

# High-strength glass ionomer with atraumatic restorative treatment for prevention of deciduous caries\*\*\*★

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## Abstract

**BACKGROUND:** It has been reported that glass ionomer sealants have a poor wear resistance and low rupture strength that are easy to fall off on the occlusal surfaces.

**OBJECTIVE:** To observe the effects of high-strength glass ionomer *via* the atraumatic restorative treatment (ART) on the pit and fissure of deciduous teeth in the young children.

**METHODS:** A self-controlled method was used to compare ART glass ionomer-based pit and fissure seal on unilateral molars with resin sealant on the contralateral side in 89 children aged 3 years.

**RESULTS AND CONCLUSION:** The retention rates of ART glass ionomer sealant after 6 and 18 months were 94.15% and 77.72%, respectively. At 6 months after treatment, ART glass ionomer sealant was more caducous in mandibular second deciduous molars > mandibular first deciduous molars > maxillary second deciduous molars > maxillary first deciduous molars; at 18 months after treatment, the rank was mandibular second deciduous molars > maxillary second deciduous molars > mandibular first deciduous molars > maxillary first deciduous molars. The second deciduous molar of the lower mandible, but the caducous position of resin sealant was the second deciduous molar of the upper mandible. The caries prevalence rate of the deciduous teeth treated with ART glass ionomer sealant was significantly lower than that without sealant at 6 and 18 months ( $P < 0.01$ ). These findings indicate that ART glass ionomer pit and fissure sealant is of a lower drop-out rate, easy to operate and of low cost with excellent caries-preventing effect.

## INTRODUCTION

Pit and fissure seal refers to spreading a layer sticky material on the pit fossa on the occlusal surface, buccal surface or lingual surface to prevent adamantine layer from erosion by bacterium and other metabolites, resulting in effective anti-caries<sup>[1]</sup>. Pit and fissure seal is a commonly found effective method to prevent pit and fissure caries, commonly in permanent teeth, especially in the first permanent molar<sup>[2]</sup>. Light-cured resin sealant requires etching, strict facing wet insulation, special equipment-light-cure machine, and high cost. The operation of this technique is difficult for child matching<sup>[3]</sup>. Previous glass ionomer sealants, including Katak-Molar, Vitrebond, Fuji III, Fuji III LC, Vitremer, have a poor wear resistance and low rupture strength that is easy to fall off on the occlusal surfaces<sup>[4]</sup>, that is why the resin sealant is not replaced. To change the caries prevalence rate of children in the countryside and undeveloped area, to use simple hand instrument and modified glass ionomer as a sealant to perform prophylactic treatment is a method for preventing caries, which has been approved and recommended by WHO<sup>[5]</sup>. Numerous studies have addressed atraumatic restorative treatment (ART) glass ionomer sealant<sup>[6-7]</sup>. Wan *et al*<sup>[8]</sup> observed the application on permanent teeth. No reports have concerned the ART glass ionomer sealant in 3- or 4-year-old children in China. The present study was a self-controlled trial to observe the retention rate and secondary caries rate at 6 and 18 months following treatment with ART glass ionomer pit and fissure sealant in 3-year-old children, and to explore the economic materials and suitable methods for prevention of caries in children

providing the scientific basis for the government to develop scientific measures of oral disease prevention.

## MATERIALS AND METHODS

### Design

Self-controlled test.

### Time and setting

Experiments were performed at the Guangzhou First Kindergarten from October 2008 to October 2010.

### Subjects

Publicity materials about pit and fissure sealant and informed consents were sent in the Guangzhou First Kindergarten in March 2009. Primarily, 100 children were qualified. Finally, 89 children were included, with the loss rate of 11%.

Inclusive criteria: ① Healthy 3-year-old children in accord with the condition of pit and fissure sealant; ② guardians signed informed consent.

Exclusive criteria: Children who did not participate in the test twice consecutively due to sick leave or transfer to another school were excluded.

