

## The Microleakage of Polycarboxylate, Glass Ionomer and Zinc Phosphate Cements for Stainless Steel Crowns of Pulpotomized Primary Molars

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Article information	Abstract
<p>Article history: Received: 5 Mar 2012 Accepted: 25 July 2012 Available online: 15 Oct 2012 ZJRMS 2013; 15(1): 6-9</p> <p>Keywords: Microleakage Zinc phosphate Polycarboxylate Glass Ionomer Dental Cement</p> <p>*Corresponding author at: Department of Pediatric Dentistry, Member of Children and Adolescence Health Research Center, Zahedan University of Medical Sciences, Zahedan, Iran. E-mail: mirkarimi200@hotmail.com</p>	<p><b>Background:</b> Microleakage in Stainless Steel Crowns (SSC) margins leads to seepage of oral fluids and bacteria and it is one of the reasons for treatments failures. The aim of this study was to assess the effect of zinc phosphate, glass Ionomer and polycarboxylate cements on microleakage of stainless steel crowns for primary pulpotomized molar teeth.</p> <p><b>Materials and Methods:</b> In this experimental in vitro study, 60 extracted primary molar teeth were randomly divided in to three groups (n=20). Stainless steel crowns were fitted for each tooth after pulpotomy procedures. Crowns were luted with a zinc phosphate, glass ionomer or polycarboxylate cement. All specimens were stored in 100% humidity at 37°C for 1 hour and thermocycled 500 times (5°C to 55°C) with a 30 seconds dwell time and then immersed in 0.5% basic fuchsin solution for 24 hours. The specimens were sectioned buccolingually and each section was evaluated for microleakage under a stereomicroscope.</p> <p><b>Results:</b> In zinc phosphate group 45% of specimens and in glass ionomer group there was 5% of specimens showed leakage extending on to occlusal aspect and in polycarboxylate group none of the specimens had this situation. According to the kruskal wallis test in all groups there were significant differences in microleakage (<math>p &lt; 0.001</math>).</p> <p><b>Conclusion:</b> The use of zinc phosphate cement resulted in the highest percentage of microleakage. The microleakage of SSCs cemented with polycarboxylate and glass ionomer were similar.</p> <p>Copyright © 2013 Zahedan University of Medical Sciences. All rights reserved.</p>

### Introduction

Stainless steel crowns (SSCs) have been widely used since its introduction to pediatric dentistry in 1950 [1]. They are generally considered superior to large two or three surface amalgam restorations and have a longer clinical lifespan [2]. The term microleakage refers to the seepage of oral fluids containing bacteria and debris between the tooth and restoration or cement layer. It is one of the important reasons for dental restorations failures.

The extent of microleakage through the stainless steel crown's margin is of great importance because the bacteria may have harmful effects on remaining tooth structures and pulpal tissues. There are many kinds of luting agents that vary considerably from the viewpoint of solubility, strength and ability to adhere to tooth structure.

Lack of adhesion of the luting cements to the tooth structure is one of the reasons for microleakage related to different types of crowns [3]. Cement breakdown may result in entrance of fluids and microorganisms along the tooth restoration interface.

Previous studies have reported significant differences among luting agents in their ability of interfacial leakage

prevention between the luting agent and tooth structure [3, 4, 5].

Glass ionomer, zinc phosphate and polycarboxylate cements are all recommended by manufactures for cementing SSC restorations. The objective of this study was to investigate the in vitro microleakage of these three cements in pulpotomized primary molar teeth restored with SSCs. The null hypothesis was that there would be no difference in microleakage among the three cements.

### Materials and Methods

In this experimental interventional study, sixty human primary molar teeth were selected and stored in 0.5% chloramin solution for 24 hours. All the teeth had at least three buccal, lingual and one proximal intact surfaces. The root surfaces were sealed with 2 layer of nail polish then the teeth were mounted in a self curing acrylic base by using metallic molds to allow ease in handling.

All pulpotomies were performed using a conventional technique in which the caries was completely removed and upon removal of the roof of pulp chamber pulp

tissues were removed and irrigation was performed with normal saline solution.

The reinforced zinc oxide eugenol paste (Kemdent, England) was placed in pulp chamber space. Standard SSC preparations were made on all teeth by single operator in which reduction of occlusal surface was made to a depth of 1 mm following the contours of the tooth. Proximal reduction was accomplished with maintaining vertical walls.

The preparations were finished with smooth featheredge finishing line in cervical with no step or shoulder and rounded off with no sharp line angles. The smallest crown (3M, USA) that can be seated on the tooth were selected and tried by seating the lingual first and applying pressure in a buccal direction so that the crown slipped over the buccal bulge.

The teeth were assigned to 3 groups (n=20) which labeled G, Z, P using simple randomization method with toss. Because of anatomic variations and possibly differences in adaptation of SSCs. The maxillary and mandibular first primary molar teeth and second primary molar teeth were divided in groups separately so the number of these teeth was equal in each group.

Crowns in each group were cemented using zincphosphate (Prime-dent, USA), polycarboxylate (Prime-dent, USA) or glass ionomer (Prime-dent, USA) cements. The cements were mixed according to manufactures instructions.

The crowns were cemented using a static load of 5 kg held for 10 minutes, following initial setting the excess cement was removed and the specimens were stored in 100% humidity at 37°C for 1 hour and thermo cycled 500 times (5°C/55°C) with a 30 second dwell time to stimulate thermal stresses and aging of the cemented crowns. Specimens were immersed in 2% basic fuchsin solution for 24 hours and then washed. Each tooth was invested in a clear self curing acrylic resin and sectioned buccolingually through the restorations by using a saw (Isomet, Germany) with diamond blade.

