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An In Vitro Evaluation in the Effect of Walking Bleach Agent on the Coronal Microleakage of Coltosol F, Biodentine, Cavit G, MD-Temp and Zinc Phosphate Temporary Restorative Materials In Endodontic Practice

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ABSTRACT

Aim: Evaluation in the effect of walking bleach agent on the coronal microleakage of Coltosol F, Biodentine, Cavit-G, MD-Temp and Zinc phosphate temporary restorative materials by stereomicroscopic analysis. An invitro study.

Materials and Method: Seventy-five extracted human maxillary central incisor teeth were collected and endodontic access cavity preparations were done on all specimens. All the teeth were prepared chemo-mechanically and obturated with gutta-percha in lateral condensation technique. All the teeth were then randomly divided into five groups. 15 teeth in each group, 10 teeth served as experimental specimens, in which bleaching agent was placed in the pulp chamber and 5 teeth served as control, in which no bleaching agent was placed. Access cavities were restored with temporary restorative materials being tested per each group respectively. All specimens were then immersed in 1% Indian ink dye for 72 hours. All the specimens were then longitudinally sectioned and observed with stereomicroscope and were graded according to the depth of linear dye penetration.

Results: Statistical analysis was done using Mann-Whitney U test and Kruskal-Wallis test. Cavit G, Coltosol F have shown minimal or no dye leakage compared to other temporary restorative materials used.

Conclusion: Cavit G and Coltosol F showed minimal or no dye leakage and were not influenced by the effects of walking bleach agent.

Keywords: Bleaching paste mixture, Dye leakage values, Hygroscopic, Microleakage.

INTRODUCTION

Patients concerned with their discolored teeth have shown increased demand in the improvement of the technique and materials used for teeth whitening. The intra-coronal bleaching of teeth is one of the most conservative means of teeth whitening. Staining of discolored teeth can be intrinsic or extrinsic, pre-eruption or post-eruption usually from various natural or iatrogenic causes.[1]

The walking bleach is a traditional method of bleaching the endodontically treated teeth. This bleaching technique uses 30% Hydrogen peroxide

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as the primary oxidizing agent and Sodium perborate powder. An increase in pressure inside the root canal space may occur due to generation of oxygen gas from the bleaching paste mixture resulting in loosening of coronal temporary restorative materials. Some of the paste components leaks into oral cavity causing acidic taste to the patient, irritation and localized sloughing of the adjacent gingival tissues and decrease in the effectiveness of the bleaching agent. So the choice of coronal temporary restorative materials becomes atmost important for the successful outcome of walking bleach technique.[2]

The five temporary restorative materials which were used in the present study are Cavit G, Coltosol F, Biodentine, Zinc phosphate cement and MD-Temp.