Materials and reagents: Glass ionomer sealant (Fuji IX GP, Chemosetting, Japan), that releases fluoride ions, has a good adhesion to the dental tissue, less demanding on the wet compartment and a small stimulation on the pulp tissue, commonly used in the filling, cavity liner, relining, adhesive, *etc.*; simple dental chair, CPI probe, plane mouth mirror, forceps, large cotton balls, tampons, disposable syringes, Vaseline, glass plate, spatula, digging spoon.

### Methods

Baseline examination in 3-year-old children was

conducted by two experienced dentists to understand the dental caries. The teeth required pit and fissure seal were selected. Eight left or right unilateral deciduous molar teeth were treated with ART glass ionomer sealant, and eight contralateral deciduous molar teeth were treated with resin seal. All procedures were completed within 1 month. The preservation of pit and fissure sealant and condition of new dental caries were rechecked at 6 and 18 months. Cost-efficiency analysis of the two methods was performed<sup>[9]</sup>.

**Examiner:** Two experienced physicians from the prevention department, who had been trained in the National Stomatological Health Epidemiologic Survey and grasped standard indication and contraindication of pit and fissure seal, were selected. 10% samples were selected for recheck every time. The baseline results of dental caries showed that Kappa value was 0.85. During reexamination, Kappa value was between 0.82 and 0.90, and results of pit and fissure seal were 0.80 and 0.89, showing good consistency. **Therapist:** One pediatric dentist who had been trained in ART training was selected. This physician understood basic theory and methods of ART technique and resin pit and fissure seal, and mastered the therapeutic method and main points.

#### Standards of caries examination

Oral examination required that: lie evenly; artificial source of light; plane mouth mirror; CPI probe; strict sterilization of instrument. Diagnosed criteria were in accordance with the criteria of Oral Health Surveys: Basic Methods. 4<sup>th</sup> edition, recommended by the World Health Organization in 1997<sup>[10]</sup>. Results were recorded as dmft.

#### Inclusion criteria of pit and fissure seal<sup>[11-13]</sup>

Deep fossa could wedge a probe or be inserted by a probe, and enamel caries did not involve dentine. Wedging a probe: the probe was wedged in a clean dried fossa, which was characterized by ①vertically probed in the fossa; ②no clinical or X-ray manifestation of dental caries; ③action could be repeated or not; ④only probed in the fossa; ⑤the probe could induce slight indisposition. Inserted by a probe: the probe could be inserted in a clean dried fossa, which was characterized by ①vertically probed in the fossa; ②initial caries of enamel; ③action could be repeated; ④the operator supported the probe to check the fossa by slight power; ⑤the probe entered the enamel and dentin; ⑥X-ray exhibited or did not exhibit dental caries; ⑦probing might lead to slight indisposition or pain.

#### Performance standards of ART glass ionomer pit and fissure sealant<sup>[14]</sup>

The patient lied on the tilted chair. ① The tooth was separated from wet by cotton cylinder to keep dry in the therapy area. The wet cotton ball was used to clean the residual on the tooth surface, and the

residual in the deep fossa was removed using the probe. ② Diluted glass ionomer fluid (also called dentin treatment solution, and the main component was phosphoric acid) was utilized to dispose the pit of the fossa for 10–15 seconds, and above-mentioned fluid was removed using a wet cotton ball, twice or three times, and finally the dry cotton ball was employed to wipe the fossa dry. ③ Glass ionomer was mixed with powder/fluid at a ratio of 2: 1 after filling (traditional ratio was 1: 1). The mixture was filled in the fossa, and pressed by a vaseline-coated forefinger that wore a glove. Several seconds later, the forefinger was removed, and redundant mixture was removed with a spoon excavator. One to two minutes later, the material was stiff, and the surface of tooth kept dry. ④ Articulating paper was used, and if necessary, a scoper was used for adjustment. The tooth was coated with Vaseline, and the tampon was removed. The child should not eat within 1 hour.

#### Score and evaluation of pit and fissure seal and new caries examination

Scoring: 0: perfect seal, no caries; 1: sealant fell off, no caries; 2: sealant fell off, with caries  
Evaluation standard: 0 and 1 refer to a success, but 2 refers to a failure.

