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Comparison of Microbial Microleakage in Three Temporary Restorative Materials (Cavit, Coltosol, and Zonalin) in Primary Teeth

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ABSTRACT

Background and Objective: Temporary restorations between sessions are essential to prevent the entry of microorganisms and inflammation of peri-radicular tissue. The aim of this study was to compare the microbial microleakage of three temporary restorative materials (Cavit, Coltosol, and Zonalin) in primary canine teeth under in vitro conditions.

Methods: In this in vitro study, 72 primary canines extracted for orthodontic treatment were selected. After preparation and restoration of cavity with different materials (Cavit, Coltosol, and Zonalin), the teeth were subjected to thermal cycles, immersion in methylene blue dye, and subsequent longitudinal sectioning for microbial microleakage assessment. The degree of microbial microleakage was categorized into five levels, increasing with the intensity of dye penetration.

Findings: At the incisal edge, Coltosol predominantly showed grade 1 microbial microleakage (68%), while Cavit showed grade 2 microbial microleakage (40%) and Zonalin showed grade 4 microbial microleakage (76%). At the cervical edge, Coltosol showed grade 3 microbial microleakage (40%), Cavit showed grade 3 microbial microleakage (56%), and Zonalin showed grade 4 microbial microleakage (100%). Statistical analyses showed significant differences in microbial microleakage between Cavit, Coltosol, and Zonalin at both the incisal and cervical edges ($p<0.001$).

Conclusion: According to the results of the present study, all materials showed cervical and incisal microbial microleakage. However, Cavit showed a greater ability to seal the cervix, while Zonalin showed the highest microbial microleakage in both the cervical and incisal areas.

Keywords: *Dental Microleakage, Dental Restoration, Temporary, Methylene Blue, Primary Teeth*.

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Introduction

Pulp therapy in primary teeth is usually divided into two categories: vital and non-vital. These approaches aim to preserve primary teeth with pulp involvement in the dental arch until natural loss of these teeth. Dentists prefer multi-session pulpectomy to a single-session procedure to ensure complete sterilization of the root canals before obturation (1-3). In addition, shorter sessions are recommended to improve children's cooperation (4). Crown coverage between visits is essential to prevent bacteria and salivary toxins from entering the canal and causing inflammation in the peri-radicular tissue (5, 6). Therefore, temporary restorative materials prevent contamination of the root canal by microorganisms, salivary toxins, and food particles and prevent microleakage of drugs (7). In other words, these materials act as a barrier against microbial microleakage, which includes penetration of bacteria, fluids, molecules, and ions. Microbial microleakage is the main cause of sensitivity and secondary caries in inter-session restorations (8).

Temporary filling materials must have properties such as resistance to chewing forces, pressure, and abrasion, as well as ease of use and dimensional stability against thermal changes (9). Among the materials commonly used for this purpose, three stand out: Cavit, Coltosol, and Zonalin. Cavit is a temporary restorative material with curing capability that is easily placed in cavities. Coltosol, in contrast, is a temporary filling material that expands upon contact with moisture. The expansion property of Coltosol allows it to conform to the cavity walls and effectively fill irregular cavities. Zonalin, on the other hand, requires mixing of the powder with liquid before use. The incorporation of polymers can increase its durability (10-12).

Previous studies have investigated the microbial microleakage of temporary restorative materials in permanent teeth (7, 13). However, few studies have been conducted on primary teeth, which have a different composition compared to permanent teeth, and none have compared these three materials (14-16). Therefore, the present study was conducted to compare the microbial microleakage of three temporary restorative materials (Cavit, Coltosol, and Zonalin) in primary canine teeth.

Methods

After approval by the Ethics Committee of Islamic Azad University, Khorasgan Branch with the code IR.IAU.KHUISF.REC.1398.001, this in vitro study was conducted in the Department of Dentistry, Islamic Azad University, Khorasgan, Iran, from August 2019 to April 2020. The sample size was calculated using G*Power statistical software and based on Mann-Whitney test. Considering a significance level of 5% (α=0.05), a power of 90% (β=0.1) and an effect size of 1 (d=1), 24 samples were assigned to each group. A total of 72 primary canines extracted during the past 6 months for orthodontic treatment were selected. Teeth with decay, fracture, wear, cracks, or root resorption were excluded from the samples. Primary canines were selected for this study because of their larger size and single-root anatomy, which allow for standard cavity preparation and easier control during laboratory procedures. In addition, canines have less natural morphological variation compared to molars, which ensures uniformity in the samples (17, 18).

After extraction, primary canines were preserved in 10% formalin. First, the teeth were removed from the formalin and washed with sterile distilled water. Then, a standard cavity (1.5×2×2 mm) was created on the buccal side of the teeth using a periodontal probe. Each tooth was given a unique identifier and then randomly divided into three groups of 24: Group 1: Cavit (Voco, Germany), Group 2: Coltosol (Coltene, Switzerland) and Group 3: Zonalin (Kemdent, England). After performing 500 30-second thermal cycles in a temperature range of 5 to 55 ºC, the ends of all samples were sealed with wax. Then, the apex and the entire tooth were sealed with two layers of nail polish up to a distance of 2 mm from the restoration margin.

