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Microleakage comparison of glass-ionomer and white mineral trioxide aggregate used as a coronal barrier in nonvital bleaching

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Abstract

Objectives: There is some evidence that the pH at the root surface is reduced by intracoronal placement of bleaching pastes, which is known to enhance osteoclastic activity. Therefore, it is recommended that a protective barrier be used over the canal filling to prevent leakage of bleaching agents. Glass-ionomer (GI) is commonly used as a coronal barrier before nonvital bleaching. Because mineral trioxide aggregate (MTA) creates high alkalinity after mixing with water, using MTA as a protective barrier over the canal filling may not only prevent leakage of bleaching agents and microorganisms, but may prevent cervical resorption. The aim of this study was to evaluate sealing ability of white mineral trioxide aggregate (WMTA) as a coronal barrier before nonvital bleaching.

Study design: Root canals of one hundred thirty human maxillary incisors were instrumented and filled with gutta-percha without sealer. Gutta-percha was removed up to 3 mm below the cementoenamel junction (CEJ). The teeth were randomly divided into six experimental groups of 20 teeth each and two control groups of 5. In three experimental groups, WMTA was packed into the canal to the level of CEJ. In the remaining experimental groups, glass-ionomer (GI) was used as a coronal barrier. After a 24-hour incubation period, one of the following three bleaching agents was placed in the access cavity of each of the WMTA or GI groups. These three bleaching agents were 30% hydrogen peroxide, sodium perborate mixed with 30% hydrogen peroxide, and sodium perborate mixed with distilled water. The bleaching agents were replaced every 3 days for three times. In the positive controls, no

coronal barrier was used. In the negative controls, all the tooth surfaces were covered by two layers of nail varnish. Microleakage was evaluated using protein leakage test. Statistical analyses were performed with the Kruskal-Wallis and Mann-Whitney tests.
Results: The experimental groups showed minimum leakage which was not significantly more than tha in the negative controls. There was no statistically significant difference in leakage between the experimental groups ($p<0.05$).
Conclusions: This study indicated that different bleaching agents have no effect on sealing ability of WMTA.

Key words: *Coronal barrier, nonvital bleaching, WMTA.*

Introduction

Walking bleaching is a technique commonly used in discolored endodontically treated anterior teeth. Bleaching agents used in this technique include hydrogen peroxide and sodium perborate (1). Although these agents are effective in lightening tooth color, their use has been associated with some undesirable complications.

One of the complications is external resorption of cervical root (2-4). The mechanism responsible for cervical resorption in bleached teeth has not been adequately explained. This is probably caused by the highly concentrated oxidizing agents which diffuse through dentinal tubules and cementum defects and cause necrosis of the cementum, inflammation of the periodontium, and, subsequently, root resorption (5-7). Moreover, some studies have shown that the pH at the root surface is reduced by intracoronal placement of bleaching pastes (4). This acidic environment is known to enhance osteoclastic activity leading to cervical root resorption (4). However, there also appears to exist different views on the nature of the resorption process. Some have regarded it as a purely inflammatory process (4) which may, on occasion, become secondarily invaded by microorganisms (3). Others have suggested that microorganisms from either gingival sulcus or the pulp space in necrotic pulps provide the necessary stimulus to sustain resorptive lesions (8). Therefore, it is recommended that a protective barrier be used over the coronal extent of the root canal filling to prevent leakage of bleaching agents into the periodontium (7). A variety of dental materials such as intermediate restorative material (IRM), hydraulic filling materials (Cavit, Coltosol), resin composites, photoactivated temporary resin materials, zinc oxide-eugenol cement, zinc phosphate cement and glass-ionomers (GI) have been suggested as interim sealing agents during bleaching techniques (9).

One of the disadvantages of temporary sealing materials is the necessity to remove them after bleaching process before the final restoration of the access cavity. Therefore, a 2-mm of layer of glass-ionomer cement has been recommended as a base material during bleaching, which can be left in place after bleaching and can serve as a base for the final restoration (10).

Mineral trioxide aggregate (MTA) was originally developed as a root-end filling material (11). However, numerous studies have shown that MTA can be suitable for a wide variety of applications (12). Moreover, MTA has been used successfully to treat invasive cervical resorptions (13, 14). One of the important properties of MTA is its superior ability to resist leakage (15), which may be explained by its superior marginal adaptation (16). High alkalinity, due to the predominant presence of calcium hydroxide in the formulation of MTA after mixing with water, results in biologic properties similar to those of calcium hydroxide (17). Thus, it is hypothesized that MTA may be used to prevent or arrest tooth resorption. On the other hand, the effect of alkaline and acidic pH values on physical properties of WMTA has been well documented (18, 19). However, the effect of bleaching agents on WMTA, when used as a protective barrier over the root canal filling, is disputed.

