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Original Article

Assessment of micro-leakage for light-cure glass ionomer and pro-root mineral trioxide aggregate as coronal barriers in intracoronal bleaching of endodontically treated teeth

Maryam Zare Jahromi[1], Mehrdad Barekatain[2], Niloufar Bonakdar Hashemi[3], Poorandokht Refaei[4]✉

1. Assistant Professor, Department of Endodontics, Islamic Azad University Isfahan (Khorasgan) Branch, Isfahan, Iran.
2. Assistant Professor, Department of Operative Dentistry, Islamic Azad University Isfahan (Khorasgan) Branch, Isfahan, Iran.
3. Dentist, Islamic Azad University Isfahan (Khorasgan) Branch, Isfahan, Iran.
4. Post graduate Student, Department of Endodontics, Islamic Azad University Isfahan (Khorasgan) Branch,Isfahan, Iran.

✉**Corresponding Author:** Poorandokht Refaei, Dental School (Faculty), Islamic Azad University Isfahan (Khorasgan) Branch, Isfahan, Iran.

Email: p_refaei@yahoo.com **Tel:** +983132331085

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Abstract

Introduction: Cervical root resorption is one of the most important complications of intra coronal bleaching .A way of preventing this type of resorption is using a coronal barrier under the bleaching materials. The aim of this study was to compare the sealing ability of glass ionomer cement and Pro Root Mineral Trioxide Aggregate (MTA) as a coronal barrier in intra coronal bleaching.

Materials &Methods: In this study, 40 single-root maxillary anterior teeth were endodontically prepared and divided into two experimental groups (n= 15) and two positive and negative control groups (n=5). In the experimental groups, gutta percha was removed up to 3 mm below the cemento enamel junction (CEJ).RMGI and MTA were placed over gutta percha up to the level of CEJ. After a 24-hour incubation period, the bleaching agent (a mixture of sodium perborate and 30% hydrogen peroxide) was placed in the access cavities. The bleaching agents were replaced every 3 days over 9 days. Then, the access cavity was filled with 2% methylene blue for 48 hours. All samples were longitudinally sectioned and the dye penetration range was evaluated using a stereomicroscope. Data were statistically analyzed using Kruskal-Wallis and Mann–Whitney tests (α=0.05).

Results: Leakage mean indicated that there was a significant difference between these two groups and leakage was less in ProRoot than glass ionomer.

Conclusion: It seems that the MTA can provide a better coronal seal during the bleaching.

Keywords: Dental leakage, Glass ionomer cements, Tooth bleaching

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ارزیابی میزان ریزنشت دو ماده ی گلاس آینومر نوری و ام تی ای پروروت به عنوان پلاگ کرونالی هنگام سفید کردن داخل تاجی دندان‌های معالجه ریشه شده

مریم زارع جهرمی، مهرداد برکتین، نیلوفر بنکدار هاشمی، پوراندخت رفائی*

چکیده

مقدمه: مهمترین عارضه سفید کردن داخل تاجی، تحلیل سرویکالی ریشه، میباشد. یکی از راه های پیش گیری از این نوع تحلیل استفاده از یک سد کرونالی زیر ماده سفید کننده است. این مطالعه آزمایشگاهی، به مقایسه توانایی سیل کنندگی سمان گلاس آینومر و Pro Root MTA، بعنوان سد کرونالی طی درمان سفید کردن داخل تاجی گام به گام ،پرداخته است.

مواد و روش ها: در این مطالعه ازمایشگاهی ۴۰ دندان تک کاناله قدامی فک بالا درمان ریشه و به دو گروه آزمایشی ۱۵ تایی و دو گروه کنترل مثبت و منفی ۵ تایی تقسیم شدند. در گروههای آزمایشی گوتا پرکا تا ۳ میلیمتری زیر CEJ حذف گردید. رزین مادیفاید گلاس آینومر و MTA تا لبه CEJ قرار گرفتند. پس از ۲۴ ساعت انکوباسیون، ماده بلیچینگ (مخلوط سدیم پربورات و هیدروژن پراکساید ۳۰٪) در حفره دسترسی قرار گرفت.ماده بلیچینگ هر سه روز یکبار به مدت ۹ روز تعویض شد. سپس حفره دسترسی با متیلن بلو ۲٪ برای ۴۸ ساعت پر شد. نمونه ها بصورت طولی برش داده شده و نفوذ رنگ توسط استریومیکرسکوپ ارزیابی شد. داده ها با آزمونهای کروسکال–والیس ومن –ویتنی مورد تجزیه و تحلیل قرار گرفت (سطح معنی دار $\alpha = 0.05$).

