

## A One-Year Clinical Evaluation of a High-Viscosity Glass Ionomer Cement in Primary Molars

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### Abstract

In this study one-year clinical results of high-viscosity glass ionomer cement (GIC) (Fuji IX, A3, GC, Japan) were determined in class I and class II restorations in 68 primary molars with occlusal or approximal caries. Following caries removal and cavity preparation, the teeth were restored with Fuji IX. The restorations were evaluated according to the U.S. Public Health Service's (USPHS) criteria at the end of one year. Statistical analyses of the data obtained were analyzed using the  $X^2$  test. The evaluations showed no statistically significant difference between class I and class II restorations in terms of the color mismatch, anatomic form, marginal adaptation, and secondary caries ( $P>0.05$ ), but they were statistically significant with regard to cavosurface marginal discoloration ( $P<0.05$ ). At the end of one year, the success rate of the class I and class II restorations of the primary molars restored with Fuji IX was 94%.

**Keywords:** Glass ionomer cement, GIC, high viscous glass ionomer cement, primary tooth restorations

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## Introduction

Glass ionomer cements (GIC) were first developed by Wilson and Kent<sup>1</sup> in 1972. GICs were reported to have both advantages and disadvantages. The advantages of the GICs are: physicochemical bonding to enamel and dentin, release of fluoride, rechargeable when exposed to fluoride treatments and fluoride dentifrices, and expansion coefficient comparable to tooth structure. Despite their outstanding properties, GICs have some disadvantages. Their disadvantages are: the brittleness of the material, lack of strength, and poor resistance to wear on occlusal surfaces.<sup>2-10</sup> To eliminate these disadvantages, the combination of alloy powder with glass ionomers was used in 1983 by Simmons.<sup>11</sup> He reported clinically successful results with this newly-developed material.<sup>11</sup> However, Bilgin et al.<sup>12</sup> evaluated clinical success rates of the combination of amalgam powder with glass ionomer and GIC restorations in primary teeth. They found no significant difference between the combination of amalgam powder with glass ionomer and GIC restorations in the clinical failure rate at the end of six months. Cements, derived from high temperature sintering of silver particles to fusing glass powder, were first developed based on conventional GICs in the mid-1980s.<sup>13,14</sup> Nevertheless, clinical studies have shown the mean survival time of glass cement restorations is not better than that of conventional GICs, especially in the class II restorations in primary molars.<sup>9,15,16</sup> Kilpatrick et al.<sup>16</sup> observed significantly better results for conventional glass ionomer (77%) after 2.5 years compared to the cement material (59%). Hickel and Voss<sup>17</sup> also determined the survival rate of the cement was 58% in the class II cavities in the primary molars after three years.



Generally, glass cement materials have displayed lower clinical success rates relative to other restorative materials. Because of the available clinical advantages of GICs, efforts had been made to improve the properties of conventional glass ionomers. In the early-1990s high-viscosity GICs were developed for use with atraumatic restorative treatment in some developing countries. In some investigations it was reported both the abrasion resistance and flexural strengths of high-viscosity GICs were higher than those of conventional and cement glass ionomers.<sup>18-21</sup> Lo et al.<sup>22</sup> found the 24-month success rates of atraumatic restorative treatment in primary teeth restored with a highly viscous GIC (Fuji IX, A3, GC, Japan) were 92 and 75% for class I and class II restorations, respectively. Hickel and Manhart<sup>15</sup> reported success rates of the high-viscosity GICs were 94% for one year and 72% for two years. Frankenberger et al.<sup>23</sup> recommended the use of the high-viscosity GICs for the class I and class II restorations in the primary molars.

The aim of our 12-month study was to clinically evaluate, using the U.S. Public Health Service's (USPHS) criteria, a high-viscosity GIC restorative material in class I and class II restorations in primary first or second molars.

## Materials and Methods

This study was conducted in Ataturk University's Pedodontic Clinic on 68 primary molars, having occlusal or approximal caries, of 42 children at the mean age of  $6.5 \pm 1.6$  years. It was required carious lesions should not appear radiographically in the pulpal one-third of dentin<sup>24</sup> and that teeth should need only class I or class II restorations.