Glass-ionomer is traditionally used as a common protective barrier in nonvital bleaching (20).

Despite its wide range of applications, no study has evaluated WMTA as a coronal barrier in nonvital bleaching. The aim of this study was to compare the sealing ability of GI and WMTA as a coronal barrier when different bleaching agents were used in nonvital bleaching technique.

Materials and Methods

-Preparation of specimens

One hundred thirty human maxillary incisors, extracted as a result of periodontal disease, were selected for the study. The teeth were cleaned and then radiographed from buccolingual and mesiodistal directions. The specimens with calcification, internal or external resorption, or cracks were excluded and substituted with other intact ones. The selected teeth were stored in 0.5% chloramine until used.

Access cavities were prepared. Then, the working length was determined by inserting a 15 K-file into the canal until the end of the file was visible at the apex. Half of a millimeter was subtracted from this measurement and recorded as the working length. The canals were prepared with crown-down technique. Gates Glidden drills 3, 4 (Maillefer, Ballaigues, Switzerland) and RaCe rotary file 40, 0.1 taper (FKG Dentaire, Switzerland) were used to flare the coronal and middle thirds. The apical thirds were instrumented with hand stainless steel K-

files (Maillefer, Ballaigues, Switzerland). A 40 K-file was used as master apical file. The canals were irrigated with 10 mL of 2.5% NaOCl during instrumentation. Five mL of saline solution was used as the final irrigant. The canals were dried with paper points and obturated with gutta-percha without sealer. Peeso reamer 4 (Maillefer, Ballaigues, Switzerland) was used to remove the gutta-percha up to 3 mm below the CEJ in palatal aspect. The depth was confirmed by using a periodontal probe. The pulp chambers were irrigated with saline and dried with cotton pellets. The teeth were randomly divided into six experimental groups of 20 teeth each and two control groups of 5.

In three experimental groups, WMTA (Tooth-colored Formula, Dentsply, Tulsa Dental, USA) was prepared according to manufacturer's instructions and packed into the unfilled portion of the canals to the level of CEJ in palatal and facial aspects. Wet cotton pellets were placed over WMTA. The teeth were restored with Cavit (ESPE Dental, Seefeld, Germany) and incubated at 37ºC for 24 hours at a relative humidity of 100%.

In experimental group 1, Cavit and the cotton pellet were removed and another piece of cotton pellet wetted with 0.05 mL of 30% hydrogen peroxide (Merck, Darmstadt, Germany) was placed in the pulp chamber, and again the teeth were restored with Cavit (ESPE Dental, Seefeld, Germany). In experimental group 2, cotton pellets wetted with 0.05 mL of 30% hydrogen peroxide (Merck, Darmstadt, Germany) mixed with 0.15 g of sodium perborate (Merck, Darmstadt, Germany) were used. In experimental group 3, cotton pellets were wetted with 0.15 g of sodium perborate mixed with distilled water.

The teeth were incubated for 3 days. Then Cavit and cotton pellets were removed and replaced with new cotton pellets wetted with fresh bleaching agents. This process was repeated three times. Then the pulp chamber was rinsed with distilled water and dried. Two layers of nail varnish were applied over the tooth surfaces except for the access cavity margins. Three-millimeter apical roots were resected using a high-speed handpiece and a fissure diamond bur under constant water spray.

In the remaining three groups, Fuji glass-ionomer cement (GI) (II LC, Japan) was used as a 3-mm-thick coronal barrier instead of WMTA. All the above-mentioned processes were repeated in the remaining three groups. In the positive control group, no coronal barrier was used over the gutta-percha. In the negative control group, all the tooth surfaces were covered by two layers of nail varnish.

-Protein leakage test

The apparatus used to evaluate protein leakage was prepared by using a 10-mL glass vial with a rubber stopper and a plastic cylinder. A heated instrument was used to create a 2-mm-diameter hole in the center of each rubber stopper. The teeth were inserted in the hole with the roots into the vial and crowns upwards into the cylinder. Fast-setting cyanoacrylate was used to seal the interfaces of tooth and plastic cylinder with rubber stopper. Glass vials and plastic cylinder were filled with 9.5 mL of distilled water and 1 mL of 22 % Bovine Serum Albumin – BSA (Sigma-Aldrich, St. Louis, MO, USA), respectively. The cylinders were covered by aluminum foils. The whole apparatus was incubated at 37ºC for thirty days at a relative humidity of 100%. BSA was changed every day throughout the study.

