

## Clinical evaluation of multi-surface ART restorations

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### Abstract

The aim of this study was to evaluate the performance of two different glass-ionomer cements: a high-density (Ketac Molar - ESPE) and a resin-modified cement (Fuji VIII - GC) using the Atraumatic Restorative Treatment technique to restore multi-surface cavities in permanent teeth. A total of 60 ART restorations (30 with each material) were placed in schoolchildren (9-16 years of age) by two operators. After a period of 6 months, two independent examiners evaluated 59 restorations according to the criteria used in previous ART studies. Data were submitted to McNemar and Fischer tests. The success rate of the treatment was 98.3%. One restoration (Ketac Molar) was replaced by another material and was recorded as failure. The success rates of the restorations were 100% and 96.6% for Fuji VIII and Ketac Molar, respectively. There was no statistically significant difference in the restorations' success between baseline and 6 months ( $p>0.05$ ). In the same way, no significant differences were found between materials, cavity types or operators ( $p>0.05$ ). The ART approach was highly appropriate and effective in restorations involving two or more tooth surfaces, after 6 months. The results showed a promising performance of the ART technique with both materials. *First published in J Appl Oral Sci 2005; 13: 15-9.*

### Introduction

Since its development as part of a community-based primary oral health program carried out in Tanzania in the mid 1980s, the Atraumatic Restorative Treatment (ART) technique has been used around the world<sup>1-5</sup>. Such approach consists of caries removal using hand instruments only, followed by restoration of the prepared cavity with adhesive filling material, currently a glass ionomer cement (GIC)<sup>6</sup>.

The advantages of ART include the use of easily available and inexpensive hand instruments rather than the more expensive electrically-driven dental equipments, conservation of sound tooth tissue through the chemical adhesion of glass ionomers, limitation of pain, minimizing the use of local anaesthesia, and low cost. Owing to these features, many people living in less developed areas can receive oral care by the ART. It is, moreover, also suitable for patients with permanent or temporary physical disabilities<sup>7</sup>.

Studies have shown high success percentage rates for one-surface ART restorations<sup>2,3,8,9</sup>. However, very few studies have reported the success rates for multi-surface restorations, mainly in permanent teeth. After one year, one study on an early GIC reported a success rate of 67%<sup>10</sup>. More recently, Holmgren, et al.<sup>2</sup> (2000) found approximately 90% and 80% success for Class I restorations involving two or more tooth surfaces and Class II restorations, respectively.

Initially, conventional GICs were used in ART clinical trials. Thereafter, high-density GIC were especially developed for ART use and substituted for the conventional ones<sup>2,8,11,12</sup>. In 1997, Ewoldsen, Covey and Lavin<sup>13</sup> suggested the use of resin-modified glass-ionomer luting cements in ART. The authors tested luting ionomers in increased powder/liquid ratio for restorative consistency and found higher diametral tensile and bond

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strengths than those of the conventional GICs. Although resin-modified GICs have shown better mechanical properties than the conventional<sup>14-16</sup> ones, only one ART study evaluating this type of material in permanent teeth was found in the literature<sup>5</sup>. Souza et al. found higher success rates for Class II ART restorations in permanent teeth than other authors did, who used conventional GICs<sup>5</sup>.

Therefore, the aim of this study was to evaluate the performance of two different glass ionomer cements, a high-density and a resin-modified cement, using the Atraumatic Restorative Treatment technique to restore multi-surface cavities in permanent teeth.

### Material and methods

The study was carried out in suburban public schools of Bauru, in the northwest of São Paulo, Brazil. Ethical approval was obtained from the Ethics Committee of Bauru Dental School. Sixty children aged 9 to 16 years presenting carious lesions involving two or more surfaces in posterior permanent teeth were included in the project. The exclusion criteria were teeth with pulp exposure, history of pain, or presence of swelling or fistula<sup>4</sup>. During selection of the subjects, the name, address, age, school, and medical and dental history were obtained. The subjects were included in the study only after parental or caretaker consent had been given, with the respective signature on the consent form.

The working team consisted of two operators, both PhD students of Bauru Dental School, and one chairside assistant. Prior to applying the technique in the field, operators and assistant had undergone a two-day instruction period.