Class I or class II cavities were prepared with high-speed #330 diamond burs (North Bell 820/042, Italy), and carious tooth tissue was removed with low-speed #016 round steel burs (0337/51766 Engelskirchen, Germany). Narrow isthmuses in the preparations were avoided to provide a sufficient bulk of material.<sup>25</sup> The width of the isthmuses at the class II cavity design was more slightly one-third the intercuspal dimension.<sup>26</sup> After the cavity preparation, teeth were isolated using a quick-dam. The contoured

matrix was placed on teeth with class II cavities. To remove the smear layer from the cavities, conditioner agent ( $H_2O_2$ , AOSEPT® Novartis) was applied for 20 seconds. In recent studies no significant differences were found between a poliacrylic acid conditioner agent and  $H_2O_2$ . Therefore, the authors preferred to use the  $H_2O_2$  conditioner agent for this study.<sup>27,28</sup> The cavities were rinsed with water spray and dried with polyurethane pellets. No base materials were used in any cavity. Next the restorative material (Fuji IX) was mixed according to the manufacturer's instructions (powder-to-liquid mixing ratio = 1:1) and placed into the prepared cavities. All exposed surfaces of the restorative materials were protected by applying GIC varnish (Final Varnish, Voco Cuxhaven, Germany). Contouring and finishing were accomplished using Sof-Lex discs (2380, 3M ESPE Dental Products D-82229 Seefeld-Germany); again, all surfaces of the restorations were covered by applying the varnish.

At the end of one year, clinical views of the restorations were recorded using an intraoral camera (D60204449 RF System, Japan). In addition marginal adaptation of the restorations was assessed using a dental explorer. The clinical condition of the restorations was assessed according to USPHS criteria (Table 1).<sup>29</sup> Bite-wing radiographs were taken of the class II restorations in addition to the clinical evaluation. Chi-square test was applied in order to determine whether there was a statistically significant difference between the data obtained.

### Results

In our evaluation of the one year success rates of Fuji IX in primary first or second molars, a total of 68 class I and class II cavities were restored with this restorative material. The distribution of the restorations in the primary molars is given in Table 2.

Clinical examination and inspection using an intraoral camera of each restoration were independently done by two calibrated authors. Decision by consensus was made whenever disagreement occurred.

Two dentists evaluated 67 of the 68 restorations using USPHS criteria. After 12 months (Figures 1, 2, 3, 4, and 5), only one restoration was



**Figure 1.** Clinical view of class I restoration in tooth 64 after 12 months.



**Figure 2.** Class I restoration in tooth 75 after 12 months of clinical service.



**Figure 3.** At the end of one year, class II restoration in tooth 74.



**Figure 4.** Class II restoration fractured and caries on the approximal surface in tooth 55.

**Table 1. U.S. Public Health Service's criteria rating system.**

<b>Category and rating</b>	<b>Criteria</b>
<i>Color match</i>	
Alpha	Restoration matches adjacent tooth structure in color, shade, or, translucency.
Bravo	There is a mismatch in color, shade, or translucency but within the normal range of adjacent tooth structure.
Charlie	There is a mismatch in color, shade, or translucency outside of the normal range of adjacent tooth structure.
<i>Cavosurface marginal discoloration</i>	
Alpha	There is no discoloration anywhere on the margin between the restoration and the tooth structure.
Bravo	Discoloration is present but has not penetrated along the margin in a pulpal direction.
Charlie	Discoloration has penetrated along the margin in a pulpal direction.
<i>Anatomic form</i>	
Alpha	The restoration is continuous with existing anatomic form.
Bravo	The restoration is discontinuous with existing anatomic form, but missing materials are not sufficient to expose dentin or base.
Charlie	Sufficient restorative material is missing to expose the dentin or base.
<i>Marginal Adaptation</i>	
Alpha	There is no visible evidence of a crevice along the margin into which the explorer will penetrate.
Bravo	There is visible evidence of a crevice along margin into which the explorer will penetrate or catch.
Charlie	The explorer penetrates the crevice, and dentin or base is exposed.
Delta	The restoration is mobile, fractured, or missing, either in part or total.
<i>Secondary Caries</i>	
Alpha	No caries is present at margin of the restoration, as evidenced by softness, opacity, or etching at the margin.
Bravo	There is evidence of caries at the margin of the restoration.

Table 2. The distribution of the restorations according to primary molars.

