

## In Vitro Comparison of Coronal Micro-leakage of Three Temporary Restorative Materials by Dye Penetration

Manijeh Mohammadian,<sup>\*1</sup> Tahereh-Sadat Jafarzadeh-Kashi<sup>1</sup>

1. Department of Dental Materials, Research Center for Science and Technology in Medicine, Faculty of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

Article information	Abstract
<p>Article history: Received: 13 Jun 2011 Accepted: 25 Aug 2011 Available online: 8 Apr 2012 ZJRMS 2013; 15(1): 24-27</p> <p>Keywords: Leakage Coltosol Temporary restorative material Dye penetration</p> <p>*Corresponding author at: Research Center for Science and Technology in Medicine, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran. E-mail: mohammadnezhad@yahoo.com</p>	<p><b>Background:</b> It is necessary to seal the dental access cavity which is under root canal treatment with temporary restorative materials. For this purpose, the main attention in selecting the temporary restorative material during endodontic treatments is drawn to the sealing ability. The purpose of this study is to investigate the coronal sealing ability of 3 temporary filling materials, Cavizol, Coltosol, and Zonalin through DPI (Dye Penetrant Inspection).</p> <p><b>Materials and Methods:</b> In this study, 98 extracted with no decay mandibular and maxillary molar teeth were used. The teeth were divided into 3 experimental groups of 30 teeth and two positive and negative control groups of 4 teeth. In the experimental group, 4×4mm endodontic access cavity was created on the occlusal surface and in each experimental group the teeth were filled with Cavizol, Coltosol, and Zonalin. In the positive control group, access cavity was created but restorative material was not used. In the negative control group, access cavity was not created. Experimental groups (teeth) were placed in normal saline for 2 hours. Then, the first, second and third groups were immersed in methylene blue dye for 24 hours, 1 week, and 4 weeks, respectively.</p> <p><b>Results:</b> Zonalin showed significantly more (micro) leakage than Coltosol and Cavizol. Cavizol also showed more leakage than Coltosol, but there was no significant difference between them.</p> <p><b>Conclusion:</b> According to the results of the study, Coltosol and Cavizol are suitable for dressings with less than one week duration because of better sealing. In case the interval between treatment sessions lasts more than a week, the dressing should be replaced.</p> <p>Copyright © 2013 Zahedan University of Medical Sciences. All rights reserved.</p>

### Introduction

The ability of the dentist for achieving desirable and favorable results can be influenced by different factors such as availability of suitable materials. Familiarity with different dental materials is the basis for many discussions of dentistry which in any of the related branches depends on knowledge of the materials and proper use of them [1]. Cements are one of the materials which are used in dentistry and have many applications in various disciplines including endodontics. Temporary cements which are used as intermediate restorations at endodontic treatment intervals and also at the end of endodontic treatments before permanent restoration play an important role in the success of endodontic treatments. Large number of studies on microleakage will indicate its importance for comparing the efficiency and superiority of different materials and various methods of tooth restoration more than ever [2]. Sealing the endodontic access cavity successively or at endodontic session intervals is mandatory in order to prevent the canal from being contaminated by food debris, oral fluids, and microorganisms until the ultimate coronal restoration [3].

In spite of the progress in the knowledge of root canal treatment, root canal treatment still fails [4]. Several

factors contribute to the failure of root canal treatment such as inadequate debridement, undetected canals, inadequate root canal obturation (filling), over filling and over instrumentation, examiner errors, and apical and coronal seal [5]. Post space preparation has negative effects on root canal filling materials [6]. Many people believe that coronal microleakage is one of the main factors of endodontic treatment failure [7, 8]. Vire found that 59% of extractions of endodontically treated teeth were due to prosthetic reasons [9].