The amount of albumin leaked into the glass vials was measured with Bradford method at the end of thirty days. Bradford protein reagent is an aqueous solution of Coomassie Brilliant Blue G (Sigma-Aldrich, St. Louis, MO, USA), ethanol, and phosphoric acid. If albumin leaks into the solution, the wavelength of maximum absorption of Coomassie Brilliant Blue G is changed from 465 to 596 nm (21). The rubber stopper together with the plastic cylinder and the attached teeth were removed. Then 100 µL of test solution of vials was pipetted into Eppendorf tube and 1 mL of Bradford protein reagent was added to the tube, and the contents were mixed. Maximum absorption was measured with spectrophotometry and microleakage was calculated. Kruskal-Wallis and Mann-Whitney tests were used for statistical analysis. Statistical significance was defined at $\alpha = 0.05$.

Results

Eight samples were damaged and excluded from the study. The negative controls showed no leakage. The mean ± SD of protein microleakage in the positive controls was 12± 3.43 mg/mL. The mean ± SD of protein microleakage in glass-ionomer groups were 0.42± 0.01, 0.65± 0.36 and 0.63± 0.29 mg/mL for sodium perborate and hydrogen peroxide (SH), sodium perborate and water (SW), hydrogen peroxide (H), respectively. The mean ± SD of protein microleakage in WMTA groups were 0.85±0.38, 0.67±0.31 and 0.44±0.14 mg/mL when SH, SW and H were used as bleaching agents, respectively. There were no statistically significant differences in leakage between the experimental groups ($p<0.05$) (Fig 1).

Discussion

A variety of methods have been used to evaluate coronal microleakage. The methods which use dye tracers are inexpensive and easy to perform. However, the usefulness and clinical relevance of these methods have been questioned by some researchers (21, 22). Therefore, in this study protein was used to evaluate microleakage. Protein leakage test does not have drawbacks of dye leakage tests and has more clinical relevance (21). In this method, the specimens are not destroyed, and the leakage may be evaluated repeatedly (21).