Cavities	Teeth	
	IV	V
Class I	6	28
Class II	13	21
Total	19	49

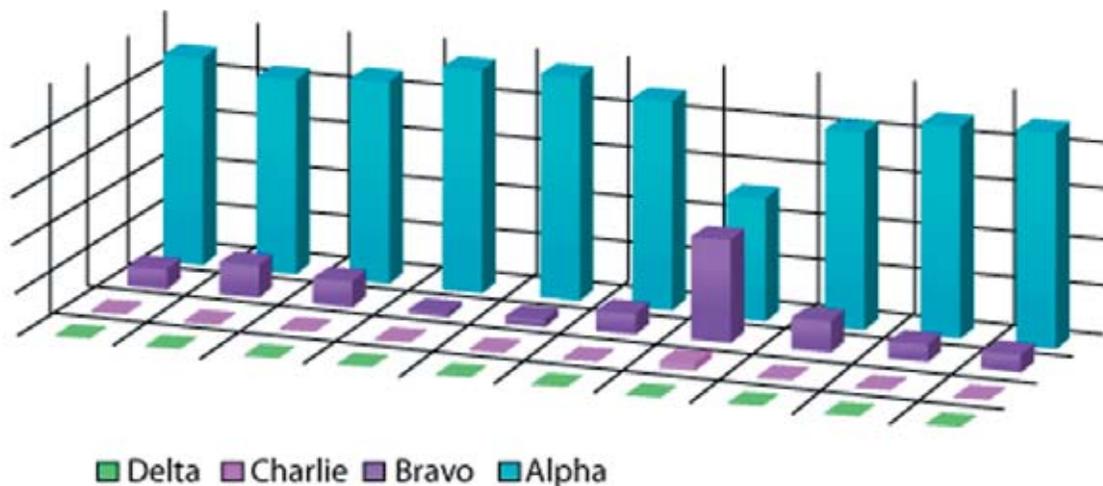


Figure 5. USPHS criteria ratings of class I and class II restorations

excluded from the study due to being fractured completely. One approximal fracture of a class II restoration was detected (Figure 4).

The results of the USPHS criteria are given in Figure 5.

Almost all of the class I and class II restorations presented Alpha ratings at one year recall in terms of both color. In both class I and class II restorations, equal numbers of Bravo ratings were seen. There was no statistically significant difference between these two restoration types ( $P>0.05$ ). Color mismatches were evaluated using

a vita color scale (Lumin Acryl V-Farbring D-7880 Bad Säckingen/Germany) considering the body color of the restorations.

The difference between the cavosurface marginal discoloration of class I and class II restorations was statistically significant ( $P<0.05$ ). The percentages of Alpha ratings for cavosurface marginal discolorations were 85.3% for class I restorations and 51.5% for class II restorations. Five class I restorations (14.7%) and fifteen class II restorations (45.4%) exhibited Bravo ratings. Only one class II restoration (3.1%) demonstrated a Charlie rating.

In anatomic form it was seen that 30 class I (88.2%) and 28 class II (84.8%) restorations had Alpha ratings, and four class I (11.8%) and five class II (15.2%) restorations had Bravo ratings.

Alpha ratings for marginal adaptation in the class I and class II restorations were 97.1 and 90.9%, respectively. One class I (2.9%) and three class II (9.1%) restorations showed Bravo ratings for marginal adaptation.

At the end of 12 months, secondary caries were found in only one tooth for the class I restorations and in three of the class II restorations. That is, Alpha ratings were 97.7% for class I restorations and 90.9% for class II restorations. Also, one class I (2.9%) and three class II (9.1%) restorations were rated Bravo. Caries lesions in the teeth with Bravo ratings were not detected radiographically.

According to the criteria for anatomic form, there was no statistically significant difference between marginal adaptation and secondary caries restorations ( $P>0.05$ ).

After 12 months, four (5.97%) of the total 67 restorations were replaced. In the radiographical examination of the class II restorations caries were not detected.

## Discussion

The high-viscosity GICs were designed as an alternative to amalgam restorations, especially in deciduous molars.<sup>23</sup> In the present study, no statistically significant differences were found between the Alpha ratings of class I and class II restorations with respect to the USPHS criteria of color match, anatomic form, marginal adaptation, and secondary caries ( $P>0.05$ ) but was statistically significant for cavosurface marginal discoloration Alpha ratings between the class I and class II restorations ( $P<0.05$ ).

