Original Article

Effect of Glass Ionomer and Polycarboxylate Cements on Gingival Health of Primary Molars Restored with Stainless Steel Crown

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Abstract

Introduction: Glass ionomer and polycarboxylate cement have different effects on the marginal seal, microleakage, pulp tissue stimulation, and gingival health. The purpose of this study was to assess the effect of these cement on the gingival health of primary molars restored with stainless steel crowns (SSC). **Methods:** A total number of 34 children were selected who were within the age range of 4-7 years and required SSCs on both sides. The selected teeth were identical in terms of the dental arch and tooth number. After preparing the teeth, glass ionomer and polycarboxylate were used randomly on each side to cement SSCs. After placing the crowns, parents were asked to maintain the oral hygiene of their children by brushing and flossing their teeth. Subsequently, 6 months after the crown cementation, the gingival index, plaque index, and additional cement were evaluated. Statistical analysis was performed in SPSS software (version 25) using Wilcoxon Rank, Chi-square, and binary logistic regression tests. **Results:** There was more gingival inflammation in the group of teeth that used polycarboxylate as cement (P=0.022) and in the lower arch (P=0.007). The plaque index was significantly lower 6 months after the crown cementation (P<0.001). **Conclusion:** Based on the results, gingivitis is less prevalent in primary molars with SSCs cemented with glass ionomer. Moreover, maxillary primary molars have a lower rate of gingivitis after placing SSCs. Besides, gender and tooth numbers did not affect the gingival health of primary molars restored with SSCs

Keywords: Gingival index, Glass ionomer cement, Plaque index, Polycarboxylate cement, Primary molar, Stainless steel crown

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Introduction

Preformed metal veneers, known as stainless steel crowns (SSCs), were first developed by Humphrey for pediatric dentistry in 1950. These crowns provide valuable restoration for severely damaged primary teeth (1) and last more than amalgam restorations for primary molars (2). Some studies have reported the prevalence of gingivitis to be higher around primary teeth with SSC (3, 4). On the other hand, according to some other research, the occurrence of gingivitis was not significantly different between the teeth with SSC and the controlled teeth (5, 6). Gingivitis is an inflammation that only affects the gingival margin. Its symptoms include redness, edema, and bleeding on probing (7). Some defects may result in marginal gingivitis, including poor edge adjustment, lack of complete cement removal, and irregular length of occlusogingival dimensions of the crown (8,9). Regarding the advancements in dental materials, a variety of options are available as cement (2). Four major groups of dental materials have been used for years as crown cement, namely glass ionomer cement, zinc phosphate cement, resin cement, and polycarboxylate cement (9). Among

different materials, glass ionomer, zinc polycarboxylate, and zinc phosphate are used for SSCs (2). Histological evaluations revealed primary inflammatory reactions to cement near the connective tissue. These responses are usually due to the low initial pH of acid-base cement (10). According to the findings of a study conducted by Reitemeir et al.(11), the gingival health of primary molar teeth was assessed before and after receiving metal-ceramic crowns. They found that crowns with subgingival margins caused more inflammation than the supragingival ones. On the other hand, Farsi and Sharaf, in an investigation on the health of gingiva around primary molars with SSCs, reported contradictory results. They found that the spread of the crown margin did not affect the gingival tissue, while adjustment of the crown margin was significantly related to the clinical condition of the gingiva (5). The results of another study performed by Belduz Kara et al. (12) in 2014 demonstrated that the oral hygiene and health of periodontal tissue in primary molars deteriorate with time following the placement of SSCs. Moreover, in a review study by Madrigal et al. (13) in 2014, the predisposing factors for gingivitis related to SSCs were evaluated. According to this review, there is not sufficient evidence regarding the role of crown adjustment, remaining cement, SSCs, and their marginal spread as predisposing factors for gingival disease in children. It can be concluded that there are contradictory views about the influencing factors on gingival inflammation around restored teeth with SSCs. Moreover, different cement properties, such as solubility, microleakage, chemical components can have various effects on the surrounding gingiva. Therefore, the present study aimed to evaluate the effect of glass ionomer and polycarboxylate cement used in SSCs for primary molars on the gingival health of these teeth.