After the nail polish dried, the samples were immersed in 1% methylene blue and transferred to an incubator at 37 ºC and kept there for 24 hours. After removing the samples from the incubator, they were washed with water and mounted with acrylic and monomer in such a way that the restoration area and 2 mm around it would be clear. Then, using a dental turbine, four longitudinal sections were prepared in the buccolingual dimension of the samples.

The extent of methylene blue penetration was assessed using a stereomicroscope with a magnification of 18x (Dewinter Technologies, Italy) at the incisal and cervical margins. Microbial microleakage was classified into five levels: grade 0: no dye penetration, grade 1: dye penetration up to one-third of the restoration margin, grade 2: dye penetration up to two-thirds of the restoration margin, grade 3: dye penetration across the entire restoration margin, and grade 4: dye penetration beyond the restoration margin (19, 20).

Data analysis was performed using SPSS version 22 software (SPSS Inc., Chicago, IL, USA) and Kruskal-Wallis and Mann-Whitney tests, and $p<0.05$ was considered significant.

Results

At the incisal edge, the Coltosol predominantly showed grade 1 microbial microleakage (68%), while Cavit showed grade 2 microbial microleakage (4 0%) and Zonalin showed grade 4 microbial microleakage (76%). At the cervical edge, grade 3 microbial microleakage (40%) was observed in the Coltosol group, grade 3 microbial microleakage (56%) in Cavit group, and grade 4 microbial microleakage (100%) in Zonalin group. Graphs 1 and 2 show the rates of microbial microleakage in the three different materials at the incisal and cervical edges.

Kruskal-Wallis test showed a statistically significant difference in microbial microleakage between the three materials (Cavit, Coltosol, and Zonalin) at both the incisal and cervical edges of restoration ($p<0.001$). Mann-Whitney test with Bonferroni corrections was used for pairwise comparison of groups. Table 1 shows the results of Mann-Whitney test for comparison of microbial microleakage at the incisal edge of restoration between the three temporary restorative materials. Table 2 presents the results regarding the comparison of microbial microleakage at the cervical edge with the same materials.

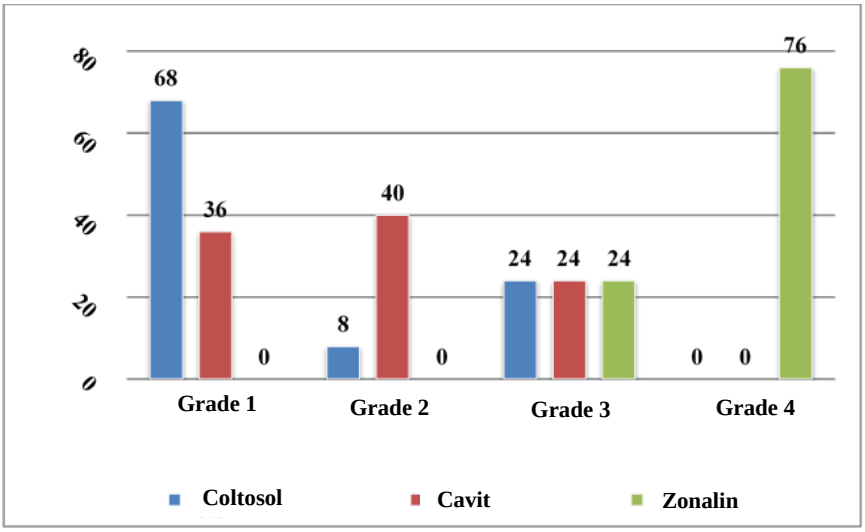

Figure 1. Microleakage rate at the incisal edge of restoration in the three temporary restorative materials

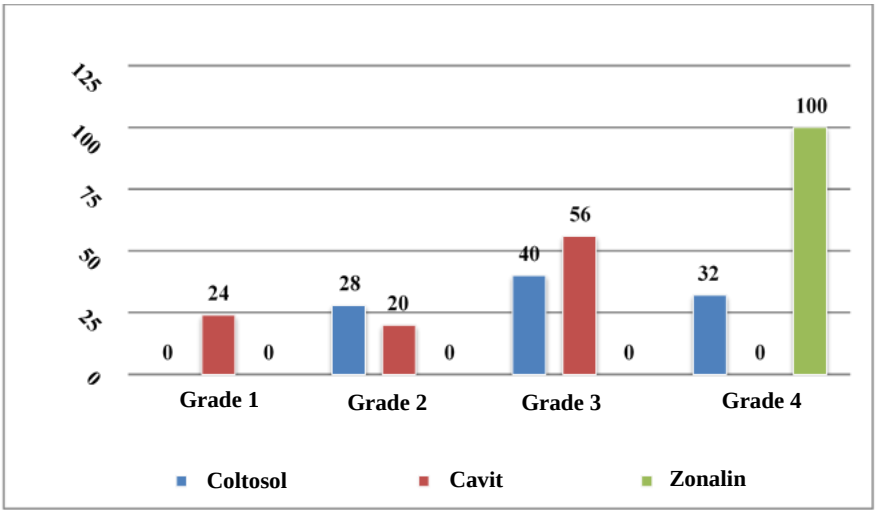

Figure 2. Microleakage rate at the cervical edge of restoration in the three temporary restorative materials

