

การรั่วซึมของวัสดุเรซินคอมโพสิตภายหลังการฟอกสีฟัน

Marginal Leakage of Composite Resin after Tooth Bleaching

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บทคัดย่อ

วัตถุประสงค์ของงานวิจัยนี้เพื่อศึกษาผลกระทบของสารฟอกสีฟันคาร์บาไมด์เปอร์ออกไซด์ที่มีความเข้มข้นและระยะเวลาการฟอกสีฟันที่ต่างกันต่อการรั่วซึมของฟันที่บูรณะด้วยวัสดุเรซินคอมโพสิตตำแหน่งคอฟันด้านใกล้แก้ม โดยศึกษาในฟันกรามน้อยมนุษย์ที่ต้องถอนเพื่อการจัดฟันจำนวน 150 ซี่ แบ่งกลุ่มตัวอย่างเป็น 5 กลุ่ม กลุ่มละ 30 ซี่ ได้แก่ กลุ่มควบคุม (ไม่ได้รับการฟอกสีฟัน) กลุ่ม 1 (ฟอกสีฟันด้วย 16 เปอร์เซ็นต์คาร์บาไมด์เปอร์ออกไซด์ 2 สัปดาห์) กลุ่ม 2 (ฟอกสีฟันด้วย 16 เปอร์เซ็นต์คาร์บาไมด์เปอร์ออกไซด์ 4 สัปดาห์) กลุ่ม 3 (ฟอกสีฟันด้วย 22 เปอร์เซ็นต์คาร์บาไมด์เปอร์ออกไซด์ 2 สัปดาห์) และกลุ่ม 4 (ฟอกสีฟันด้วย 22 เปอร์เซ็นต์คาร์บาไมด์เปอร์ออกไซด์ 4 สัปดาห์) ประเมินผลการรั่วซึมของวัสดุบูรณะโดยใช้เมทิลีนบลูภายใต้ไมโครสโคป และวิเคราะห์ข้อมูลโดยใช้สถิติวิธีของครัสคาล-วัลลิส และแมน-วิทนีช ยู เทสต์ พบว่า กลุ่มควบคุมมีการรั่วซึมน้อยกว่าทั้งสี่กลุ่มอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) เมื่อเปรียบเทียบผลของเวลา กลุ่ม 1 (ค่ากลาง = 1.7230) และกลุ่ม 2 (ค่ากลาง = 1.0567) มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ แต่กลุ่ม 3 (ค่ากลาง = 1.0667) และกลุ่ม 4 (ค่ากลาง = 1.1540) ไม่มีความแตกต่างกัน เมื่อเปรียบเทียบผลของความเข้มข้น กลุ่ม 1 และกลุ่ม 3 มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ แต่กลุ่ม 2 และกลุ่ม 4 ไม่มีความแตกต่างกัน และค่าเฉลี่ยการรั่วซึมสูงสุดอยู่ที่กลุ่ม 4 และต่ำสุดอยู่ที่กลุ่ม 1 สรุปว่าการฟอกสีฟันด้วยคาร์บาไมด์เปอร์ออกไซด์มีผลต่อการรั่วซึมบริเวณรอยต่อระหว่างฟันและวัสดุเรซินคอมโพสิต และเมื่อใช้สารฟอกสีฟันความเข้มข้น 16 เปอร์เซ็นต์ที่ระยะเวลา 2 สัปดาห์จะช่วยลดความเสี่ยงต่อการเกิดการรั่วซึมบริเวณรอยต่อระหว่างฟันและวัสดุเรซินคอมโพสิต