Treatment was carried out inside classrooms at the schools selected to be part of the trial. Patients were positioned on a table combined with a foldable cushion and a soft headrest in order to achieve a proper patient-to-operator position. Since suction of saliva was not available for the ART procedure, cotton rolls were used to isolate the tooth. The tooth surface was cleaned with a wet cotton pellet for removal of debris and plaque. Cavity access was achieved with the use of an enamel hatchet. The next step was removal of decalcified tissue with an

excavator, first at the dentin-enamel junction and then from the cavity floor. The cavity was then cleaned with water on a small cotton pellet and dried with a dry cotton pellet. When necessary, pulp protection with calcium hydroxide cement (Hydro C – Dentsply) was used in deep cavities. Conditioning of the tooth structure was carried out with a cotton pellet saturated with Dentin Conditioner for Fuji VIII (GC Corp., Tokyo, Japan) or the liquid component of the material for Ketac Molar (ESPE, Seefeld, Germany) for about 10 seconds. The conditioned surfaces were then washed several times with wet cotton pellets and dried with dry cotton pellets. Matrix strips and wedges were used for restoration of proximal surfaces. The glass ionomer cements used were Ketac Molar (conventional high-density GIC) and Fuji VIII (resin-modified GIC). The manipulation and mixing of glass ionomer cements were carried out according to the manufacturer's instructions. The selection of material for restorations was done in a randomized manner. The filling material was inserted into the cavity, using an applicator and plugged into the corners of the cavity with the smooth side of an excavator. The material was also placed over the previously conditioned pits and fissures. Petroleum jelly was used to coat the operator's gloved finger and a slight pressure was applied on top of the entire occlusal surface for approximately 30 seconds. Any excess material was removed with a carver and an articulating paper was used to check the bite. Two coats of varnish (Copalite, Cooley & Cooley, Houston, USA) were applied over the restoration to prevent cracks and the patient was instructed not to eat for at least one hour. Local anaesthesia was used in 4 treatments.

A total of 60 fillings (30 for each material) were placed in 60 individuals. After a 6-month period, 59 patients were present and 59 restorations were evaluated. Two independent examiners evaluated the restorations according to the criteria used in previous ART studies<sup>1,3,4,9,10,12,17</sup> (Table 1).

The McNemar test was used to assess statistically significant differences between the evaluation periods (baseline and 6 months).

**Table 1.** Codes used for evaluation of the ART restorations

Score	Description
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 > 0.05 mm, repair is needed
5	Not present, restoration partly or completely missing
6	Not present, restoration replaced by another restoration
7	Tooth is missing, exfoliated or extracted
8	Restoration not assessed, child was not present

Codes: 0, 1, 2 = successful; 3, 4, 5, 6 = failure; 7, 8 = excluded

The Fischer test was used for comparisons between materials, between operators and between cavity types. A difference was considered to be statistically significant if  $p < 0.05$ . Inter-examiner agreement was assessed by kappa statistics.

## Results

The mean age of the children at baseline was 11.59 years (SD=1.59). The mean DMFT was 3.48 (SD= 1.77), of which 82% teeth were decayed. Restorations were placed in Class I cavities involving two or more tooth surfaces and in Class II cavities (Table 2). Local anesthesia was necessary in 4 treatments. In 12 deep cavities, a thin layer of calcium hydroxide was applied over the deep spots. At the 6-month evaluation, one restoration (Ketac Molar) was not examined as the child was absent. Table 3 shows the status of ART restorations at the 6-month evaluation by Class type.

**Table 2.** Distribution of restorations according to Class type

	Class I		Class II	
	Ketac Molar	Fuji VIII	Ketac Molar	Fuji VIII
Number of restorations	17	19	13	11
Total	36		24	

One restoration (Ketac Molar) was replaced with another material and was recorded as a failure. The success rates of the restorations were 100% and 96.6% for Fuji VIII and Ketac Molar, respectively. The success rate of the treatment was 98.3%.

There was no statistically significant difference in the success of restorations, between baseline and 6 months ( $p > 0.05$ ). Similarly, no significant differences were found between materials, cavity types or operators ( $p > 0.05$ ). Interexaminer reproducibility was very good (Kappa = 1.00).

