Caspian J of Dent Res

Original Article

# Comparison of coronal microleakage of resin modified glass ionomer and composite resin as intra-orifice barriers in internal bleaching

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**Received: 22Apr 2015 Accepted: 27 Jan 2016**

## Abstract

**Introduction:** Internal bleaching is a treatment option for wightening endodontically treated discolored teeth. Cervical resorption is one of the side effects of this method. The aim of this study was to compare the sealing ability of resin composite and light-cured resin modified glass ionomer (RMGI) as intra-orifice barriers in internal bleaching.

**Materials &Methods:** In this study, 34 single-canal anterior teeth were used. All samples were endodontically prepared and divided into two experimental groups (n=12) and two control groups (n=5). In the experimental groups, Gutta-percha was removed up to 3 mm below the cemento enamel junction (CEJ). RMGI and composite resin was placed over gutta-percha in the experimental groups up to the level of CEJ. After 24-hours 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 stereomicroscope. Data was statistically analyzed by using T-student test and variance analysis.

**Results:** The microleakage in RMGI group was 0.945mm and in composite resin group was 0.641mm**.** Statistically, no significant difference was observed in microleakage between the experimental groups (p=0.121).

**Conclusion:** Both materials can be applied as the intra-orifice barriers for internal bleaching.

**Keywords:**, Tooth bleaching, Composite resins ,Glass ionomer, Dental leakage

***Citation for article:*** Barekatain M, ZareJahromi M, Habibagahi S. Comparison of coronal microleakage of resin modified glass ionomer and composite resin as intra-orifice barriers in internal bleaching. Caspian J Dent Res 2016; 5: 8-13.

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[ DOR: 20.1001.1.22519890.2016.5.1.3.7 ]

[ DOI: 10.22088/cjdr.5.1.8 ]

# مقایسه ریزنشت رزین کامپوزیت و رزین مادیفاید گلاس آینومر به عنوان سد کرونال در سفید کردن داخلی دندان ها

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## چکیده

**مقدمه:** سفید کردن داخلی دندان ها یک گزینه درمانی جهت روشن تر کردن دندان های تغییر رنگ یافته بر اثر درمان ریشه می باشد. تحلیل سرویکالی دندان یکی از عوارض جانبی این روش درمانی است. هدف از این مطالعه مقایسه توانایی سیل کردن دو ماده رزین کامپوزیت و رزین مادیفاید گلاس آینومر نوری به عنوان سد داخل اریفیس کانال در بلیچینگ داخلی می باشد.

**مواد و روش ها:** در این مطالعه ۳۴ دندان قدامی تک کاناله مورد استفاده قرار گرفته است. تمامی نمونه ها درمان ریشه شده و در دو گروه آزمایشی (۱۲ عدد) و دو گروه کنترل (۵ عدد) تقسیم شدند. در گروه های آزمایشی گوتا پرکا تا ۳ میلی متر زیر CEJ حذف گردید. رزین مادیفاید گلاس آیونومر و کامپوزیت رزین درگروههای آزمایشی، روی گوتا پرکا تا سطح CEJ قرار داده شد. پس از ۲۴ ساعت انکوباسیون، ماده بلیچینگ (مخلوط سدیم پربورات و هیدرژن پراکسید ۳۰٪) در حفره دسترسی قرار داده شد. ماده بلیچینگ هر ۳ روز یکبار به مدت ۹ روز تعویض شد. سپس حفره دسترسی با متیلن بلو ۲٪ برای ۴۸ ساعت پر شد. تمامی نمونه ها به صورت طولی برش داده شدند و میزان نفوذ رنگ توسط استریو میکروسکوپ مورد ارزیابی قرار گرفت. داده ها به صورت آماری با تست T-student و آنالیز واریانس مورد آنالیز قرار گرفتند.

**یافته ها:** میزان میکرولیکج در گروه رزین مادیفاید گلاس آیونومر ۰/۹۴۵ میلیمتر و در گروه کامپوزیت رزین ۰/۶۴۱ میلیمتر بود. هیچ گونه تفاوت معنی داری از نظر آماری بین گروه های آزمایش از لحاظ میزان میکرولیکیج وجود نداشت (P=0.121).

