

Antioxidant Activity of Chlorhexidine in Various Concentrations and Effect of Chlorhexidine on Tooth Bond Strength with Resin Composite after Non-Vital Tooth Bleaching

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Abstract

The aim of this study was to compare the antioxidant activity between chlorhexidine in various concentrations and sodium ascorbate and to compare dentin bond strength between composite resin and dentin surface treated by chlorhexidine or sodium ascorbate solution after non-vital tooth bleaching. The solution of 20%, 10%, 5%, 2.5% and 1.25% chlorhexidine and 10% sodium ascorbate were prepared to analyse antioxidant activity by DPPH assay. Two concentrations of chlorhexidine with the highest antioxidant activity were selected to perform this study on surface treatment and shear bond strength test. Sixty extracted human upper premolar teeth were divided randomly into 4 groups (N=15): no surface treatment (negative control: C1); surface treatment with sodium ascorbate (positive control: C2); surface treatment with 20% chlorhexidine: T1 and 10% chlorhexidine: T2. Specimens were sectioned with slow-speed diamond disc. Dentin surface were prepared and bleached with sodium perborate for 7 days 3 cycles, surface treated by cotton pallet moistened with each solution for 5 mins, rinse off and immediately restored with two-step self-etch and composite resin in the cylinder with 4 mm height and diameter. The shear bond strength test was performed. Median Antioxidant Activity (AA%) by DPPH Assay of 20%, 10%, 5%, 2.5%, 1.25% chlorhexidine and 10% sodium ascorbate solution group were 33.44 (23.20,43.14), 20.80 (19.23,30.47), 23.98 (11.84,28.60), 10.40 (9.53,14.03), 15.86 (6.46,17.65) and 37.96 (34.54,53.28) % respectively. Median SBS in C1, C2, T1 and T2 group were 22.07 (18.14,25.08), 72.69 (67.56,81.67), 6.14 (2.91,8.41) and 14.30 (12.42,23.13) MPa respectively. Data was statistically analyzed by Kruskal-Wallis test and Pairwise Comparison. There were no significant differences of antioxidant activity between chlorhexidine and sodium ascorbate solution ($p>0.05$) except between sodium ascorbate solution group and 2.5% chlorhexidine group. There were significant differences of shear bond strength between both control group and experimental group ($p<0.05$) except between C1 group and T2 group. In summary, the antioxidant activity of highly concentrated chlorhexidine was not different from sodium ascorbate solution but effected to decrease dentin shear bond strength of composite resin after non-vital tooth bleaching.

Keywords: Shear bond strength/ Non-vital tooth bleaching/ Sodium ascorbate/ Chlorhexidine

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Introduction

Walking bleaching is a method of non-vital tooth bleaching. It is a popular technique for traumatized tooth and minimal tooth structure loss.¹ 10% sodium perborate are typically used in non-vital tooth bleaching which turns into active free oxygen or free radicals. Oxidation reaction affects the double bond of the organic and inorganic pigment molecules

inside the dentinal tubule.² Sodium perborate is easier to control, safer, and has lower cervical resorption than a concentrated hydrogen peroxide solution.³

The principal adverse effect of free radical is the inhabitation of composite resin polymerization,⁴ decreasing the enamel or dentin bond strength of restorations placed immediately after bleaching.⁵

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Optimal bond strength can be restored after 1-3 weeks and is recommended,⁶ therefore it is recommended to place composite resin at least 1 week after bleaching. Several studies have shown that antioxidant agents react to free radicals, called “sodium ascorbate”, which immediately increase the bond strength between composite resin and dentin.^{7,8} Several agents have been found that also exhibit antioxidant activity, such as alpha tocopherol (vitamin E), green tea extract, aloe vera extract, ethanol, and acetone.⁸ However, these agents are not generally present in dental clinics and difficult to prepare.