MATERIALS AND METHOD

Seventy-five freshly extracted human permanent maxillary central incisor teeth were collected from the Department of Oral and Maxillofacial surgery, Triveni institute of dental sciences and Hospital, Bilaspur. Chhattisgarh. Inclusion criteria: Non-carious, non-fractured, non-restored single rooted teeth. Exclusion criteria: Carious, fractured, restored and multi rooted teeth. All the specimens were stored in 10% neutral formalin until used. Endodontic access cavity preparations were made on all the teeth using high speed rotary hand piece and Endo access bur No:2 (Dentsply, Malleifer, Tulsa Dental, USA). Necrotic pulp tissue was removed with barbed broaches (Mani,Inc Japan) and No:10-K file was placed in to the root canal to establish the patency of the apical foramen and the working length was determined by substracting 1mm from the length achieved with the tip of the trail file just visible at the apical foramen of the root canal. Biomechanical preparation was done upto No:40 size K-file following step-back technique in all the specimens. During the process of instrumentation of root canal, 17% EDTA (Ethylene Diamine Tetra acetic Acid) (Prime Dental Products Pvt Ltd, Thane, India), 3% Sodium hypochlorite (Vishal Dentocare Pvt Ltd, Ahmedabad, India) and normal saline were used as root canal irrigants. Root canals were then dried with absorbent paper points, coated with thin mix of AH (Amine Hydroxyl) plus root canal sealer (Dentsply Maillefer, USA) and were obturated with gutta-percha(Dentsply Maillefer, USA) in lateral condensation technique. Finally the gutta-percha was removed to a level of 3mm apical to the cemento-enamel junction and the canal orifices were sealed with 2mm thickness of Glass Ionomer Cement-Type II Universal restorative material (GC Corporation, Tokyo, Japan) as cervical barrier. All the teeth were then randomly divided into five groups. Each group consisting of 15 teeth, of which 10 teeth served as experimental specimens, in which bleaching agent was placed in the pulp chamber and 5 teeth served as control, in which no bleaching agent was placed. 30% Hydrogen peroxide liquid (Molychem, Mumbai, India) and Sodium perborate tetrahydrate powder (HiMedia Laboratories Pvt Ltd, Mumbai, India) was freshly mixed in volume ratio of 1:3 into a paste form and was placed in the pulp chambers of all the experimental group specimens. In control group specimens, no bleaching material was placed in the pulp chamber, instead dry cotton pellets were placed.

Fig 1: 30% Hydrogen peroxide.

Fig 2: Sodium perborate tetrahydrate powder.

Access cavity openings of all the teeth in each group were sealed with three millimeter thickness of one of the five temporary restorative materials being tested respectively, irrespective of either experimental or control group specimens as summarized in Table No: I

Table 1: Temporary restorative materials used in the study.

Groups	Type of Temporary restorative materials used	Experimental group (No. of teeth)	Control group (No. of teeth)
A	Cavit G	10	5
B	Coltosol F	10	5
C	Biodentine	10	5
D	Zinc phosphate cement	10	5
E	MD-Temp	10	5

The five temporary restorative materials used in the present study were Cavit G (3M, ESPE, GmbH Co, Seafeld, Germany), Coltosol F (Coltene Whaledent, Altastatten, Switzerland), Biodentine (Septodent, France), Zinc phosphate cement (Pyrex Exports, Roorkee, India) and MD-Temp (META Biomed Co Ltd, Korea). All the temporary restorative materials were manipulated and allowed to set according to manufacturer's instructions. Surfaces of all the teeth were double coated with nail polish except 1mm around the circumference of the access cavity. All the teeth were then immersed in 1% Indian ink dye (Loba Chemie Pvt Ltd, Colaba, Mumbai, India) and in the dye solution the teeth were subjected to thermocycling at 4° ± 2°C and 56° ± 2°C via refrigeration and heated water bath for 200, 2 minute cycles with a dwell time of 60 seconds for 3 days. Teeth were then removed from the dye solution and were thoroughly rinsed under running tap water for 5 minutes, dried and the nail polish was completely removed with a scalpel. All the teeth were longitudinally sectioned in a bucco-lingual direction with a diamond disc of 0.3mm in thickness (DFS, Germany) at a speed of 20,000 rpm. The depth of linear dye penetration was observed with stereomicroscope of magnification 20X equipped with micromeasure grid and the measurements of dye penetration were recorded by graded scores of 0 to 3. 0 for No dye penetration, 1 for Dye penetration not reaching the pulp chamber, 2 for Dye penetration reaching the pulp chamber and 3 for Loss of temporary restorative material from the access cavity.

RESULTS

Statistical analysis was done using Mann–Whitney U test and Kruskal–Wallis test.

Table 2: Mann-Whitney U test: Comparision of the experimental and control groups.

Experimental Vs Control groups	Mann-Whitney U test (Z-Value)	P – Value (P = Probability)
Cavit G	-1.169	0.239 (NS)
Coltosol F	-0.577	0.550 (NS)
Biodentine	-2.543	0.011 (HS)
Zinc phosphate cement	-2.270	0.020 (HS)
MD-Temp	-1.622	0.101 (HS)

HS: Highly Significant NS: Non Significant.

