# Two-year evaluation of the atraumatic restorative treatment approach in primary molars class I and II restorations

# CAROLINA DA FRANCA<sup>1</sup>, VIVIANE COLARES<sup>1</sup> & EVERT VAN AMERONGEN<sup>2</sup>

<sup>1</sup>Departament of Social Dentistry, Dental School, University of Pernambuco, Pernambuco, Brazil, and <sup>2</sup>Academic Centre for Dentistry in Amsterdam, Amsterdam, The Netherlands

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**Background.** Atraumatic restorative treatment (ART) has the advantages of reducing pain and fear and of being more cost-effective than the traditional approach.

**Aim.** The aim of this study was to investigate the survival of ART class I and II restorations in primary molars at 2 years.

**Design.** The sample consisted of 190 restorations and placed in 155 children 6–7 years old of both genders. The treatment was performed by two final-year dental students. All patients were trea-

ted in a completely supine position on tables available in the schools. The restorations were evaluated at 1, 12, and 24 months.

**Results.** 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. The most frequent failure characteristics were totally or partially lost and gross marginal defect.

**Conclusions.** The rate of success of restorations using the ART approach was significantly lower for class II.

### Introduction

Atraumatic restorative treatment (ART) is an approach that involves a preventive and restorative caries management concept that has been developed in the last two decades<sup>1</sup>. This technique consists of removing demineralized dental tissue using only hand-held instruments and restoring the cavity with an adhesive filling material<sup>2</sup>. This is in accordance with the modern concept of minimal intervention because it conserves sound tooth tissue and it is also preventive because it protects adjacent pits and fissures.

Atraumatic restorative treatment is a simple technique with many advantages, such as it reduces pain and fear during dental treatment<sup>3</sup>; it does not require electricity<sup>2</sup>; and it is more cost-effective than the traditional approach using amalgam<sup>4</sup>. It is an alternative treatment available to a large part of the world's population<sup>2</sup>. In addition, it is mostly indicated for use in children, as it is reportedly atraumatic because no rotary instruments are used and in most cases no local anaesthesia is needed<sup>3,5</sup>.

According to a systematic review, ART restorations with high-viscosity GIC are successful, and their survival rate may even exceed that of amalgam fillings, although these findings should be treated with caution owing to unclear randomized sequence allocation and/or allocation concealment<sup>6</sup>.

In addition, the introduction of ART into the oral health care systems of low- and middle-income countries would reduce extractions and increase the proportion of teeth restored and sealed<sup>1</sup>. A reduction in tooth extractions is a goal of WHO for 2020<sup>7</sup>.

In the literature, there are relatively few investigations on this treatment approach in the primary dentition. Table 1 shows the most recent studies in which the rate of success of ART restorations ranges from 43.4% to 96.7% for class I and from 12.2% to 83.3% for class II.

The aim of this study was to investigate the survival of ART restorations in primary molar classes I and II restorations at 2 years.

### Materials and methods

#### Study population

This study was conducted at schools in Recife, Brazil, with children 6–7 years old of both genders.

Correspondence to:

Carolina da Franca, Rua Jacobina, 45/2102. Recife – PE – Brazil, 52011180. Tel.: +55 81 3242 9708/+55 81 9606 6850. E-mail: carolinafbandeira@yahoo.com.br

	Sample (n)/			Time	Rate of success (%)		
References	age (years)	Brand of the glass ionomer*	Country	(months)	Class I	Class II	
Lo and Holmgren <sup>10</sup>	170/±5.1	Ketac-Molar Easymix (3M ESPE)	China	30	79.0	51.0	
Taifour <i>et al.</i> <sup>11</sup>	482/6–7	Ketac-Molar Easymix (3M ESPE); Fuji IX (GC Europe, Leuven)	Syria	36	86.1	48.7	
Honkala <i>et al.</i> <sup>18</sup>	77/±5.7	Chem-Flex (Dentsply, DeTrey GmbH, Germany)	Kuwait	22	93.7	83.3	
Ersin <i>et al.</i> <sup>12</sup>	219/6-10	Fuji IX (GC Europe)	Turkey	24	96.7	76.1	
Gemert-Schriks <i>et al.</i> 9	475/±6.09	Ketac-Molar Easymix (3M ESPE)	Suriname	36	43.4	12.2	
Kemoli and van Amerongen <sup>14</sup>	804/6-8	Ketac-Molar Easymix (3M ESPE); Fuji IX (GC Europe); Ketac-Molar Aplicap (3M ESPE)	Kenya	12	-	44.8	

Table 1. Distribution of studies on longevity of atraumatic restorative treatment in primary dentition.