Chlorhexidine is a useful solution in dentistry. It is easy to prepare and stock up. Some studies found that 0.12% chlorhexidine has antioxidant activity, but is not as high as sodium ascorbate.⁹ However, some studies reported a relationship between chlorhexidine concentration and antioxidant activity; when the concentration of the solution is increased, the antioxidant activity is also increased.¹⁰ In addition, some studies have shown that it plays a role in inhibiting the process of collagenolytic activity by metalloprotease enzyme (MMPs), which results in a hybrid layer. This process makes the bond strength values last longer.^{11,12} Moreover, some studies showed that tooth surface treatment with chlorhexidine has no negative effect on the dentin bond strength of composite resin.¹³ However, the antioxidant activity of chlorhexidine and the effect of chlorhexidine on the dentin bond strength of composite resin after non-vital tooth bleaching have not been studied especially at high concentration. Therefore, this study aimed to investigate the antioxidant activity of various concentrations of chlorhexidine and its effect on dentin bond strength of composite resin.

Materials and methods

The study was approved by the local ethics committee (Faculty of Dentistry/Faculty of Pharmacy, Mahidol University, Institutional Review Board, COE. No.MU-DT/PY-IRB 2020/037.2608

1. Antioxidant activity of chlorhexidine by DPPH Assay

Prepared absolute ethanol (Merck, Darmstadt, Germany); the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) (Sigma-Aldrich, Darmstadt, Germany) solution 0.5 mmol in ethanol; the solution of 10% sodium ascorbate (Sigma-Aldrich, Darmstadt, Germany) in distilled water; 20%, 10%, 5%, 2.5% and 1.25% chlorhexidine (Sigma-Aldrich, Darmstadt, Germany) in distilled water. The study was divided into 3 groups for analysis (Figure 1).

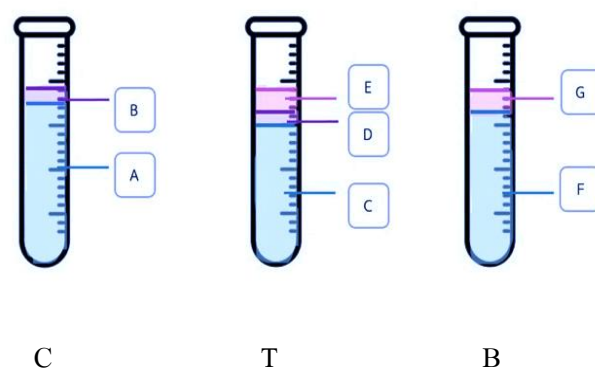


Figure 1 Demonstration of solution group preparation: Control group (C); Experimental group (T); Blank group (B); A: 3.5 ml of absolute ethanol, B: 0.5 mmol of DPPH solution in 0.3 ml of ethanol, C: 3 ml of absolute ethanol, D: 0.5 mmol DPPH solution in 0.3 ml of ethanol, E: 0.5 ml of the substance, F: 3.3 ml of absolute ethanol, G: 0.5 ml of the substance

Control group (C):

Added 3.5 ml of absolute ethanol (A) to 0.5 mmol of DPPH solution in 0.3 ml of ethanol (B) in a 15 ml tube.

Experimental group (T):

Added 3 ml of absolute ethanol (C) to 0.5 mmol DPPH solution in 0.3 ml of ethanol (D) and 0.5 ml of the substance (E): 20% chlorhexidine (T1), 10% chlorhexidine (T2), 5% chlorhexidine (T3), 2.5% chlorhexidine (T4), 1.25% chlorhexidine (T5), 10% sodium ascorbate solution (T6) in 15 ml tubes.

Blank group – No DPPH (B):

Added 3.3 ml of absolute ethanol (F) and 0.5 ml of the substance (G): 20% chlorhexidine (B1), 10% chlorhexidine (B2), 5% chlorhexidine (B3), 2.5% chlorhexidine (B4), 1.25% chlorhexidine (B5), 10% sodium ascorbate solution (B6) in 15 ml tubes.