คำสำคัญ: การรั่วซึมบริเวณขอบวัสดุอุด สารฟอกสีฟัน ฟันที่ได้รับการบูรณะ

Abstract

Bleaching resin composite restored teeth may affect the tooth/restoration interface. The purpose of this study was to evaluate the effects of different concentrations and exposure times of bleaching agent on marginal leakage of post-operative teeth restored with resin composite. One hundred and fifty freshly extracted caries-free human upper premolars were selected for the study. Class V cavities were prepared on the buccal surfaces of the teeth. Then the teeth were divided into five groups of 30 teeth each; control (no bleaching), group 1 (bleaching with 16% carbamide peroxide for 2 weeks), group 2 (bleaching with 16% carbamide peroxide for 4 weeks), group 3 (bleaching with 22% carbamide peroxide for 2 weeks), and group 4 (bleaching with 22% carbamide peroxide for 4 weeks). Dye penetration was used for evaluation of marginal leakage. Data were analyzed using Kruskal-Wallis and Mann-Whitney U test ($p < 0.05$). Statistical analysis revealed significant difference ($p < 0.05$) between the control group and the experimental groups for resin composite restored teeth. When the time intervals were compared, there was a significant difference in the marginal leakage of teeth restored with resin composite after bleaching between group 1 (mean = 0.7230) and group 2 (mean = 1.0567), whereas there was no significant difference between group 3 (mean = 1.0667) and group 4 (mean = 1.1540). When the concentrations of carbamide peroxide were compared, there was a significant difference between group 1 and group 3, but group 2 and group 4 had no significant difference. Additionally, group 4 had the highest number of mean values, whereas group 1 showed the least number of mean values. Bleaching affects the marginal integrity of the resin composite restored tooth. With 16% carbamide peroxide, the risk of marginal leakage increases with time. Since the concentration of 22% carbamide peroxide is high, time did not affect the risk of marginal leakage. So bleaching with less concentration of carbamide peroxide and less amount of time can reduce the risk of marginal leakage at the tooth and restoration interface.

Keywords: *marginal leakage, bleaching agent, existing restoration*

1. Introduction

Bleaching has been used to whiten teeth for quite some time. More people have started giving interest in improving the esthetics of natural dentition. It can be classified by whether they involve vital or non-vital teeth and by whether the procedure is performed in the office or has an at-home component.

Agents that contain or release hydrogen peroxide are implemented to help brighten the tooth color. For home bleaching method, a custom tray is fabricated and a low concentration bleaching agent is given to the patient. The frequency of the bleaching depends on the patient's satisfaction. In office bleaching, on the other hand, involves the use of high concentration of bleaching agent and is done in one visit.

In pre-operative bleaching, carbamide peroxide breaks down to form urea and hydrogen peroxide, which in turn inhibits the polymerization of the resin bonding agent (Ulukapi et al., 2003). Hydrogen peroxide alters the tubular permeability that may enhance the rate of penetration of the bleaching agent and residual oxygen diffusion. The consequences may be a higher concentration of residual oxygen in the more porous dentin margins than on enamel margins, thereby increasing microleakage (Barkhordar et al., 1997; Shinohara et al., 2001).

In post-operative bleaching, hydrogen peroxide affects the marginal seal of a tooth colored restorative material, leading to marginal gap, and eventually microleakage. The microleakage formed may be responsible for secondary caries, marginal discoloration, pulpal inflammation and hypersensitivity (Ulukapi et al., 2003; Crim, 1992; Owens et al., 1998; Gokay et al., 2000; Hersek et al., 2002; Gogna et al., 2011).

From the above information, researchers have emphasized on the effect of bleaching after restoration with tooth colored filling material. As a result, a study is carried out on the freshly extracted caries free human upper premolars to evaluate the effect of bleaching agent on marginal integrity of existing tooth colored restorative materials, in various times and concentrations. Since home bleaching agents are more widely used, with longer durations of bleaching as compared to in-office bleaching, a home-bleaching product (16%, 22% carbamide peroxide) is used with intervals of 2 and 4 weeks to evaluate the effects it has on the tooth colored filling material.

2. Objective

1. To evaluate the effects of different concentrations of bleaching agent on marginal leakage of existing resin composite restoration.
2. To evaluate the effects of different exposure time of bleaching agent on marginal leakage of existing resin composite restoration.

3. Material and method

One hundred and fifty freshly extracted caries free human upper premolars were used in this in vitro study. After mechanical debridement with ultrasonic scaler, all teeth were cleaned with pumice-water slurry (Indiresha et al., 2011). The teeth were stored in normal saline (Jacob and Dhanya Kumar, 2007).

Class V cavities were prepared with FG8400N round diamond bur (Intensive Swiss[®], Grancia, Switzerland) under water coolant on the buccal surface. The gingival margin is under CEJ 1.0 mm. The approximate dimension of the cavity was 4 mm wide, 3.0 in height and 1.5 mm in depth.

Two steps total-etch adhesive (single bond 3M ESPE[®], Minnesota, USA) was used for bonding procedure, and clinical application steps were done according to manufacturer's instruction (Table 1)

Table 1 Clinical application steps of two steps total-etch adhesive (Single bond 3M ESPE®).