Magura et al. investigated the saliva penetration rate in root canals filled (obtured) with Gutta-percha. They found that in teeth that have had root canal treatment and their crown have had bacterial contamination for 3 months, root canal retreatment, also known as endodontic treatment, should be done before permanent treatment [8]. Barthel et al. tested the sealing ability of IRM, Cavit and glass ionomer in 100 single-rooted teeth by bacterial penetration. Their findings indicated that glass ionomer has better sealing in this group [10].

Using dye, radioisotopes, bacteria and fluid filtration in the study conducted by Zaia et al. on 4 temporary restorative materials, Coltosol, IRM, Vidrion R and

Scotchbond, indicated that none of these materials were able to prevent dye from penetrating into the canal; however, Coltosol and IRM had significantly less microleakage than other materials of the study [11]. In their study, Zmener et al. couldn't find a significant difference in the sealing ability of Cavit, IRM and polycarboxylate cement (Ultra Temp) [12].

## Materials and Methods

In this experimental study, coronal microleakage rate of 3 temporary filling materials-Coltosol, Cavizol and Zonalin- were examined by dye penetration. Selecting these 3 materials among several temporary restorative materials as experimental groups is for the reason that Coltosol has been used as a basis for comparing other temporary restorative materials in all researches. Dentists believe that Zonalin better than other temporary restorative materials can prevent the ingress of external factors in long term and Cavizol has also been studied as a home-made (domestic) restorative material. SPSS-16 (statistical analysis software) and standardized tests such as Wilcoxon and Mann-Whitney *U* were used for statistical analysis of data extracting the results.

To conduct this research, dye penetration method and tooth longitudinal incision were used (for investigating dye penetration rate). In this study, dye penetration method is used due to its adequate accuracy as well as its ease of use in comparison with radioisotope, bacterial penetration and fluid filtration methods.

In this study, 98 non-carious mandibular and maxillary molar teeth with no obturation were used (missing teeth extracted because of gum (periodontal) diseases or diabetes). After being extracted, the teeth were placed in Sodium hypochlorite solution for a minimum of 2 hours.

In the next stage, an endodontic access cavity was made on the teeth with creating a Class I cavity with dimensions of 4×4 mm. Carbide fissure burs were used for cavity preparation and the teeth were rinsed with air-water spray and dried. Then, dry cotton was put on the entrance of the canals so that the distance between the occlusal plane and the cotton surface will be 4 mm. Afterwards, the teeth were dressed (filled) with temporary restorative materials. In order that the materials stick to the cavity walls and create a smooth and uniform lump, restoration of each cavity was done in 2 stages: by pressing the temporary restorative material slowly into the walls in the first stage and re-placing the temporary restorative material on the previous layer and shaping the tooth surface (a tooth contains 5 different surfaces including: mesial, distal, lingual or palatal, occlusal or incisal and buccal or facial surface.) with spatula in the second stage and in external edges, adequate adaptation was made between tooth and temporary restoration using Burnisher.

The samples consisted of 3 experimental groups including 30 teeth; 10 teeth were filled with Coltosol, 10 with Cavizol, and 10 with Zonalin. The way of putting the dressing was by pressing layer after layer. While putting each layer, it is also pressed to the walls in order to ensure the restoration wall sealing. In addition to these groups,

two positive and negative groups were also selected. Each group consisted of four teeth. Negative control group consisted of 4 healthy teeth without decay and obturation with healthy and intact crown and access cavity was not prepared and the positive control group consisted of 4 teeth without decay and obturation which access cavity was created but not filled with any restorative material according to the previous method.

Then, the teeth in separate groups were placed in normal saline for 2 hours so that the stiffness of the materials will be ensured. Afterwards, all the teeth surfaces (root and crown) other than the occlusal surface were covered with 2 layers of nail polish in order to prevent dye penetration.

The teeth were then placed in methylene blue liquid. A group of 30 for 24 hours, a group of 30 for one week, and another group of 30 were placed in methylene blue for 4 weeks beside positive and negative control groups. In this stage, the teeth were specified with A, B and C classes before being placed in methylene blue in order to prevent identification. After being taken out of methylene blue, the teeth were rinsed under running water for 2 hours.