**نتیجه گیری:** هر دو ماده را میتوان به عنوان سد کرونالی، برای بلیچینگ داخلی، مورد استفاده قرار داد.


**واژگان کلیدی:** سفیدکردن دندان، کامپوزیت رزین، گلاس آینومر، لیکیج دندانی

## Introduction

Systemic and local factors can cause intrinsic changes, which may in turn result in visual tooth discoloration. The main intrinsic changes related to endodontic processes may result in serious esthetic complaints. Internal bleaching is a minimally invasive, simple and cost-effective intervention for discolored nonvital teeth.[1] Walking bleach technique is a very efficient method to get the desired results quickly while it is economically acceptable.[2]

Today, the most commonly used bleaching agents contain hydrogen peroxide as the active ingredient. Hydrogen peroxide may be applied directly or be a by-product of a chemical reaction from sodium perborate or carbamide peroxide. [3]A typical walking bleach technique uses a paste of 30% watery hydrogen peroxide and sodium perborate powder that is sealed into the chamber to permit activation of the solution over several days. The patient returns weekly, and the solution is changed one to four times until the maximum wightening of the tooth is achieved. [4]

Although these agents are effective in lightening tooth color, their use has been associated with some undesirable complications such as the occurrence of external root resorption.[5,6]Other safer options for walking bleach include the use of sodium perborate mixed with distilled water or anesthetic, or 10% carbamide peroxide sealed in the pulp chamber. [4]Other factors including cementum defects, a history of trauma and marked overheating may also need to be present for resorption to occur .[4]This problem has led to the recommended core material placement at the orifice of the root canal, directly after the completion of orthograde root canal treatment.[7,8]Animal studies have shown that intracoronal bleaching with 30% Hydrogen peroxide causes 0 to 6% resorptionin at the cervical part of the root which is increased to 18-25% when the heat is used.[4]

The certain mechanism of cervical resorption in bleached teeth has not been explained yet.[8]This is probably caused by the highly concentrated oxidizing agents which diffuse through dentinal tubules and



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[ DOR: 20.1001.1.22519890.2016.5.1.3.7 ]
[ DOI: 10.22088/cjdr.5.1.8 ]

cementum defects and cause necrosis of the cementum, inflammation of the periodontium, and subsequently root resorption.[8,9]Because of its low molecular weight, hydrogen peroxide can penetrate through dentin and release oxygen radicals that break the double bonds of the organic and inorganic compounds inside the dentinal tubules.[10]Moreover, some studies have indicated that the PH at the root surface is reduced by intracoronal placement of bleaching pastes. This acidic environment is known to enhance osteoclastic activity leading to cervical root resorption.[11]Therefore, the use of a protective barrier over the coronal extent of the root canal filling is recommended to prevent leakage of oxygen and heat into the periodontal tissues in the cervical area of the tooth.[9]

On the other hand, the sealing properties of restorative materials used as intra-orifice barriers may be jeopardized by the negative effects of bleaching agents including their chemical and physical properties.[10]Because the severity of these effects can depend on the type of the restorative materials used, it is essential to evaluate the effects of non-vital bleaching agents on different intra-orifice barrier materials.

Glass-ionomer is traditionally used as a common protective barrier in nonvital bleaching. Despite its wide range of applications, only few studies have evaluated the composite resin as a coronal barrier in nonvital bleaching.

Methods utilized for leakage assessment during intracoronal bleaching include dye penetration, fluid filtration, chemical and microbial tests.[10] The methods which use dye tracers are inexpensive and easy to perform.[12] Thus, this study utilized a dye penetration test to evaluate the effect of the bleaching agent on the sealing properties of resin composite versus resin modified glass ionomer as intra-orifice barriers for internal bleaching.