Steps	Times
1. 37% phosphoric acid etchant	15 seconds
2. Rinse with water	10 seconds
3. Moist dried with gentle air blow	--
4. Single Bond (3M ESPE®) bonding agent was applied and agitated twice followed by air blow	5 – 10 seconds
5. Kerr® Demi LED light (450-470 nm) cure	20 Seconds

The Filtek™ Z350 XT universal restoration (3M ESPE®, Minnesota, USA) was used to restore the buccal preparations. The resin composite should be placed in two increments to compensate for polymerization shrinkage, the first increment of resin composite should be placed from midpoint of gingival floor to the occlusal cavosurface margin and light polymerized. And the second increment can then fill the remainder of the preparation.

Each layer was cured with Kerr® Demi LED curing light (450-470 nm) (Kerr®, California, USA) for 40 seconds (distance between light and restoration = 1 mm with the light positioned 90 degrees from the restoration surface).

The restorations are finished and polished with Sof-Lex™ (Kerr®, California, USA) finishing and polishing systems.

The restored teeth were divided into 5 groups (n=30) and stored in ice tray containing distilled water for 1 day before apply bleaching agent.

Control group No bleaching procedure.

Group I The teeth were bleached with Nite White Excel 4 ACP (Discus Dental®, California, USA) 16% carbamide peroxide gel for 6 hours per day for 2 weeks and bleaching material was renewed daily. The teeth were stored in distilled water when not under the bleaching process.

Group II The teeth were bleached with Nite White Excel 4 ACP (Discus Dental®, California, USA) 16% carbamide peroxide gel for 6 hours per day for 4 weeks and bleaching material was renewed daily. The teeth were stored in distilled water when not under the bleaching process.

Group III The teeth were bleached with Nite White Excel 4 ACP (Discus Dental®, California, USA) 22% carbamide peroxide gel for 6 hours per day for 2 weeks and bleaching material was renewed daily. The teeth were stored in distilled water when not under the bleaching process.

Group IV The teeth were bleached with Nite White Excel 4 ACP (Discus Dental®, California, USA) 22% carbamide peroxide gel for 6 hours per day for 4 weeks and bleaching material was renewed daily. The teeth were stored in distilled water when not under the bleaching process.

All samples were sealed with sticky wax at apical foramen and coated with nail varnish (Revlon red, Revlon®, New York, USA) except for a 1.0 mm diameter ring surrounding the restoration. The teeth were immersed in 1 % solution of methylene blue dye for 24 hours at 37 °C (Indiresha. H., et al., 2011; Jacob AS and Dhanya Kumar NM., 2007).

The teeth were sectioned bucco-lingually through the center of restoration with a diamond disc creating two test specimens with exposure of the tooth restoration interface from the cavosurface margin to the pulpal wall (Indiresha et al., 2011; Jacob and Dhanya Kumar, 2007).

The results were evaluated using Kruskal-Wallis and Mann-Whitney U test ($p < 0.05$).

The specimens were examined under measurement microscope (Nikon®, New York, USA) at 3x magnification to observe the dye penetration along the tooth-restoration interface (Figure 1). The results were recorded in millimeters from the cavosurface margin to the end of the dye penetration.

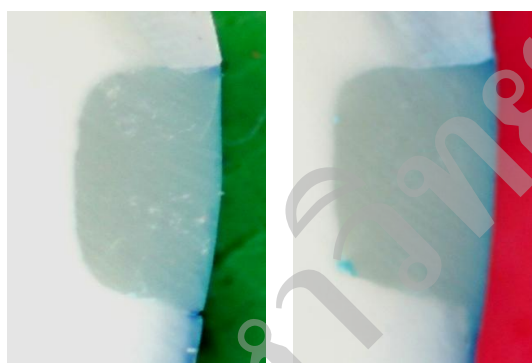


Figure 1 Sample of marginal leakage.

From the results obtained, the mean values were determined for each specimen. The data was analyzed using Kruskal-Wallis, a non-parametric test ($p < 0.05$). Multiple comparison tests at 5% level significance were employed and analyzed via Mann-Whitney test to verify the hypothesis of equality among the groups. SPSS program was used for the entire analysis.

4. Result

Table 2 Shows the $\bar{X} \pm SD$ of dye penetration in each groups.

