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A Comparative evaluation of different techniques for microleakage reduction of zirconomer restorations in primary teeth

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Abstract

Objectives: To use zirconomer in adjunction with Ketac molar, varnish and conditioning of teeth, in order to evaluate and compare their effect on the microleakage.

Methods and materials: Class V cavities were prepared on the buccal surface of 60 non- carious primary molars and were divided into four groups (n=15): group A-zirconomer Improved (control group), group B-zirconomer Improved with GIC, group C-zirconomer Improved with varnish, group D-zirconomer improved with 35% phosphoric acid conditioning. The samples were thermocycled and after application of nail varnish, were immersed in 0.5% methylene blue for 24 hours. The teeth were sectioned buccolingualy and microleakage was assessed using stereomicroscope. The degree of dye penetration was recorded and analysed with ANOVA and Post Hoc Bonferroni test.

Results: The mean score of microleakage was highest for the control group, and lowest for Group D. Difference between the four groups was statistically significant (p=0.001).When group A was compared with group B, difference was insignificant but there was significant difference between group A and C and Group A and D.

Conclusion: Within the limitations of the study, the results suggest that conditioning of the surface with 35% phosphoric acid before placement of zirconomer can reduce the microleakage significantly resulting in an ideal restorative material for primary teeth.

Keywords: Zirconomer Improved, microleakage, conditioning

Introduction

Glass ionomer cement has always been the preferred material for restoration of primary teeth since its introduction in 1972 by Wilson and Kent. However, the conventional glass ionomer cement is not free from disadvantages like delayed setting, low strength and poor aesthetics [1]. The quest for an ideal restorative material for primary teeth lead to several modifications in glass ionomer cements, Zirconomer and Zirconomer Improved(white amalgams) being the recent ones. Zirconomer is zirconia reinforced glass ionomer cement which exhibits strength consistent with amalgam and maintains fluoride release like GIC. It consists of a powder and a liquid. The powder consists of Baddeleyite ($ZrO2$) which contains 96.5% - 98% zirconia and the liquid contains tartaric acid (1-10%), polyacrylic acid (20-50%), and deionized water. It is said to be an ideal restorative material for Class I and II cavities, core build-up under indirect restorations, root surfaces where overdentures rest, paediatric and geriatric restorations [2].

Zirconomer has striking mechanical properties with eminent edge strength, excellent marginal adaptation and resistance to abrasion and erosion, sustained fluoride release, and durability of silver amalgam without the hazards of mercury. Zirconomer improved is formulated with zirconia nano fillers which give better translucency than zirconomer for more natural colour [2].

However, high microleakage has been reported with zirconomer due to which its use in permanent restorations has been low [3-6]. Microleakage of restorations can be reduced by introducing changes in techniques of application which improve the bonding of the restorative material with the tooth or sealing the microgaps that are present between the restoration tooth interface.

Thus, the present study was conducted with the aim to find a suitable technique of Zirconomer placement in primary teeth which would reduce the microleakage.

Materials and method

Sample size determination was done based on previous literature. This in vitro study was carried out in 60 freshly extracted primary molars having a sound coronal surface (no white spot / cavitations). Ethical clearance was obtained from the institutional ethical committee. Class V cavities measuring 4 mm in length, 2 mm in width, and 2 mm in depth were prepared on the buccal surface of each tooth with no.012 and 010 round and cylindrical diamond burs. They were randomly divided into four groups containing 15 teeth each.

Group A- control group- Zirconomer Improved (n=15)

Group B- Zirconomer Improved with GIC (n=15)

Group C-Zirconomer Improved with Varnish (n=15)

Group D- Zirconomer Improved with conditioning (n=15)

For group A, the class V cavities were restored with Zirconomer Improved (Shofu Inc) alone which was the control group. The powder liquid ratio was maintained according to manufacturer's instructions. A layer of petroleum jelly was applied after setting.

For group B, two third of the cavity was restored with Zirconomer Improved and the occlusal one third was filled with ketac molar. A layer of petroleum jelly was applied on the surface of the completed restoration after setting.

For group C, the cavity was restored with Zirconomer Improved and a layer of nano coat light cure varnish was applied over the set restoration.

For group D, conditioning with 35% phosphoric acid was done after preparation of the class V cavity which was then restored with Zirconomer Improved followed by application of petroleum jelly over the restoration.

All the samples were subjected to thermocycling for 250 cycles at temperature of 5degrees, 37degrees and 60degrees. The apices of the teeth were then sealed with acrylic resin and a layer of nail varnish was applied to the teeth leaving a window of 1mm around the cavities. All the samples were then immersed in methylene blue dye for 24 hours after which they were dried and sectioned buccolingualy.