For longitudinal section of the teeth, carbide fissure burs with diameter of 1 mm was used because of its ease of access and easy application. For this purpose, the teeth were first cut from the furca area. Then, the teeth were cut (split) longitudinally in a buccolingual direction in a way that the burs were entered up to 2 mm near the dressing wall parallel with buccal and lingual surface and then after a longitudinal furrow (line) was made on the tooth surface by a spatula, the teeth were cut into half. Then, dye penetration rate on the occlusal surface was measured using a periodontal probe (Fig. 1) and dye penetration rate was classified as follows:

- A: Degree 0→ without dye penetration
- B: Degree 1→ dye penetration up to (a depth of) 1 mm
- C: Degree 2→ dye penetration up to a depth of 2 mm
- D: Degree 3→ dye penetration up to a depth of 3 mm
- E: Degree 4→ dye penetration up to a depth of 4 mm
- F: Degree 5→ dye penetration of more than 4 mm



Figure 1. Sample of microleakage in the split teeth

## Results

The average microleakage of three temporary restorative materials used in this research for 24 hours, one and four successive weeks is indicated in figure 3. As it is indicated in this figure, microleakage rate in Zonalin is more than Cavizol and Coltosol. The amount of

microleakage indicators in the three groups during successive times are presented in table 1.

1- Coltosol: According to Wilcoxon rank-sum test, significant difference was seen between microleakage rates after 24 hours and after one week ( $p= 0.028$ ). There was also a significant difference between microleakage rate after 24 hours and after four weeks ( $p= 0.04$ ). But there was no significant difference between microleakage rates after one week and four weeks.

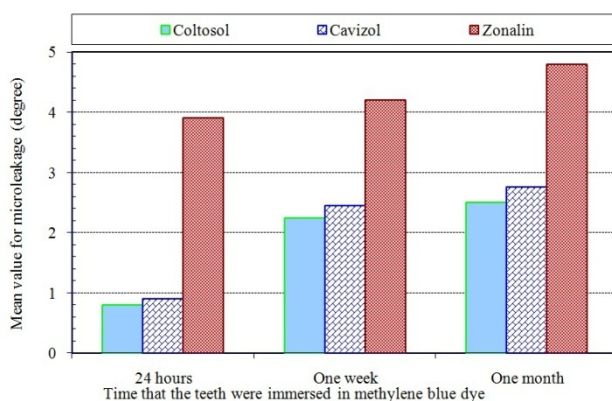
2- Cavizol: According to Wilcoxon rank-sum test, significant difference was seen between microleakage rates after 24 hours and after one week ( $p=0.026$ ). There was also a significant difference between microleakage rate after 24 hours and after four weeks ( $p=0.02$ ). But there was no significant difference between microleakage rates after one week and four weeks.

3- Zonalin: According to Wilcoxon rank-sum test, no significant difference was seen between microleakage rates after 24 hours and one week and also microleakage rate after one week and 4 weeks. But, comparing the microleakage rate after 24 hours with 4 weeks, a borderline result was observed ( $p=0.051$ ).

**Table 1.** The amount of microleakage indicators in the three groups during successive times

Time	Microleakage Group	Number	Min	Max	Mean±SD	kruskal-wallis test
1.22	Coltosol	10	0	3	0.8±1.22	* $p=0.0001$
1.28	Cavizol	10	0	3	0.9±1.28	
0.87	Zonalin	10	3	5	3.9±0.87	
0.79	Coltosol	10	1	3	2.2±0.79	* $p=0.0002$
1.07	Cavizol	10	1	4	2.4±1.07	
0.63	Zonalin	10	3	5	4.2±0.63	
0.97	Coltosol	10	1	4	2.5±0.97	* $p=0.0001$
0.63	Cavizol	10	2	4	2.8±0.63	
0.42	Zonalin	10	4	5	4.8±0.42	

\*The significance level  $\alpha=0.01$ , indicates significant difference microleakage between the three groups.



