

Evaluation of the Clinical Behavior of Resin Modified Glass Ionomer Cement on Primary Molars: A Comparative One-year Study

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Abstract

Aim: The objectives of the present study were to evaluate and compare the clinical behavior of resin modified glass ionomer cement (RMGIC) on primary molars with conventional and modified cavity preparations.

Methods and Materials: Forty-two children, 5-9 years of age, having bilateral initial occlusal caries on the mandibular primary second molars were selected for the study. A split mouth design was employed where conventional Class I cavities with a 90° cavosurface angle were prepared randomly on primary second molars on one side and modified cavities with a 1 mm straight bevel along the cavosurface margin on the contra-lateral side. These cavities were restored with RMGIC. The restorations were evaluated during subsequent visits, for a period of one year.

Results: At the end of one year, 90% of the restorations survived in the conventional cavity group whereas 100% of the restorations survived in the modified cavity group.

Conclusion: Incorporation of a bevel in Class I cavities increases the survival rate of RMGIC restorations. There was no significant difference in the clinical behavior between the two groups. However, beveling does contribute to long term clinical success of these restorations.

Clinical Significance: Incorporation of a straight bevel in conventional cavities will improve the retention of RMGIC by increasing the bonding area and enhancing the desired properties of the material.

Keywords: Resin modified glass ionomer cement, RMGIC, beveling, primary molars, conventional cavities

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Introduction

Pediatric dental care is an integral component of a child's overall healthcare. Providing this optimal oral healthcare comes under the purview of all dentists, especially pedodontists.¹

Among all the aspects of pediatric dentistry, conservative restoration of primary teeth continues to be the most important issue today. To date, most of the restorative materials used have inherent shortcomings, such as mercury toxicity associated with amalgam, poor strength of glass ionomer cements, polymerization linkage, microleakage associated with composites, and the unaesthetic appearance of stainless steel crowns.

In the current era of adhesive dentistry, glass ionomer cements offer the following advantages:^{2,3,4}

- A coefficient of thermal expansion similar to that of tooth structure
- A physicochemical bond to enamel and dentin
- Fluoride release from the restoration

However, its compressive strength is questionable as is its wear resistance and color stability in posterior teeth. To overcome these shortcomings, restorative materials that incorporate light curable resin and increased filler content, i.e., resin modified glass ionomer cements (RMGIC), were developed.⁵ The command set of RMGIC resulted in the early development of higher bond strength, reduced brittleness, lower moisture sensitivity, reduced solubility and wear resistance,^{6,7,8} and it has antibacterial characteristics.⁹ These cements have demonstrated success by inhibiting secondary caries at restoration margins and have the ability to enhance remineralization by inhibiting adjacent proximal caries.^{10,11,12}



G.V. Black's principles of cavity preparation for permanent teeth, although initially considered the gold standard in primary teeth, are not relevant today. The restoration of deciduous teeth using adhesive materials warrants non-adverse conditions in cavity preparation. Therefore, some of the major differentiating factors in pediatric restorative dentistry are cavity design and preparations that consider tooth morphologic differences such as a narrower occlusal table, a reduced thickness of enamel and dentin, high pulp horns, and altered tooth composition.¹³

Within the currently available literature, there are only a few studies that evaluate the effect of cavity morphology on the survival rate of adhesive resin in primary teeth. Adhesion between the restorative material and tooth structure is the major determinant in the success of a restoration. If the state of bonding is poor, microleakage at the cavity margins is inevitable leading to secondary decay, marginal pigmentation, and pulpitis.¹⁴

To overcome this limitation, beveling the cavity margin to increase the available bonding area has been proposed; *in vitro* studies have shown there is a decrease in microleakage in cavities with beveled margins.^{14,15} Very few clinical trials have been undertaken or documented to evaluate the clinical performance of RMGIC after incorporating changes in cavity morphology. This study was undertaken to evaluate and compare the survival rate of RMGIC restorations in primary molars with standardized class I conventional and modified cavity preparations.

Materials and Methods

The present *in vivo* study was carried out in the Department of Pediatric and Preventive Dentistry in association with the Department of Oral Pathology and Microbiology of the Bapuji Dental College and Hospital in Davangere, India.