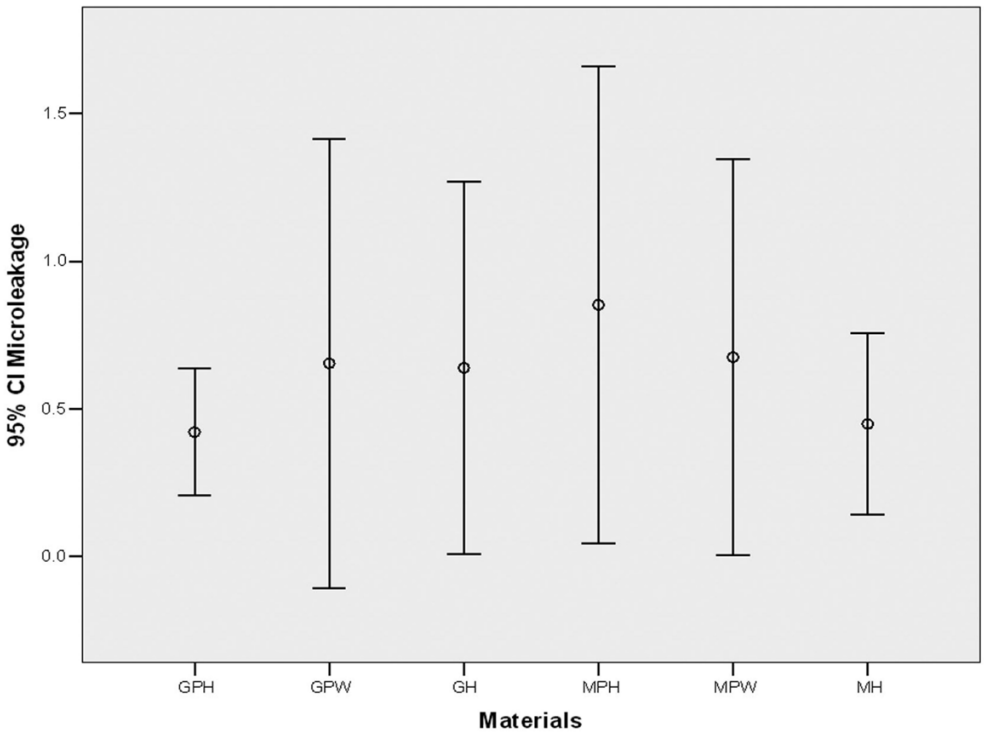

Fig. 1. Protein leakage of glass ionomer (GI) and mineral trioxide aggregate (WMTA) as a coronal barrier in non-vital bleaching. Micloleakge was given in mg/ml. There was no significant difference between experimental groups ($p<0.05$). GPH: glass ionomer/sodium perborate with hydrogen peroxide; GPW: glass ionomer/sodium perborate with distilled water; GH: glass ionomer/hydrogen peroxide; MPH: WMTA/sodium perborate with hydrogen peroxide; MPW: WMTA/ sodium perborate with distilled water; MH: WMTA/ hydrogen peroxide.

The results of this study showed that the positive controls with no coronal barrier demonstrated extensive leakage while the negative controls showed no leakage. It was also demonstrated that GI and WMTA, when used as a coronal barrier, exhibited minimal leakage which was not significantly different from the negative controls. Some studies have shown the negative effects of bleaching agents on dental materials. Lee et al (23) demonstrated that the microhardness of compomer might decrease by bleaching agents. In a systematic review, Attin et al (24) showed that bleaching agents may exert a negative influence on restorations and restorative materials. On the other hand, intracanal oxidizing agents can reduce the push-out strength of MTA when used as perforation repair materials (25). However, our study showed that in spite of negative effects of bleaching agents on restorative materials, these effects could not alter microleakage properties of GI and WMTA. The results of our study are consistent with the results of a bacterial leakage study performed by Tselink et al, who reported no difference in bacterial leakage between gray MTA, WMTA or GI as double barriers over guttapercha without using bleaching agents and recommended both of them as a proper coronal barrier for up to 90 days (26). Moreover, another study showed that MTA produces a much better seal than GI (27). Brito-Junior et al (28) used WMTA or Vidrion R GI as a coronal barrier in nonvital bleaching. They measured the microleakage of oxidizing agents through the barriers and concluded that WMTA has better sealing ability than Vidrion R. The results of this study are inconsistent with those of the present study, which might be attributed to the use of different tracers and frequency of using them. However, this study supported the use of WMTA as a coronal barrier during nonvital bleaching. Llena et al (29) evaluated the microleakage of a flowable composite used as a protective isolating base, applied with different adhesive systems. They concluded that there were no significant differences between the adhesive systems in terms of leakage, and acid etching significantly reduced leakage. However, using acid etching has some drawbacks, including decrease in the pH on the root surface, which has been suggested as a mechanism involved in cervical resorption (11).

Interestingly, MTA has other properties that make it an appropriate alternative for GI or composite as a barrier

in nonvital bleaching. Predominant presence of calcium oxide in the formulation of MTA results in the release of calcium hydroxide during MTA hydration (30). Calcium hydroxide has been shown to arrest or prevent tooth resorption (8). Meanwhile, bleaching agents lower the pH on the root surface, which has been suggested as a mechanism for cervical resorption (11). Higher pH of the MTA and released calcium hydroxide may further protect the root and prevent cervical resorption. The color of MTA can also be advantageous in case of retreatment or post space preparation, as its removal would be much easier and faster than glass-ionomer or other modified resins, which are the same color as the dentin.