The prepared solution was placed on a vibrator (Bohemia, N.Y. USA) for 10 seconds to mix and waited for 30 mins for a complete reaction. Then, 200ul of each solution from the control group, experimental group, and blank group were placed in 96 well plate (Figure 2) and transferred into a microplate spectrophotometer (Epoch, BioTek, Vermont, U.S.A) by ELISA technique using the GEN 5 program to measure. The absorbance of the solution (Abs) at a wavelength of 517 nm calculated the scavenging activity percentage (AA%) according to the following formula.

$$AA \% = 100 - \frac{[(Abs_{test} - Abs_{blank}) \times 100]}{Abs_{control}}$$

The results of the study were analyzed by using the Kruskal -Wallis statistic test and the difference was identified with Pairwise comparison at a 95% confidence level.

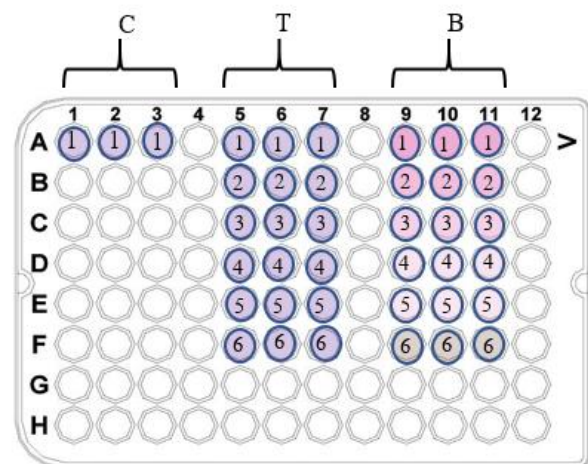


Figure 2 Demonstration of solution preparation in 96 well plate: Control group (C), Experimental group (T); 20% chlorhexidine (T1), 10% chlorhexidine (T2), 5% chlorhexidine (T3), 2.5% chlorhexidine (T4), 1.25% chlorhexidine (T5), 10% sodium ascorbate solution (T6), Blank group (B); 20% chlorhexidine (B1), 10% chlorhexidine (B2), 5% chlorhexidine (B3), 2.5% chlorhexidine (B4), 1.25% chlorhexidine (B5), 10% sodium ascorbate solution (B6)

2. Shear bond strength between composite resin and dentin in non-vital bleaching teeth

Tooth Preparation

Sixty extracted human upper premolar teeth were used in this study. Each tooth was visually examined to verify the absence of caries, fillings, cracks, and history of tooth bleaching, as well as morphological or structural abnormality, and half of tooth structure loss. The teeth were cleaned with an ultrasonic scaler and hand scaling instruments to removed soft tissue debris and calculus, stored in 0.1% thymol solution (M Dent, Mahidol University, Thailand). Each tooth was horizontally sectioned at the cemento-enamel junction and approximately 5 mm coronal from first line (red line), then vertically sectioned approximately 4 mm lingually to the labial surface (Figure 3) using a low speed, water-cooled diamond disc (Isomet®, Buehler Ltd., Lake Bluff, NY). Labial portions were used.

The dentin surface was examined under a microscope at 40X magnification to check for dentin cracking. The buccal surface of buccal portion was embedded by self-cured acrylic (Curefast, Tokuso, Japan) in PVC block. The dentin surface was ground with 600-grit silicon carbide paper under running water to achieve a smooth and flat dentin surface

(Figure 4). The samples were rinsed thoroughly with 10 ml of 2.5% sodium hypochlorite (M dent, Mahidol University, Thailand) and dried lightly with compressed air, following 10 ml of 17% EDTA (M dent, Mahidol University, Thailand) and dried lightly with compressed air. The samples were stored in distilled water for 3 weeks in the dark.

