Microleakage of Different Temporary Filling Materials in Primary Teeth

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Objective: *The aim of this study was to compare the sealing properties of IRM, Coltosol, Cavit G, Adhesor and Clip, which used as temporary filling material in coronal access openings in extracted human primary teeth.* ***Study Design:*** *Standardized access cavities of 2×2 mm were prepared in the eighty-four, caries-free human primary anterior teeth. The teeth were divided randomly into five groups of 16 teeth each. Temporary restorative materials Group A: IRM (Dentsply), Group B: Coltosol (Coltone), Group C: Cavit G (3M), Group D: Adhesor (Spofa Dental) and Group E: Clip (Voco) were applied according to the manufacturer's directions. The specimens were immersed silver nitrate and placed in film developer under fluorescent for 24 hours. The sectioned specimens were evaluated under a digital microscope at x 20 magnifications and blindly scored for microleakage.* ***Results:*** *Clip presented the least microleakage value whereas; Adhesor and IRM presented the higher microleakage values. There were statistically significant differences between Clip and the others groups, while there were no statistically significant differences in microleakage between IRM, Adhesor, Coltosol and Cavit G. However, the leakage scores of Clip and Cavit G were congruent (p= 0.454).*
Conclusion: *Amongst the five materials, Clip exhibited a better sealing ability.*
Keywords: *IRM, Coltosol, Cavit G, zinc phosphate cement, Clip, temporary filling material, primary teeth.*
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INTRODUCTION

The purpose of root canal therapy of primary teeth is to maintain function, arch length symmetry, esthetics and the integrity of the primary dentition until normal exfoliation. According to the Guidelines of the American Academy of Pediatric Dentistry pulpectomy is indicated in primary teeth with carious pulp exposures in which, following coronal pulp amputation the radicular pulp exhibits clinical signs of hyperemia, or evidence of necrosis of the radicular pulp with or without caries involvement.[1]

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With the exception of single visit treatment, the use of a temporary restoration in root canal therapy is peremptory.[2] The purpose of a temporary restoration is to seal the endodontic access cavity to avoid reinfection of the root canal system during the endodontic treatment. Temporary restoration materials should prevent contamination of the root canal by fluids, organic materials and oral bacteria from the oral cavity. These materials are required to allow easy manipulation, placement and removal and protect tooth structure during the treatment.

Many different materials have been advocated for its use in endodontic temporary restoration, and all sealing abilities have been evaluated in permanent teeth.[3-6] Intermediate Restorative Material (IRM) is zinc oxide and eugenol cement reinforced with polymethly methacrylate. IRM was compared to other temporary filling materials in many studies with conflicting results.[7-11] Studies using zinc phosphate cement have shown controversial results.[12-14] Coltosol is a zinc oxide, zinc sulphate and calcium sulphate hemihydrate-based material and this material designed for short term temporization not exceeding 2 weeks.[15] Cavit G is variety of Cavit that differ in its resin content. Cavit (non resin)was found to provide a superior to seal.[11] Clip is light-polymerized composite based on urethane dimethacrylate polymer. These composite based materials were investigated in several studies with controversial findings,.[7, 8, 16, 17]

The purpose of this *in vitro* study was to compare the sealing properties of IRM, Coltosol, Cavit G, Adhesor (zinc

phosphate cement) and Clip when used as temporary filling material in coronal access openings in extracted human primary teeth.

MATERIALS AND METHOD

Eighty-four, caries free freshly extracted, intact, human primary anterior teeth were cleaned and examined to ensure that there were no cracks and fractures especially at the future access site. These teeth were stored in distilled water until ready for use.

Standardized access cavities of approximately 2×2 mm were prepared using a highspeed hand piece under copious water spray with a #4 round carbide burs (Dentsply Int./Maillefer, Ballaigues, Switzerland). After removal of the coronal pulp tissue, each cavity was rinsed with distilled water for 20 seconds (s) and air dried with a oil-free compressed air for 20 s. Then, a dry compressed cotton pellet was placed on the floor of the pulp chamber. The depth of the cavity was measured with a periodontal probe to allow a 3 mm space for the temporary filling material.

The teeth were divided randomly into five groups of 16 teeth each. The temporary restorative materials Group A: Intermediate Restorative Material (IRM) (Dentsply, Caulk USA), Group B: Coltosol (Coltone, Swiss), Group C: Cavit G (3M, ESPE, Germany), Group D: Adhesor (Spofa Dental, Czech Republic) and Group E: Clip (Voco, Cuxhaven, Germany) were applied according to the manufacturer's directions. The only exception was IRM, which was mixed with a powder to liquid ratio 2:1 (g mL^{-1}). It was recommended that lower powder to liquid ratio (2:1) gave better initial sealability than manufacturer's recommendations (powder liquid ratio 6:1).[18]

After sealing, the specimens were then placed in normal saline and stored in an incubator at a constant temperature of 37°C for 12 hours to ensure proper settings of materials. Two positive control primary teeth had their access preparations without temporary filling materials and two negative control primary teeth had intact crowns with no access opening nor temporary fillings.[5]

The specimens were thermocycled for 1000 cycles in distilled water at 5°C and 55°C, with a dwell time of 30 s in each bath. The apices of all specimens were occluded with a resin composite (Concise White Sealant Systems, 3M Dental Products). All tooth surfaces were covered with two layer of nail polish except for the access area. The specimens were immersed in room temperature 3 mol/L silver nitrate in amber vials for 24 hours in a dark room. They were then removed, rinsed with tap water and placed in film developer (Film Developer; Eastman Kodak, Rochester NY 14650) under fluorescent lights for 24 hours. The teeth were then washed under tap water and dried. The roots were removed from the crowns 2 mm below the cemento-enamel junction. The crowns were embedded in epoxy resin (Buehler Ltd, lake Bluff IL, USA). After polymerization, the blocks were sectioned longitudinally in a buccolingual direction using a low-speed diamond blade (Mecatome T201, Presi, France) under constant water lubrication.