#### Adverse effects

The patients were asked whether “unbearable, dislike, nausea” or not. 0: no; 1: yes.

#### Formula for evaluating the effect of glass ionomer<sup>[15]</sup>

Calculation of relative risk reduction (RRR):

$$RRR = \frac{|CER - EER|}{CER} \times 100\%$$

EER: the incidence of caries in the experimental group; CER: the incidence of caries in the control group.

Calculation of absolute risk reduction (ARR):

$$ARR = CER - EER$$

Calculation of number need to treat (NNT): a control measure was performed to observe how many cases were required to be treated to avoid the appearance of adverse outcomes once.

$$NNT = 1/ARR$$

#### Statistical analysis

After investigation, the data were input in Excel table to establish a database. All data were checked artificially. After database establishment, examination and cleaning of singular data were used. Logic check and cleaning functions among variables were

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employed for data purging. If a mistake was found, original data were rechecked and revised. The data of people number and rate were analyzed using SPSS 13.0. Intergroup and intragroup differences were analyzed using Chi-square test. A value of  $P < 0.05$  was considered statistically significant.

## RESULTS

### Quantitative analysis of participants

The survey included 100 children, and finally 89 children entered the result analysis with the loss rate of 11%. No intentional analysis was performed.

### Effect of ART glass ionomer sealant on caries prevention

The incidence rates of caries were 8.69% and 10.33%, respectively, at 6 and 18 months after treatment with ART glass ionomer sealant; while the incidence rates of caries without ART glass ionomer sealant were 22.28% and 25.54% ( $P < 0.01$ ; Table 1).

Caries	6 mon		18 mon	
	Number of experimental teeth	Number of control teeth	Number of experimental teeth	Number of control teeth
No	168/91.31	143/77.72	165/89.68	137/74.46
Yes	16/8.69	41/22.28	19/10.33	47/25.54
Total	184/100	184/100	184/100	184/100
$\chi^2$	11.138		12.371	
P	0.001		0.000	

RRR calculation: Up to 18 months after treatment, the incidence of caries was decreased by 40.45% compared with the control (Table 2).

Group	Caries (+)	No caries (-)	Total
ART glass ionomer sealant	A(19)	B(165)	A+B(184)
Blank control	C(47)	D(143)	C+D(184)

$EER=A/(A+B)=19/184=10.33\%$ ,  $CER=C/(C+D)=47/184=25.54\%$ ,  $RRR=(25.54\%-10.33\%)/25.54\% \times 100\%=40.45\%$ . RRR indicated the relative reduction in the incidence in the two groups. In the present study, the incidence of caries was 25.54% in the control group and 10.33% in the experimental group. The relative incidence of caries in the experimental group was reduced by 40.45% compared with the control group.

ARR calculation:  $ARR=25.54\%-10.33\%=15.21\%$ , indicating the absolute amount of the increase or decrease in the disease incidence. In the present study, the incidence of caries was 25.54% in the control group and 10.33% in the experimental group. The absolute incidence of caries in the experimental group was reduced by 15.21% compared with

the control group. 25.54 teeth having caries in every 100 teeth without sealing treatment could be reduced to 15.21 teeth having caries with sealing treatment.

NNT calculation: NNT indicated that a control measure was performed to observe how many cases were required to be treated to avoid the appearance of adverse outcomes once. In the present study,  $NNT=1/15.21\%=6.57$ , suggesting that one caries tooth can be reduced after 6.57 teeth have received ART glass ionomer sealant.

### Retention of sealant after ART glass ionomer sealing

The retention and missing rates of sealant are seen in Table 3.

Retention of sealant	6 mon	18 mon
Existence of sealant	177/94.15	147/77.72
Complete or partial detachment	11/5.85	41/23.94
Total	188/100	188/100

### Detachment condition of sealant materials on different tooth positions

The detachment condition of sealant materials on different tooth positions are seen in Tables 4, 5.