یافته ها: مقایسه میانگین ریزنشت نشان داد بین دو گروه آزمایشی تفاوت آماری معنی دار وجود دارد و پروروت ریزنشت کمتری نسبت به گلاس آینومر نوری داشته است.

نتیجه گیری: به نظر می رسد MTA می تواند سد کرونالی مناسب تری در درمان سفید کردن فراهم کند.

واژگان کلیدی: لیکیج دندانی، سمان گلاس آینومر، سفید کردن دندان

Introduction

Whitening discolored endodontically treated teeth is a cautious and proper alternative than more aggressive treatments such as crowns or veneers. [1] Among the methods of nonvital tooth bleaching, Thermo catalytic and walking bleach techniques are the most common intracoronal bleaching techniques. [2] Cervical root resorption is a serious complication of whitening procedures with peroxide compounds. [3] The etiology for external root resorption is complex. The oxidative action of bleaching agent and releasing of nascent oxygen which is later transferred to the cervical periodontal ligament (PDL) through the dentinal tubules and cementum defects can act as a stimulus for inflammatory changes and subsequent up-regulation of odontoclastic cells responsible for invasive cervical root resorption. [4] The use of a protective barrier over the orifice during tooth bleaching is recommended to prevent oxygen and heat transferring to the periodontal ligament in the cervical area. [5-9] Materials which have been suggested as coronal barrier include glass-ionomer cements, intermediate restorative material (IRM), Cavit and Coltosol and resin composites. [2] Temporary restoration materials must be removed after completion of teeth whitening and before placing the final restoration but materials such as glass ionomer cements can remain and act as the basis for the final restoration after completion of tooth bleaching. [10] Mineral Trioxide Aggregate (MTA) was introduced initially as root end filling materials. [11] Nevertheless, several studies have recorded a wide variety of applications such as suitable treatment of invasive cervical resorption. [12] MTA has a good sealing ability and can set in the presence of moisture. One of the most striking features of this material is its resistance to microleakage which may be obviously explained by high marginal adaptation. [13, 14] The potential tooth discoloration is the only reason to prevent MTA used as an effective intra-orifice barrier during tooth bleaching. [12]

Glass ionomer cement has conventionally been used as a coronal barrier in the internal bleaching treatment.

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[11, 15, 16] This cement can make a circular connection with tooth structure, thus it can be a suitable separator material. [17] Recently, efforts have been established to develop new glass ionomer cements with reduced working time which are more advantageous to the previous generation. One of the newly introduced cements is Ionoseal (Voco Germany) glass ionomer cement. Fast and hygienic application, ready for use and one –component material, light curing in seconds that saves time, high biocompatibility and radio opacity are some benefits which mentioned for this product. [11, 18, 19] Junior et al. compared the microleakage of White MTA and Glass ionomer as a coronal barrier and they concluded that WMTA's sealing ability was superior to glass ionomer. [16]

Sealing ability of root filling materials is well illustrated by the microleakage tests. Generally, in endodontic treatments, this index is measured based on the amount of labeled materials which can penetrate through the filled canal. These labeled materials include radioisotopes, dyes, bacteria and their products such as proteins.[20] The dye penetration methods are inexpensive and easy to perform.[21] Thus, this study utilized a dye penetration test to evaluate the sealing properties of ProRoot MTA versus resin modified glass ionomer as intra-orifice barriers for internal bleaching.

Materials & Methods

Forty [22] fresh single canal human maxillary central incisors and canine, extracted because of periodontal disease were selected for this experimental study. Teeth with internal or external resorption, cracks (detectable under light stereomicroscope), severe coronal or root caries, large coronal restoration, root fractures, dilacerations, deep depression on root surfaces were excluded and replaced with intact ones. To control the cross infection and minimize soft tissues and periodontal remnants, all teeth were stored in 5.25% solution of sodium hypochlorite (NaOCl) (Golrang, Tehran, Iran) for 6 h and the residual calculus were removed by an ultrasonic scaler(Cavitron Bobcat Pro, Dentsply, York, PA, USA). The selected teeth finally stored in 0.5% chloramine solution until experiment commencement. The access cavity was prepared using a high-speed handpiece and #2 round diamond bur (TizKavan, Tehran, Iran) under copious water irrigation and pulp horns were eliminated. Then, the working length was determined by #15 K-file (Mani, Utsunomiya, Japan) inserted into the canal until the file tip got visible at the apex. One millimeter was subtracted from this measurement and then recorded as the working length. The canals were instrumented by step-back technique (MAF=35).Gates Glidden drills 1, 2 and 3 (Maillefer, Ballaigues, Switzerland) were used to flare the coronal and middle thirds. The canal was alternatively irrigated with 2 mL of 2.5% NaOCl during instrumentation between each file size. Finally, the canals were flushed with 5 mL of normal saline. The canals were dried with paper points (Gapadent-China) and obturated with gutta-percha (Gapadent-China) and AH26 sealer (Dentsply, Konstanz, Germany) by using lateral condensation method.