Forty-two children, 5-9 years of age, were selected from four different schools in the city of Davangere. A general dental examination of all children was done, and informed written consent was obtained from the parents prior to the start of the study. The selection criteria included the presence of bilateral initial occlusal caries involving a minimum of two or more pits and fissures on mandibular primary second molars with no gross destruction of the cusps.

Isolation was achieved using a rubber dam. Class I cavities were prepared on each of the bilateral mandibular primary second molars, on all 42 subjects selected using a Mani CR-12F straight fissure diamond bur (MANI Inc., Utsunomiya, Tochigi, Japan). The Class I cavities were prepared as small conventional cavities with undercuts and occlusal dovetails.¹⁶ They were not extended for prevention, but the target dimensions of the cavity depth were at least 1-1.4 mm with a width of the cavity being one-third the distance between the buccal and lingual cusps.¹⁴ The specifications for a conventional cavity included a 90° cavosurface line angle and, for a modified cavity, a straight bevel at an angulation of 45° using a superfine taper fissure bur (Figure 1). The cavities were randomly assigned. To create precisely 1 mm of straight bevel, a point measuring 1 mm from the tip of the bur was marked on the fissure bur while placing the bevel.

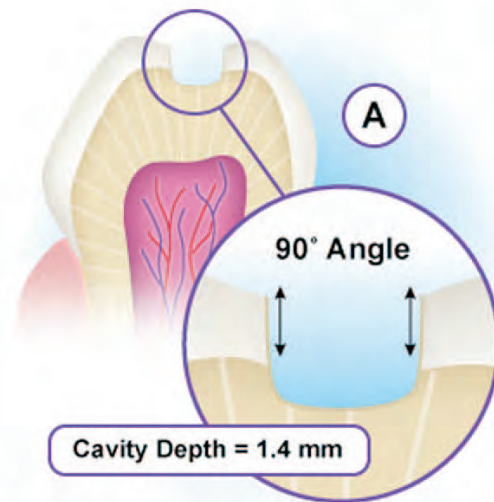


Figure 1A. Conventional Class I preparation with no bevel.

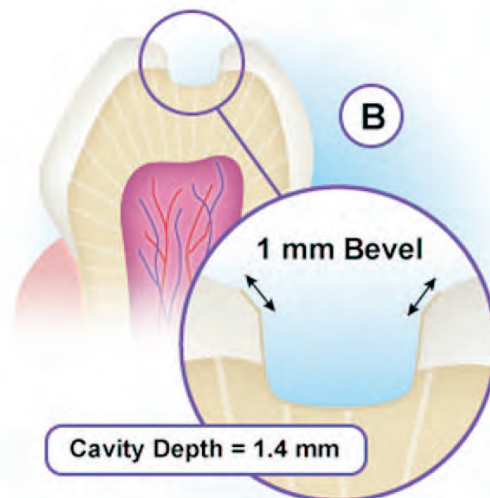


Figure 1B. Conventional preparation with a 1 mm bevel along the cavosurface margin.

After the preparation, both of the cavities were conditioned and restored with Vitremer® (3M Dental Products, St. Paul, MN, USA) in accordance with the instructions. The mixed RMGIC material was then inserted into the cavity preparations and light polymerized for 40 seconds. The surfaces of the restorations were coated with cavity varnish after the initial hardening. The occlusion and articulation were evaluated for high points and then polished. The restorations were in contact with 168 unrestored occlusal surfaces in 82% of primary and 18% of permanent teeth.

Impressions of the restored teeth were made using Reprosil™ vinyl polysiloxane impression

Table 1. Quality evaluation criteria.¹⁷

<p>Score 1 (Meets all standards)</p>	<ul style="list-style-type: none"> • Surface of restoration is smooth or slightly rough or pitted, but shows no irregular surface. • Restoration contour is continuous with existing anatomical contour • No visible evidence of a crevice along the margin.
<p>Score 2 (Meets basic standards)</p>	<ul style="list-style-type: none"> • Surface of the restoration is rough and irregular but does not show little cracks. • Restoration is slightly under contoured. Occlusal contour is not continuous with that of cusps. • Visible evidence of crevice along the margin.
<p>Score 3 (Replace for Prevention)</p>	<ul style="list-style-type: none"> • Surface of restoration is deeply pitted or shows small cracks or grooves not related to anatomy. • A clearly visible step from tooth to filling material can be seen indicating under contoured; filling with probably exposed dentin or base.
<p>Score 4 (Replace)</p>	<ul style="list-style-type: none"> • Surface is flaking or fractured • Mobile or fractured restoration • Tooth structure fracture • Restoration is missing or a traumatic occlusion or restoration causes pain in tooth.

