Original Article

In vitro study of Coronal Leakage of Four Temporary Filling Materials Immersed in Alcoholic Methylene Blue Dye

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Abstract

Introduction: Temporary restorative materials are placed in access cavity to provide the coronal seal of the root canal during multi-visits RCT. This in vitro study was designed to evaluate the coronal microleakage of four different temporary restorative materials commonly used in endodontics in Myanmar, viz., MD.Temp, Orafil, Caviton, Zinc oxide eugenol.

Materials and Methods : Forty-four extracted human premolars were selected, and access cavity was prepared. Pulp chambers were filled with wet cotton pellets leaving approximately 4 mm coronally. Forty teeth were randomly divided into four experimental groups equally. The remaining four teeth were equally divided into two control groups. Access cavities in each group were filled with one of the above tested materials, and immediately put into the water. Tooth surfaces except occlusal surface were then coated with nail varnish. Equal parts of 2% methylene blue and methylated alcohol were mixed to prepare a dye solution. Samples were immersed in dye for 10 days at 32 ± 2°C. Teeth were rinsed, dried, and sectioned mesiodistally and evaluated under a stereomicroscope at a magnification of 15X for linear dye penetration along cavity walls. Data were analyzed using Kruskal-Wallis and Tukey HSD tests.

Results : The lowest microleakage value was observed in MD.Temp and Orafil, and the highest in Zinc oxide eugenol (ZOE). Caviton was not statistically different from Orafil and ZOE, but significantly higher in microleakage than MD.Temp.

Clinical Significance : ZOE which is dissolvable in alcohol was the least effective material for preventing microleakage, while MD.Temp and Orafil provided the best sealing in content of alcohol in this study.

Introduction

Endodontic treatment aims to eliminate infections in the root canal system and to prevent reinfection ultimately. Maintenance of asepsis in the canal during endodontic treatment is paramount (Yun et. al. 2012). It is estimated that more than 500 species are able to colonize in the adult mouth and that any individual typically harbors 150 or more different species (Teughels et. al. 2012). Different food types for raw consumption contain enterococci commonly (Kampfer et. al. 2007). They can penetrate into the canal if there is no coronal seal and it may lead to reinfection then result endodontic failure.

An inadequate coronal seal will allow canal contamination by penetration of saliva, nutrients, chemicals and importantly microorganism and by products. Swanson and Madison (1987) reported that saliva leakage through coronal seal can reach 85% of canal length. This saliva can dissolve the sealer and extensively contaminate the gutta-percha then develop pathologic lesion in treated cases (Aminozarbian et. al. 2009). In multi visits RCT, the pulp space must be closed with temporary cement during visits (Cohen & Burns 2002).
A commonly suggested cause of endodontic failure is apical leakage due to inadequate apical seal (Swanson & Madison 1987).But lack of satisfactory temporary coronal seal during RCT is also important cause for endodontic failure while it is ranked second amongst the contributing factors in continuing pain (Naoum 2002, Naseri et. al. 2012).There must be an adequate seal to prevent bacteria and fluid from contaminating the canal.They also prevent escape into oral cavity of medicaments placed in the pulp chamber (Shahi et. al. 2010). Coronal microleakage appears to be of equal or greater clinical relevance as a factor in endodontic failure than apical leakage due to risk of recontamination (Aledrissy et. al. 2011). Sealing of access cavity during endodontic treatment visits

is essential element in achieving endodontic success (Walton &Torabinejad 1996).

Temporary restorative material should provide permanent air tight seal as coronal seal until treatment is completed or permanent restoration (Djeri et. al. 2010).Failure of temporary material is usually due to the lack of thickness of material, improper placement of material and failure to evaluate the occlusion after placement. Allowing temporary filling to remain longer than three weeks is an invitation to coronal leakage (Bellamy 2004). Space for material, occlusal forces and length of time till permanent restoration are also considerable factors. Factors; including coefficient of thermal expansion, modulus of elasticity or handling property may affect on temporary filling materials (Yun et. al. 2012). Dissolution of coronal seal can be potential for oral fluid and bacterial contamination of root canal space (Swanson & Madison 1987).

In most of the microleakage studies, carried out for determination of sealing ability of temporary filling materials, thermocycling and mechanical loading are used to simulate temperature changes and occlusal stresses that take place in vivo. Temperature changes is thought as a cause of failure of temporary restoration because of dimensional changes; shrinkage and expansion. Besides, chemical dissolution should also be considered for failure of temporary restorative materials. Thus, beverages and foods containing alcohol should also be considered in the deterioration of temporary filling materials. Eugenol is freely soluble in alcohol (Madjackfrost 2009). So, eugenol containing temporary filling could deteriorate by exposure of alcohol in the oral cavity. Thus, this study was designed to evaluate the coronal seal of four commercially available temporary restorative materials, viz., MD.Temp, Orafil, Caviton, and Zinc oxide eugenol (ZOE), immersed in a dye solution that contained alcohol.