The prepared specimens were studied under stereomicroscope at a magnification of ×20 to measure the depth of the dye penetration on the occlusal and gingival walls of the cavity.

The scoring was done as described by Khera and Chan [7].

0- No leakage

1- Dye penetrating is to the lesser than and up to one half of the depth of the prepared cavity.

2- Dye penetrating is to more than one-half of the depth of the prepared cavity but not up to the junction of the axial and occlusal or gingival wall.

3-Dye penetrating up to the junction of the axial and occlusal or gingival wall but not including the axial wall

4- Dye penetration including the axial wall.

The statistical analysis was done with Anova test and Post hoc Bonferroni test.

Results

In Group A (control), more than half (60%) of the samples showed score 3 and 40% of the samples showed score 4 [refer Figure 1] which indicates a very high microleakage. In Group B, 60% of the samples showed score 3 and remaining 40% samples showed score 4 and 2 equally. Only 20% of the samples in Group C scored 3 and 40% scored 1 [refer Figure 2]. Maximum score of 4 was not seen in any of the samples in Group C. This shows that a reduction in microleakage is present when zirconomer is modified with the application of ketac molar or varnish on the surface. Finally in Group D, 20% of the samples showed score 0, 60% showed score 1 and 20 % of the samples showed score 2 [refer Figure 3]. Scores 3 and 4 were not obtained in any of the samples. Thus, 20% of samples in group D showed no dye penetration, hence no microleakage.

Less dye penetration, i.e., score 1, was seen in maximum samples of group D i.e. 60%. Highest dye penetration (score 4) was observed in 40% samples of group A as shown in table 1. Hence, highest microleakage was observed when zirconomer was used alone. Least microleakage was present in 20% of samples which were preconditioned with 35% phosphoric acid before placement of restoration.

ANOVA test for all the groups showed mean score of 3.40 $\pm$ 0.54 for Group A, mean score 3.00 $\pm$ 0.71 for Group B. For Group C, a mean score of 1.40 $\pm$ 0.54 was found whereas for Group D, mean 1.00 $\pm$ 0.71 was found. The F value was found to be 17.33 with P=0.001 which is significant. [refer Table 1].

Post hoc Bonferroni test for the intergroup comparison showed a lack of statistically significant difference when group A(control) was compared with group B. However, there was a significant difference when group A was compared with C and D. [refer Table 2].

Discussion

Microleakage can be defined as the clinically detectable passage of bacteria, molecules, fluids or ions between a cavity wall and restorative materials applied to it [4]. It is one of the most common reasons behind the long term failure of a restorative material in both primary and permanent teeth. Hence, reduction of microleakage is crucial for the restorative material to perform better.

Zirconomer is zirconia reinforced glass ionomer cement which has all the properties required for primary teeth restoration. However, studies have provided enough evidence of its high microleakage [3-6].

The present in vitro study was done to assess the effect of different techniques of application of zirconomer on its microleakage property. Class V cavities were chosen for the study because of its complex morphology [8]. Thermocycling of the prepared teeth is a standard protocol done to mimic the variability in oral temperature and environment. The marginal leakage in restorations has been studied both clinically and in laboratories. Because of less number of clinical data, laboratory studies are a very well accepted method of screening and detecting marginal leakage. In the present study the method of dye penetration with methylene blue was used.

In this study, maximum microleakage was seen in group A (control) where zirconomer was used alone, followed by group B and C and least microleakage was observed in group D. This reiterates the fact that zirconomer, when used alone, shows a very high microleakage as 40% of the samples had the score 4 and 60% of the samples had score 3[refer Table 1].

In group B, ketac molar was used to fill the occlusal one third of the cavity depth as it has been shown to have a low microleakage. Walia et al. compared the microleakage and compressive strength of Ketac molar, Giomer, Zirconomer and Ceram x, and found that the microleakage of Ketac molar was the least which was in accordance to another study done by Fracasso et al [9]. Chelation reaction with calcium on the tooth enamel or dentin has been stated to be the reason for better adhesion of ketac molar to the tooth surface [9]. But in the present study it did not significantly improve the overall microleakage however the depth of dye penetration reduced in 3 samples which was not statistically significant.

Conventional GIC are moisture sensitive restorative materials and its exposure to oral fluids after placement without surface protection disturbs the setting reaction [10-11]. In the present study, a layer of nano coat light cure varnish was applied over the restorations in group C. This group showed improved reduction in microleakage with 40% of the samples scoring 1 and 40% scoring 2. The improvement was statistically significant when compared with the control group. The use of surface coatings such as varnishes over GIC reduces the leaching of Ca and Al ions into the oral fluids. It also prevents the removal of superficial layer by saliva along with inhibition of its diffusion through pores, hence, increasing the adhesion of restorative material to the tooth surface [11]. An increase in the adhesion property of glass ionomer cement was noted by Powis et al after treating with polyacrylic acid, dodicin solution and tannic acid [12].