Kruskal-Wallis test between the experimental groups showed statistically significant difference in the dye leakage values with P-Value < 0.001 (Highly significant). So to find out where the significant difference was, Mann-Whitney U test for experimental groups was done.

Table 3: Mann-Whitney U test: For experimental groups.

Experimental Groups	Mann-Whitney (Z-Value)	P-Value (P=Probability)
Cavit G Vs Coltosol F	-0.688	0.488 (NS)
Cavit G Vs Biodentine	-3.402	0.001 (VHS)
Cavit G Vs Zinc phosphate cement	-3.452	0.001 (VHS)
Cavit G Vs MD-Temp	-2.179	0.027 (SIG)
Coltosol F Vs Biodentine	-3.118	0.002 (VHS)
Coltosol F Vs Zinc phosphate cement	-3.229	0.001 (VHS)
Coltosol F Vs MD-Temp	-1.701	0.088 (NS)
Biodentine Vs Zinc phosphate cement	-0.759	0.449 (NS)
Biodentine Vs MD-Temp	-1.665	0.093 (NS)
Zinc phosphate cement Vs MD-Temp	-2.105	0.033 (SIG)

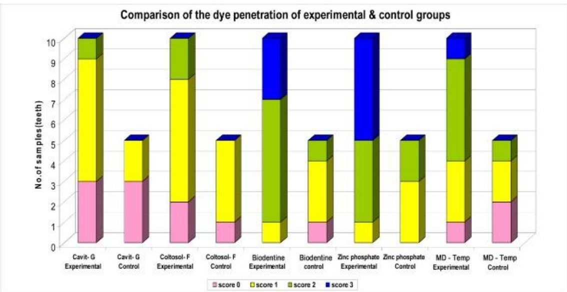
VHS = Very Highly Significant NS = Non Significant.
SIG = Significant.

Kruskal-Wallis test between the control groups showed P-Value > 0.202 and as there was no statistically significant difference between the control groups, it was not required to go for Mann-Whitney U test. In the experimental group specimens, Cavit G showed minimal dye leakage values in the linear dye penetration tests with a mean value of 13.30 followed by Coltosol F with 16.20, MD-Temp with 25.70, Biodentine with 34.80 and maximum dye leakage values were exhibited by Zinc phosphate cement with a mean of 37.50.

In the control group specimens, Cavit G showed minimal dye leakage values in the linear dye penetration tests with a mean value of 8.20, followed by Coltosol F with 12.10, MD-Temp with 12.40, Biodentine with 14.20 and Zinc phosphate cement with 18.10.

Linear dye penetration was graded as 0,1,2,3. (Graph No: I)

0 = No dye penetration
1 = Dye penetration not reaching the pulp chamber
2 = Dye penetration reaching the pulp chamber,
3 = Loss of temporary restorative material from the access cavity.



Graph 1: Comparison of the dye penetration of experimental and control groups.

DISCUSSION

The discoloration of endodontically treated teeth may result from several factors such as necrotic pulp tissue, remnants of endodontic filling materials in the pulp chamber and haemorrhage following trauma. Non-vital bleaching technique was suggested by Spasser[3] in the year 1961. It uses a mixture of sodium perborate powder and water in the paste form placed in the pulp chamber of tooth between the appointments. Nutting and Poe[4] in 1963 suggested mixing of sodium perborate powder with 30% hydrogen peroxide to enhance the bleaching effects and it is believed that the combination of these two oxidizing agents would be synergistic and more effective in tooth bleaching, this method is known as walking bleach technique. To simulate fluctuations in temperature changes of the oral cavity, thermocycling was included in the present study as it has been reported by Mclnerney[5] that temperature fluctuations can adversely affect the marginal sealing ability of temporary restorative materials. In the present study, we standardized the thickness of all the coronal temporary restorative materials used to 3mm as Webber etal[6] suggested a minimum thickness of 3mm for any temporary restorative materials to achieve a superior marginal sealing ability.