## Materials & Methods

In this experimental study, 34 freshly single-canal anterior teeth[13]which were extracted due to periodontal problems in patients ages of 45 to 65 years were selected on the basis of their macroscopically similar size and straight roots, they were stored in 5.25% sodium hypochlorite (Daropakhsh, Karaj, Iran) for 20 minutes and the ligaments were removed by an ultrasonic scaler (Cavitron Bobcat Pro, Dentsply, York, PA, USA) and examined for immature root apices, cracks on the root surfaces, gross caries involving the root sand for exceptionally short, thin or curved roots. Teeth with these characteristics were discarded and excluded from the study. The selected teeth were stored in 0.5% chloramine-T. Access cavities were prepared with a fissure bur (TizKavan, Tehran, Iran) and pulp horns were eliminated by a round bur (Tizkavan, Tehran, Iran). The canals were instrumented by step-back technique (MAF=35).Gates Glidden drills 3, 4 (Maillefer, Ballaigues, Switzerland) were used to flare the coronal and middle thirds. The canals were irrigated with 10 mL of 2.5% NaOCl (Daropakhsh, Karaj, Iran) during instrumentation. 5 mL of saline solution was used as the final irrigant. Canals were obturated with gutta-percha (Ariadent - Iran) and AH26 sealer (Dentsply, Tulsa Dental, USA) by using lateral condensation method. Then, access cavities were restored with Cavit (ESPE Dental, Seefeld, Germany). Radiographs were taken of the teeth for obturation evaluation. The Cavit was removed after a weekand Peazo reamer 4 (Maillefer, Ballaigues, Switzerland) was used to remove the gutta-percha up to 3 mm below the CEJ. The depth was confirmed using a periodontal probe. The pulp chambers were irrigated with saline and dried with cotton pellets. After that, the teeth were randomly classified into two experimental groups of 12 teeth and two control groups of 5.

In the first experimental group, RMGI (FujiII LC, GC Corp, Tokyo, Japan) was prepared according to the manufacturer's instructions and packed into the unfilled portion of the canals up to the level of CEJ in palatal and facial aspects and cured (550 mW/cm2) by LED Light cure coltolux (Coltene/Whaledent- USA).

In the second group, after application of phosphoric acid %37 (3M-USA) for 15 seconds, teeth were washed, dried and the single bond adhesive (3M-ESPE, St. Paul, MN. USA) was applied. After curing for 20 seconds, the Resin composite (Z100, shade $A_2$, 3M-ESPE, St. Paul, MN. USA) was applied in 2 separate layers. Each one of these layers filled half of the prepared area and was cured for 20 seconds. In the negative control group, the area was covered with sticky wax (as an unpermeable barrier) and in the positive control group, no coronal barrier was used over the gutta-percha.

The samples were restored with Cavit and incubated at 37ºC for 24 hours at a relative humidity of 100% to allow the materials to set completely. After that Cavit and the cotton pellet were removed. A mixed paste of Sodium perborate (Sigma-Aldrich, St. Louis, MO,

USA) and 30% hydrogen peroxide (Merck, Darmstadt, Germany) was placed into the chamber, after which the chamber was sealed with a temporary material. The Cavit was manually pressed for 10 minutes in order to prevent cavit egress due to the gas production.

After 3 days, the Cavit was removed and the bleaching agent was washed out with air-water jet for 60s. Thereafter, a fresh portion of the bleaching agent was placed into the chamber. This procedure was repeated every 3 days for three times, in accordance with the walking bleach technique.[4]The same bleaching technique was used in the control groups. During the bleaching procedures, the specimens were kept in an incubator at 37°C, wrapped in gauze and soaked with distilled water. After completion of the bleaching procedure, pulp chambers were rinsed with distilled water and dried. All root surfaces were covered with 2 layers of nail varnish in the CEJ area to prevent any penetration of the dye to the CEJ. Wet cotton was put in the labial side of the teeth to prevent dryness. The access cavity was filled by 2% methylene blue (Merck, Darmstadt, Germany). The teeth were washed after 48 hours and vertical buccolingual sections were made using a none-stop device (BEGO, Bremen**,** Germany) and a diamond disc. The leakage of samples (the amount of dye penetration into canals) was measured with a stereomicroscope (MJC IO, Moscow, Russia) and the data were recorded. The gathered data were evaluated by T-student and variance analysis methods (ANOVA).