Phosphoric acid in different concentrations is used as pretreatment options with GIC restorations. Conditioning of the tooth surface with 35% phosphoric acid improves the bonding of GIC and significantly boosts the microleakage as studied by Mazaheri et al. [13]. Using a conditioner removes the loose debris remaining after biomechanical preparation, and creates microporosities for greater interlocking by enhanced demineralization. According to Glasspoole et al the bond strength of RMGIC was increased by pretreatment with polyacrylic acid and 35% phosphoric acid. They proposed that resin tags into conditioned enamel may contribute to micromechanical component of bonding to enamel [14].

A decreased microleakage and close contact at the enamel/restoration interface has also been shown after the application of different conditioners in cavities filled by Fuji IX glass ionomer [15]. In this study, in group D 35% phosphoric acid was used for conditioning the tooth surface before the cavity was restored with zirconomer. This Group showed a statistically significant decrease in microleakage when compared with group A and B.

Conclusion

The use of 35% phosphoric acid as conditioner before placement of zirconomer can significantly improve its microleakage. Applying a surface coating such as varnish also reduces the microgaps which is better than using zirconomer alone. However a larger sample size and long term in vivo research is needed to establish this conclusively.

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Legends Figure and Tables

Table 1: Distribution of samples according to microleakage scores, mean and standard deviation

Group	Samples	Microleakage scores					Mean	S.D (standard deviation)
		Score 0	Score 1	Score 2	Score 3	Score 4		
A	15	0	0	0	9 (60%)	6 (40%)	3.40	0.54
B	15	0	0	3(20%)	9(60%)	3(20%)	3.00	0.71
C	15	0	6(40%)	6(40%)	3 (20%)	0	1.40	0.54
D	15	3 (20%)	9(60%)	3 (20%)	0	0	1.00	0.71
ANOVA F=17.33, p=0.001 ; significant								

Table 2: Intergroup comparison using Post hoc Bonferroni

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
A	B	.400	.400	1.000
	C	2.000(*)	.400	.001
	D	2.400(*)	.400	.000
B	C	1.600(*)	.400	.006
	D	2.000(*)	.400	.001
C	D	.400	.400	1.000

The mean difference is significant at the .05 level.

