Micro Leakage of Composite Resin Restorations Following Contamination with Primary Teeth Root Canal Filling Materials: An *in vitro* Study

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Abstract

Aim: The aim of this in vitro study was to assess the microleakage of composite restorations following contamination of access cavity with root canal filling materials of primary teeth.

Materials and Methods*:* Forty primary canines were selected for this study. Standardized access cavity on the lingual surface of the canine was prepared. The margins of preparation were ended on enamel. The teeth were randomly assigned into 4 groups (10 teeth/group). Teeth in group 1 served as a control, no material applied. For the other 3 groups the access cavity was filled with one of the following root canal filling material: Zinc Oxide and Eugenol (ZOE), calcium hydroxide ($Ca(OH)_2$) and Vitapex. The root canal filling paste was left for two minutes in the cavity then washed out. The access cavity then restored with composite resin. After thermocycling for 500 cycles, teeth were immersed in 1% methylene blue for 24 hours, and then sectioned longitudinally in bucco lingual direction. The microleakage evaluation was carried under stereo-microscope and the worst result for each section was recorded. The data were statistically analyzed using Kruskal-Wallis and Post Hoc tests.

Results: All samples in the ZOE group showed leakage. However, the control, $Ca(OH)_2$ and Vitapex groups showed leakage in 30%, 40% and 50% of the tested samples respectively. Microleakage occurred more significantly in ZOE group in comparison to the other test groups (p=0.00). Nevertheless, there was no significant difference in microleakage between the control group, $Ca(OH)_2$ and Vitapex groups.

Conclusions: Contamination of the access cavity with primary teeth root canal filling materials showed different levels of leakage in composite resin restoration and the ZOE group showed the highest microleakage scores.

Key Words: Pulpectomy, Microleakage, Composite, Primary teeth

Introduction

Pulpectomty of primary teeth is indicated for pulp tissue that is irreversibly infected or necrotic due to caries or trauma [1]. The treatment consists of extirpation/debridement of the pulp tissue, filing of the canals and obturation with a resorbable material [2].

A number of different materials have been reported to be successful filling materials in the pulpectomty of primary teeth [3]. The most popular of these are Zinc Oxide and Eugenol (ZOE), calcium hydroxide ($Ca(OH)_2$) and iodoform pastes [3-5]. The tooth is then restored with a filling material that seals the tooth from microleakage [6].

Traditionally, Stainless-Steel Crowns (SSCs) have been recommended for restoration of pulpotomized or pulpectomized for full crown coverage with less leakage compared to other restorative techniques [7]. However, this assumption was not supported by some literature as adhesive restorations were found to provide less leakage for pulpotomized primary molars in comparison to SSCs [7,8]. The acid etch bonding of composite resin to enamel has proven to be an effective method to enhance the strength of bonding and decreasing leakage [9]. In addition, Swanson et al. [10] found that total etch adhesives and beveled enamel margins were associated with least microleakage [10].

To maintain the integrity of the interface between enamel and composite resin, contamination of cavity with oral fluids or pulp therapy medicaments should be avoided [11,12]. Few studies assessed the effect of root canal medicaments for primary teeth on the resin-dentine interface. Togay et al. [13] assessed the effect of different endodontic irrigation solutions on microleakage of resin composite in primary molars. They compared saline (control group), 2.5% sodium hypochlorite and 17% Ethylene Diamine Tetra Acetic Acid (EDTA) and reported no significant effect of irrigation regimens on microleakage of composite. Alves and Vieira Rde [14] compared the effect of four primary teeth root canal filling materials on the retention of composite post in extracted primary anterior teeth [14]. They found no significant difference for bond strength of the post between the filling materials. In a clinical scenario, the placement of root canal filling material in primary teeth may present a potential problem. The expression of the filling material out of the coronal portion of the canal during the obturation procedures or during insertion contaminates the access cavity which may interfere with the sealing capability of resin composite.

The literature lacks studies that compare the microleakage of composite resin restoration of access cavity when different materials were used during root canal filling. Therefore, the purpose of this study was to assess the microleakage of composite resin following contamination of access cavity with root canal filling materials of primary teeth.

Materials and Methods

Forty primary canines free of caries crack, or restoration which were extracted for orthodontic purpose, were selected for this in vitro study. The study was approved by the College of Dentistry Research Center (CDRC), King Saud University, Saudi Arabia. The teeth stored at room temperature in distilled water for no longer than 3 weeks before they were used. Immediately before cavity preparation the crown cleaned

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with rubber cup and slurry of pumice. One operator prepared standardized access cavity on the lingual surface of the canine using no. 330 bur on high-speed hand piece under copious water spray. The depth of the preparation was about 2 mm. All the margin of preparation end on enamel and no bevel were added at any margin of preparation.