**Figure 2.** Mean microleakage of temporary restorative materials in successive time

## Discussion

In this research, the microleakage rate of the three materials- Zonalin, Cavizol and Coltosol- was investigated with dye penetration. Webber et al., Chohayeb & Bassiouny, Barkhordar & Stark, Lee et al.,

Beckham et al., and Pai et al. have used dye penetration method to examine the sealing ability of different temporary restorative materials [13-18].

Longitudinal section of the teeth was done with a 1mm-diameter carbide fissure burs similar to the method used by Beckham et al. The reason for using burs is its ease of access and easy application. Zonalin is a temporary restorative material of ZOE group (Zinc Oxide Eugenol). In fact, it is polymer-reinforced ZOE. Cavizol and Coltosol are temporary restorative materials of Cavit group and like Cavit their main ingredients (constituents) are zinc oxide, calcium sulfate, zinc sulfate and resins. Coltosol is made in Switzerland by Coltene Co.; Zonalin is manufactured by Kement, UK and Cavizol has been manufactured by Golchai Company in Iran.

The results of the study indicated that Zonalin showed significantly more microleakage than Cavizol and Coltosol; however, when Cavizol and Coltosol are compared, with a little difference microleakage in Cavizol is more than Coltosol.

Considering the above results and the familiarity with ZOE, it can be mentioned that one of the causes of difference in microleakage rate of Zonalin in comparison with the other two materials may be because of being in powder and liquid and the need for being mixed with a certain consistency by dentist. Craig also believes that obtaining the proper consistency in ZOE depends on the dentist's experience. He has also mentioned the importance of proper combination of power and liquid and believes that any wrong change in the proportion of each of the materials may result in losing some of the characteristics of the material [1]. In this study, Zonalin cement was mixed in a liquid to powder ratio recommended by the manufacturer.

The result of the study for each material during three successive times (24 hours, one week, and one month) indicates an upward trend in the amount of microleakage which is in fact indicative of the decrease of sealing rate in the materials. Lamers et al. also stated that Cavit microleakage will increase with an increase in the treatment intervals [16]. Moreover, microleakage rate after 24 hours in Zonalin samples is noticeably more than Coltosol and Cavizol. The same result was also obtained after one week and four weeks. Microleakage in Zonalin samples in certain periods was more than the other two groups. The result was similar to the results reported by Chohayeb [14]. But microleakage amount of the Coltosol and Cavizol during the aforesaid period was not significantly different. Cavit group (Coltosol and Cavizol) will expand as it absorbs water and will result in better sealing of the cavity. Studies with desirable results about Cavit sealing have often been carried out in a period less than 7 days [14].

Another cause of difference in the results of Zonalin in different researches can be time factor because in each research certain desirable periods of the researcher have been considered and in case the periods will be long, the results of the study will differ with the results of short-term studies. The following results can be obtained from this research:

- 1- There was no significant difference between Cavizol and Coltosol in terms of microleakage rate and the ability of sealing the cavity and Cavizol temporary restorative material is similar to Coltosol in terms of performance.
- 2- Although Zonalin (reinforced ZOE) is generally an appropriate material but it is not suggested for temporary restoration because its sealing ability is dependent on the method of preparation and combination of powder and liquid. Thus, the old belief among the dentists to the effect that Zonalin is the most appropriate material for filling the teeth in cases when the permanent restoration is postponed for a long time will be put into question.
- 3- Cavizol and Coltosol temporary restorative materials (of Cavit group) are not appropriate for cases more than a week and they should be replaced after one week, in case

of need. This is confirmed by another group of researchers [16, 19].

### Acknowledgements

We express our gratitude to Dr. Mohammad Nejad who helped us in preparing this paper. It should be mentioned that this research is extracted from the dentistry thesis done by Ms. Manijeh Mohammadian with Code No. 258.