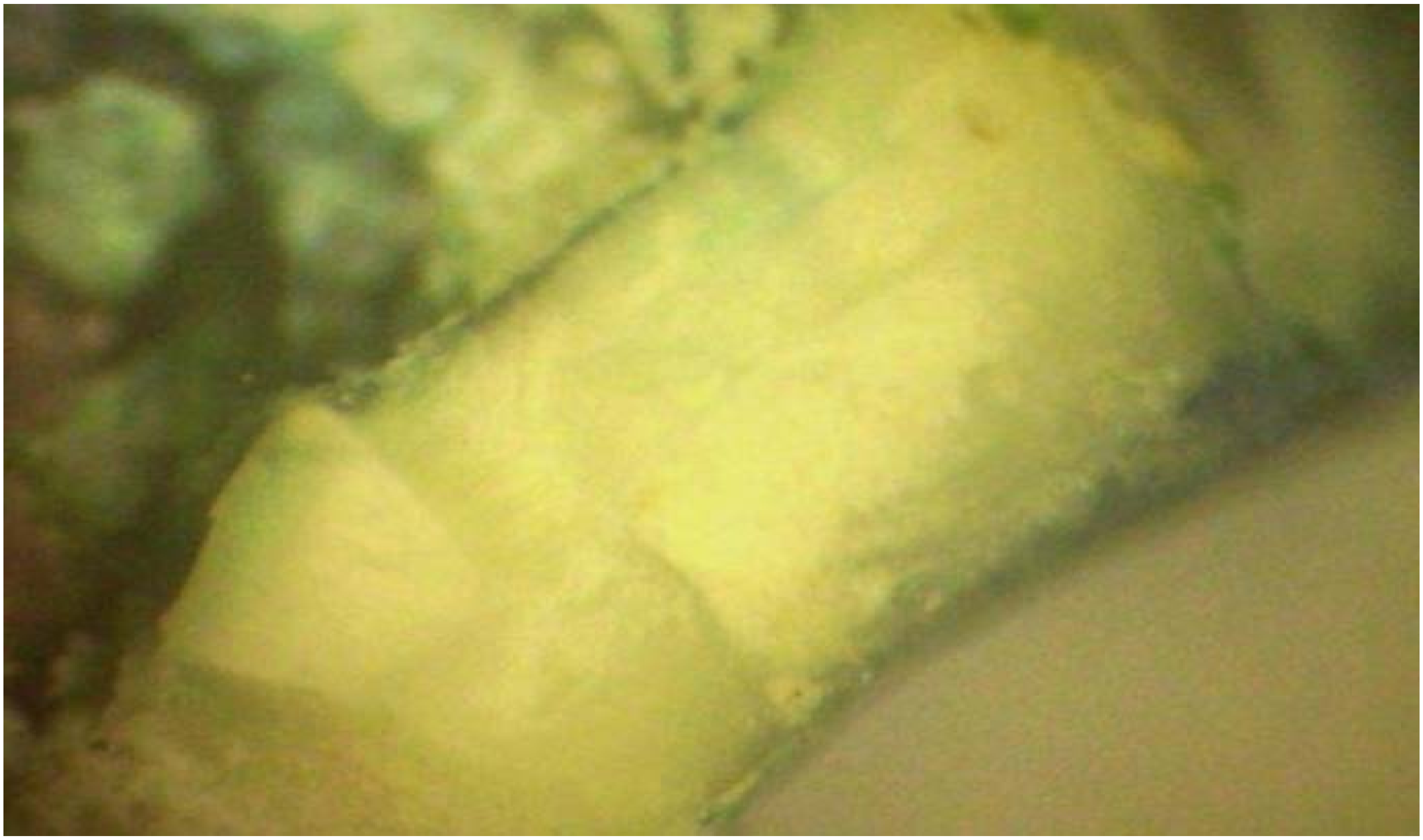

Figure 1: Group A showing dye penetration including the axial wall

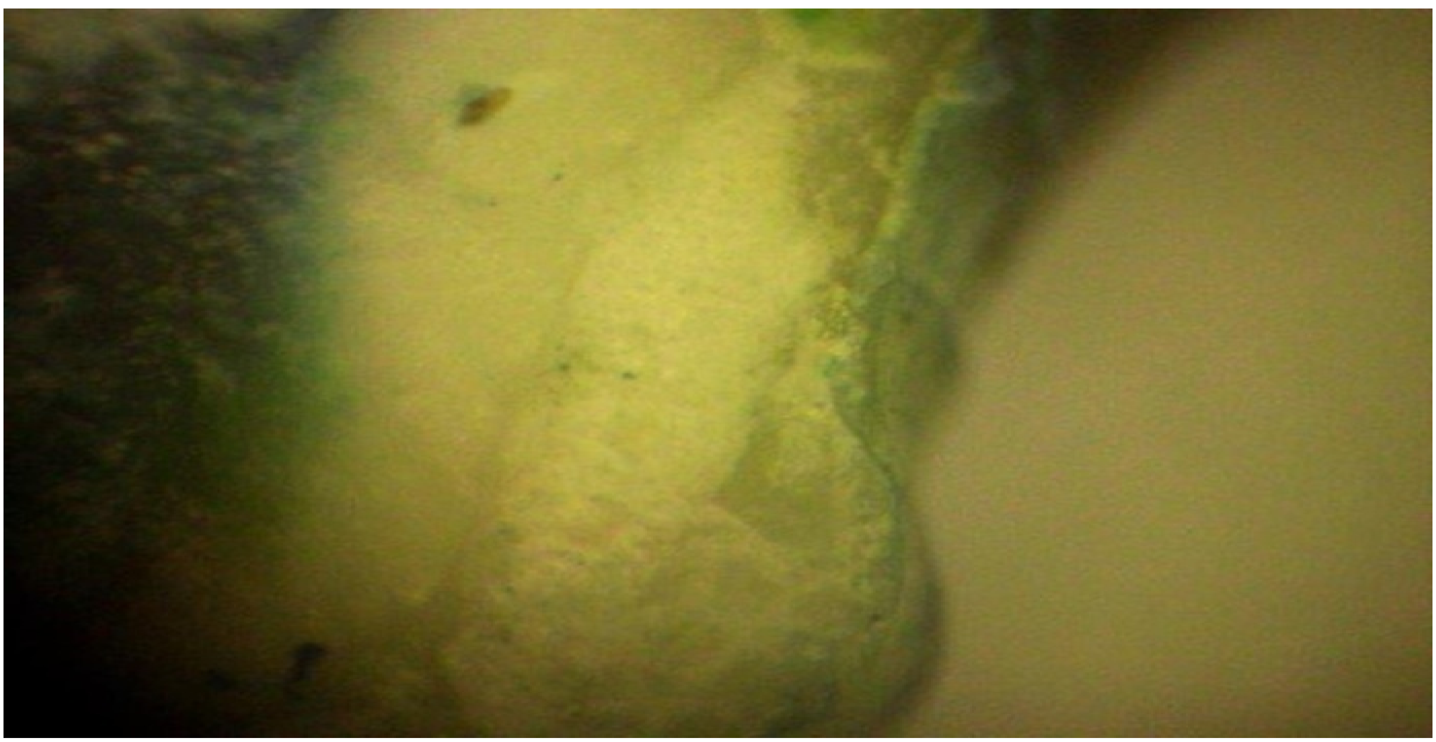

Figure 2: Group C showing dye penetration upto