## Results

The descriptive data of microleakage in each group are presented in Table 1. There were no statistically significant differences in leakage between the experimental groups (p=0.12).

**Table1. Comparison of different groups including frequency, mean, standard deviation, and minimum/maximum**

| Group | Microleakage(mm) Mean±SD | Range |
|---|---|---|
| RMGI (n=12) | 0.945±0.474 | 0.296-1.738 |
| Composite Resin (n=12) | 0.641±0.447 | 0-1.498 |
| Positive control (n=5) | 11.344±2.160 | 8.361-14.239 |
| Negative control (n=5) | 0.15±0.101 | 0-0.270 |

Variance analysis shows that the mean of microleakage in the negative control group is significantly lower than other groups (p<0.001) and the mean microleakage in the positive control group is significantly higher than other groups (p<0.001).

## Discussion

In the current study, the sealing ability of resin composite and RMGI was compared. Both materials are permanent restorative materials with good bond strengths.[14,15]In this study, the application of these barriers was not significantly different and their ability to prevent the microleakage of the bleaching agents was relatively similar. The results of this study suggested that the positive controls with no coronal barrier demonstrated extensive leakage while the negative controls had no leakage. However, our study showed that in spite of the negative effects of the bleaching agents on restorative materials, these effects could not alter the microleakage properties of RMGI and resin composite.

de Oliveira research concluded the same results and the group using GI reinforced with vitremer resin represented better coronal sealing compared to the control group.[16]Shindo compared the coronal sealing abilityof six materials including protect liner F (PL), panvia F (PF), DC Core- light-cured (DCL), DC core-chemically-cured (DCC), super EBA(SE) and ketac (KC) and found that the adhesive materials had better sealing ability.[15]Rafeek studied the microleakage of three materials (intermediate restorative, FujiII, and Direct AP) and observed that the coronal leakage in Direct AP was more than the other materials. [17]

The thickness of the plug is a contributing factor and several researches have noted that the thickness of the coronal barrier is of great importance in the sealing ability. Sherwood in 2004 achieved better results (less leakage) with GI in greater thicknesses.[14]Lim demonstrated that the minimum thickness of coronal barrier for Hydrogen peroxide must be at least 2mm.[18] Sherwood found that the barrier thickness of RMGI and Resin composite must be at least 4 mm.[14]

Canoglu evaluated the effect of sodium perborate or %35 Hydrogen peroxide as bleaching materials on RMGI, resin composite and proroot Mineral trioxide aggregate (MTA) as intra-orifice barriers and illustrated that the type of bleaching agents and applied materials for the root treatment is not effective as much as the

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types of the barrier material. In addition, composite leakage was less than glass ionomer so the application of acid etching and bonding agents caused better bonding and sealing ability.[10] Vosoughhosseini compared the leakage between glass ionomer and MTA in nonvital bleaching and found that there was no significant difference between the examined groups.[8]

Finally, one should keep in mind that bleaching materials with oxygen byproducts reduce the bonding ability of composites. After bleaching treatment, at least a week of delay is essential to achieve an efficient composite bonding. [4]But in the present study because the composite was placed first and then the bleaching material was applied, so the composite bonding was not compromised. Therefore, the secondary application of bleaching material did not have any negative effects on composite bonding.

## Conclusion

The effect of light-cure resin composite on microleakage prevention is not significantly different from RMGI and both materials can be applied as intra-orifice barriers for non-vital bleaching techniques. Further studies are necessary to evaluate the sealing ability of different types of composite resins such as flowable ones. It is also recommended that different thicknesses of barrier materials and different concentrations of bleaching agents be tested to evaluate their effects on the amount of microleakage.

**Funding**: This study was a part of thesis and research project (Grant No: 291) which was supported and funded by Islamic Azad University of Isfahan (khorasgan).

**Conflict of interest disclosure**: The authors state that they have no conflict of interest.

## Authors' Contributions

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

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