### 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.

### Funding/Support

Tehran University of Medical Sciences.

### References

1. Craig R, Powers JM. Restorative dental materials. 11<sup>th</sup> ed. Las Vegas: Mosby; 2006:480.
2. Gomes MS, Barletta FB, Della Bona A, et al. Microbial leakage and apical inflammatory response in dog's teeth after root canal filling with different sealers, post space preparation and exposure to the oral environment. J Appl Oral Sci 2007; 15(5): 429-36.
3. Grossman LI, Suresh Chandra B, Gopi Krishna V, editors. Endodontic practice. 12<sup>th</sup> ed. New Delhi: Wolters Kluwer Press; 2010: 278-307.
4. Verissimo DM, do Vale MS. Methodologies for assessment of apical and coronal leakage of endodontic filling materials: A critical review. J Oral Sci 2006; 48(3): 93-98.
5. Ingle JJ, Slavkin HC. Modern endodontic therapy; Past, present and future. In: Ingle JJ, Bakland LK, Craig Baumgartner J, editors. Ingles Endodontics. 6th ed. Ontario: BC Decker Inc; 2008: 1-35.
6. Pappen AF, Bravo M, Gonzalez-Lopez S and Gonzalez-Rodriguez MP. An in vitro study of coronal leakage after intraradicular preparation of cast-dowel space. J Prosthet Dent 2005; 94(3): 214-218.
7. Madison S, Wilcox LR. An evaluation of coronal microleakage in endodontically treated teeth: Part III. In vivo study. J Endod 1988; 14(9): 455-8.
8. Magura Me, Kafrawy AH, Brown CE Jr and Newton CW. Human saliva coronal microleakage in obturated root canals: An invitro study. J Endod 1991; 17(7): 324-31.
9. Vire De. Failure of endodontically treated: Classification and evaluation. J Endod 1991; 17(7): 338-42.
10. Barthel CR, Strobach A, Briedigkeit H, et al. Leakage in root coronally sealed with different temporary fillings. J Endod 1999; 25(11): 731-4.
11. Zaia AA, Nakagawa R, De Quadros I, et al. An in vitro evaluation of four materials as barriers to coronal microleakage in root-filled teeth. Int Endod J 2002; 35(9): 729-34.
12. Zmener O, Banegas G, Pameijer CH. Coronal microleakage of three temporary restorative materials: An in vitro study. J Endod 2004; 30(8): 582-4.
13. Webber RT, del Rio CE, Brady JM and Segall RO. Sealing quality of a temporary filling materials. Oral Surg Oral Med Oral Pathol 1978; 46(1): 123-30.
14. Chohayeb AA. Sealing; ability of intermediate restorations used in endodontics. J Endod 1985; 11: 241-5.
15. Barkhordar, RA, Stark MM. Sealing ability of intermediate restorations and cavity design used in endodontics. Oral Surg Oral Med Oral Pathol 1990; 69(1): 99-101.
16. Lamers Ac, Simon M, van Mullem PJ. Microleakage of cavit temporary filling materials used in endodontic access in monkey teeth. Oral Surg Oral Med Oral Pathol 1980; 49(6): 541-3.
17. Beckham BM, Anderson RW, Morris CF. An evaluation of three materials as barriers to coronal microleakage in endodontically treated teeth. J Endod 1993; 19(8): 388-91.
18. Pai SF, Yang SF, Sue WL, et al. Microleakage between endodontic temporary restorative materials placed at different times. J Endod 1999; 25(6): 453-6.
19. Lim KC. Microleakage of intermediade restorative materials. J Endod 1990; 16(3): 116-8.

*Please cite this article as:* Mohammadian M, Jafarzadeh Kashi T. In vitro comparison of coronal micro-leakage of three temporary restorative materials by dye penetration. Zahedan J Res Med Sci (ZJRMS) 2013; 15(1): 24-27.