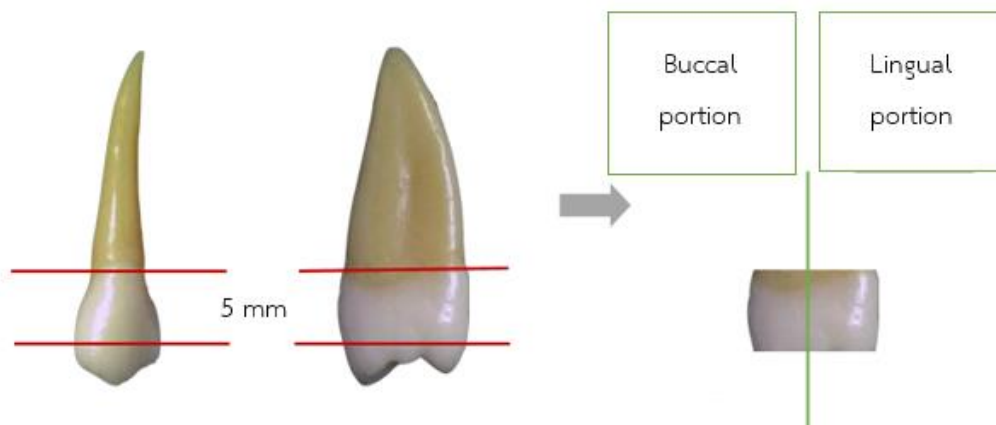


Figure 3 Demonstration of sectioning the tooth to produce specimen

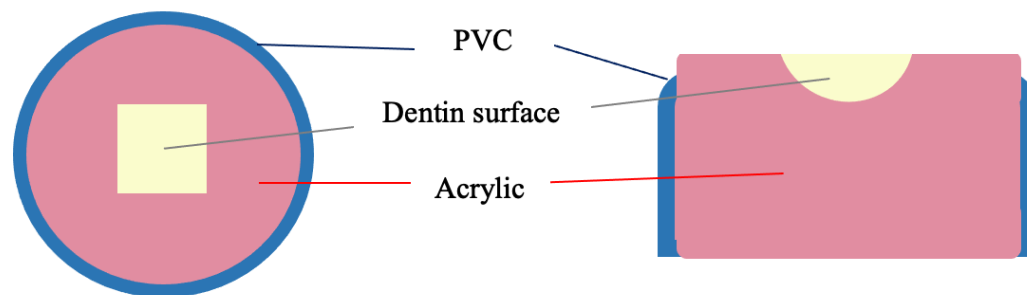


Figure 4 Demonstration of sample preparation

Specimen Preparation

The teeth were divided randomly into 4 groups (N=60) by surface treatment after tooth bleaching; negative control group (C1), positive control group (C2), the first experimental group (T1), and the second experimental group (T2); each group contained 15 samples.

Group C1: No surface treatment.

Group C2: Surface treatment with 10% sodium ascorbate solution

Group T1: Surface treatment with the first value of the antioxidant activity of chlorhexidine

Group T2: Surface treatment with the second value of the antioxidant activity of chlorhexidine

Tooth Bleaching Treatment

The bleaching agent was prepared by mixing 2 g of sodium perborate with 1 ml DI water. Agent was placed in the cylinder silicone tube with 3 mm thick base on the dentin surface. Agent was changed every 7 days for 3 weeks. The samples were stored in dark environment at 37° temperature 100% humidity during the bleaching period. The dentin surface was cleaned thoroughly in running distilled water for 15 seconds and dried lightly with compressed air.

Tooth Surface treatment

After 3 weeks of bleaching cycles, sodium ascorbate and chlorhexidine were prepared and ready to use. A cotton pellet moistened with 10% sodium ascorbate, 20% chlorhexidine, 10% chlorhexidine were used to apply the solution on the prepared tooth surface in C2, T1, T2 group respectively. Then left for 5 mins, rinsed off with water spray for 15 s, and dried with a cotton pellet represent clinical practice.