Walking bleach technique recommends removal of gutta percha 3mm apical to the cemento-enamel junction allowing the bleaching agent to diffuse and lighten the cervical-third of the crown.[7]So in the present study gutta percha was removed 3mm apical to the cemento-enamel junction.

External cervical root resorption has commonly been associated with walking bleach technique. The passage of bleaching agents into the periodontal space through the defects at cemento-enamel junction is the main factor related to this resorption. Hydrogen peroxide induces pH changes and generates hydroxyl radicals that degrade connective tissue components. So, 2mm thickness of cervical barrier is placed to block the dentinal tubules that lead from the pulp chamber apical to the epithelial attachment, so as the bleaching agent stays within the access cavity. Glass Ionomer Cement, Zinc oxide eugenol cement, Resin composite have been used as cervical barriers during walking bleach technique, showing satisfactory results.[8] In the present study, 2mm thickness of Glass Ionomer Cement-Type II was placed as cervical barrier.

Microleakage between the restorative materials and the tooth surface can be evaluated by various methods such as dye penetration tests, fluid filtration methods, radioisotopes, electrochemical methods and chemical tracers. Of these, dye penetration method was the most widely used as it is simple and reproducible.[9] So in the present study, linear dye penetration method was used and the dye utilized was 1% Indian ink.

Marosky etal[10] found a correlation between the ease of handling and sealing ability of coronal temporary restorative materials and it was found that, premixed dental cements allowed less marginal leakage and showed better sealing ability, because of fewer chances for manipulative errors with premixed cements compared to the cements that depends on the clinician's skill in mixing powder and liquid components of the dental cements.

In the present study, in Group A; Cavit G, in Group B; Coltosol F and in Group E; MD-Temp, premixed hygroscopic dental cements were used as coronal temporary restorative materials over bleaching paste mixture. Cavit G is a grey coloured, radiopaque temporary restorative material composed of zinc oxide, calcium sulphate, zinc sulphate, glycol acetate, polyvinylacetate resins, polyvinyl chloride acetate, triethanolamine and synthetic resin filler material with no eugenol content.[2] Coltosol F is a white coloured, radiopaque temporary restorative material composed of zinc oxide, zinc sulphate-1-hydrate, calcium sulphate-hemihydrate, diatomaceous earth, natrium fluoride, synthetic resin material with no eugenol content and with peppermint aroma.[2] MD-Temp is a white coloured, radiopaque temporary restorative material composed of zinc oxide, calcium sulfate, zinc sulfate, glycol acetate, polyvinyl acetate resins, polyvinyl chloride acetate, triethanolamine and pigments.[11]

The hygroscopic temporary restorative materials are available in pre-mixed putty like paste form and when comes in contact with moisture from water or saliva in the oral cavity, they show high linear expansion during setting thus showing good sealing ability with the tooth structure. Therefore, these materials are gaining popularity as they do not need mixing and has good operativity.[12]

In the present study, both Cavit G and Coltosol F showed the best sealing ability with minimal or no dye leakage in the linear dye penetration tests and there was no statistically significant difference in the dye leakage values between Cavit G(Group A) and Coltosol F(Group B) in both experimental and control group specimens.

There was statistically significant difference in the dye leakage values between Cavit G(Group A) and MD-Temp(Group E) in the experimental group specimens, but there was no statistically significant difference in the control group specimens. This shows effect of bleaching paste mixture on its contact with the sealing ability of MD-Temp to a certain extent, but the dye leakage values were minimal with no loss of MD-Temp cement from the coronal access in both experimental and control group specimens.

However there was no statistically significant difference in the dye leakage values between Coltosol F(Group B) and MD-Temp(Group E) in both experimental and control group specimens.

