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Clinical performance of atraumatic restorative treatment in children with severe early childhood caries

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Abstract

Objective: This longitudinal study evaluated the clinical performance of atraumatic restorative treatment (ART) restorations in children who had severe early childhood caries (S-ECC) and were being assisted by a dental care program in Teresina-Piaui-Brazil.

Methods: Seventy-nine children of both genders between the ages of 10 and 36 months were enrolled in the study, and the 398 restorations were placed in one or more than one tooth surface. The restorations were made in the knee-to-knee position by a single operator (MSM) in a simplified environment. A resin-modified glass ionomer cement (Vitro Fill LC/DFL) was used as the restorative material. The restoration performance was clinically assessed using criteria proposed by Phantumvanit et al. 1996 and data were analysed with BioEstat Version 5.0 using Chi-square, Wilcoxon, Mann Whitney and Friedman's tests at a 5% significance level.

Results: Out of the total 398 restorations, 230 were reassessed after three months, 178 after six months, 124 after 9 months, and 103 after 12 months. Furthermore, the success rate was 56.3% after one year. The number of tooth surfaces that were involved directly influenced the clinical performance of the restorations ($P<0.05$).

Conclusion: Based on this 12-month follow-up evaluation, the ART restorations that were placed in children with S-ECC had a moderate survival rate, and the number of surfaces was inversely related to the restoration performance.

Keywords: Atraumatic restorative treatment; dental caries; glass ionomer cements; survival rate; primary teeth

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Desempenho clínico do tratamento restaurador atraumático em crianças com cárie precoce de infância

Resumo

Objetivo: Este estudo longitudinal avaliou o desempenho clínico das restaurações provenientes do tratamento restaurador atraumático (ART) em crianças que tiveram cárie precoce na infância (S-ECC) e estavam sendo assistidas por um programa de atendimento odontológico em Teresina-Piauí-Brasil.

Métodos: Setenta e nove crianças de ambos os sexos com idades entre 10 e 36 meses, foram incluídas no estudo, com 398 restaurações, localizadas em uma ou mais superfícies do dente. As restaurações foram realizadas por um único operador (MSM) previamente treinado na posição joelho-a-joelho em ambiente simplificado. Ionômero de vidro modificado por resina (Vitro Fill LC/DFL) foi utilizado como material restaurador. O desempenho da restauração foi avaliado clinicamente utilizando os critérios propostos por Phantumvanit et al. 1996 e os dados foram analisados com BioEstat versão 5.0 usando os teste de qui-quadrado, Wilcoxon Mann Whitney e Friedman ao nível de significância de 5%.

Resultados: Do total de 398 restaurações, 230 foram reavaliadas após três meses, 178 após seis meses, 124 depois de 9 meses, e 103 após 12 meses. Além disso, a taxa de sucesso foi de 56,3% após o período de um ano. O número de superfícies dentárias que estavam envolvidas influenciou diretamente no desempenho clínico das restaurações ($P<0.05$).

Conclusão: Com base nesta avaliação de 12 meses de seguimento, as restaurações ART que foram colocadas em crianças com S-ECC apresentaram uma taxa de sobrevivência moderada, e do número de superfícies foi inversamente proporcional ao desempenho da restauração.

Palavras-chaves: Tratamento restaurador atraumático; cáries dentárias; cimento de ionômero de vidro; padrão de sobrevivência; dentes decíduos

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Introduction

Early childhood caries (ECC - formerly known as baby bottle tooth decay) is the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in a primary teeth in a children under five years of age. In children younger than 36 months, any sign of smooth-surface caries is indicative of severe early childhood caries (S-ECC) [1]. This condition is often due to the feeding pattern in this age group. Successful clinical results are difficult to achieve because ECC requires specialised treatment, and many dentists who work in the public health system are not willing to treat infants.