Item	Maxillary first deciduous molar	Maxillary second deciduous molar	Mandibular first deciduous molar	Mandibular second deciduous molar
No detachment	42	38	37	36
Detachment	1	5	6	7
Detachment rate (%)	2.33	11.63	13.95	16.28

Item	Maxillary first deciduous molar	Maxillary second deciduous molar	Mandibular first deciduous molar	Mandibular second deciduous molar
No detachment	37	30	33	30
Detachment	6	13	10	13
Detachment rate (%)	13.95	30.23	23.26	30.23

### Adverse reaction

ART glass ionomer seal was characterized by short operation time [(8.21±0.52) minutes], no etching, no refiller washing and strong power aspiration. Only one case felt uncomfortable during the operation, and this child experienced strong gag reflex.

## DISCUSSION

For some reasons, the resin sealant is not popularized in the

treatment of deciduous caries. One of the main reasons is wet compartment<sup>[16]</sup>: the teeth must be absolutely dry during etching and sealant coating. For the cooperative patients, cotton cylinder is enough to ensure the drying of the teeth; but for children who cannot cooperate the treatment, especially young children, it is very difficult to apply the cotton cylinder for wet compartment.

Invented and reported by Wilson *et al*<sup>[17]</sup> in 1972, glass ionomer materials have been widely used within 30 years. The composition of glass ionomer materials is a kind of silicate glass powder and polyacrylic acid liquid, also known as aluminosilicate polyacrylic acid<sup>[18]</sup>, characterized by acrylic adhesion, biocompatibility and silicate glass powder rigidity, strength and fluoride release, sustained release of fluoride after solidification, which can be used for treatment of pit and fissure caries. As previously reported, glass ionomer sealants have a poor wear resistance and low rupture strength that are easy to fall off on the occlusal surfaces, and therefore, the resin sealants are not replaced. In recent years, many foreign scholars carried out a series of clinical studies on "high-strength, high-bonding glass ionomer" as a permanent pit and fissure sealant<sup>[19]</sup>. This material can release fluoride ions slowly after tooth sealing to play the role of fluoride and traditional sealers against caries. In view of the above, the authors firstly studied glass ionomer "Fuji IX" with high strength and high adhesion as a pit and fissure sealant against deciduous caries of young children in China. The present study has certain advantages. The results showed that the retention rates of sealant materials were 94.15% and 77.72%, respectively, at 6 and 18 months after treatment with ART glass ionomer sealant. During the treatment, in combination with "finger pressure method" of ART technique, the material powder and liquid was mixed at 2: 1, and the Vaseline was coated on the sealant surface, which demonstrated that retention rate of ART glass ionomer sealant was better than the fluid resin sealant, which was identical to previous foreign studies<sup>[20]</sup>.

The incidence rates of caries were 8.69% and 10.33%, respectively, at 6 and 18 months after treatment with ART glass ionomer sealant; while the incidence rates of caries without ART glass ionomer sealant were 22.28% and 25.54%. There was a significant difference between the two groups ( $P < 0.01$ ).

After treatment with ART glass ionomer sealant, the incidence of caries was decreased by 40.45% (RRR=40.45%) compared with the blank control, indicating that 25.54 teeth having caries in every 100 teeth without sealing treatment could be reduced to 15.21 teeth having caries with sealing treatment (ARR=CER-EER=25.54%-10.33%=15.21%). Up to the 18th month after treatment, the incidence rates of caries were 25.54% in the blank control group and 10.33% in the ART glass ionomer sealant group, ARR=15.21%. NNT=1/15.21%=6.57, indicating that one caries tooth can be reduced after 6.57 teeth have received ART glass ionomer sealant treatment. These data suggest that glass ionomer sealant is significantly effective in reducing the incidence of caries in children. Foreign studies have demonstrated that in patients with traditional glass ionomer pit and fissure sealant, 50% sealant materials completely fell off, but 2 years later, only 5% teeth after sealing suffered from caries<sup>[21]</sup>. Results

from the present study have confirmed that the complete retention rate of glass ionomer materials with high strength and high adhesiveness reached 77% after 18 months, and only 8.69% teeth after sealing suffered from caries, which was similar to the results reported by foreign scholars<sup>[22-23]</sup>. Two factors can explain the effect of glass ionomer against caries occurrence<sup>[24-25]</sup>. Firstly, glass ionomer materials release some fluorine, which can enter the enamel around the pit and fissure, resulting in a strong ability against caries. Secondly, glass ionomer materials still exist in 93% deep pit and fissure after the glass ionomer sealants completely fall off. These remained glass ionomer sealant may provide an effective barrier to prevent caries formation.