Note: Score 3 and Score 4 were considered as clinically failure and needed replacement.

material (Dentsply-Caulk, Milford, DE, USA), and casts were poured with die stone. The retrieved casts were viewed under a stereomicroscope to examine the topography of the restoration.¹⁷ During subsequent visits, at the end of six months and one year, impressions were similarly made and the casts were scored under the stereomicroscope using quality evaluation criteria (Table 1). The restorations were recorded as failed if they needed replacement.

The data obtained was statistically analyzed using the Chi-square and McNemer tests.

Results

Quality of Restoration at Various Visits (Table 2)

In the conventional cavity group, by the end of one year, 64% of restorations met all standards (Score 1) while 29% of restorations met basic standards (Score 2). During the entire period of the study, four teeth needed replacement: one after six months (Score 3) and three after one

year (Score 4). Thus, the resultant retention rate was 90%.

In the modified cavity group, by the end of one year, 81% of restorations met all standards (Score 1), 19% of restorations met basic standards (Score 2), and none of the restorations needed replacement, giving a retention rate of 100%.

The quality of restorations gradually decreased from the first visit to the third visit in both groups. However, when compared, the conventional group showed more failures in quality than the modified group.

Quality of Restorations within the Same Group (Table 3)

A statistically significant decrease in the quality of restorations was seen between the first and second and the second and third visits ($P < 0.05$). However, a highly statistically significant difference was seen between the first and third visit and the second and third visits in the conventional group ($P < 0.001$).

Table 2. Pattern of quality of restorations at various visits.

Cavity Type	Visit	Total No.	Quality Evaluation Scores			
			Score 1	Score 2	Score 3	Score 4
Conventional	I	42	42 (100)	-	-	-
	II	42	36 (86)	5 (12)	1 (2)	-
	III	42	27 (64)	12 (29)	-	3 (7)
Modified	I	42	42 (100)	-	-	-
	II	42	39 (93)	3 (7)	-	-
	III	42	34 (81)	8 (19)	-	-

Table 3. Comparison of changes in the quality of restorations at various visits.

	Visits	No Change n (%)	Quality Decreased n (%)	Difference in Visits*
Conventional Cavity (CC)	T2 – T1	36 (86)	6 (14)	P<.05, S
	T3 – T1	27 (64)	15 (36)	P<.001, S
	T2 – T3	30 (72)	12 (28)	P<.001, S
Modified Cavity (MC)	T2 – T1	39 (93)	3 (7)	P=0.25, NS
	T3 – T1	34 (81)	8 (19)	P<.05, S
	T2 – T3	37 (88)	5 (12)	P=0.07, NS

* McNamar's Test
P<0.05 Significant

There was no statistically significant decrease between the first and second visits (P=0.25) and the second and third visits (P=0.07), but a significant decrease in quality was seen between the first and third visits (P<0.05).

Quality of Restorations between Conventional and Modified Groups (Table 4)

No statistically significant difference between the conventional group and the modified group was seen when compared between any of the visits.

Discussion

The present *in vivo* study was carried out to evaluate the clinical behavior of RMGIC when used in restoring conventional and modified Class I cavity preparations in primary molars.

The selection criterion in the present study was the presence of bilateral initial occlusal caries

on mandibular primary second molars. The split mouth design was chosen so the restorations on both mandibular primary second molars were exposed to an identical environment, thus, eliminating any bias.