Materials and Methods

Forty-four caries free, extracted human premolar teeth were selected and stored in 10% formalin solution. Calculus, tissue remnants and staining were removed from teeth and rinsed. Standard access cavity for premolar was prepared on the occlusal surface of each tooth using #4 fissure diamond burs to get similar sized and shaped access cavities for all specimens. The teeth were irrigated by using 2.5% sodium hypochloride solution to remove remaining debris, pulp tissues, and smear layer in the canal. A periodontal probe was used to measure the depth of the opening assuring that it could accommodate at least 4 mm of the tested temporary filling materials. The teeth were divided randomly into four experimental groups, Group I, II, III and IV, each group consisting of 10 teeth, and also two control groups, negative and positive, consisting of two teeth in each group.

A wet cotton pellet was placed at the bottom of the access cavity leaving about 4 mm of depth to give room for the filling materials. The temporary restorations, viz., MD.Temp (MetaBiomed Co. Ltd., Korea) (Fig.1), Orafil (PrevestDentPro Ltd, Jammu, India) (Fig.2), Caviton (GC Corporation, Tokyo, Japan) (Fig.3), and Zinc Oxide and Eugenol (PrevestDentPro Ltd, Jammu, India) (Fig.4), were introduced into the access openings of the experimental groups from the bottom up with the use of a plastic instrument.

In Group I, the inserted material was MD.Temp, in Group II, III and IV, the materials placed were Orafil, Caviton and Zinc Oxide Eugenol respectively. MD.Temp, Orafil and Caviton are pre-mixed materials, so, were inserted into the access incrementally to avoid voids and porosity in the fillings. Zinc oxide powder and Eugenol liquid were mixed according to guideline of Notes on Dental Materials by E.C.Combe, (sixth edition, 1992, Churchill Livingstone, London) since there was no specific instruction of manufacturers. Powder and liquid ratio was 4/1 to get thick paste. Thin glass slab and stainless steel spatula were used in mixing. After ZOE was prepared as thick paste, it was inserted into the cavity as in above materials.

Fig. 1.MD.Temp
(MetaBiomed Co. Ltd., Korea)

Fig.2.Orafil
(PrevestDentPro Ltd, Jammu, India)

Fig. 3.Caviton
(GC Corporation, Tokyo, Japan)

Fig.4.Zinc Oxide and Eugenol
(PrevestDentPro Ltd, Jammu, India)

Table.1. Tested temporary filling materials, their compositions and manufacturers

Material	Composition	Manufacturer
MD.Temp	Zine Oxide, Zinc Sulfate, PVA-PVC	MetaBiomed Co. Ltd., Korea
Orafil	Zinc oxide, Zinc sulphate, Calcium sulphate, Plasticizers, resins, mint aroma and excipients	PrevestDentPro Ltd, Jammu, India
Caviton	Dental Plaster, Zinc Oxide , Vinyl acetate resin, Ethanol	GC Corporation, Tokyo, Japan
ZincOxide Eugenol	Powder; Arsenic free, extra pure zinc powder Liquid; Extra pure Eugenol oil	PrevestDentPro Ltd, Jammu, India

The surfaces of filling materials placed in the specimens were smoothed with cotton pellet moistened with distilled water, and immediately put into distilled water. The two positive control teeth were just filled with cotton pellets to allow leakage, and the two negative control teeth were filled with soft sticky wax to prevent leakage. The specimens' surfaces were double coated with nail varnish except 1 mm around the restorations (Fig.5).

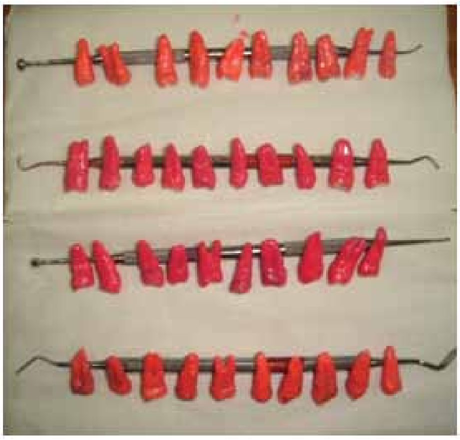

Fig.5.Specimens coated with nail varnish

All the specimens were then immersed in 2% methylene blue dye solution, which was mixed with equal part of methylated alcohol, at room temperature (32±2°C) for 10 days (Fig.6).