When the lesions are not restored at an early stage, they may quickly develop into a pulp necrosis and consequently increase the complexity of the treatment. These situations are not only technically more complex to treat and require a great deal of the child's cooperation but they also may trigger changes in the child's quality of life and cause technical difficulties for the dentist because of the poor cooperation of young children and the rapid destruction of the tooth structure in primary teeth [2,3].

Atraumatic Restorative Treatment (ART) was presented to the dental community in 1994 as an alternative treatment that used hand tools to remove caries. Glass Ionomer Cement (GIC) has been the material of choice for the ART technique due to its adhesive characteristics and fluoride release. ART was initially recommended for communities with reduced access to dental services, scarce technological resources and electric energy [4].

In most ART studies, the ART approach has been used in the permanent dentition in developing countries for populations with a low caries risk [5] and it has been successfully used in single-surface restorations [6]. However, no study has been carried out to assess the clinical performance in children with severe early childhood caries in a non-clinical environment in and who needed restorations in more than one tooth.

The purpose of this longitudinal study was to evaluate the clinical performance of ART restorations in children who had S-ECC and were being treated in a dental care program in Teresina-Piauí-Brazil.

Methods

Study population

This study was developed with an observational longitudinal prospective design and was ethically conducted in accordance with the Declaration of Helsinki. It was approved by the Ethics Committee of the Federal University of Piauí (UFPI), protocol 0167-07. Those legally responsible for the individuals signed a consent form (ICF), according to resolution 196/96 of the National Health Council, which sets guidelines and standards for research involving humans.

The research was carried out at the Institute of Social Perinatology of Piauí (IPSP) – Brazil in the "Preventive Program for Pregnant Women and Babies" (PPPWB) a university extension project of a Federal University of Piauí (UFPI) in Teresina, Piauí, Brazil [7]. The PPPWB goals are focused on recovering and maintaining oral health in pregnant women and children aged zero to 36 months. Children with decayed deciduous teeth and positive prognosis received atraumatic restorative treatment (ART), while more complex cases were referred to the Children's Clinic of the Federal University of Piauí (UFPI).

Seventy nine children of both genders were treated. These children were 10-36 months old (mean age, 28.3 months), had cavitated carious lesions with dentin involvement that affected one or more of the surfaces in the anterior or posterior teeth without pulp involvement, and were treated between August of 2007 and January of 2009.

Treatment procedure

Children were examined by two trained and calibrated examiners (Kappa = 0.89) using a CPI (Community Periodontal Index) probe, a dental mirror, and gauze to dry the field. The presence of caries was measured using WHO criteria [8]. Primary teeth that had a cavity extending into the dentin and had an entrance that allowed access by hand instruments were selected for treatment using the ART approach. Teeth were excluded if pulp exposure or an associate abscess was apparent or suspected.

The restorations were made in the knee-to-knee position under indirect ceiling lighting that was aided by a spotlight, in a simplified environment [7]. Individual clinical forms were filled out with the patient's identification data and information regarding their personal habits of oral health, such as the frequency of brushing one's teeth. After completing the medical records, the parents were provided with the following: guidance on aetiology, literature on methods of preventing dental caries, and oral hygiene training with a toothbrush and fluoride toothpaste.

The cavity preparation consisted of opening the cavity with a dental hatchet when necessary, removing the soft caries' tooth tissues with a dentin excavator at the dentin-enamel junction, the surrounding walls, and the axial or pulpar wall to minimise pain. The damaged enamel was also removed to allow better sealing. The cavities were filled using resin-modified glass ionomer cement (Vitro Fill LC® DFL, Rio de Janeiro (RJ), Brazil). Isolation was achieved using cottons wool rolls. Cavities were wetted and dried through the use of water-soaked cotton pellets and sterile cotton pellets, respectively. Restorations were coated with Vitro Fill LC gloss according to the manufacturer's instructions. No local anaesthesia or radiographs were used. The restorations were performed by a single professional.