References with links to Crossref - DOI

References

1. Chng HK, Palamara JE, Messer HH. Effect of hydrogen peroxide and sodium perborate on biomechanical properties of human dentin. J Endod. 2002;28:62-7.
2. Heithersay GS, Dahlstrom SW, Marin PD. Incidence of invasive cervical resorption in bleached root-filled teeth. Aust Dent J. 1994;39:82-7.
3. Heithersay GS. Invasive cervical resorption: an analysis of potential predisposing factors. Quintessence Int. 1999;30:83-95.
4. Patel S, Kanagasingam S, Pitt Ford T. External cervical resorption: a review. J Endod. 2009;35:616-25.
5. Rotstein I, Torek Y, Misgav R. Effect of cementum defects on radicular penetration of 30% H2O2 during intracoronal bleaching. J Endod. 1991;17:230-3.
6. Koulaouzidou E, Lambrianidis T, Beltes P, Lyroudia K, Papadopoulos C. Role of cementoenamel junction on the radicular penetration of 30% hydrogen peroxide during intracoronal bleaching in vitro. Endod Dent Traumatol. 1996;12:146-50.
7. Zimmerli B, Jeger F, Lussi A. Bleaching of nonvital teeth. A clinically relevant literature review. Schweiz Monatsschr Zahnmed. 2010;120:306-20.
8. Fuss Z, Tsesis I, Lin S. Root resorption--diagnosis, classification and treatment choices based on stimulation factors. Dent Traumatol. 2003;19:175-82.
9. Plotino G, Buono L, Grande NM, Pameijer CH, Somma F. Nonvital tooth bleaching: a review of the literature and clinical procedures. J Endod. 2008;34:394-407.
10. Rotstein I, Zyskind D, Lewinstein I, Bamberger N. Effect of different protective base materials on hydrogen peroxide leakage during intracoronal bleaching in vitro. J Endod. 1992;18:114-7.
11. Torabinejad M, Watson TF, Pitt Ford TR. Sealing ability of a mineral trioxide aggregate when used as a root end filling material. J Endod. 1993;19:591-5.
12. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review--Part III: Clinical applications, drawbacks, and mechanism of action. J Endod. 2010;36:400-13.
13. Park JB, Lee JH. Use of mineral trioxide aggregrate in the nonsurgical repair of perforating invasive cervical resorption. Med Oral Patol Oral Cir Bucal. 2008;13:E678-80.
14. Baratto-Filho F, Limongi O, Araújo Cde J, Neto MD, Maia SM, Santana D. Treatment of invasive cervical resorption with MTA: case report. Aust Endod J. 2005;31:76-80.
15. Torabinejad M, Rastegar AF, Kettering JD, Pitt Ford TR. Bacterial leakage of mineral trioxide aggregate as a root-end filling material. J Endod. 1995;21:109-12.
16. Torabinejad M, Smith PW, Kettering JD, Pitt Ford TR. Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials. J Endod. 1995;21:295-9.
17. Jacobovitz M, de Lima RK. Treatment of inflammatory internal root resorption with mineral trioxide aggregate: a case report. Int Endod J. 2008;41:905-12.
18. Saghiri MA, Lotfi M, Saghiri AM, Vosoughhosseini S, Aeinehchi M, Ranjkesh B. Scanning electron micrograph and surface hardness of mineral trioxide aggregate in the presence of alkaline pH. J Endod. 2009;35:706-10.
19. Saghiri MA, Lotfi M, Saghiri AM, Vosoughhosseini S, Fatemi A, Shiezadeh V, et al. Effect of pH on sealing ability of white mineral trioxide aggregate as a root-end filling material. J Endod. 2008;34:1226-9.
20. De Oliveira LD, Carvalho CA, Hilgert E, Bondioli IR, de Araújo MA, Valera MC. Sealing evaluation of the cervical base in intracoronal bleaching. Dent Traumatol. 2003;19:309-13.
21. Valois CR, Costa ED Jr. Influence of the thickness of mineral trioxide aggregate on sealing ability of root-end fillings in vitro. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97:108-11.
22. Wu MK, Wesselink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. Int Endod J. 1993;26:37-43.
23. Lee JH, Kim HI, Kim KH, Kwon YH. Effect of bleaching agents on the fluoride release and microhardness of dental materials. J Biomed Mater Res. 2002;63:535-41.
24. Attin T, Hannig C, Wiegand A, Attin R. Effect of bleaching on restorative materials and restorations--a systematic review. Dent Mater. 2004;20:852-61.
25. Loxley EC, Liewehr FR, Buxton TB, McPherson JC 3rd. The effect of various intracanal oxidizing agents on the push-out strength of various perforation repair materials. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;95:490-4.
26. Tselnik M, Baumgartner JC, Marshall JG. Bacterial leakage with mineral trioxide aggregate or a resin-modified glass ionomer used as a coronal barrier. J Endod. 2004;30:782-4.
27. Barrieshi-Nusair KM, Hammad HM. Intracoronal sealing comparison of mineral trioxide aggregate and glass ionomer. Quintessence Int. 2005;36:539-45.
28. Brito-Júnior M, Faria-e-Silva AL, Fonseca B, Camilo CC. Sealing ability of MTA used as cervical barrier in intracoronal bleaching. Acta Odontol Latinoam. 2009;22:118-22.
29. Llena C, Amengual J, Forner L. Sealing capacity of a photochromatic flowable composite as protective base in nonvital dental bleaching. Int Endod J. 2006;39:185-9.
30. Camilleri J, Pitt Ford TR. Mineral trioxide aggregate: a review of the constituents and biological properties of the material. Int Endod J. 2006;39:747-54.