Fig.6.Specimens immersed in dye solution

The teeth were then rinsed, dried, and longitudinally sectioned in a mesiodistal direction using a slow speed diamond disc under constant water. Dye leakage was scored using a stereomicroscope at a 15X magnification (Fig.7.a, b, c and d). The scoring was as follow: score 0 = no leakage, score 1 = leakage through one fourth of the cavity, score 2 = leakage through half of the cavity, score 3 = leakage through three-fourth of the cavity and score 4 = leakage through full length of the cavity. Then, the results were analyzed using Kruskal-Wallis and Tukey HSD test as post hoc.

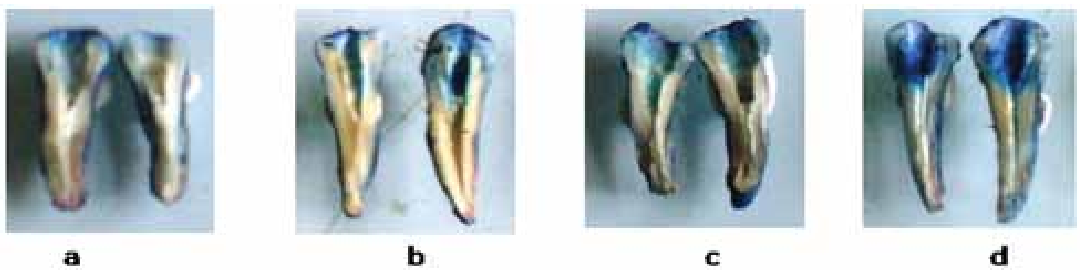

Fig.7.Specimens showing leakage of dye;
a. MD. Temp group, b. Orafil group, c. Caviton group, d. ZOE group

Results

The negative control group showed no dye penetration, and the positive control group demonstrated maximum dye penetration. The specimen of ZOE group showed the highest dye leakage among all of the specimens (Fig.7.d). Dye penetration into the specimens of MD.Temp, Orafil and Caviton are shown in Fig.7.a, band c. The mean marginal dye leakage scores described in ranks are presented in Table 2, and the results of multiple comparisons are given in Table 3.

According to the results obtained by comparison, there was no significant difference between MD.Temp and Orafil (p=0.998), but MD.Temp was significantly low in microleakage than the specimens of Caviton (p=0.041) and ZOE group (p=0.001). Orafil showed significant lower score of microleakage than ZOE (p=0.001), but not significantly different from Caviton (p=0.061). ZOE was the temporary filling cement that exhibited the highest leakage score but not statistically different from Caviton (p=0.413).Thus, it indicates that ZOE has lower sealing property than MD.Temp andOrafil.

Table 2. Mean ranks of the leakage scores of the temporary filling materials

(Same letters indicate no statistically significance.)

Materials	Mean Rank
MD.Temp	13.60a
Orafil	13.55ab
Caviton	24.40bc
ZOE	30.45c

Table 3.The results of multiple comparisons carried out by using Turkey HSD test at 95% confidence interval (p < 0.05)

	Orafil	Caviton	ZOE
MD.Temp	0.998	0.041*	0.001*
Orafil		0.061	0.001*
Caviton			0.413

(*) indicates statistically significant differences at p < 0.05

Discussion

A temporary restoration is the restoration placed within an endodontic access cavity that has been cut through an interim restoration or through tooth structure (Jensen et. al. 2007). So many microleakage studies about temporary restoration were performed for a long time.

The integrity of temporary restorations used during endodontic treatment has been usually assessed with dye penetration to attempt to simulate bacterial ingress between the tooth and the restorative materials, especially methylene blue dye. Methylene blue dye has smaller molecular size than bacteria to diffuse. Some of the literatures pointed out that the methylene blue dye studies may reveal misleading conclusion (Veri'ssimo& Vale 2006). However, the tested temporary fillings give satisfactory seal with this methylene blue dye, we believed that these materials are reliable to use clinically. In this study, alcohol which may be deteriorative agent for temporary fillings was mixed with dye. Restoration thickness of 4mm is placed in the study because minimum 3.5 to 4 mm thickness of temporary restoration is needed to prevent coronal leakage (Aledrissy et. al. 2011).

Today, commonly used temporary restoratives are hydraulic temporary sealing materials, zinc oxide eugenol based materials and resin based cements. MD.Temp, Oralfil and Caviton contained calcium sulphate and resin (PVA-PVC). So they are plaster based or zinc oxide/ calcium sulphate preparations. In other words, they are hydraulic temporary filling materials. Hydraulic temporary sealing materials are based on calcium sulphate: they set upon contact with saliva in the oral cavity. During setting, the materials begin to chemically react and adhere to dentin as they undergo linear hygroscopic expansion like plaster (Ogura &Katsuumi 2008).The hygroscopic expansion of hydraulic temporary filling materials provides good adaptation between the restoration and cavity walls. So they provide a tight seal in endodontic access cavities and prevent microleakage.