Evaluation

The follow-up examinations were carried out through a tactile/visual examination that used a dental mirror and a CPI probe. This was completed under an artificial light source with the aid of a "spotlight". The teeth were first cleaned and then dried with sterile gauze. The evaluation was carried out in the knee-to-knee position by two trained examiners (kappa

higher than 0.8). The evaluators were involved neither in the planning of the study nor in its execution.

The restorations were evaluated at 3, 6, 9, and 12 months after they were complete using the following analysis criteria proposed by Phantumvanit et al. 1996 [9] aided with a WHO probe (Table 1).

Table 1. Codes used in evaluation of the ART restorations.

Code	Criteria
0	Present, in good condition
1	Present, slight marginal defect, no repair is needed
2	Present, slight wear, no repair is needed
3	Present, marginal defect > 0.5 mm, repair is needed
4	Present, wear > 0.5 mm, repair is needed
5	Not present, restoration partly or completed missed
6	Not present, restoration replaced by another restoration
7	Tooth is missing, exfoliated or extracted
8	Restoration not assessed, child is not present

The scores 0,1,2 and 7 were considered "success" and the scores 3,4,5,6 and 8 were considered "failure". All restorations evaluated as being failures were also regarded as failures in the other periods of evaluation, and when ART was indicated, the teeth were refilled.

Statistical analyses

The data registered in the clinical forms were evaluated using BioEstat version 5.0. The Chi-square test was used for calculating the association of qualitative variables. Comparisons between numerical variables were carried out using nonparametric tests (Wilcoxon test, Mann Whitney test, Friedman test). The significance level was set at 0.05.

Results

Table 2 summarises the number of restorations per patient.

Table 2. Number (No) of restorations carried out per patient.

Nº restorations	Nº patients (%)	Total Restorations (%)
1 to 3	31 (39.2%)	63 (15.8%)
4 to 9	39 (49.4%)	226 (56.8%)
10 or more	9 (11.4%)	109 (27.4%)
Total	79 (100%)	398 (100%)

The mean decayed, extracted, filled-tooth (dmf-t) values at baseline and at 12 months were 4.4 and 5.0, respectively, and the mean decayed, extracted, filled-surfaces (dmf-s) values at baseline and at 12 months were 6.2 and 7.0, respectively. No statistically significant differences were found, which indicates that the disease remained stable during the studied period (Table 3).

Table 3. Mean (and SD) dmf-t (decayed, missing and filled teeth) indices and initial and final dmf-s (decayed, missing and filled surfaces).

Index – component	Baseline	Final
D	4.10 (2.49)[a]	1.20 (1.96)[b]
M	0.00 (0.00)	0.00 (0.00)
F	0.30 (0.83)[a]	3.80 (2.41)[b]
dmf-t	4.40 (2.53)[a]	5.00 (2.78)[a]
B	1.40 (1.67)[a]	1.50 (1.69)[a]
L	1.10 (1.56)[a]	1.10 (1.56)[a]
M	1.00 (1.42)[a]	1.00 (1.54)[a]
D	0.60 (1.11)[a]	0.60 (1.16)[a]
O	2.10 (2.03)[a]	2.80 (2.37)[a]
dmf-s	6.20 (4.52)[a]	7.00 (5.03)[a]

Wilcoxon test. Different letters in the same line denote statistical difference. Legend: d - decayed, m - extracted, f – filled, b – buccal, l – lingual, m - medial, d - distal; o – occlusal, t – total, s – surfaces.

Out of the 398 restorations, 230 (57.8%) were reassessed after three months, 178 (44.7%) after six months, 124 (31.2%) after 9 months, and 103 (25.9%) after 12 months. In all of the reassessments, the success rate was higher than the failure (Table 4).

Table 4. The clinical performance of the restorations according to the assessment period.