Restorative procedure

Self-etching bonding agent was applied (Clearfil SE bond®, Kuraray dental, NY). Firstly, dentin primer agent was applied, leaved 20 s, did not rinse, and dried with mild air blow. Then applied dentin bonding agent, distributed evenly with mild air blow and light-cured (Bluephase®, Ivoclar Vivadent, Liechtenstein) for 10 seconds. Next, nanofiller composite resin (Filtek Z350 XT; 3M ESPE, Seefeld, Germany) was placed in the cylinder silicone tube with 4 mm height and diameter. Each layer of the composite resin was 2 mm thick and light-cured for 40 seconds for 2 layers.

Shear Bond Strength Measurement

Shear bond strength (SBS) was determined after 24 h storage using a universal testing machine (Instron 5566: Instron Ltd, Massachusetts, United State) at a strain rate of 1 mm/minute. SBS was calculated from the force at specimen failure. The

results of the study were analyzed by using the Kruskal-Wallis statistic test and the difference identified with Pairwise comparison at a 95% confidence level.

Results

Median AA% by DPPH Assay of 20% 10%, 5%, 2.5%, 1.25% chlorhexidine and 10% sodium ascorbate solution group were 33.44 (23.20, 43.14), 20.80 (19.23, 30.47), 23.98 (11.84, 28.60), 10.40 (9.53, 14.03), 15.86 (6.46, 17.65) and 37.96 (34.54, 53.28) % respectively (Table 1). The results showed that the 20% chlorhexidine group revealed the highest median AA% in all chlorhexidine groups, followed by the 10% chlorhexidine group. The median AA% of 10% sodium ascorbate solution revealed the highest and higher than all groups of chlorhexidine. No significant difference were detected in various concentration chlorhexidine group and chlorhexidine-sodium ascorbate solution group ($p>0.05$) except sodium ascorbate solution group -2.5% chlorhexidine group was significant difference ($p<0.05$). Although, no significant difference was found on sodium ascorbate solution group -1.25% chlorhexidine group but there was a trend of decrease antioxidant activity of 1.25 chlorhexidine group.

Median SBS in C1group, C2 group, T1 group (surface treatment with 20% chlorhexidine) and T2 group (surface treatment with 10% chlorhexidine) were 22.07 (18.14, 25.08), 72.69 (67.56, 81.67), 6.14 (2.91, 8.41) and 14.30 (12.42, 23.13) MPa respectively (Table 2). The results showed that the median SBS of the T1 group, T2 group revealed lower than the C1 group. The C2 group revealed the highest median SBS. A significant difference were detected in all groups except between C1 group - T2 group, which showed no significant difference ($p>0.05$).

Table 1 Percentage of antioxidant activity

Group (N=3)	Percentage of antioxidant activity				
	Mean $\pm$ SD	Median (Q1, Q3)	IQR	Min	Max
20% Chlorhexidine	33.26 $\pm$ 5.75	33.44 ^{a,b} (23.20, 43.14)	19.94	23.20	43.14
10% Chlorhexidine	23.50 $\pm$ 3.51	20.80 ^{a,b} (19.23, 30.47)	11.24	19.23	30.47
5% Chlorhexidine	21.47 $\pm$ 4.50	23.98 ^{a,b} (11.84, 28.60)	16.76	11.84	28.60
2.5% Chlorhexidine	11.3 ^a $\pm$ 1.376	10.40 ^b (9.53, 14.03)	4.50	9.53	14.03
1.25% Chlorhexidine	13.26 $\pm$ 3.45	15.86 ^{a,b} (6.46, 17.65)	11.19	6.46	17.65
10% Sodium ascorbate	41.93 $\pm$ 5.76	37.96 ^a (34.54, 53.28)	18.74	34.54	53.28

Data was statistically analyzed by Kruskal-Wallis test and Pairwise Comparison. Groups identified by different lower-case letters are significantly different ($p < 0.05$).