\*No statistical significant differences were found in those studies that tested more than one make of glass ionomer.

## Sampling procedure

The selection of children was conducted in 2007 by three dentists (postgraduate students), trained in the calibration and standardization of examining techniques described in the oral health survey manual ( $\kappa = 0.824$ ). The simplified WHO form was used to record information. Dental caries was recorded according to WHO criteria<sup>8</sup>.

Atraumatic Restorative Treatment was indicated in cases of (I) class I or class II cavities in primary molars, accessible to manual instruments; (II) absence of abscess or fistula near the carious tooth and no pulp exposure expected if caries was removed; (III) the teeth selected could not have any other cavity, caries, or pain; (IV) the measurements of the cavity should not be bigger than 1 mm mesio-distally and 2 mm in bucco-ligual/ palatinal direction.

The parents or guardians were informed of the purpose and methods of this study, and their prior informed consent was obtained. The study design was approved by the Suriname Ministry Health in and by the Ethics Committee of the University of Pernambuco, Brazil (Protocol no 124180), and was in accordance with the principles of the Helsinki Declaration.

#### Treatment procedure

The ART restorations consisted of caries removal using hand-held instruments only, combined with the use of a high-viscosity glass ionomer (Ketac Molar Easymix/3M ESPE, Seefeld, Germany). Caries removal followed the recommendations of Frencken *et al.*<sup>2</sup>, as well as the principal steps of ART. Caries removal after cavity preparation was verified by optical and tactile conventional criteria.

Two final-year dental students performed the treatment. All patients were treated inside classrooms at the schools selected to take part in the trial. Patients were positioned on a table. A battery-powered headlamp was available. Cotton rolls were used to isolate the tooth, the opening of the cavity was performed with a dental hatchet, the removal of soft carious tooth tissue with an excavator. and the filling of the cavity and the adjacent pits and fissures with a glass-ionomer cement (Ketac Molar Easymix/3M ESPE). Conditioning of the cavity (using a drop of the liquid of glass-ionomer cement-Ketac Molar/3M ESPE for 15 s) and adjacent pits and fissures with cotton wool pellets preceded the placement of the glass ionomer, and the cavities being cleaned with three cotton wool pellets and dried with three other cotton wool pellets before and after the conditioning. The chairside assistant, a dental student, mixed the glass-ionomer cement according to the manufacturer's instructions. The powder to liquid ratio used was 1:1. Class II cavities were filled after the placement of plastic bands and wedges. No local anaesthesia was used. Excess material was removed by means of an applier/caver instrument, and the restoration was coated with a layer of petroleum jelly.

#### Evaluation

The restorations were evaluated after 1 month. at baseline, and after 12 and 24 months by six final-year dental students, two in each period. In this way, the evaluations in each period were made by two different final-year dental students. The evaluators were trained and calibrated by a senior researcher in ART over the 2-year period. A kappa test was performed for intra- and interexaminer evaluations. The kappa test result was higher than 0.8. The fillings were evaluated using the criteria established by Gemert-Schriks et al.<sup>9</sup> The evaluators were involved neither in the planning of the study nor in its execution. 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 analysis

The data were subjected to simple descriptive analysis, and the statistical analysis was carried out with SPSS version 11 (SPSS Inc. Chicago, IL, USA) and SAS version 8.2 (SAS Institute, Cary, NC, USA), with a level for acceptance of statistical significance being set at  $P \leq 0.05$ .