Table 1. Pairwise comparison of microleakage rates between the three temporary restorative materials at the incisal edge

Group 1	Group 2	Statistical test of microleakage rate	p-value
Coltosol	Cavit	6.080	0.305
Coltosol	Zonalin	-38.380	<0.001
Cavit	Zonalin	-32.300	<0.001

Table 2. Pairwise comparison of microleakage rates between the three temporary restorative materials at the cervical edge

Group 1	Group 2	Statistical test of microleakage rate	p-value
Coltosol	Cavit	14.160	0.014
Coltosol	Zonalin	-38.580	<0.001
Cavit	Zonalin	-24.420	<0.001

Microbial microleakage at the incisal edge did not show a significant difference between the two temporary materials, Coltosol and Cavit. However, microbial microleakage was significantly higher in Zonalin compared to Coltosol ($p<0.001$). Similarly, microbial microleakage was significantly higher in Zonalin compared to Cavit ($p<0.001$). At the cervical edge of restoration, microbial microleakage was significantly higher in Coltosol compared to Cavit ($p=0.014$). Furthermore, microbial microleakage was significantly higher in Zonalin compared to Coltosol ($p<0.001$) and also significantly higher in Cavit ($p<0.001$).

Discussion

Among the different materials, Cavit showed better results in preventing cervical microbial microleakage. Microbial microleakage was highest in the Zonalin group at both the cervical and incisal edges. Recent studies have investigated microbial microleakage using different methods, with the dye penetration method being the most widely used due to its simplicity and easy availability. In this study, methylene blue dye was used to assess microbial microleakage (21). Different levels of microbial microleakage were observed between the incisal and cervical edges because dye penetration was different in these two locations, which indicates the need for separate reporting to accurately reflect changes in microbial microleakage in different areas of the temporary restoration.

The findings of this study are in line with the studies of Ciftçi et al. (22), Tulunoglu et al. (23) in permanent teeth and Odabas et al. (14) in primary anterior teeth, as they observed satisfactory performance of Cavit in preventing microbial microleakage. Furthermore, in the study of Hansen et al. (24), it was found that TERM, a temporary restorative material with similar curing capability to Cavit and available in thicknesses of 1 to 3 mm, maintained its ability to prevent microbial microleakage. This study showed that Cavit with a depth of 1.5 mm played a significant role in preventing microbial microleakage.

In this study, Coltosol showed greater microbial microleakage at the cervical margin than Cavit, but at the incisal margin it showed microbial microleakage similar to Cavit. The higher degree of microbial microleakage in the cervical region could be due to the different structure of the cervical enamel compared to the incisal enamel and the orientation of the enamel prisms there (25). In accordance with the present study, several previous studies have confirmed the more effective ability of Coltosol compared to Zonalin. In the study of Milani et al. (15), Coltosol showed superior sealing ability to Zonalin and Compoglass at one-week and one-month intervals. Naseri et al. (11) also found that Zonalin had a higher degree of microleakage than Cavisol and Coltosol, which increased from day 1 to week 4. These results are consistent with the study of Mohammadian et al. (16). The higher degree of microbial microleakage of Zonalin may be due to the need to mix Zonalin powder with liquid, which may reduce the homogeneity of the mixture and allow bacteria to infiltrate it (26).

Damman et al. conducted a study to investigate the ability of glass ionomer cement and composite resin on 1-mm-thick root canal filling materials and concluded that the dual restoration method, i.e. using glass ionomer and composite resin on Coltosol, is a suitable protocol to reduce microleakage (27). In their study, Shah et al. concluded that there was a difference in crown coverage capability of Orafil LC, Cavit-G, and Coltosol. Coltosol showed the highest microbial microleakage scores, while Orafil LC showed the lowest scores among the test groups (28). In line with the present study, Wuersching et al. also reported better results with Cavit and found its use desirable in combination with methacrylate restorative materials (10).

This study elucidated the difference in microbial microleakage performance of temporary restorative materials and provided valuable insights for clinical studies. However, study limitations, such as the use of a single type of tooth and investigation of three specific materials, may limit the generalizability of the findings. Future research can examine a greater variety of materials and tooth types to improve the comprehensiveness and relevance of the findings.

Considering the limitations of in vitro studies, it is concluded that all materials showed cervical and incisal microbial microleakage. However, Cavit showed greater capability to seal the cervical region, while Zonalin showed the highest microbial microleakage in both cervical and incisal regions.

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