The teeth were randomly assigned into 4 groups (10 teeth/ group).

- Group 1: received no pretreatment and served as control group. For the other 3 groups the access cavity was filled with one of the following root canal filling materials:
- Group 2: Zinc Oxide Powder USP (Sultan Health Care Inc., Englewood, NJ, USA) which was mixed at 10g: 2 g of eugenol. The paste loaded in the cavity with spoon excavator.
- Group 3: Medical (Promedica, NeumÜnster, Germany): which is $Ca(OH)_2$ based cement.
- Group 4: Vitapex (Neo Dental Chemical Products Co., LTD. Japan) which is a premixed paste of 30% $Ca(OH)_2$, 40.4% Iodoform and silicone lubricant.

For group 3 and 4 the paste loaded directly from the tip of the syringe into the cavity. The root canal filling paste was left for two minutes in the cavity, and then washed out with air-water spray until the access macroscopically looked clean, and then dry. Any left debris was removed with an excavator and the cavity was then washed and dried as above. The cavities were acid etched with 37% phosphoric acid gel for 20 seconds, rinsed with air-water spray for 20 seconds and dried for 15 seconds. Then, two layers of the single-bottle adhesive (Prime & Bond NT, Dentsply, Germany) were applied and each layer photo-cured for 10 seconds. A composite resin material (Tetric®Ceram, ivoclarVivadent) was placed into the cavities, with maximum increment of thickness 2mm. Each increment was photo-cured for 40 seconds. Each restoration was contoured and shaped before curing, therefore no finishing or polishing was carried out for the composite filling.

Specimens were stored in water at 37°C for 48 hours after which thermal cycling (Thermaocycler THE 1100/1200, Huber, Germany) was performed in distilled water at 5°C-55°C for 500cycles with a dwell time of 30 seconds.5 Following thermocycling, the roots of the teeth were sealed with self-curing acrylic resin and the crowns were coated with two layers of nail varnish up to 1mm from the restoration margin. Then, the teeth were immersed in 1% methylene blue for 24 hours. Thereafter, samples were cleaned thoroughly under tap water.

One longitudinal section was made through the resin restoration in a bucco-lingual direction using water-cool diamond saw (Precision Saw, Isomet 2000, Buehler, USA). Two sections were obtained from each tooth and were then inspected under stereomicroscope (Wild Photomakroskop M400, Heerbrugg, Switzerland) with magnification of X 40. The tooth-resin composite interface was evaluated and a microleakage score from 0 to 3 was given to each section based on dye penetration:

- Score 0 was given to no dye penetration;
- Score 1 was given to dye penetration limited to enamel only;
- Score 2 was given to dye penetration up-to dentino-enamel junction(DEJ);
- Score 3 was given to dye penetration into dentine.

The highest micro leakage score obtained after examination of both sections was recorded for each tooth. Reliability of the linear dye penetration measurements was tested by comparing the results obtained of from 20 samples from the same examiner (intra-examiner observation), at 2 different occasions with one week apart. There was 100% correlation (percent agreement) between readings.

The micro leakage data was analyzed by using the SPSS (Version 15.0, SPSS Inc.,Chicago, IL). To compare between the groups Kruskal-Wallis test and Post Hoc test were used at a significant level of 0.05.

Results

The Microleakage scores for each group are presented in *Table 1* and *Figure 1*. Results of statistical analysis are shown in *Table 2*. The ZOE group showed the highest microleakage scores compared to the other study group and control. All samples in the ZOE group showed microleakage ranging from grade 0 to 3. The other 3 groups showed significantly less leakage than ZOE group (P=0.000). The $Ca(OH)_2$ and Vitapex showed comparable results to that of control group. Around 90% of the samples showed microleakage to dentin and DEJ in ZOE group.

Discussion

Providing optimal marginal seal is a major goal in restorative dentistry [9]. Also, perfect coronal seal of root canal treated teeth is critical to avoid re-infection which is now known to be a major cause of root canal treatment failure [15,16]. Marginal leakage at the resin-tooth interface may occur due to polymerization shrinkage, lack of adhesion of the resin to the tooth surfaces, or contamination of cavity with oral fluids [9].