one half of the depth of prepared cavity.

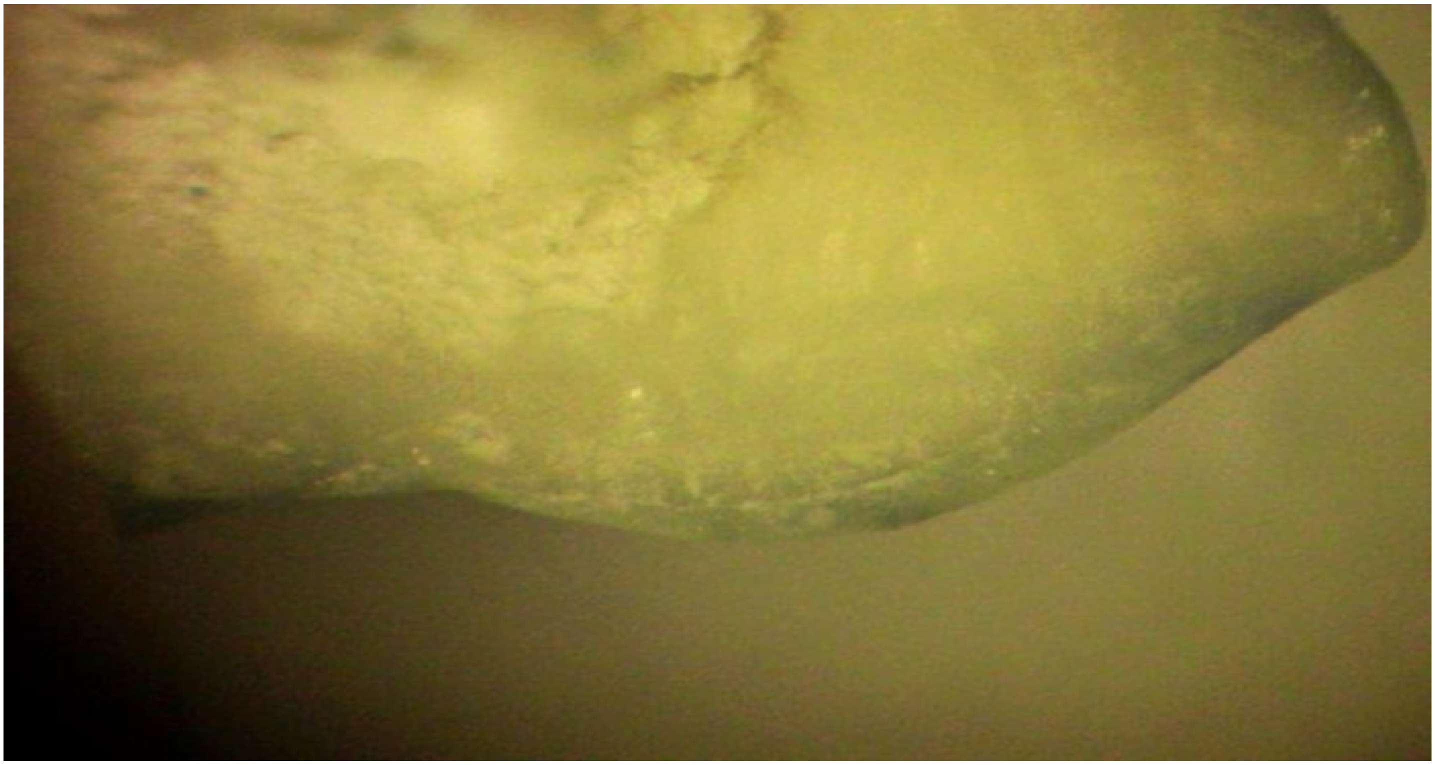

Figure 3: Group D showing dye penetration to lesser than and up to one half of the depth of the prepared cavity