ZOE and its based temporary filling show lower sealing ability through so many studies. They showed lower property when they meet with thermal stress since it probably be attributed to the instability of zinc oxide (Aledrissy et. al. 2011).And inconsistencies in the mixing process and lack of homogenecity lower its sealibility. Because of these, ZOE based materials are believed to be less leakproof among temporary restorative materials.

In the study made by Aledrissy et. al. (2011) tested with thermal cycling and immersed in methylene blue dye for 10 days, calcium sulphate based temporary material showed the lowest leakage followed by zinc phosphate cement, then ZOE sample had worse result. On the other hand, several in vitro studies using silver nitrate as an indicator (Noguera& McDonald 1990), calcium chloride radioisotope, dye penetration (Lee et. al. 1993, Mayer & Eickholz 1997), fluid filtration method and bacterial penetration (Deveaux et. al. 1992), all demonstrated that IRM (ZOE based material) provides sealing properties inferior to those of Cavit (plaster based material) (Naoum 2002).

In this study, 2% methylene blue dye solution was mixed with equal part of methylated alcohol in attempt to simulate the alcoholic beverages and food. Our hypothesis is that the temporary filling materials that contain substance which is highly soluble in the alcohol will certainly show a greater microleakage than those containing substance which is less soluble in it. Greater dye penetration found in the specimens of ZOE is believed to be due to its solubility in the alcohol since eugenol is unstable in alcohol, or the permeability of alcohol into the material. The dissolution of set ZOE in fluid is high mainly due to elution of eugenol (Combe 1992). Eugenol is freely dissolvable in alcohol (Madjackfrost 2009).

Thermocycling is the most performed procedures in microleakage studies that tested thermal changes that affect on dimension of set temporary filling materials by expansion and shrinkage. Intraoral temperature is usually accepted as approximately 35°C. It can change depending upon the foods and drinks that we eat; ranging from 1.0°C to 58.5°C (Gale & Darvell 1999). These temperature changes may lead to the dimensional changes of filling materials.

But Deveaux et. al.(1992) found that thermocycling had no significant effects on microleakage but it does affect the various temporary materials. In fact, hygroscopic temporary fillings will expand either in hot moisten or in cold moisten environment and provide tight seal. Oral cavity is almost always moistening. So, validity for application of thermal stresses for the study of temporary restoration may be doubtful.

Though consideration of thermal and mechanical stresses as causes for leakage seems to be meaningful, chemical dissolution should not be overlooked for consideration of microleakage. In the case of temporary restorations, it is possible that the disintegration of the restoration margin is associated with the dissolution of certain components of the materials in the oral fluid. Therefore, beverages and foods containing alcohol could be considerable factor. There are so many alcoholic fermentable, alcohol flavored and alcohol contained foods in our traditional diet. Alcohol could be retained in cooked foods also. According to a survey, an average American adult drinks 386-packs of beer, 12 bottles of wine & 2 quarts distilled spirits of alcohol per year. Besides, some of mouthwash contains alcohol from 6.6 % to 26.9 % (Lachenmeier et. al. 2012). Concentration of methylated alcohol that we used is about 70%. And the concentration of alcoholic beverages is ranged from 0.0% to 99 % (Wikipedia.com 2012).

In this study, teeth specimens were immersed in alcoholic dye for 10 days. Actually alcoholic foods and drinks just pass the oral cavity. But the residual alcohol after drink remains for 15-20 minis in the oral cavity (Langille & Wigmoe 2000). Although immersion of teeth specimens in alcoholic dye for 10 days is irrelevant to in vivo nature, that is just consideration of alcohol as a deteriorative factor. Repeated drinking will last the exposure time more and it may favour for dissolution of eugenol. However staying of alcohol in mouth can deteriorate the ZOE materials and this study is more relevant for alcohol-drinkers.

MD.Temp and Orafil exhibited minimal microleakage when compared with the ZOE group. This result for this study implies that these two materials are more resistant to dissolution in alcohol or less permeable to it than ZOE cement. In other way, hydraulic temporary filling materials provide better coronal seal by hygroscopic expansion during their setting. According to the results obtained from this preliminary experiment, alcohol has certain effects on temporary filling material especially on those containing zinc oxide compounds. Therefore, further studies are needed to gain more insight in the effect of alcohol containing foods on temporary filling materials.

Clinical significance

ZOE based temporary filling materials are not reliable to prevent the microleakage of temporary restorations due to the fact that these materials will deteriorate rapidly in the alcohol containing food and drink according to this study. The hydraulic or calcium sulphate based temporary restorative materials are seemed to possess ability to seal the coronal sealing and to prevent microleakage better in involvement of alcohol. The temporary filling materials which are not dissolving in or not permeable to alcohol should be considered for temporary restoration.

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