In this study, the contamination of the access cavity with primary teeth root canal filling materials was investigated. All groups in this study showed different levels of leakage, however, ZOE group showed the maximum leakage. Previous studies that assessed the influence of ZOE on microleakage of composite restoration reported controversial results [17-19]. Hansen and Asmussen [17] recorded increased gaps in dentin pretreated with ZOE filling materials. Also, Peutzfeldt and Asmussen [18] reported no effect of ZOE on composite contraction. Yap et al. [19] found significant leakage of composite following temporization of the cavity with polycarboxylate cement or ZOE mixed at the lower powder to liquid ratio of 10g:2g in comparison to higher powder to liquid ratio of 10g:1g. They concluded that greater amount of eugenol may inhibit polymerization of bonding system which result in bond failure and microleakage. The findings of this investigation are in accordance with the results of a previous study by Yap et al. [19]. The wetter ZOE mixture used in this study contained large amount of eugenol and could explain the results obtained in this investigation. Furthermore, Carvalho et al. [20] also found that the use of ZOE was associated with reduced dentin-resin bond strength; this in turn would increase the microleakage.

There was no significant difference in microleakage between the control, $Ca(OH)_2$, and Vitapex groups.

Table 1. *Frequency distribution of micro leakage scores among the study groups.*

Microleakage score		Groups			
		Control	ZOE	$Ca(OH)_2$	Vitapex
0	No leakage	7	0	6	5
1	Into Enamel	3	1	3	4
2	Into DEJ	0	5	1	1
3	Into Dentin	0	4	0	0
Total		10	10	10	10

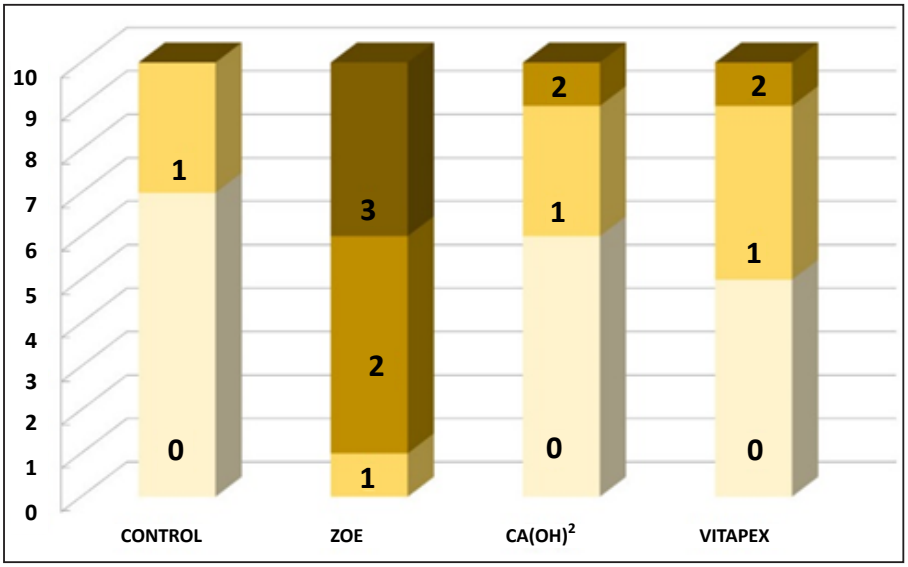

Figure 1. *The distribution of microleakage scores among the study groups (0- No leakage, 1-Into Enamel, 2- Into Dentino enamel junction, 3- Into Dentin).*

Table 2. *Results of statistical analysis of microleakage among groups using Post Hoc tests.*

Groups	Groups			
	Control	ZOE	$Ca(OH)_2$	Vitapex
Group 1 (control)		0.000*	0.947	0.805
Group 2 (ZOE)			0.000*	0.000*
Group 3 ($Ca(OH)_2$)				0.966

*The mean difference is significant at 0.05 level.

This finding might be attributed to the relatively shorter contamination time (two minutes), as well as the washing and drying of the cavity immediately before restoration. Also, the acid etching with 37% phosphoric acid could be effective in removing the remaining paste.

The result of this *in vitro* study could be used as a guide to prevent the effects of contamination with root canal filling materials on the microleakage of composite in primary teeth. The removal of excess paste from the access cavity with air-water spray is not enough, especially if it is contaminated with ZOE. Refinement of access cavity with high or slow speed headpiece could result in better removal of root canal filling materials and provide better adhesion of resin to the tooth surfaces.

Conclusions

Based on the results of this *in vitro* study, the following conclusions can be drawn:

1. All materials showed varying levels of microleakage with maximum leakage for the ZOE group.

2. $Ca(OH)_2$ and Vitapex groups showed comparable levels of microleakage to the control group.

3. Consideration may be given in the selection of the root canal sealants along with other measures of preventing microleakage, for optimal results in restoring deciduous teeth with composite restorations.

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