Each side of the section was examined under stereomicroscope for evidence of dye penetration (Fig. 1 and Fig. 2). Criteria for evaluation were as follows:

0= No leakage

1= Leakage up to one third of axial wall

2= Leakage up to two thirds of axial wall

3= Leakage along entire length of axial wall

4= Leakage extending on to occlusal aspect

Dye penetration was evaluated by an observer who was blind with assigning the teeth to groups. The SPSS software package version 11.5 was used to perform statistical analysis. The scores were compared using

Kruskal-Wallis and Dunn tests with a level of significance of  $p < 0.05$ .

## Results

Table 1 summarizes the percentages of maximum microleakage scores for 3 different cements. Kruskal wallis test showed that there was a significant differences between the result of the three groups ( $p < 0.05$ ). Dunn test revealed that there were significant differences between zincphosphate and glass ionomer groups and between zincphosphate and polycarboxylate groups ( $p < 0.05$ ) which was zincphosphate cement significantly increased the microleakage. There was no significant differences in microleakage between polycarboxylate and glass ionomer groups ( $p > 0.05$ ) (Table 2).



**Figure 1.** Stereomicroscope evaluation of a specimen exhibits no dye penetration



**Figure 2.** Stereomicroscope evaluation of a specimen exhibits dye penetration up to two thirds of axial wall

**Table 1.** Percentages of maximum microleakage

			Maximum leakage					Total
			0	1	2	3	4	
Cement	Glass ionomer	Count	4	10	5	0	1	20
		% within CEMENT	20.0	50.0	25.0	0	5.0	100
	Zinc phosphate	Count	0	3	4	4	9	20
		% within CEMENT	0	15.0	20.0	20.0	45.0	100
	Polycarboxylate	Count	7	9	1	2	1	20
		% within CEMENT	35.0	45.0	5.0	10.0	5.0	100
Total	Count		11	22	10	6	11	60
	% within CEMENT		18.3	36.7	16.7	10.0	18.3	100

**Table 2.** Comparison of maximum microleakage of different groups

Groups	Number	Mean	p-Value
Glass Ionomer	20	13.28	0.001
Zinc phosphate	20	27.73	
Polycarboxylate	20	13.10	
Zinc phosphate	20	27.9	0.001
Glass Ionomer	20	22.05	
Polycarboxylate	20	18.95	

## Discussion

This In-vitro study evaluated the effect of different luting agents on microleakage of stainless steel crowns of pulp-tomized primary molar teeth. The ability of the cementing layer to adapt closely to the tooth preparation has an important role in minimizing microleakage.

Severe microleakage took place with zincphosphate cement. lack of adhesion to dentin is one of the most important reasons for this finding [3] and it's in agreement with similar findings reported in other studies [4, 6]. This suggest that lack of micromechanical and chemical bonds, setting shrinkage and dissolution in aqueous solutions were possibly attributable to the amount of microleakage of zinc phosphate cement [7].

With respect previous studies other possible reasons include the presence of internal stress within the brittle, thin film zincphosphate cement, that when subjected to the effects of pressure cycling may have produced stresses. These stresses could exceed the cohesive and adhesive strength of the material and result in disruption of the cement layer which causes microleakage [4, 8].

There was no significant difference in leakage between polycarboxylate and glass ionomer cements and both showed less microleakage scores than zincphosphate .

Other studies have also revealed polycarboxylate and glass ionomer cements to result in substantially less microleakage [4, 9].

The polycarboxylate cements establish a chemical bond between tooth structure and cement by virtue of its chemical structure (frequently repeating carboxyl groups) the polyacrylic acid chemically binds or chelates with certain cations, thus calcium or phosphorus in tooth structure chemically unites with the setting cement. A binding seems to occur between carboxylate cements and stainless steel [10] so carboxylate is highly suggestive cement for use with steel crowns.

Glass ionomer cement also provides a bond with tooth structure. Fluoride release from the glass ionomer luting agent is a beneficial characteristics not inherent to other luting agents. Other studies have shown that the amount

of fluoride release from glass ionomer materials is sufficient for altering bacterial growth [11, 12].

Glass ionomer cement is stronger and less brittle than zincphosphate cement [4]. Finally Berg et al. [12] found that there was no difference in marginal leakage of stainless steel crowns based on the cement used. They analysed the microleakage by measuring the amount of  $^{45}\text{Ca}$  through the crown margins with radio permeability technique.

In present study microleakage was investigated using a dye leakage model with basic fuchsin. Dye penetration technique has been used in many of the previous studies to demonstrating microleakage. There is no universally accepted technique applied to determine the microleakage patterns of restorative materials. In authors agreement it seems that various leakage detection methods do not yield equivalent results and therefore should not be compared.

And it concurs with Crim et al. [13] and Charlton et al. [14]. It has believed that if a material responds positively to in vitro dye tests it is likely that clinical response is even better [3, 15], because the dye is more easily diffused than bacteria and their by products and the buildup of proteins in the margin opening may improve the seal.

In this work attempts were made to simulate standard clinical procedures, although this is not a substitute for the complex oral environment but the results provide useful information to choosing best cement materials. Based on the results of this study it seems that zinc phosphate cement should be avoided when cementing stainless steel crowns.

1. Zinc phosphate cement exhibited significantly more microleakage than polycarboxylate and glass ionomer cements when used as a luting agent with SSCs.

2. There was no apparent different permeability of glass ionomer and polycarboxylate cement.

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## Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

## Conflict of Interest

The authors declare no conflict of interest.

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