Table 2 Shear bond strength (MPa)

Group (N=15)	Shear bond strength (MPa)				
	Mean $\pm$ SD	Median (Q1, Q3)	IQR	Min	Max
C1	21.55 $\pm$ 0.97	22.07 ^b (18.14, 25.08)	6.94	16.36	38.81
C2	73.83 $\pm$ 2.68	72.69 ^a (67.56, 81.67)	14.11	51.54	89.42
T1	6.40 $\pm$ 0.93	6.14 ^c (2.91, 8.41)	5.50	0.23	14.14
T2	16.88 $\pm$ 1.70	14.30 ^b (12.42, 23.13)	10.71	8.02	26.93

Data was statistically analyzed by Kruskal-Wallis test and Pairwise Comparison. Groups identified by different lower-case letters are significantly different ($p < 0.05$).

Discussion

To compare the antioxidant activity between chlorhexidine in various concentrations and sodium ascorbate and to compare dentin bond strength between composite resin and dentin surface treated by chlorhexidine or sodium ascorbate solution after non-vital tooth bleaching. Currently, sodium ascorbate has been widely recognized as an antioxidant agent used to treat the bleached tooth surface. This enables immediate restoration with composite resin and improves the dentin bond strength of composite resin.^{4,14-15} However, sodium ascorbate needs to be prior prepared. On the chair-side because it is not generally used in dental clinic which make it an important limitation

In dentistry, chlorhexidine is a versatile, pre-prepared solution and no tooth staining in short term and plaque-free area.¹⁶ Studies have shown that chlorhexidine has antioxidant activity, but still less

value compared with sodium ascorbate solution. It has been found that when the concentration of chlorhexidine was higher, antioxidant activity was also higher.⁹⁻¹⁰ In this study, it was found that the highest antioxidant activity of chlorhexidine was 20% chlorhexidine and antioxidant activity was decreased in concentration dependent manner. Although the antioxidant activity of 20%, 10%, and 5% chlorhexidine was lower than sodium ascorbate solution, but there was no significant difference. Therefore 20% and 10% chlorhexidine were selected for using on SBS test part of this study. The antioxidant activity of 2.5% chlorhexidine was significantly lower than the sodium ascorbate solution and antioxidant activity of 1.25% was a trend of decrease. Therefore, low concentrations of chlorhexidine were not selected for using on SBS test part of this study. Chlorhexidine has the ability to bind free radicals due to the structure having electrons that can bind electrons, as well as

other antioxidants, but the intensity of binding is inequivalent to vitamin C, and vitamin E.⁸ In additions, the more concentration of the chlorhexidine is the better ability to compete free radicals.¹⁰

Chlorhexidine is also useful in dentistry. It inhibits the process of collagen breakdown in the hybrid layer. It directly affects the rate of collagen breakdown. Some studies have shown that the dentin bond strength of chlorhexidine treated group was significantly better than untreated group after follow for many years.¹⁷⁻¹⁹ Moreover, many studies have shown that chlorhexidine did not interfere with the bonding ability of adhesive in low concentration.²⁰⁻²³ Because it both inhibits the breakdown of collagen in the hybrid layer and owns antioxidant activity, highly concentrated chlorhexidine surface treatment may have the benefit to dentine bond strength of composite resin after non-vital tooth bleaching. This hypothesis was not assumed. The median SBS of 20% and 10% chlorhexidine group was revealed lower than both untreated and sodium ascorbate groups, particularly the 20% chlorhexidine group. Therefore, other factors tend to affect the dentin bond strength of composite resin.

In general, several factors tend to affect the dentin bond strength of composite resin. Both mechanical factors such as stress, strain, temperature changes, water absorption, restorative material shrinkage, and chemical factors such as type of adhesive, composition of adhesives, and restorative materials. However, this study controlled other factors except for different chlorhexidine concentrations. In previous studies, chlorhexidine had a positive effect on the dentin bond strength of composite resin, but a very low concentration of chlorhexidine was used. Some studies showed that a higher concentration of chlorhexidine has decrease the dentin bond strength of composite resin.²⁴ Consistent with this study, the 20% chlorhexidine group revealed the lowest SBS and lower than 10% chlorhexidine group significantly. Furthermore, the

tendency for SBS in the 5% chlorhexidine treated group was estimated to be close to the surface untreated group. Study showed that 5% chlorhexidine group decreases dentin bond strength when compared with other lower concentration of chlorhexidine group.¹⁶ Thus, 5% chlorhexidine should not be used for surface treatment in this study.