## Discussion

Most ART studies have evaluated restorations in Class I cavities and have shown high success rates, ranging from 93%-99% in the first year of evaluation<sup>2,3,8,9</sup>. However, few studies in the literature have evaluated the performance of ART restorations in cavities involving two or more tooth surfaces<sup>2,5,10</sup>. In these situations, the cavity is usually deep and pulp involvement can happen at any moment. For the majority of people living in less developed areas, the treatment provided in these cases is extraction. In the present study such type of cavities was selected with the aim of avoiding extraction, once a considerable number of extractions had been observed in previous ART studies conducted in suburban schools of Bauru. The treatment success rate was 98.3%. Regarding the cavity type, 100% of Class I restorations were considered successful for both materials. For Class II, the success rates were 100% for Fuji VIII and 92% for Ketac Molar. Frencken, et al.<sup>10</sup> evaluated 18 restorations involving

two or more tooth surfaces after 1 year and found a lower success rate (67%) than the present study. The higher success rate of the present study is probably due to improvements in the ART approach combined with the use of high strength glass-ionomers. Holmgren, et al.<sup>2</sup> found more promising results, with success rate of 90% for "large" Class I and approximately 80% for Class II restorations, in the first year. The authors considered as "large" the cavities extending over more than half the tooth surface either in a mesio-distal or bucco-lingual direction or involving more than one tooth surface. Nevertheless, the success of the present study was higher, mainly for Class II restorations. Although the found results are satisfactory, further clinical evaluations after longer periods are necessary, because the ART studies have shown a decrease in the success rate of restorations over the years<sup>3,4,9,17</sup>.

In earlier studies, conventional GICs were used<sup>3,4,10,17</sup>. Thereafter, high-density GICs specifically developed for the ART replaced the conventional ones<sup>2,8,12</sup>. The development of resin-modified GICs resulted in better mechanical properties in these materials than in conventional GICs<sup>14-16</sup>. Consequently, Ewoldsen, Covey and Lavin<sup>13</sup> suggested the use of resin-modified GICs in ART, aiming at a higher success rate in the restorations. The authors tested resin-modified glass ionomer luting cement at increased powder/liquid ratio for restorative consistency and observed higher diametral tensile and shear bond strengths in these materials than in conventional ones. However, only one ART study evaluated resin-modified GICs in permanent teeth<sup>5</sup>. Souza et al.<sup>5</sup> found an 86.7% success rate for Class II restorations with Fuji Plus, after 8 months. The results were better than those found in other research using conventional GICs in the same cavity type<sup>2,10</sup>. The higher success rate found in the present study may be related to the materials, which were different from that used by Souza et al.<sup>5</sup> and/or to the technique.

Although the present work is a short-term study, data are significant because ART literature is scarce in both studies evaluating both resin-modified GICs and multisurface restorations. Resin-modified glass ionomers

for luting application were suggested for ART because they are chemically activated rather than photo-activated. However, a restorative resin-modified GIC indicated for anterior teeth, Fuji VIII (GC), is now available on the market. Such material was chosen because it has presented higher diametral tensile and bond strengths than Ketac Molar (ESPE)<sup>18,19</sup>. On the other hand, there was no significant difference in the materials' performance in the present short-term clinical trial.

The evaluation criteria used were based on previous similar ART studies<sup>1,3,4,9,10,12,17</sup>. One restoration (Ketac Molar) was replaced by another material (intermediate restorative material) and was recorded as failure. The child's mother reported that about 4 months after the treatment the patient felt pain. So, the patient had looked for a Public Health Center, where pulp extirpation was done. At the evaluation period, this patient was directed to Bauru Dental School, where endodontic treatment was provided.

Unfortunately, ART is not suitable for all types of carious lesions. Exclusion criteria are teeth with pulp exposure, history of pain, or presence of swelling or fistula. However, sometimes diagnosis is difficult because pain is subjective. Also, due to the lack of an x-ray machine renders prediction the lesion depth impossible. In this case, a previous pulp involvement could have existed and the treatment could then have contributed to acceleration of an irreversible pulpitis.

Carious lesions located on proximal surfaces of posterior teeth are a challenge to the ART operator. Access to the lesion is sometimes difficult without a bur and saliva contamination is hard to control at the cervical area. Besides this, caries removal was difficult in some areas such as beneath cusps and at the dentinoenamel junction. In these cases, the improved design of Carisolv™ excavators makes caries removal easier.

An important aspect to be considered in the success of treatment is the presence of a chairside assistant. In the present study, an assistant was responsible for manipulation of the materials. In this way, the operators could better control the relative isolation, avoiding

contamination of the prepared cavity with saliva. Safar, Davis and Overton<sup>20</sup> verified that salivary contamination adversely affected the adhesion of glass ionomer cements to the dentin. Rinsing and re-etching the dentin failed to result in strength as great as that of noncontaminated dentin.