After cutting and pressing the excess gutta-percha up to the CEJ level, access cavity was cleaned with alcohol-soaked cotton pellets to remove the remaining sealer in the pulp chamber. Then, access cavities were restored with Cavit (ESPE Dental, Seefeld, Germany). The final obturation radiography was taken. The Cavit was removed after a week. Thereafter, a Peeso reamer #3 (Maillefer, Ballaigues, Switzerland) was used to remove the intra canal Gutta-percha, 3 mm below the cementoenamel junction (CEJ). The depth was confirmed using a periodontal probe. The teeth were randomly divided into two experimental groups (n = 15) and two "positive and negative" control groups (n=5).

In the experimental groups, the canal obturation material was covered as follows: Group 1-RMGI LC (Ionoseal-Voco-Germany), group 2-WMTA (ProRoot-Dentsply-Germany).All the materials were prepared according to the manufacturer's instruction and were packed into the unfilled cervical portion of the canals up to the palatal and facial aspects of CEJ to provide a 3-mm thick barrier. Glass ionomer cured (550 mW/cm^2) by a LED Light cure (Turbo-USA). Wet cotton pellets were placed over WMTA to provide their setting hydration.

All the teeth were temporized with cavit and incubated at 37°C for 24 hours at a relative humidity of 100%. In the positive control group, teeth received neither coronal barrier nor temporal restoration after canal obturation and in the negative control group, the unfilled coronal area was filled with sticky wax (as an impermeable barrier) and the tooth (including crown and root) was completely covered with three layers of nail varnish. Subsequently, all root surfaces of the samples in the experimental groups and positive control group were coated with three layers of nail varnish.

After 24 hours, in experimental groups, a mixed paste of Sodium perborate (Sigma-Aldrich, St. Louis, MO, USA) and 30% hydrogen peroxide (Merck, Darmstadt, Germany) was placed into the chamber, then the chamber was sealed with a temporary material. Cavit was manually pressed for 20 minutes in order to prevent cavit egress due to the gas production. The bleaching period was arranged for 9 days. The bleaching agent was refreshed every 3 days. During the bleaching procedures, the specimens were kept in an incubator at 37°C, wrapped in gauze and soaked in distilled water. At the end of the 9th day, cavit was removed again and pulp chamber was rinsed with distilled water. Then, the samples were mounted in a wax base up to CEJ and the access cavity was filled by 2% methylene blue (Merck, Darmstadt, Germany).

Wet cotton was put on the labial side of the teeth to prevent dryness. The negative control group teeth were immersed in methylene blue. The teeth were irrigated after 48 hours and then were mounted into a 5 cc syringe using transparent acrylic resin. Vertical buccolingual sections were made using a non-stop device (BEGO, Bremen, Germany) and a diamond disc. A stereomicroscope (HP-Canada) was used to measure the leakage of samples and the data were recorded. Statistical analysis of the data was conducted using Kruskal-Wallis and Mann–Whitney tests. The level of significance was set at 0.05. (17.0 SPSS Inc. Chicago, IL, USA)

Results

Table 1 illustrates the average dye penetration in different groups. MTA had the lowest mean leakage value and the positive control group demonstrated the highest leakage. The negative control group represented no dye penetration. Kruskal-Wallis test indicated that there was a significant dye leakage difference between groups (P-value <0.001)

The mann-Whitney test showed that ProRoot MTA compared to glass ionomer cement had significantly lower dye leakage (P-value= 0.001).

Table 1. Comparison of dye penetration in different groups including frequency, mean, standard deviation, and minimum/maximum

Group	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum	Mean Rank
Ionoseal GI	15	2538.2700	1362.57	351.81465	705.72	5268.53	26.67
ProRoot MTA	15	997.3927	817.31	211.03064	182.76	3589.40	15.00
Positive control	5	4476.8420	1026.57	459.09663	3376.52	5935.28	36.00
Negative control	5	.0000	.00000	.00000	.00	.00	3.00