Chlorhexidine has a cathode that can bind well with the anode of a phosphate group (PO_4^{3-}) in hydroxyapatite, resulting in substantivity.²⁵ Studies have shown that more concentrated chlorhexidine has a stronger dentin binding capacity. In additions, cations can bind to an anode of other substances in the oral cavity²⁶⁻²⁷.

Clearfil SE Bond, two-step self-etch adhesive system, was chosen because it creates good dentin bond strength and suitable hybrid layer thickness.²⁸ In case of surface treatment with chlorhexidine and two-step self-etch improve dentin bond strength.²⁹ A weak acidic primer was applied on the dentin, which partially dissolute the smear layer.³⁰ This anode has a chance to bind the cathode of chlorhexidine. In 2013, Nishitani et al showed that 4MET acidic primer consist of negative ion which interfered by positive ion of highly concentrated chlorhexidine, accordingly dentin bond strength was reduced.¹⁶ This event reduces the acidity of adhesive, resulting in lower solubility of the smear layer and diffusion of the adhesive agent in the hybrid layer. This directly affects the dentin bond quality of composite resin. Highly concentrated chlorhexidine has more cathode with the ability to bind the more an anionic phosphate group in self-etch adhesive agent. According to the results of this study, highly concentrated chlorhexidine was found to have antioxidant activity, but it reduces the dentin SBS of composite resin. The results revealed lower SBS than the no surface treatment group. Therefore, in case of non-vital teeth, chlorhexidine should not be used for tooth surface treatment, especially in high concentrations.

Conclusion

Within the limitations of this study, the antioxidant activity of highly concentrated chlorhexidine was not different from sodium ascorbate solution but decrease dentin shear bond strength of composite resin. Further study chooses etch and rinse bonding system which did not interfere by highly concentrated chlorhexidine.