The sectioned specimens were evaluated under a digital microscope (Leica 4000B, Leica Microsystems Germany) at x 20 magnifications and blindly scored for microleakage by a second investigator. Each specimen was photographed at ×20 original magnifications using a digital camera fitted on the microscope. Microleakage at the enamel/dentin was scored using ordinal scale where 0 = no evidence of dye penetration; 1 = dye penetration of less than half the cavity depth; 2 = dye penetration to the full cavity depth and 3 = dye penetration to the axial wall and beyond.

The two examiners were calibrated before the examinations. Intra-examiner reliability was assessed using the Kappa statistics showing an excellent reliability (κ =0.98).

The data were analyzed using the Kruskal-Wallis H test with Benferroni correction and post hoc Dunn's test to determine whether any statistically significant differences existed between groups ($p < 0.05$).

RESULTS

The positive controls showed complete dye penetration while negative controls showed no dye penetration. The leakage value indicated differences among the materials. The results of dye penetration obtained from test groups are listed in Table 1. Clip presented the least microleakage whereas; Adhesor and IRM presented the higher microleakage values. No dye penetration into filling material was noted in any groups.

The results of the statistical analysis are summarized in Table 2. There were statistically significant differences

Table 1. Number of teeth with different leakage values.

Filling Material	Number of Specimens	Leakage Grades 0	1	2	3
Group A: IRM	16		8		8
Group B: Coltosol	16	4	4	3	5
Group C: Cavit G	16	5	5	2	4
Group D: Adhesor	16	3	3	4	6
Group E: Clip	16	10	4	2	
Negative control	2	2			
Positive control	2				2

Table 2. Dunn's post hoc values for materials ($P < 0.05$)

Filling Material	*P*-value				
Group A: IRM	1,00000				
Group B: Coltosol	0,25827	1,00000			
Group C: Cavit G	0,08482	0,55324	1,00000		
Group D: Adhesor	0,59087	0,55324	0,23569	1,00000	
Group E: Clip	**0,00020**	**0,00951**	**0,04549**	**0,00144**	1,00000

($p<0.05$) between Clip and the others groups, while there were no statistically significant differences ($p>0.05$) in microleakage between IRM, Adhesor, Coltosol and Cavit G. However, the leakage scores of Clip and Cavit G were congruent ($p= 0.454$).

DISCUSSION

Previous studies have evaluated the sealing ability of temporary filling materials in permanent teeth. However, this is the first study to evaluate the sealing properties of endodontic temporary materials in primary teeth.

Microleakage of temporary filling materials was tested using different methods, including dyes, radioisotopes, bacterial penetration and fluid filtration.[10, 14, 15, 17, 19-21] Each technique has its advantages and disadvantages. In this study, dye penetration method was used, because this method was easy to perform and did not require sophisticated materials. It has been reported that dye penetration technique bore the same results when compared to fluid filtration method.[19] On the other hand, several studies reported poor or no correlation between dye penetration technique and fluid filtration method and radioisotopes technique.[22-26]

In root canal therapy in primary teeth, especially in the anterior teeth, restoring the small access presents some inherent difficulties. Therefore, for a successful root canal therapy in a primary teeth, a temporary restorative material, should have a superior sealing ability in a minimum width and depth access. In this study, a temporary restorative material of 3 mm thickness was placed into access cavities, while in most of the studies performed on the permanent teeth, the depth of cavities was at least 4 mm.[17-19, 27]

Regarding the filling contents of endodontic materials may influence the bonding of temporary filling materials to dentin. It has been shown that a layer of Grossman cement, zinc oxide, or Maisto's paste placed over dentin and later removed, can reduce the adhesive strength of a composite resin bonded with a coupling agent or even preclude bonding.[28] On the other hand, Capurro *et al* [29] reported that IRM, Grossman cement, Maisto's paste, Dycal and Cavit did not interfere with the bonding of the glass ionomer to dentin. Also, the properties of the root canal filling materials could influence the overall setting results of the temporary filling materials.

The result in this study indicated that Clip provided a statistically superior sealing properties than the other temporary filling materials. Clip has similar physical properties to other composite containing temporary filling materials, such as TERM (Dentsply Caulk) and Fermit (Vivadent, Schaan, Liechtenstein). Hansen and Montgomery[30] reported that 1-3 mm thick TERM were as effective as a 4-mm depth cavity seal after 5 week interval. Webber *et al* [31] showed that at least 3.5 mm of Cavit is required to prevent dye leakage. It was found that Cavit was more effective than TERM and IRM in that order.[32] In another study, a 2 mm thickness Cavit did not provide an effective sealing.[33] IRM performed almost equally to Cavit using a 4 mm thickness over a 3 week period.[8] It was reported that the use of less IRM powder provided a better seal.[18, 34] for this reason, in our study,IRM was mixed with a powder to liquid ratio 2:1.

CONCLUSION

According to the result of this study amongst the five materials, Clip exhibited the best sealing ability. During the root canal therapy of primary anterior teeth, composite based temporary restorative materials are more effective in sealing properties in small access cavities.

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