#### Results

To select the children with cavities that could be treated with ART restorations, 1134 children were examined, of whom 602 (53.1%) were boys and 644 (56.8%) were 7-year-olds. Of the 1134 children, 21.9% were caries free. The majority of the children (781) presented at least one decayed primary tooth (68.9%), and only 22.9% presented one or more restorations in primary teeth.

A total of 190 restorations were performed in 155 children, of whom 79 (50.9%) were boys. Thirty-five children had two restorations. There was a significantly higher percentage of failed restorations in the presence of antagonist teeth at 24 months of follow-up (Table 2). With regard to type of cavity, the success of class II restorations was significantly lower at all periods of evaluation (1, 12, and 24 months) (Table 3). Among the Table 2. Distribution of ART restorations according to presence of antagonist teeth.

	ART restora	tions			
	Survived	Failed			
Antagonist present	% (n)	% (n)	Total	Value of <i>P</i> **	
1 month					
Yes	92.9 (145)	94.1 (32)	100.0 (177)	0.579	
Total	100.0 (156)	100.0 (34)	100.0 (190)		
12 months					
Yes	90.6 (48)	93.5 (100)	100.0 (148)	0.359	
Total	100.0 (53)	100.0 (107)	100.0 (160)		
24 months					
Yes	88.5 (46)	98.3 (59)	100.0 (105)	0.037*	
Total	100.0 (52)	100.0 (60)	100.0 (112)		

\*Significant association at 5.0%.

\*\*Using Fisher's exact test.

ART, atraumatic restorative treatment.

Table 3. Classification of results according to the type of cavity at 1, 12, and 24 months of follow-up.

	Type of cav	vity		
	Class I % (n)	Class II % (n)	Total % ( <i>n</i> )	Value of <i>P</i> **
1 month Success Total Missing	94.6 (88) 100.0 (93) –	70.1 (68) 100.0 (97) –	82.1 (156) 100.0 (190) 0	0.001*
12 months Success Total Missing	50.6 (41) 100.0 (81) 13.0 (12)	15.2 (12) 100.0 (79) 18.5 (18)	33.1 (53) 100.0 (160) 15.8 (30)	0.000*
24 months Success Total Missing	60.0 (39) 100.0 (65) 30.1 (28)	27.6 (13) 100.0 (47) 51.5 (50)	46.4 (52) 100.0 (112) 41.0 (78)	0.000*

\*Significant association at 5.0%.

\*\*Using the Pearson chi-square test.

cases of failure, the most frequent evaluation characteristics were a lost or partially lost restoration and a gross marginal defect (Table 4).

Missing values, due either to the absence of teeth as a result of extraction or shedding or to the absence of the patient, due to illness or change of school, were only observed after 12 months of follow-up. Those restorations not available for evaluation were not considered as restorative failures, but as dropouts.

#### Discussion

All possible efforts were made to remain in contact with the participating children over the

	1 month					12 months				24 months					
	Class	1	Class	II		Class	1	Class	; II		Class	l	Class	II	
Evaluation characteristics	%	n	%	n	Value of P**	%	n	%	n	Value of P**	%	n	%	n	value of P**
Gross marginal defect	60.0	3	13.8	4	0.000*	30.0	12	10.4	7	0.000*	3.85	1	_	_	0.001*
Underfilled	-	-	34.5	10		2.5	1	-	-		3.85	1	-	-	
Overfilled	-	-	10.3	3		2.5	1	3.0	2		-	-	3.0	1	
Sec caries, surface intact	-	-				2.5	1	1.5	1		-	-	-	-	
Sec caries, surface defect	-	-				22.5	9	8.9	6		-	-	-	-	
Lost or partially lost	40.0	2	41.4	12		40.0	16	68.7	46		92.3	24	97.0	33	
Inflammation of the pulp	-	-	-	-		-	-	7.5	5						
Total	100.0 (	5)	100.0 (	29)		100.0 (	40)	100.0 (	67)		100.0 (2	6)	100.0 (	34)	

Table 4. Failure characteristics for evaluation at 1, 12, and 24 months.

\*Significant association at 5.0%.