Materials and Methods

This double-blind randomized clinical trial was performed on 34 children within the age range of 4-7 years, who were referred to the Dentistry Faculty of Qazvin University of Medical Science, Qazvin, Iran for bilateral SSCs in one jaw. This study was approved by the Ethics Committee of Qazvin University of Medical Sciences (IR.QUMS.REC.1394.267). At the beginning of the study, the objectives and procedures were explained for the parents of the subjects, and written informed consent was obtained from the legal guardian of the participants. The inclusion criteria were as follows: 1) age range of 4-7 years, 2) lack of known systemic diseases, mental disorders, or physical disabilities that may interfere with the person's adherence to the principles of oral hygiene, 3) not having rotation or improper occlusion in the intended teeth, and 4) having two defective teeth with similar numbers in one jaw. Before the study, the parents were instructed regarding the principles of oral hygiene, such as brushing the teeth using a horizontal scrub technique and applying dental floss. The parents were requested to brush the teeth of their children twice a day (in the morning and before sleep at night) and use dental floss every night for cleaning the teeth. The hygiene level was determined using the Simplified Debris Index (DI-S), according to Silness-Löe Index (14). It was scored based on four levels of 0= no plaque, 1=soft debris within 1/3 of the tooth surface, 2=soft deposit beyond 1/3 of the tooth surface, but within 2/3 of the tooth surface, and 3=soft matter beyond 2/3 of the tooth surface. Preparation of the teeth was carried out by a resident of pediatric dentistry under the supervision of a pediatric specialist. Following the initial examination of occlusion, suitable regional anesthesia was performed as an inferior alveolar nerve block for the mandible and as buccal and palatal infiltration for the maxilla. In order to provide ideal isolation, a rubber dam was used. Afterward, the occlusal surface was cut by dental burs (#169 L; SUNSHINE, CA, USA) with a cusp slope of 1-1.5 mm, and the pulp therapy was applied as required. Moreover, the proximal region was cut by diamond burs (SUNSHINE, CA, USA) at a distance of 1 mm from the adjacent tooth and a feather-edge finish-line. Next, all angles were blunted by the sides of the burs. For example, the occluso-buccal and lingo-buccal angles were blunted at angles of 30-45°. At this stage, a suitable SSC was selected (3M ESPE, St. Paul, USA) through trial and error. The smallest SSC that could restore proximal contacts was selected in this study. The SSCs were first placed from the lingual side with pressure on the buccal side. Following the evaluation of the occlusion, correction preparation was performed if the veneer was not at the same level as the marginal ridge of the adjacent tooth. In addition, the over contoured or high margins were corrected when the gingival tissue around the margin was bleached. The latter procedure was practiced using special scissors, ball, and socket plier. When the crown was placed, the gingival margins were examined using an explorer for finding regions with unsuitable fitting. A suitable crown should have been placed 1 mm in the gingival sulcus. Afterward, the crowns were removed, the rubber dam was evacuated, and the crowns were placed again for the final evaluation of the occlusion. Moreover, the crowns were polished if they were cut. Next, the crowns were washed, dried, and prepared for the cementation step. The SSC on each side was randomly stuck by glass ionomer cement (GC gold label luting and lining cement, GC Corporation, Tokyo, Japan) and polycarboxylate cement (Master Dent, Dentonics Inc., NC, USA) using random allocation software (version 2.0). Two-thirds of the crowns were filled with the chosen cement and placed on the clean, dry tooth. Prior

to the final setting, the occlusion was re-examined and the extra cement was then removed from the sulcus by water spray and dental floss at interproximal regions. The type of cement, jaw, tooth number, and crown were all recorded in checklists. The children were followed-up after six months, and their gingival health was assessed using the gingival index (GI) in the follow-up session by a blind pedodontist. For this purpose, gingiva of the intended tooth was evaluated regarding color, presence/absence of edema, and bleeding on probing. The health or inflammation of the gingiva was determined based on Silness-Löe Index with four levels of 0=normal gingiva; 0-1=mild inflammation, no bleeding on probing, change in color and edema; 1-2=moderate inflammation, bleeding on probing, redness, edema, and glazing; and 2-3=severe inflammation, spontaneous bleeding, marked redness and edema.

In order to examine the crown margin adjustment, the explorer was moved from the gingival to the occlusal direction. The adjustment was considered weak or favorable in case the explorer stuck or did not stuck, respectively. The presence or absence of extra cement at the buccal surface and lingual margin of the crown was determined through observation and examination by an explorer ("Yes" or "No") (Table 1).