A program including diet and oral hygiene instructions as well as ART treatment should be adopted in schools of underprivileged communities. Such a program could provide oral assistance for people from the childhood to the adolescence and contribute to prevention, reduction and even eradication of caries disease.

The ART approach was highly appropriate and effective in restorations involving two or more tooth surfaces, after 6 months. The results showed promise regarding the performance of the ART technique with both materials.

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### 摘要

本研究的目的在于评估两种不同的玻璃离子粘合剂的功效：一种为高密度（Ketac Molar - ESPE），一种为树脂改良粘合剂（Fuji VIII - GC），应用此两种粘合剂，并使用ART技术来修补恒齿中的多面龋洞。由2位医师对学龄儿童（9-16岁）进行了总共60例的ART修补（每种材料各30例）。

在6个月后，两位独立检查员按照以前的ART研究中使用的标准对59例修补进行了评估。

数据呈交给了 McNemar 和 Fischer 试验。治疗的成功率为 98.3%。其中一例修补（使用 Ketac Molar

材料）被其他材料取代，并被记录为失败。修补成功率分别为 Fuji VIII 100%，Ketac Molar 96.6%。

在基线和6个月的修补成功率上没有统计数字的较大差异（ $p>0.05$ ）。

同样的，在材料、龋洞类型或操作医师上也没有发现较大差异（ $p>0.05$ ）。

6个月后，ART方法在修补涉及两个或多个牙面的龋洞时极为适合并有效。

结果表明ART技术在采用两种材料的情况下都有较

好的功效。首次发表于 *J Appl Oral Sci* 2005; 13: 15-9。

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### Resumen

La meta de este estudio era evaluar el rendimiento de los dos cementos vidrio-ionomer diferentes: un cemento de alta densidad (muela Ketac - ESPE) y un modificado de resina (Fuji VIII - GC) utilizando la técnica de Tratamiento Reconstituyente Atraumático para restaurar cavidades en multi-superficies en dientes permanentes. Un total de 60 restauraciones de ART (30 con cada material) se colocaran en alumnos (9-16 años de edad) por dos operadores. Después de un período de 6 meses, dos examinadores independientes evaluarán 59 restauraciones segundo los criterios utilizados en estudios previos de ART. Los datos fueran sometidos a las pruebas de McNemar y de Fischer. Las tasas de éxito de las restauraciones fueran 100% 96.6% para Fuji VIII y Muela Ketac, respectivamente. No había ninguna diferencia significativa de estadísticas en el éxito de las restauraciones entre la línea de base y 6 meses ( $p>0.05$ ). En la misma manera, no se encontraran ningunas diferencias entre materiales, tipos de cavidad o operadores ( $p>0.05$ ). El enfoque de ART era altamente apropiado y efectivo en restauraciones implicando dos superficies o más de diente, después de 6 meses. Los resultados mostraran una ejecución prometedora de la técnica de ART con ambos materiales. Publicado primero en *J Appl Oral Sci* 2005; 13: 15-9.

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### Resumo

O objetivo deste estudo foi avaliar o comportamento de dois cimentos de ionômero de vidro: um de alta viscosidade (Ketac Molar - ESPE) e um modificado por resina (Fuji VIII - GC) em restaurações envolvendo duas ou mais superfícies dentárias, confeccionadas pela técnica do Tratamento Restaurador Atraumático.

Sessenta restaurações (30 com cada material) foram inseridas em estudantes (9-16 anos) por dois operadores. Após 6 meses, dois examinadores independentes avaliaram as restaurações de acordo com os critérios utilizados em trabalhos prévios semelhantes. Os dados foram analisados pelos testes de McNemar e Fischer. A porcentagem de sucesso do tratamento foi de 98,3%. Uma restauração (Ketac Molar) foi substituída por outro material e classificada como falha. As porcentagens de sucesso das restaurações foram de 100% e 96,6% para o Fuji VIII e Ketac Molar, respectivamente. Não houve diferença estatisticamente significativa no sucesso das restaurações entre o baseline e 6 meses ( $p > 0,05$ ). Da mesma forma, não houve diferença estatística entre os materiais, tipos de cavidade ou entre operadores. ( $p > 0,05$ ). A técnica ART foi altamente apropriada e efetiva em restaurações envolvendo duas ou mais superfícies, após 6 meses. Os resultados mostraram um comportamento promissor com ambos os materiais. *J Appl Oral Sci* 2005; 13: 15-9.

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