\*\*Using the verosimilarity ratio.

evaluation period. A number of children had left school, however, and some were long-time sick. Also, a number of children had shed their restored primary teeth or had had them extracted. The percentage of children lost to the present study was 15.8% after 12 months, although after 24 months, it was 41.0%, which may raise doubts concerning the result of the final period of evaluation.

The percentage of failed restorations was higher when an antagonist was present. This result may be associated with occlusal forces on those restorations.

With regard to type of cavity, the lowest rate of success was for class II restorations, which is in agreement with most studies<sup>9–12</sup>. In the first month, around 30.0% of class II restorations failed, and this may be related to the technique. Class II restorations are more complex, according to Gemert-Schriks *et al.*<sup>9</sup>, and contamination with saliva when placing two-surface restorations attests to this complexity. In addition, it is part of the guidelines for ART restoration<sup>2</sup> that children should not eat in the first hour after treatment; however, it was not possible to ensure the application of this guideline.

After 12 months, the rate of success was 50.6% and 15.2% for class I and II restorations, respectively, which is lower than the results of other studies at the same times of follow-up. For example, Yassen<sup>13</sup>, in Iraq, found 74.0% for class I and Kemoli and van Amerongen<sup>14</sup> 44.8% for class II. At 24 months, the results of the present study remained similar to those found at 12 months, the rate of

success being even lower than that found in the literature, such as that of Ersin *et al.*<sup>12</sup>, 2006, at the same period of follow-up: 96.7% for class I and 76.1% for class II. Only one study<sup>9</sup>, Gemert-Schriks *et al.*, 2007, showed a poorer result: 43.4% for class I and 12.2% for class II. The poor result obtained in that study may have been because of a longer period of follow-up, rarely 36 months.

In relation to the make of glass ionomer, in this study, Ketac Molar Easymix (3M ESPE) was used, and the rates of success were compared with those of Kemoli<sup>14</sup> and Gemert-Schriks *et al.*<sup>9</sup> whose results were better and worse, respectively, than those of the present study, using the same make of glass ionomer used in this study. Two studies<sup>11,14</sup> compared more than one make of glass ionomer with no statistically significant difference at being found between different makes.

Failure characteristics were mainly because of total or partial losses and gross marginal defects for both class I and II restorations in the primary dentition, which is in agreement with other studies<sup>9–11,15,16</sup>. Gross marginal defects may be related to excessive occlusal forces, although the material used was specifically developed for ART purposes.

Total or partial losses may be related to reasons, such as incorrect mixing of the glass ionomer, incorrect selection of the cavity for ART, or insufficient cleaning and conditioning of the cavity<sup>9</sup>, despite the fact that the operators had been trained in all steps of the ART procedure. In addition, the operators' lack of experience in working with children in the school environment as well as the lack of infrastructure of the dental office may be considered as factors contributing to the low rate of success in the present study.

In relation to the failed restorations, the rate of secondary caries at 12 months was 25.0% for class I and 10.4% for class II. At 24 months, secondary caries was no longer a reason for failure. The low rate of secondary caries is in agreement with Anusavice<sup>17</sup>, who suggested that the ART technique reduces the rate of caries progression because the glass ionomer has an antibacterial effect.

The last factor to be considered is the size of the cavity, particularly for class II restorations<sup>14</sup>. The indication for ART in the present study included small cavities in a primary molar, but in the study by Kemoli and van Amerongen<sup>14</sup>, the medium-sized proximal cavities had the best survival results.

In general, the tendency found in the literature regarding ART in primary dentition is an increased rate of success with the passage of time (Table 1).In more recent studies<sup>9,14</sup> and in the present study, however, a low rate of success was found. This may be related to some factors present in these more recent studies, including the factors discussed earlier. The rate of success in restorations carried out using the ART approach was low, particularly for class II.

Why this paper is important to paediatric dentistsThe paper suggests some reasons for failures of ART restorations in primary molars.

Why this paper is important to paediatric dentistsART is a simple technique with many advantages, one of which is that it is indicated mostly for use in children, as it is reportedly atraumatic.

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