Table I. Clinical criteria used for evaluation of SSC

Criteria	score	Definition	Evaluation
Crown marginal adaptation	0	Sealed margin detected with explorer	sealed
	1	Open margin detected with explorer	open
Plaque index(DI-S)	0	Clean	no
	1	Tooth surface covered with less than 1/3 soft dental plaque	yes
	2	Tooth surface covered with less than 2/3 but over 1/3 soft dental plaque	
	3	Tooth surface covered with over 2/3 soft dental plaque	
Gingival index	0	normal	no
	1	Mild gingivitis	
	2	Moderate gingivitis	yes
	3	Severe gingivitis	

Statistical analysis

The descriptive statistics, namely the Wilcoxon Rank test, Chi-square test, binary logistic regression with entry method were performed for statistical analysis. In the regression model for the dependent variables, the normal status category represents the reference group. The SPSS software (version 25.0) (25 IBM Corp. IBM SPSS Statistics for Window, Armonk, NY) was used for analyses.

Results

In the present study, 68 primary molars of 34 children (18 females [53%] and 16 males [47%]), within the age range of 4-7 years, were investigated. There were 24 maxillary teeth, including 10 first molars and 14 second molars, and 44 mandibular teeth, including 18 first molars and 26 second molars (Table 2).

Table II. Tooth distribution according to the arch and type

	First primary molar	Second primary molar	total
Upper arch	10(14.7%)	14(20.5%)	24(35.2%)
Lower arch	18(26.6%)	26(38.2%)	44(64.8%)
total	28(41.2%)	40(58.8%)	68(100%)

The plaque index for the primary molars was measured before and after the crowning. Prior to the intervention, 16 (23.5%), 24 (35.3%), and 28 (41.2%) teeth had good, moderate, and weak plaque indices, respectively. After the crowning, 22 (32.4%), 39 (57.4%), and 7 (10.3%) teeth had good, moderate, and weak plaque indices, respectively; the latter difference was statistically significant (Table 3).

Table III. The plaque index for primary molars before and 6 months after SSC placement

	good	moderate	poor	p-value
before	16(23.5%)	24(35.3%)	28(41.2%)	<0.001
after	22(32.4%)	39(57.4%)	7(10.3)	

**Wilcoxon Ranks test*

Based on the results of the present study, in the gingiva adjacent to the crowns cemented with glass ionomer, 11 (32.4%) teeth were normal, while 13 (38.2%), 9 (26.5%), and 1 (2.9%) teeth had slight, moderate, and severe inflammation, respectively. Furthermore, in crowns cemented with polycarboxylate, the gingiva was healthy in 9 (26.5%) teeth, while it was affected by slight, moderate, and severe inflammation in 6 (17.6%), 15 (44.1%), and 4 (11.8%) teeth, respectively. Considering the distribution of data and possibility of a more accurate interpretation, the variable was dichotomized and defined as "normal" (normal and mild) and "with gingivitis" (moderate and severe) (Table 4).

Table IV. Gingival situation before and 6 months after SSC placement

		normal	With gingivitis	P value
cement	Glass Ionomer	24(70.6%)	10(29.4%)	0.022
	polycarboxilat	15(44.1%)	19(55.9%)	
arch	maxilla	19(79.2%)	5(20.8%)	0.007
	mandible	20(45.5%)	24(54.5%)	

**Chi-Square test*

Logistic regression analysis was used for evaluating confounding factors, including gender, tooth number, and jaw. The results indicated that gender and tooth number (first or second molar) did not exert any significant effects (P=0.674 and P=0.942, respectively). On the other hand, cement type and jaw (maxilla or mandible) had significant effects (P=0.022 and P=0.007, respectively). Therefore, normal GI was more probable in the maxilla, compared to the mandible. Moreover, we found that the rate of normal GI was significantly higher in teeth with glass ionomer cement, compared to polycarboxylate cement (Table 5).

Table V. Odds ratio (OR) and 95% confidence intervals (CI) for gingivitis

criteria	Tested variable: Gingival index			
	P value	OR	95% CI	
			Lower value	Upper value
Arch (ref:maxilla)	0.007	5.509	1.587	19.125
Cement (ref:GI)	0.022	3.547	1.198	10.500
Gender (ref:male)	0.674	1.264	o.424	3.763
Tooth (ref:primary first molar)	0.942	0.961	0.326	2.833

**binary logistic regression*

Discussion

The present study compared the impact of glass ionomer and polycarboxylate cement on gingivitis around the teeth restored with SSC. These two dental materials are widely used for variety of applications. Since SSCs are routinely used as a standard treatment after primary molars pulp-therapies and Glass ionomer and polycarboxylate are widely used as luting cements, the study just observed and compared the gingival health status around the restored teeth and no intervention was done.