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อเปรียบเทียบความสามารถในการต้านอนุมูลอิสระของสารละลายคลอเฮกซิดีนที่หลายหลายความเข้มข้นกับสารละลายโซเดียมแอสคอร์เบตและเปรียบเทียบผลของการบูรณะด้วยคอมโพสิตเรซินต่อค่ากำลังแรงยึดเหนี่ยวของเนื้อฟัน เมื่อเตรียมเนื้อฟันด้วยสารละลายคลอเฮกซิดีนกับสารละลายโซเดียมแอสคอร์เบตภายหลังการฟอกสีฟันที่ไม่มีชีวิต โดยทำการศึกษารายละละคลอเฮกซิดีน 5 ความเข้มข้น ได้แก่ ความเข้มข้นร้อยละ 20 ร้อยละ 10 ร้อยละ 5 ร้อยละ 2.5 และร้อยละ 1.25 ตามลำดับ และสารละลายโซเดียมแอสคอร์เบตความเข้มข้นร้อยละ 10 เพื่อนำไปวิเคราะห์หาความสามารถในการต้านอนุมูลอิสระของสารละลายผ่านกระบวนการตีพิมพ์เอช เอสเอส นำสารละลายคลอเฮกซิดีนที่มีค่าความสามารถในการต้านอนุมูลอิสระอันดับที่หนึ่งและสองมาศึกษาต่อในการเตรียมผิวฟัน โดยนำฟันกรามน้อยของมนุษย์ที่ถูกถอนจำนวน 60 ซี่ แบ่งด้วยวิธีสุ่มออกเป็น 4 กลุ่ม (N=15) กลุ่มที่ 1 เป็นกลุ่มควบคุมเชิงลบที่ไม่มีการเตรียมผิวฟัน (C1) กลุ่มที่ 2 เป็นกลุ่มควบคุมเชิงบวกที่เตรียมผิวฟันด้วยสารละลายโซเดียมแอสคอร์เบต (C2) กลุ่มที่ 3 และกลุ่มที่ 4 เป็นกลุ่มทดลองที่เตรียมผิวฟันด้วยสารละลายคลอเฮกซิดีนความเข้มข้นร้อยละ 20 (T1) และร้อยละ 10 (T2) เตรียมขึ้นตัวอย่างด้วยเครื่องตัดฟันกรอเข้าให้เผยผิวเนื้อฟัน จากนั้นทำการฟอกสีฟันด้วยสารละลายไฮโดรเจนเปอร์ออกไซด์เป็นเวลา 7 วัน จำนวน 3 รอบ และทำการเตรียมผิวฟันแต่ละกลุ่ม (C2 T1 และ T2) โดยนำสารดังกล่าวข้างต้นชุบสีผิวฟันเป็นเวลา 5 นาที จากนั้นใช้น้ำกลั่นล้างออก บูรณะทันทีโดยใช้สารยึดติดระบบเซลล์เอชแบบ 2 ขั้นตอน และก่อคอมโพสิตเรซินบนเนื้อฟันเป็นรูปทรงกระบอกเส้นผ่านศูนย์กลางและความสูง 4 มิลลิเมตร นำขึ้นตัวอย่างไปทดสอบหาค่ากำลังแรงยึดเหนี่ยวด้วยเครื่องทดสอบในเวอร์ชอลด้วยความเร็ว 1 มิลลิเมตรต่อนาที ผลการศึกษาค่ามัธยฐานของค่าความสามารถในการต้านอนุมูลอิสระของสารละลายคลอเฮกซิดีนความเข้มข้นร้อยละ 20 ร้อยละ 10 ร้อยละ 5 ร้อยละ 2.5 และร้อยละ 1.25 และโซเดียมแอสคอร์เบตเท่ากับ ร้อยละ 33.44 (23.20, 43.14) 20.80 (19.23, 30.47) 23.98 (11.84, 28.60) 10.40 (9.53, 14.03) 15.86 (6.46, 17.65) และ 37.96 (34.54, 53.28) ตามลำดับ และค่ามัธยฐานของค่ากำลังแรงยึดเหนี่ยวของกลุ่ม C1 C2 T1 T2 เท่ากับ 22.07 (18.14, 25.08) 72.69 (67.56, 81.67) 6.14 (2.91, 8.41) และ 14.30 (12.42, 23.13) เมกะปาสกาล ตามลำดับ ทำการวิเคราะห์ข้อมูลโดยใช้สถิติทดสอบของครัสคาล-วอลล์ และเปรียบเทียบคู่ต่างแปรไวลส์ (Kruskal-Wallis test, Pairwise Comparison) จากการศึกษาพบว่าความสามารถในการต้านอนุมูลอิสระแต่ละกลุ่มไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p>0.05$) ยกเว้น ระหว่างกลุ่มสารละลายโซเดียมแอสคอร์เบตกับสารละลายคลอเฮกซิดีนความเข้มข้นร้อยละ 2.5 และพบว่าค่ากำลังแรงยึดเหนี่ยวแต่ละกลุ่มแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p<0.05$) ยกเว้นระหว่างกลุ่ม C1 กับ T2 จากการศึกษาสรุปได้ว่าความสามารถในการต้านอนุมูลอิสระของสารละลายคลอเฮกซิดีนที่ความเข้มข้นสูงไม่แตกต่างกับสารละลายโซเดียมแอสคอร์เบต แต่ส่งผลต่อค่ากำลังแรงยึดเหนี่ยวของวัสดุบูรณะคอมโพสิตเรซินที่น้อยลงภายหลังการฟอกสีฟันที่ไม่มีชีวิต

คำไรหส์: ค่ากำลังแรงยึดเหนี่ยว/ การฟอกสีฟันที่ไม่มีชีวิต/ โซเดียมแอสคอร์เบต/ คลอเฮกซิดีน

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