Numerous factors can lead to the failure of resin restorations. The integrity of the tooth-restoration interface is dependent on several factors, such as polymerization shrinkage at the time of cure, water absorption that takes place after the curing process, and the difference between the linear coefficient of thermal expansion of the tooth and the restorative material as well as microleakage.^{4,18}

In order to overcome these disadvantages, beveling the enamel cavosurface margins has been proposed.^{15,19} Bowen et al.²⁰ showed beveling provides a greater marginal surface

Table 4. Comparison of changes in quality of restorations between conventional cavity and modified cavity (CC and MC).

Visits	Cavity	No Change		Quality Decreased		CC vs MC*
		No.	%	No.	%	
T2 – T1	Conventional Cavity	36	86	6	14	X ² = 1.12 P=0.29, NS
	Modified Cavity	39	93	3	7	
T3 – T1	Conventional Cavity	27	64	15	36	X ² = 2.93 P=0.09, NS
	Modified Cavity	34	81	8	19	
T2 – T3	Conventional Cavity	30	72	12	28	X ² = 3.61 P=0.06, NS
	Modified Cavity	37	88	5	12	

* Chi-square test
P>0.05, Not Significant

to compensate for polymerization shrinkage. Theoretically, this compensation showed reduced marginal leakage. This reduction of marginal leakage is important because leakage is associated with an influx of bacteria and post-operative sensitivity.¹⁵ In both primary and permanent teeth, enamel prisms or rods reportedly converge radially at pits and fissures when viewed as a distribution in relation to the axis of the tooth.¹⁴ The enamel rods that form the cavosurface angle must be supported (resting on sound dentin), and their outer ends must be covered by the restorative material to provide the strongest cavity wall if cavosurface beveling is done. These beveled margins will not be exposed to injury while condensing the restorative material against it.²¹ Considering the overall bonding mechanism of resin-containing materials, a cavity design that transects these enamel prisms is necessary to enhance the bonding force. Furthermore, beveling of the cavity margins becomes an additional requirement for proper marginal sealing.¹⁵

Straight and round bevels have been evaluated for cavity margin integrity before any application of restorative materials.¹⁴ Porte et al.²² showed when using composite resins, cavities with a long bevel resulted in better margins than cavities with a right angled butt joint or with a concave bevel. Moore and Vann¹⁵ reported microleakage values of 100% at non-beveled sites, but only 12% at beveled sites with composite resins.

The present study was therefore undertaken to evaluate the clinical behavior of RMGIC when used in conventional and modified cavity preparations in primary molars.

Vitremer™ RMGIC has improved mechanical strength and resistance to fracture from occlusal forces. Rapid initial light hardening of RMGIC prevents damage from over-hydration or desiccation. The clinical success of this material in primary second molars was evaluated by Croll et al.²³ in clinical trials. These advantages make them highly desirable alternatives to amalgam.^{24,25}

Impressions of the restored teeth were made with Reprosil™ vinyl polysiloxane impression material and casts were fabricated. Evaluation of the influence of cavity design on the longevity of the restorative material was conducted. The precision of the impression material renders the minute details and irregularities of the restorations more pronounced on the models, thus, enabling easier and better evaluation than a clinical assessment.

In the conventional cavity group the resultant survival rate at the end of one year was 90%. The observations of the present study were similar to those made by Croll²⁶ who reported 100% survival rate after one year for Class I conventional cavities on permanent molars using light cured glass ionomer cements. This slight difference may be attributed to the use of quality

evaluation criteria along with casts fabricated from vinyl polysiloxane impressions of the restored teeth which reveals more detailed surface morphology.¹⁷

At the end of one year, a 100% survival rate was seen in the modified cavity group. This can be attributed primarily to beveling. Beveling increases the area of bonding and helps to dissipate the stresses transferred to tooth structures through the polymerization contraction of the RMGIC. The increased area of bonding may be responsible for the better retention of the restorations in the modified cavity group. Similar results were also reported by Crim.²⁷

Referemces

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Conclusions

The following conclusions were drawn from the study:

- The survival rate for RMGIC in the conventional cavity group after one year was 90%.
- The survival rate for RMGIC in the modified cavity group after one year was 100%.
- There was no statistical significant difference in the survival rates of RMGIC between the conventional cavity and the modified cavity after one year.

Additional long-term clinical studies to evaluate the effect of cavity modifications on the survival rates and clinical performance of these restorative materials are recommended.

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