The findings of this investigation indicated that gingivitis was less prevalent in teeth cemented with glass ionomer in comparison with polycarboxylate. In pediatric dentistry, SSCs are among the most useful restorations (15,16). Dental cement is used to fill the space between the crown and tooth, which can reduce microleakage and hinder the movements of the crown. Furthermore, if the cement is attached to the tooth, it will improve the retention (15).

Numerous studies have found gingivitis to be the most prevalent periodontal disease in children and adolescents, resulting from a non-specific inflammatory reaction of marginal gingiva (5,17). Sharaf and Farsi reported SSCs to have no harmful effects on the gingiva or bone in case of proper dental hygiene (5). Moreover, Einwag et al. (6) found that well-adjusted SSCs in primary molars lead to clinically slight and acceptable stimulation of the gingiva. However, Atieh et al. (3) reported that the rate of spontaneous bleeding is higher in the gingiva of teeth treated with SSC, compared to directly restored teeth. Henderson et al. (4) observed that there is always some gingivitis around teeth with SSCs which could be due to insufficient adaptation of the crowns or cement overhangs. Glass ionomer and polycarboxylate cement have attracted major attention, compared to other materials due to their chemical bond with the tooth structure (9). The setting mechanism for glass ionomer and zinc polycarboxylate cement is an acid-base reaction during which a chemical bond is formed through ion exchange with calcium and phosphate ions of dentin and enamel (1,9). The results of a study performed by Feroz and Bhoyar indicated that the antibacterial activity of polycarboxylate cement on oral microorganisms was higher than glass ionomer cement on the agar diffusion test (18). They claimed that this difference could be attributed to the higher solubility of polycarboxylate cement, compared to glass ionomer since according to the results of the direct contact test, the antibacterial activity of the two cement types were not significantly different. It must be noticed that even with suitable contouring and crimping, there is a chance of poor crown adaptation since the performed SSCs with specified sizes are used for primary molars with many different anatomies. Therefore, if the cement has less solubility and can provide a tight marginal seal, it will noticeably reduce microleakage and accumulation of microbial plaque and gingivitis (6). In the studies conducted by Memarpour, Rossetti, and White, microleakage of glass ionomer cement was significantly less than polycarboxylate cement in the margins of SSCs (15,19,20). In the current study, it was attempted to omit the variable of oral hygiene by using a cross-over design and comparison of the individual with him/her self. In addition, one dentist performed all procedures and tried to consider all the points related to ideal SSC adjustment (i.e., the penetration depth of 1 mm from the crown margin into the gingiva, proper trimming of edges, and omitting the excess of cement as much as possible) (5,3,21). Considering the random allocation of glass ionomer and polycarboxylate cement to each side for each person and the similar number of the tooth for comparison (first or second primary molar), gingivitis

around the crown seems to be related to the type of cement. The results of the present study showed a significant reduction in the plaque index before and after the SSC placement. According to the findings of a study carried out by Schuler et al., dental decay had a direct relationship with gingival hemorrhage as a symptom of inflammation. A significant relationship was observed between GI and the decayed, missing, and filled teeth (DMFT) index, especially the D component of this scale (decayed teeth) (22). Therefore, it seems that treatment with SSC and decreased decayed surface (D component) can diminish the accumulation of microbial plaque. Similar to the study by Schuler et al. (22), the present research utilized an explorer to examine adjustment, showing that all SSCs had a favorable adjustment. Fuks et al. (17) in their study found no extra cement around the crown margins in the 6-month follow-up, which is consistent with the results of the present study. Furthermore, in this study, GI was higher in mandibular molars than maxillary molars. This finding could be attributed to the width of the attached gingiva of primary mandibular molars which was less than that of the maxillary ones and the longer retention time of foods in the lower arch than the upper arch. In addition, usually, tooth brushing starts from the maxillary arch; therefore, it is probable that a shorter period of time was spent on the mandibular arch.

Conclusion

According to the findings of the current study, gingivitis was less prevalent in primary molars with SSCs cemented by glass ionomer, compared to those with polycarboxylate cement. Furthermore, maxillary primary molars were found to have a lower rate of gingivitis than mandibular primary molars after placing the SSCs. It was observed that gender and tooth number (first or second primary molar) did not have a relationship with gingivitis due to SSC placement.

Conflict of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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