Status of restoration	Observation period			
	3 months Nº (%)	6 months Nº (%)	9 months Nº (%)	12 months Nº (%)
Success	210 (91.3)	146 (82)	83 (67)	58 (56.3)
Failure	20 (8.7)	32 (18)	41 (33)	45 (43.7)
Total	230 (100)	178 (100)	124 (100)	103 (100)

Statistically significant differences were noted in the clinical performance of the restorations when they were evaluated according to the number of surfaces involved (Table 5). The failure rate was significant at each follow-up reassessment.

Table 5. Restorations with some need of repair (SNR) according to the assessment period and the number of surfaces involved.

Number of tooth surfaces involved in the restoration	Observation period in which the failure was identified			
	3 months n (%)	6 months n (%)	9 months n (%)	12 months n (%)
1	11 (5.8)	21 (14.8)	28 (28.6)	32 (41.0)
2	1 (5.9)	1 (7.7)	1 (9.1)	1 (9.1)
3 or more	8 (34.8)	10 (43.5)	12 (80.0)	12 (85.7)

Friedman's Test (Fr=6.5). P=0.038.

No association was found between the rates of success and failure with child gender, arch where the restoration was

performed and number of brushings performed. However, this association was statistically significant when compared with the initial age of the child (Table 6).

Table 6. Association between sex, baseline age, arch and number of brushings with success and failure rates of restorations after 12 months.

	Success		Failure		*P*
	n	%	n	%	
Sex					
Male	29	50.0	17	37.8	0.216*
Female	29	50.0	28	62.2	
Total	58	100	45	100	
Baseline Age (months) average (s.d.)	28.2 (7.7)		25.0 (7.4)		**0.042****
Arch					
lower	13	22.4	04	8.9	0.067*
Upper	45	77.6	41	91.1	
Total	58	100	45	100	
Number of brushings					
2	31	53.4	28	62.2	0.372*
3	27	46.6	17	37.8	
Total	58	100	45	100	

* Chi-square test (χ^2); ** Mann Whitney test.

Discussion

All possible efforts were made to remain in contact with the participating children over the evaluation period. During the follow-up assessments, this study was limited by the high dropout rate of the patients caused by a lack of interest from the guardians of the children. This can be explained by the myth that restorations can cure the disease. In addition a number of children attended at PPWGB are from cities near Teresina or reside in the suburbs of the city, where concentrate low-income families and was not possible to reassess the restorations. The percentage of restorations lost to the present study was 55,3% after 6 months, although after 12 months, it was 74,1%, which may raise doubts concerning the result of the final period of evaluation.

This is the first study to test the effectiveness of ART restorations on multiple surfaces of primary teeth in children with severe early childhood caries. The overall success rate after one year was 56.3% (Table 4). The simplicity and efficiency of the ART technique, its low cost and easy implementation, and its potential for treating patients outside of the dental office have extended its use. Although the operative steps are simple, they still require professional expertise and scientific knowledge related to the physical/chemical and manipulative properties of the restorative material to correctly diagnose the type of dentine and the pulp status. One application of this treatment is for young children who are being introduced to oral care [10].

A major decline in the prevalence of dental caries has been observed worldwide in recent decades. However, in some developing countries, this is not yet a reality for the vast majority of their populations [11]. Even where the prevalence of the disease is decreasing, small portions of the population have a high prevalence of caries, and tooth decay remains the primary cause of tooth loss for all age groups. In this study, 40% of the children had up to three carious lesions, and the remaining 60% had a severe form of the disease because 30% of the restorations were placed in 11% of the patients. These children had a mean of more than 10 lesions (Table 2).

Similar to conventional dental restorative treatments, the ART clinical procedure is unable to prevent dental caries unless it is incorporated as an integral part of a health promotion process [12]. The disease remained stable during the duration of the study. Regarding the surfaces affected, the occlusal component was the most prevalent in both the baseline data and the data at 12 months (Table 3).