Group	Mean(mm.)
Control	$0.3717^a \pm 0.0506$
Group 1 (16%, 2 wks)	$0.7230^b \pm 0.0905$
Group 2 (16%, 4 wks)	$1.0567^c \pm 0.0838$
Group 3 (22%, 2 wks)	$1.0667^c \pm 0.0710$
Group 4 (22%, 4 wks)	$1.1540^c \pm 0.0660$

Note: Same superscript is no significant difference.

Mean is the average distance of dye penetration.

From the table 2, statistical analysis revealed significant differences between the control group and the experimental groups for resin composite restored teeth. There was significant difference in the marginal leakage of teeth between bleaching with 16% carbamide peroxide for 2 and 4 weeks ($p < 0.05$), but there was no significant difference observed between the 22% concentration of 2 weeks and 4 weeks ($p > 0.05$). Moreover, there was significant difference in the marginal leakage after the teeth have been bleached with the two concentrations at 2 weeks interval, but at 4 weeks there was no significant difference observed.

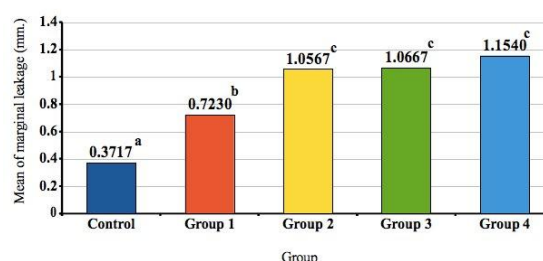


Figure 2 Shows statistical analysis between the control and experimental groups. (Same superscripted symbol demonstrate no statistically significant difference)

5. Discussion

Nowadays, teeth whitening have raised a lot of interest among people. As a result, various methods have been formulated to fulfill the need. One such method is bleaching, which comes in many types and concentrations. One such type of bleaching agent is carbamide peroxide.

From the result of the present study, there was a significant increase in marginal leakage of the 4 groups when compared to the control group. This suggests that bleaching with carbamide peroxide with either 16% or 22% may affect the marginal adaptation of the resin composite. According to Asha Sarah and Dhanya Kumar (2007) carbamide peroxide may affect the marginal leakage of resin composite. However, it must be noted that some studies show no effect of carbamide peroxide on microleakage at the tooth and restoration interface (Neimar et al., 2009). Time used in bleaching can have an effect on the marginal leakage of the resin composite restored teeth. In the present study, there was a significant difference between group 1 and group 2. This implies that if the teeth are bleached for more than 2 weeks, it is likely to increase the amount of marginal leakage. However, in the study performed by Teixeira et al. (2003) time had no effect in the microleakage bleached by carbamide peroxide. Conversely, group 3 and group 4 had no significant difference. From the researcher's perspective, it is assumed that as the concentration of Carbamide Peroxide in both the groups is high, hence the amount of marginal leakage had already occurred, regardless of time. In the study of Ayad et al. (2009) it was seen that

the higher the concentration of carbamide peroxide, the stronger are its deleterious effects

Concentration also plays an important role in the marginal adaptation of the teeth and resin composite interface. In the result of the study, there was a significant difference between group 1 and group 3, which suggest that with constant time interval, a higher concentration, 22%, had more amount of marginal leakage. It could possibly be due to a less number of the oxidizing agent hydrogen peroxide in the 16% concentration, which led to less amount of marginal leakage, and eventually less penetration of methylene blue. On the other hand, group 2 and group 4 had no significant difference. This suggests that with 22%, the marginal leakage had increased tremendously, regardless of time. But with 16%, there was a gradual pace of leakage along the 4 week interval.

Through dye penetration observation, group 1 had the least amount of dye penetration, whereas group 4 had the most amount of dye penetration. Also, the results of these two groups showed significant differences when compared, and that these two groups had the most mean value differences amongst other group comparisons.

From the results of this study, it must be noted it is extremely sensitive. Some of the factors can help make the result more accurate. For example, ISOMET can be used to section the teeth instead of diamond disc blades, which can give more clear-cut. Other more appropriate staining agents can be used to stain the teeth instead of methylene blue, since methylene blue can be washed away by water during sectioning. Moreover, equipments like thermocycler and incubator

can also be used to age the teeth and simulate the oral environment respectively. Likewise, a more detailed analysis should be studied to get a more precise result.