The high loss rate of young children also results in the difficulty in carrying out relevant studies, and foreign studies have shown that the loss rate is up to 20%–30% within 1–3 years<sup>[26]</sup>. We performed the survey at the Guangzhou First Kindergarten, the children in the kindergarten had a good compliance, and the current loss rate was only 11%. The present study filled a gap in the application of ART glass ionomer pit and fissure sealant to deciduous research. In conclusion, ART glass ionomer sealant with simple use and low detachment rate of children's deciduous teeth is confirmed to have a good effect against caries. Under poor wet compartment and uncooperative conditions, in combination with "finger press" method, glass ionomer materials with low flowability, high strength and high adhesiveness can be used as a substitute of light-cured flowable resin sealant and spread in caries prevention in young children.

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## 高强度玻璃离子材料结合非创伤性充填技术应用于乳牙封闭防龋\*\*\*★

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### 摘要

**背景:** 以往报道的玻璃离子封闭剂耐磨性能差, 抗折强度低, 合面封闭剂很容易脱落。

**目的:** 观察在非创伤性充填技术下高强度玻璃离子应用于幼儿乳牙窝沟封闭的效果。

**方法:** 按自身对照的方法, 对 89 名 3 岁幼儿的左或右半口符合窝沟封闭条件的乳磨牙在非创伤性充填技术下行玻璃离子窝沟封闭, 对侧半口符合窝沟封闭条件的乳磨牙作空白对照。

**结果与结论:** 非创伤性充填技术下窝沟封闭后 6, 18 个月, 玻璃离子完整保留率为 94.15% 及 77.72%。6 个月时牙位脱落率: 下颌第二乳磨牙 > 下颌第一乳磨牙 > 上颌第二乳磨牙 > 上颌第一乳磨牙, 18 个月时牙位脱落率: 下颌第二乳磨牙 > 上颌第二乳磨牙 > 下颌第一乳磨牙 > 上颌第一乳磨牙。非创伤性充填技术下玻璃离子封闭的乳牙患龋率远低于未作封闭的乳牙, 6, 18 个月时差异均有显著性意义 ( $P < 0.01$ )。提示非创伤性充填技术下高强度玻璃离子窝沟封闭在幼儿乳牙中的脱落率低, 操作简单, 防龋效果肯定。

**关键词:** 幼儿; 乳牙龋; 窝沟封闭; 玻璃离子; 非创伤性充填技术

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**伦理批准:** 文章采用上市已久的用于儿童龋齿治疗的充填材料——Fuji IX GP(化学固化, 日本), 经广东省口腔医院医学伦理委员会批准进行临床试验。

**本文创新性:** 检索 CHKD、PubMed 的相关文献。CHKD 检索时间为 2000/2010; ①关键词为玻璃离子、空白对照、窝沟封闭、乳牙, 检索到 538 篇文章。②关键词为乳牙、窝沟封闭时检索到 134 篇。③关键词为玻璃离子、乳牙、窝沟封闭时检索到 1344 篇。④关键词为玻璃离子、非创伤性充填技术检索到 1 篇。PubMed 检索时间为 1995/2010, 搜索同时符合下列条件的文献: ①随机对照试验。②观察时间在 2 年以上。③实验组用含氟玻璃离子, 对照组用空白对照。④可以提供有效数据如龋齿患病率, 新生龋发病率等用于效果分析。搜索到 0 篇文章, 最终检索结果显示国内外有关非创伤性充填技术高强度玻璃离子应用于乳牙封闭防龋的研究报道尚少, 文章具有一定的先进性。