In this study, a decline was observed in the clinical performance of the restorations with time. The overall success rate after one year was 56.3% and was dependent of surface number (Table 4). However, the success rate was similar to that reported by Lo and Holmgren [15] and Lo et al. [16], who evaluated ART for class II restorations. The moderate clinical performance may be related to several factors, including the fact that the study was carried out for primary dentition in young children (10 to 36 months). The ART technique has been shown to have reduced performance in primary dentition compared to permanent dentition [6]. This result may be due to the height of the tooth that has retentive cavities. The restorations were performed in babies with teeth in the process of eruption that have reduced height.

The ART technique has been validated as a method of restoring single surface cavities, but it has various limitations for restoring interproximal cavities. In a meta-analysis, Van't Hof et al. [6] found promising results for single surface ART restorations using a high-viscosity glass ionomer in primary dentition. The restoration was maintained in 95% of patients after 1 year and in 86% of patients after 3 years [6]. Other studies have shown moderate success rates for class II restorations in primary dentition that range from 46% [13] to 65% [14] after one year to 46% [16] to 51% [17] after two or more years.

For this reason, the use of ART to restore multiple surface cavities should be carefully considered [10,12]. Table 5 shows that the clinical performances of the restorations were statistically different when they were evaluated according to the number of surfaces involved. ART is a less painful and a minimally invasive approach compared with conventional treatments. It is much more difficult to treat infants. The implementation of the restoration technique should be applied when the infant is sitting on its mother's lap in a simplified environment, and this should be the therapy of choice for children with ECC regardless of the number of surfaces involved.

Pelegrinetti et al. [17] evaluated restorations in which at least three surfaces had been restored using the ART technique. After 24 months, they found that 58.8% were successfully retained and 11.8% were partially retained, which was considered a success. Inadequate mechanical retention or problems associated with inserting the material into a cavity with more than one surface can affect the clinical performance of ART [17-19].

Franca et al. [20] observed that the best results were found for class I in each period of follow up. After 1 month, the success of class I restorations was 94.6% and class II restorations 70.1%. After 12 months, the success rate was 50.6% for class I and 15.2% for class II. These results corroborate those found in this study.

Some findings have indicated that the failures in the ART restorations were due to problems that were associated with the material. One example of this is the low mechanical strength of the glass ionomer, and this can lead to fractures and excessive wear, which is a rare type of failure [4]. Van Hof et al. [6] concluded that medium-viscosity glass ionomers should not be used for ART restorations. Faccin et al. [13] demonstrated high survival rates for single surface ART restorations in a clinical setting using glass ionomer -modified resin cement for primary dentition.

Failures can also be caused by the operator. These failures can be due to the incomplete removal of infected carious dentin, inadequate etching, inadequate isolation of the operative field, and improper insertion of the glass ionomer (particularly in small cavities and can result in surface air bubbles) [12]. Franca et al. [21] concluded that the operator's experience makes a difference in the success rate of more complex ART restorations when an experienced operator receives the same training as an inexperienced operator. In the current study, the age of the children may have influenced the results. The mean age was 28.3 months and ranged from 10 to 36 months. Faccin et al. [13] observed that the performance and success rate of the ART restorations in children who were 12 to 48 months of age were not influenced by the age of the children in single-surface restorations.

Characteristics such as sex of the child, which was held in arch restoration and the number of brushings reported by parents showed no statistical association when purchased with success rates and failure of restorations after 12 months. However, the initial age of the child was significantly associated, the higher the initial age in months higher the success rate, which can be explained by the ease of implementation of restorative procedure, as well as the implementation of oral hygiene in older children (Table 6).

The ART approach should not be used alone; rather, it should be used in conjunction with a plan that aims to control the causes of the patient's disease. The ART approach fits the current paradigm of oral health promotion, which is based on the prevention and early intervention of the carious process by removing microbial masses, using fluorides in different forms of application, controlling biofilms, and rationally using fermentable carbohydrates.

Conclusions

Based on the 12-month follow-up evaluation presented here, it can be concluded that the ART restorations in children with S-ECC showed moderate survival rates, and the number of surfaces was inversely related to the restoration performance.

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