In the present study, in Group C; Biodentine was used as coronal temporary restorative material. Biodentine is available in capsules containing ideal ratio of powder and liquid. Powder contains tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetracalcium aluminoferrite, calcium sulphate, bismuth oxide, calcium oxide, silicon oxide, aluminium oxide and liquid contains calcium chloride which acts as an acclerator, hydrosoluble polymer function as water reducing agent and water. The reaction of the powder with the liquid leads to the setting and hardening of the cement. After mixing, the calcium silicate particles of powder reacts with water present in the liquid to form a high pH solution containing $Ca2+$, $OH-$ and silicate ions. The hydration of the tricalcium silicate leads to the formation of a hydrated calcium silicate gel on the cement particles and calcium hydroxide nucleates. Calcium silicate hydrated gel polymerizes to form a solid network and the hydrated calcium silicate gel surrounds the unreacted tricalcium silicate particles and the cement finally sets. The set cement is relatively impermeable to water. Biodentine is radiopaque and its initial setting time is 6 minutes and final setting time is 10 minutes.[13]

When Biodentine comes in contact with dentin, it results in the formation of tag-like structures called as "mineral infiltration zone," where the alkaline caustic effect of the calcium silicate cement's hydration products degrades the collagenous component of the interfacial dentin.[14] Koubi et al[15] confirmed that biodentine is a convenient, efficient and well-tolerated dentin substitute and can be used as intermediate restorative material for upto 6 months.

In three of the experimental specimens of group C, where biodentine was used as temporary restorative material, there was a loss of restorative material from the coronal access. Whereas in control group specimens, there was no loss of restorative material from the coronal access, which shows definite effect of the bleaching paste mixture on its contact with biodentine.

Bonding of zinc phosphate cement to tooth structure occurs by mechanical interlocking and not by chemical interactions. Zinc phosphate cement is available in powder:liquid system. Powder is composed of zinc oxide (90%), magnesium oxide (8.2%), silicone dioxide (1.4%), bismuth trioxide (0.1%) and traces of barium oxide, barium sulphate and calcium oxide. Liquid is composed of phosphoric acid (free acid) (38.2%), phosphoric acid combined with aluminium and zinc (16.2%), aluminium (2.5%), water (36%), zinc (7.1%). Recommended powder: Liquid ratio is 1.4 gms of powder to 0.5 ml of liquid.[14] Naoum etal[16] reported that the sealing ability of zinc phosphate cement is inferior to Cavit G and zinc oxide eugenol cements.

In the present study, in five of the experimental specimens of group D, where zinc phosphate cement was used as temporary restorative material, there was a loss of restorative material from the coronal access. Where as in control group specimens, there was no loss of restorative material from the coronal access. However, there was a significant difference in the dye leakage values between experimental and control group specimens as the dye leakage values were minimal in the control group compared to experimental group specimens, which shows definite effect of the bleaching paste mixture on its contact with the zinc phosphate cement.

In the present study, pre-mixed, hygroscopic temporary restorative materials Cavit G and Coltosol F were not affected by the effects of bleaching paste mixture as they showed minimal or no dye leakage and also withstood temperature changes much better compared to the other temporary restorative materials used. So both Cavit G and Coltosol F are not only be used as temporary restorative materials in contemporary endodontics, but also offers tremendous scope for their use as coronal temporary restorative materials in walking bleach techniques. However pre-mixed, hydrophilic MD-Temp cement exhibited minimal dye leakage values, but with no loss of cement from the coronal access.

Both zinc phosphate and biodentine cements were more strongly influenced by the effects of bleaching paste mixture and thermo-cycling on their sealing ability, as they showed maximum dye leakage values in the dye penetration tests of experimental group specimens compared to the control group specimens.

CONCLUSION

Cavit G and Coltosol F were not influenced by the effects of bleaching agent and thermo-cycling and they offer tremendous scope for their use as coronal temporary restorative materials for the successful outcome of the walking bleach treatment. In-vitro studies definitely cannot duplicate the environment that exists in-vivo. However, these in-vitro evaluations provide information that helps clinician in the selection of the best material to be used for specific clinical situations.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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