In this study, in accordance with cavosurface marginal discoloration, the class I restorations had more Alpha ratings than the class II restorations (85.3% and 51.5%, respectively). As mentioned above, five class I restorations (14.7%) and 15 class II restorations (45.4%) had Bravo ratings. Only one class II restoration (3.1%) demonstrated a Charlie rating. This difference

was statistically significant ( $P<0.05$ ). The reason may be explained as follows. The cavosurface marginal discoloration criterion may be considered as a sign of microleakage. To reduce the microleakage and to remove the smear layer and surface contaminants, hydrogen peroxide was applied to the prepared cavities as a conditioner agent because some manufacturers recommend the application of 3%  $H_2O_2$  to cavities prior to placement of glass ionomer restorative materials. However, in this study the application of hydrogen peroxide may have failed to remove the smear layer and surface contaminants from cavities completely forming an effective bonding to the tooth hard tissues. Gurbuz and Yilmaz<sup>28</sup> conducted a study with conditioner class I cavities in primary molars using the following different agents, which were restored with Fuji IX: Fuji Cavity Conditioner, maleic aside, phosphoric aside, and hydrogen peroxide. They found hydrogen peroxide reduced the microleakage but failed to eliminate it completely. Also, the other conditioner agents proved to be more effective than this material in eliminating the microleakage. Accordingly, if we had applied a different conditioner agent instead of hydrogen peroxide, we could have obtained more Alpha ratings according to the cavosurface marginal discoloration criterion.

In the evaluation of the restorations with respect to the anatomic form criterion, there was no difference between Alpha ratings of class I and class II restorations ( $P>0.05$ ). This may be explained by a smaller than average particle size of high viscous GICs and their improved distribution within the matrix.<sup>23</sup> Furthermore, some investigators have also stated the abrasive resistance and flexural strengths of the high-viscosity GICs are better than those of the conventional and cement GICs.<sup>18-21</sup>

In this study the Alpha ratings of the marginal adaptation of the restorations were 97.1% for the class I restorations and 90.9% for the class II restorations. The presence of some failure in the marginal adaptation of both restorations might be the result of the fact the sensitivity of the GICs to humidity in the early period has increased the solubility of the cements.<sup>30</sup> In the present study Alpha ratings of marginal adaptation of the restorations agreed with those of Bilgin et al.<sup>12</sup> However, they evaluated the restorations

for a period of six months. Gundogdu and Kirzioglu<sup>30</sup> reported Alpha ratings of the marginal adaptation of the conventional GICs in the class II restorations as 33.3% at the end of a year. Their results were not as favorable as those in the present study. This may be attributed to their use of conventional GIC. High-viscosity GICs have better physical properties than conventional GICs.<sup>18-21</sup>

Caries were found adjacent to both class I and class II restorations. After one year, only one tooth exhibited a Bravo rating in the class I restorations, while three teeth exhibited the Bravo ratings in class II restorations. One of the Bravo ratings observed in the class II restorations in accordance with secondary caries criterion was the restoration that exhibited the Charlie rating in the cavosurface marginal discoloration criterion, while the others were the ones that exhibited Bravo ratings. According to secondary caries criterion, development of caries lesions detected in four teeth might depend on inadequate saturation of the adjacent tooth hard tissues with fluoride released from Fuji IX.



Though the base material was not placed on the bases of the cavities in our study, none of the restored teeth developed postoperative sensitivity. Cho et al.<sup>31</sup> stated there was no need for the use of a base material before the placement of the conventional GICs.

At the end of one year, the success rate of the class I and class II restorations was 94.03% in our study. Similar findings were reported by Basso and Edelberg and Hu et al.<sup>32,33</sup> Basso and Edelberg conditioned the class I and class II cavities using polyacrylic acid in the primary teeth and restored them with Fuji IX. They showed 98% retention in class I and class II restorations.<sup>32</sup> Hu et al. applied polyacrylic acid to the cervical cavities of adult patients and restored using Fuji IX and Ketac Molar. At the 12 month recall period, they accounted for 2.7% of the failed Fuji IX restorations and for 17.8% of the failed Ketac Molar restorations.<sup>33</sup>

In the present study this material was observed as being successful at the end of one year in both class I and class II cavities restored using a H<sub>2</sub>O<sub>2</sub> conditioner agent. Longer duration studies are required to determine whether high viscous GICs can be an alternative to the amalgam.

### Conclusions

1. The class I restorations exhibited better results than the class II restorations in terms of the cavosurface marginal discoloration, marginal adaptation, and secondary caries.
2. The success rate of the class I and class II restorations at the end of a year was 94.03% (97.16% and 90.9%, respectively).
3. Fuji IX restorations in the cavities conditioned using H<sub>2</sub>O<sub>2</sub> conditioner agent was found successful after one year follow up.

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