Therefore, comprehensive oral examination should be exercised in patients with several resin composite restored teeth before bleaching, followed by routine follow-up for signs of marginal leakage.

6. Conclusion

Bleaching affects the marginal integrity of the resin composite restored tooth. With 16% carbamide peroxide, the risk of marginal leakage increases with time. Since the concentration of 22% carbamide peroxide is high, time did not affect the risk of marginal leakage. So bleaching with less concentration of carbamide peroxide and less amount of time can reduce the risk of marginal leakage at the tooth and restoration interface.

7. Acknowledgement

We would like to acknowledge and extend our heartfelt and sincere gratitude to the following people, without whom this research would not have been possible: Dr. Phanassaya Jaturanont, research advisor, for adoring guidance and moral support along until the completion of the research. Dr. La-Onghong Vajrabhaya and Dr. Ampaporn Nithipratheep for their assistance and understanding. Ms. Suwanna kausuwann, Head of Research Promotion and Development, and the research staffs, Faculty of Dental Medicine, Mahidol University for their help in the research statistics, and renting of the research laboratory and equipments. Library of Rangsit

University for assisting and collection of vital information used in the research. Faculty of Dental Medicine, Rangsit University, Accord Corporation Co. Ltd., 3M ESPE Co. Ltd. for the funds and materials used in the research. Last but not least, we would like to thank our families for their tireless efforts in making this research and our living days a blissful one.

8. References

- Asha Sarah Jacob and NM Dhanya Kumar. (2007). Effect of pre and post operative bleaching on microleakage of amalgam and composite estoration using 10% carbamide peroxide – an in vitro study. 10:33-37.
- Barkhordar RA, Kempler D and Plesh O. (1997). Effect of non-vital tooth bleaching on microleakage of resin composite restorations. Quintessence International.28:341-344.
- Crim GA. (1992). Post-operative bleaching: effect on microleakage. Am J Dent. 5(2):109-112.
- E. C. N. Teixeira, A. T. Hara, C. P. Turssi and M. C. Serra. (2003). Effect of non-vital tooth bleaching on microleakage of coronal access restorations. Journal of Oral Rehabilitation. 30:1123-1127.
- Gogna R, Jagadis S and Shashikal K. (2011). A comparative in vitro study of microleakage by a radioactive isotope and compressive strength of three nanofilled composite resin restorations. J Conserv Dent. 14:128-131.
- Gokay O, Yilmaz F, Akin S, Tuncbilek M and Ertan R. (2000). Penetration of the pulp chamber by bleaching agents in teeth restored with various restorative materials. J of Endod. 26(2):92-94.

- Hersek N, Canay S, Akca K and Ciftci Y. (2002). Comparison of microleakage properties of three different filling materials. An autoradiographic study. *J Oral Rehabi.* 29:1212.
- Indiresha. H. Narayana, Meena. N. and B.V. Sreenivasa Murthy. (2011). Effect of 10% carbamide peroxide bleaching gel on marginal integrity of tooth colored restorative materials : An in vitro microleakage study. 2:505-508
- Jacob AS and Dhanya Kumar NM. (2007). Effect of pre and post operative bleaching on microleakage of amalgam and composite restoration using 10% carbamide peroxide-an in vitro study. *J Conserv Dent.* 10:34.
- N. Ayad, A. Bedewi, S. Hanafy and S. Saka. (2009). Effect of bleaching on microleakage, surface hardness, surface roughness, and color change of an ormocer and a conventional hybrid resin composite. *The Internet Journal of Dental Science.* Volume 6 Number 2.
- Neimar S., Sylvio M.J., Alfredo M.F. and Gilberto M. A. (2009). Effect of dental bleaching on the microleakage of class V composite restorations. *Department of Operative Dentistry.* Volume 24, Number 3.
- Owens BM, Rowland CC, Brown DM and Covington JS 3rd. (1998). Post-operative dental bleaching: effect of microleakage on class V tooth colored restorative materials.
- Shinohara MS, Rodrigues JA and Pimenta LAF. (2001). In vitro microleakage of composite restorations after non-vital bleaching. *Quintessence International.* 32:413-417.
- Ulukapi H, Benderli Y and Ulukapi I. (2003). Effect of pre and post operative bleaching on marginal leakage of amalgam and composite restorations. *Quintessence International.* 34:505-508.