8. Deepa G and Shobha T. "A clinical evaluation of two glass ionomer cements in primary molars using atraumatic restorative treatment technique in India: 1 year follow up". *International journal of paediatric dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children* 20.6 (2010): 410-418.
9. Freitas M., *et al.* "Randomized clinical trial of encapsulated and hand-mixed glass-ionomer ART restorations: one-year follow-up". *Journal of Applied Oral Science – SciELO* 26 (2018): e20170129.
10. Frencken JE., *et al.* "Twenty-five-year atraumatic restorative treatment (ART) approach: a comprehensive overview". *Clinical Oral Investigations* 16.5 (2012): 1337-1346.
11. Ortiz-Ruiz AJ., *et al.* "Success rate of proximal tooth-coloured direct restorations in primary teeth at 24 months: a meta-analysis". *Scientific Reports* 10.1 (2020): 6409.
12. De Franca Lopes CMC., *et al.* "Randomized Clinical Trial of ART Class II Restorations Using Two Glass Ionomer Cements: One-Year Follow-Up". *Pediatric Dentistry Journal* 40.2 (2018): 98-104.
13. Raggio DP., *et al.* "Is Atraumatic restorative treatment an option for restoring occlusoproximal caries lesions in primary teeth? A systematic review and meta-analysis". *International journal of paediatric dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children* 23.6 (2013): 435-443.
14. Tedesco TK., *et al.* "ART is an alternative for restoring occlusoproximal cavities in primary teeth - evidence from an updated systematic review and meta-analysis". *International journal of paediatric dentistry/the British Paedodontic Society [and] the International Association of Dentistry for Children* (2016).
15. Jordan RA., *et al.* "Performance of atraumatic restorative treatment (ART) depending on operator-experience". *Journal of Public Health Dentistry* 70.3 (2010): 176-180.
16. Kemoli AM., *et al.* "Influence of the experience of operator and assistant on the survival rate of proximal ART restorations: two-year results". *European Archives of Paediatric Dentistry* (2009): 227-232.
17. Bonifacio CC., *et al.* "Survival rate of approximal-ART restorations using a two-layer technique for glass ionomer insertion". *Clinical Oral Investigations* 17.7 (2013): 1745-1750.
18. Hesse D., *et al.* "Survival Rate of Atraumatic Restorative Treatment (ART) Restorations Using a Glass Ionomer Bilayer Technique with a Nanofilled Coating: A Bi-center Randomized Clinical Trial". *Pediatric Dentistry Journal* 38.1 (2016): 18-24.
19. Van 't Hof MA., *et al.* "The atraumatic restorative treatment (ART) approach for managing dental caries: a meta-analysis". *International Dental Journal* 56.6 (2006): 345-351.
20. Da Franca C., *et al.* "Two-year evaluation of the atraumatic restorative treatment approach in primary molars class I and II restorations". *International Journal of Paediatric Dentistry / The British Paedodontic Society [and] The International Association of Dentistry for Children* 21.4 (2011): 249-253.
21. Menezes-Silva R., *et al.* "Randomized clinical trial of class II restoration in permanent teeth comparing ART with composite resin after 12 months". *Clinical Oral Investigations* (2019): 3623-3635.

22. Bresciani E., *et al.* "Influência do isolamento absoluto sobre o sucesso do tratamento restaurador atraumático (ART) em cavidades classe II, em dentes decíduos. The influence of rubber dam on the success of class II atraumatic restorative treatment (ART) restorations in primary teeth". *Revista da Faculdade de Odontologia de Bauru* 10.4 (2002): 231-237.
23. Carvalho., *et al.* "Two years survival rate of Class II ART restorations in primary molars using two ways to avoid saliva contamination". *International Journal of Paediatric Dentistry / The British Paedodontic Society [and] The International Association of Dentistry for Children* 20.6 (2010): 419-425.
24. Kemoli AM., *et al.* "Short communication: Influence of different isolation methods on the survival of proximal ART restorations in primary molars after two years". *European Archives of Paediatric Dentistry* 11.3 (2010): 136-139.
25. De Geus JL., *et al.* "At-home vs In-office Bleaching: A Systematic Review and Meta-analysis". *Operative Dentistry* 41.4 (2016): 341-356.
26. Luque-Martinez I., *et al.* "Comparison of efficacy of tray-delivered carbamide and hydrogen peroxide for at-home bleaching: a systematic review and meta-analysis". *Clinical Oral Investigations* 20.7 (2016): 1419-1433.
27. Wambier LM., *et al.* "Intra-pocket anaesthesia and pain during probing, scaling and root planing: a systematic review and meta-analysis". *Journal of Clinical Periodontology* 43.9 (2016): 754-766.
28. Moher D., *et al.* "Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement". *British Medical Journal* 339 (2009): b2535.
29. Higgins JP., *et al.* "The Cochrane Collaboration's tool for assessing risk of bias in randomised trials". *British Medical Journal* 343 (2011): d5928.
30. Gordan VV., *et al.* "A clinical evaluation of a giomer restorative system containing surface prereacted glass ionomer filler Results from a 13-year recall examination". *Journal of the American Dental Association* 145.10 (2014): 1036-1043.
31. Mandari GJ., *et al.* "Glass-ionomer ART restorations may perform as well as occlusal amalgam restorations in Tanzanian children". *Journal of Evidence-Based Dental Practice* 4.3 (2004): 226-228.
32. Oliveira FS., *et al.* "Resin-modified glass ionomer cement and a resin-based material as occlusal sealants: a longitudinal clinical performance". *Journal of Dentistry for Children - AAPD* 75.2 (2008): 134-143.
33. Costa ICO and Raggio DP. Clinical Trials: The Survival Rate of Glass Ionomer Cement, Glass Carbomer Cement and Compomer in Occlusal and Proximal ART Restorations (ARTUSP), Sao Paulo, Brazil (2015).
34. Frazon R and Araujo FB. Banco de Tese Capes: Eficácia da remoção parcial de tecido cariado em dentes decíduos – Ensaio clínico controlado randomizado, UFRGS, Brazil (2013).
35. Raggio DP., *et al.* "Clinical Trials: Cost-efficacy Between ART and Composite Resin Restorations in Primary Molars, São Paulo, Brazil (2016).
36. Souza MIC. "Avaliação in vitro, in situ e in vivo de cimentos ionoméricos utilizados no tratamento restaurador atraumático". Avaliação in vitro, in situ and in vivo of the glass ionomers cements used in atraumatic restorative treatment (2000): 140-140.
37. Dursun E and Attal JP." Combination of a self-etching adhesive and a resin-modified glass ionomer: effect of water and saliva contamination on bond strength to dentin". *The Journal of Adhesive Dentistry* 13.5 (2011): 439-443.