Discussion

The Results of the present study indicated that the average microleakage was more in the glass ionomer group than the ProRoot MTA group. The maximum and minimum leakages were related to the positive and negative control groups, respectively. Since there was a statistically significant difference in microleakage values between the positive control group and experimental groups, (p-value<0/05), it seems that placing a barrier for reducing leakage from the access cavity into the dentinal tubules is a useful and necessary way. Reduced microleakage in MTA can be attributed to its proper marginal adaptation after hardening. In the presence of moisture, MTA is set and after that, it expands slightly. This final expansion may explain the excellent marginal adaptation and reduced leakage of this material. The presence of leakage in the use of glass ionomer as a coronal barrier or plug is due to its shrinkage after curing. This shrinkage leads to the loss of marginal adaptation and increases the microleakage. According to Wolcott et al [23], ideal properties of an intraorifice barrier should include the following characteristics: 1. easily placed, 2. bond to tooth structure, 3. resistance against microleakage, 4. distinguishable from natural tooth structure, and 5. not to interfere with the final restoration.

Ionoseal is a light cure glass ionomer cement which has four of five criteria proposed for an ideal intraorifice barrier. Since introducing MTA to the field of Dentistry, several studies have reported the capability and efficiency of this material as an apical and coronal barrier. Upon high alkalinity, due to the predominant presence of calcium hydroxide in the formulation of MTA after mixing with water, it is hypothesized that MTA may prevent or arrest tooth resorption. [13] The potential tooth discoloration can be the only reason to

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prevent MTA used as an effective intra-orifice barrier during tooth bleaching. [12] In this laboratory study, to reduce tooth discoloration, MTA was placed up to the CEJ level and the access cavity was cleaned with cotton pellets to remove the remaining material in the pulp chamber. According to the discoloration ability of MTA, it is better to evaluate the probable color changes in specimens by specific equipment like spectrophotometry. Several methods have been confirmed for microleakage evaluation including dye penetration, fluorometrics, scanning electron microscopic examination, fluid filtration, and bacterial leakage. [24] In this study, the dye penetration technique was used because it was inexpensive and easy to perform. [21] Low weight dye molecules can penetrate into places where there are no possibility of bacterial penetration. Also, methylene blue 2% was used because it can be observable in visible light very well and has good diffusion. The results of this study are consistent with those of Brito-Junior [16] who used WMTA and Vidrion R GI as a coronal barrier in bleaching treatment and concluded that the sealing ability of WMTA was better than Vidrion R GI.

Canoglu et al. studied on ProRoot MTA, hybrid resin composite and conventional glass ionomer and suggested that the microleakage of these materials increased, respectively. After 3 weeks, the glass ionomer and MTA had the highest and least levels of microleakage, respectively. [19] Yavari et al. compared ProRoot MTA, resin composite and light cure glass ionomer, using a dye penetration test. All materials showed some degree of leakage, MTA represented the least coronal leakage whilst GI indicated the highest microleakage. [25]

In contrast, some studies reported different results in comparing coronal microleakage of MTA and glass ionomer. Based on the research of Zare [26] et al. MTA had greater leakage than glass ionomer. They used self-cure GC glass ionomer and Angelus MTA in their study. The reason for the contradictory results of these studies can be ascribed to differences in MTA commercial brands, compounds, setting chemical reactions and also the manner of application of glass ionomer. In the current study, more leakage resulted from glass ionomer incomplete curing at the entrance of root canal orifice because Light-cure Ionoseal glass ionomer was used. However, the problem of incomplete curing does not exist in the case of glass ionomer with a conventional chemical setting. Mohammadi [27] et al. and Tselnik [28] et al. reported the same sealing ability for glass ionomer and MTA in their studies. They believed that the ability of resin modified glass ionomer in controlling the microleakage can be explained by water absorption in the material, which leads to expansion after setting and a better sealing. Moreover, it is difficult to compare the results due to the differences in the design of studies. Attin et al. [29] showed that bleaching agents may exert a negative influence on restorations and restorative materials, in a systematic review. This may explain the reason why Tselink et al. did not report any differences in bacterial leakage between the white MTA, gray MTA and glass ionomer.

Conclusion

According to the results of this in vitro study, ProRoot MTA provides a suitable coronal seal compared to one-component Ionoseal glass ionomer. For testing the intra orifice barriers' ability to prevent coronal leakage, further investigations are recommended.

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Authors' Contributions

The study was designed by Maryam Zare Jahromi. The study data were collected by Niloufar Bonakdar hashemi and Poorandokht Refaei. RCT therapy and bleaching procedures of samples were performed by Niloufar Bonakdar Hashemi. Analysis and interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content were pre-formed by Maryam Zare Jahromi and Poorandokht Refaei. Study supervision was performed by Mehrdad Barekatain and Maryam Zare Jahromi and Poorandokht Refaei.

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