38. Kemoli AM and Amerongen WE. "Effects of oral hygiene, residual caries and cervical Marginal-gaps on the survival of proximal atraumatic restorative treatment approach restorations". *Contemporary Clinical Dentistry* 2.4 (2011): 318-323.
39. Kemoli AM and Van Amerongen WE. "Influence of the cavity-size on the survival rate of proximal ART restorations in primary molars". *International Journal of Paediatric Dentistry / The British Paedodontic Society [and] The International Association of Dentistry for Children* 19.6 (2009): 423-430.
40. Kemoli AM. "The effects of ambient temperature and mixing time of glass ionomer cement material on the survival rate of proximal ART restorations in primary molars". *Contemporary Clinical Dentistry* 5.1 (2014): 31-36.
41. Mickenautsch S and Grossman E. "Atraumatic Restorative Treatment (ART): factors affecting success". *Journal of Applied Oral Science - SciELO* 14 (2006): 34-36.
42. Innes N., *et al.* "Managing carious lesions: consensus recommendations on terminology". *Advances in Dental Research - SAGE Journals* 28.2 (2016): 49-57.
43. Frencken JE., *et al.* "Managing Carious Lesions: Why Do We Need Consensus on Terminology and Clinical Recommendations on Carious Tissue Removal?" *Advances in Dental Research - SAGE Journals* 28.2 (2016): 46-48.
44. Innes NP., *et al.* "Managing Carious Lesions: Consensus Recommendations on Terminology". *Advances in Dental Research* 28.2 (2016): 49-57.
45. Leal S., *et al.* "Atraumatic Restorative Treatment: Restorative Component". *Monographs in Oral Science* 27 (2018): 92-102.
46. Bresciani E., *et al.* "Influência do isolamento absoluto sobre o sucesso do tratamento restaurador atraumático (ART) em cavidades classe II, em dentes decíduos". *Revista da Faculdade de Odontologia de Bauru* 10.4 (2002): 231-237.
47. Carvalho TS., *et al.* "Two years survival rate of Class II ART restorations in primary molars using two ways to avoid saliva contamination". *International Journal of Paediatric Dentistry* 20.6 (2010): 419-425.
48. Kemoli A., *et al.* "Influence of different isolation methods on the survival of proximal ART restorations in primary molars after two years". *European Archives of Paediatric Dentistry* 11.3 (2010): 136-139.
49. De Amorim RG., *et al.* "Survival of atraumatic restorative treatment (ART) sealants and restorations: a meta-analysis". *Clinical Oral Investigations* 16.2 (2012): 429-441.
50. Olegario IC., *et al.* "Glass carbomer and compomer for ART restorations: 3-year results of a randomized clinical trial". *Clinical Oral Investigations* 23.4 (2019): 1761-1770.
51. Rahimtoola S and Van Amerongen E. "Comparison of two tooth-saving preparation techniques for one-surface cavities". *Journal of Dentistry for Children* 69.1 (2002): 16-26.
52. Van Amerongen WE and Rahimtoola S. "Is ART really atraumatic?" *Community Dentistry and Oral Epidemiology* 27.6 (1999): 431-435.
53. Frencken JE., *et al.* "[Clinical aspects of Atraumatic Restorative Treatment]". *Nederlands Tijdschrift voor Tandheelkunde* 123.1 (2016): 35-42.
54. Raggio DP., *et al.* "Effect of insertion method on knoop hardness of high viscous glass ionomer cements". *Brazilian Dental Journal* 21.5 (2010): 439-445.

55. Lo EC and Holmgren CJ. "Provision of Atraumatic Restorative Treatment (ART) restorations to Chinese pre-school children--a 30-month evaluation". *International Journal of Paediatric Dentistry / The British Paedodontic Society [and] The International Association of Dentistry for Children* 11.1 (2001): 3-10.
56. Van Gemert-Schriks MC., *et al.* "Three-year survival of single- and two-surface ART restorations in a high-caries child population". *Clinical Oral Investigations* 11.4 (2007): 337-343.
57. Braga MM., *et al.* "Are the Approximal Caries Lesions in Primary Teeth a Challenge to Deal With?-A Critical Appraisal of Recent Evidences in This Field 4 (2015): 83-116.
58. Calvo AF., *et al.* "Evaluation of the relationship between the cost and properties of glass ionomer cements indicated for atraumatic restorative treatment". *Brazilian Oral Research – SciELO* 30 (2016): 1-7.

Volume 21 Issue 4 April 2022

© All rights reserved by Letícia Máira Wambier., *et al.*