

Tooth Whitening Effect of Manicure Type Hydrogen Peroxide Toothwhiening Gel

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Objective: The aim of this study is to confirm the effect of the recently developed new manicure type among the home tooth whitening material for domestic use and commercialization of hydrogen peroxide gel.

Methods: Extraction of 60 teeth to 20 each of three groups as divided after. And, tooth whitening gel for experimental group, tooth whitening gel for positive control group, and tooth whitening gel for negative control group for each defined usage a day, twice two weeks apply it was.

Results: Lightness according to VITA classical[®] A1-D4 color was brightened from 13.20 ± 1.74 to 9.60 ± 3.60 after one week and 9.15 ± 3.10 after two weeks in the experimental group, in the positive control group, the change from 13.50 ± 1.93 to 11.30 ± 0.98 after one week and 10.85 ± 1.14 after two weeks, and in negative control gorup, from 13.40 ± 1.79 to 12.80 ± 1.47 after one week, and 12.65 ± 1.57 after two weeks. In a experimental group and a positive control group it showed a statistically significant level difference ($p < 0.01$).

Conclusion: Through the above results similar to conventional whitening teeth whitening using peroxide whitening gel of a new manicure type at the time of enforcement or that is how to effectively self-whitening than show an improvement of more brightness apply hydrogen peroxide whitening gel manicure type recommended do.

Keywords: tooth bleaching, tooth bleaching agents, hydrogen peroxide

Introduction

The three major functions of teeth are chewing, pronunciation and esthetics.

In particular, the anterior maxilla is a typical area where the

human need for visual beauty can be expressed and fulfilled and is affected by various oral and extraoral factors [1-3].

The factors affecting the esthetics of the anterior maxilla are the tooth factors such as shape, size, arrangement, surface condition, color tone, disease condition, external factors such as gingival, lips hue, external appearance, facial shape, and skeleton. These factors work together to influence the aesthetics of the facial area [4,5].

The cause of tooth discoloration that affects these aesthetics varies color from yellow to dark gary due to pigmentation of tetracycline in the tooth forming period in congenital, and excessive use of fluoride can lead to fluoride penetration into the dentin, resulting in deficiency of the enamel matrix, and black

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or white spots. Acquired locally, dental pulp colored substances in free decomposition products may penetrate into the dentinal tubule and cling to the surrounding dentin, or may be colored by bleeding into dental pulp, calcification degeneration due to trauma, reduction of transparency due to calcification degeneration due to drug, dentin coloration by a drug, and a filling material by a metallic material or a composite resin. Plaque and tartar can give the teeth a yellow appearance, and smoking gives the teeth a brown or black appearance. Consumption of beverages such as coffee, tea, red wine and liquids, curry, cola, etc., may appear as surface and absorption coloration, and poor oral hygiene may result in green, dark brown and orange coloration.

Treatment methods for aesthetic defects caused by damage or loss of natural teeth include treatment with aesthetic restorative materials such as composite resin restoration and Porcelain restoration, tooth cleaning, oral prophylaxis with external color removal, professional mechanical tooth cleaning and tooth whitening [6].

Among them, esthetic prosthodontic treatment is appropriate when the external appearance of the tooth is accompanied by defects, but it is said that tooth whitening is comparatively advantageous in that it is necessary to treat the natural tooth only for improvement of color tone.

It has been reported that hydrogen peroxide was used for tooth whitening experiments for the first time about 100 years ago, and tooth whitening effect in 1,958 pulp-opened dental cavities of non-vital teeth using hydrogen peroxide for 3 days.

The interest in tooth whitening has been steadily increasing, and with the development of various methods, Nutting and Poe in the late 1960s have also tried various chemical tooth whitening methods for discoloration of nerve treated teeth [7].

When vital teeth are whitened in the clinic, a high concentration of hydrogen peroxide is used. There are many ways to apply it. There are commercially available products, and heat or light is used as the catalyst [4,5,8].

All methods have some whitening effect, but the effect is different depending on the product.

The purpose of this study was to investigate the effect and efficacy of toothpastes on tooth extraction using newly developed nail polish type hydrogen peroxide gel among commercialized tooth whitening gels for home use.

Materials and Methods

This study was conducted in in-vitro.

1. Subject tooth whitening gel

The contents of tooth whitening gel used in this study are shown in Table 1 and Figure 1.

1) Subject tooth

Experimental teeth used were extracted healthy cow teeth. After extraction of the tooth from the jaw, the basic attachment was removed using a curette, the color of teeth was measured

Table 1. Contents according to group

Group	Main ingredient	Content	Final content
Experimental group			3.00%
1st material	Hydrogen peroxide (35%)	17.14 g/100 g	
2nd material	Hydrogen peroxide (35%)	0 g/100 g	
Control 1 group (positive)	Hydrogen peroxide (35%)	8.57 g/100 g	3.00%
Control 2 group (negative)	Hydrogen peroxide (35%)	0 g/100 g	0.00%

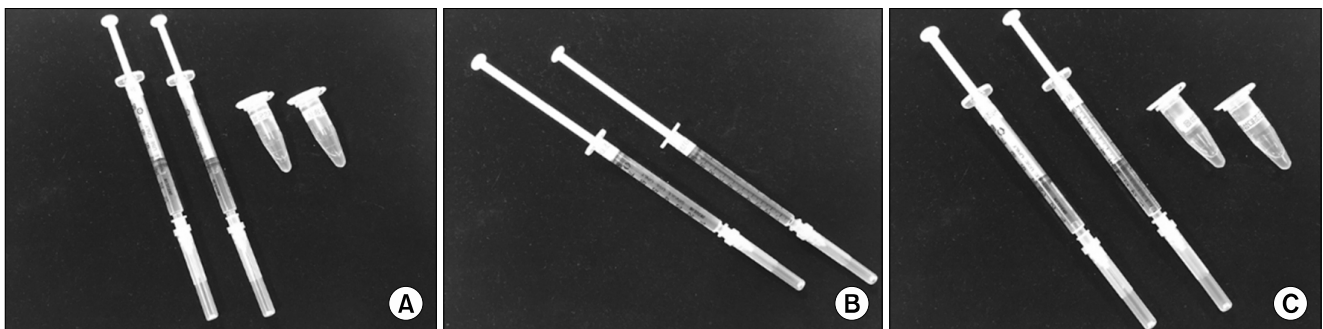


Figure 1. Experimental tooth whitening gel. (A) Manicure type toothwhitening gel for experimental group. (B) Toothwhitening gel for positive control group. (C) Toothwhitening gel for negative control group.

and teeth brighter than A3 were excluded.

The 60 selected teeth were divided into three groups of 20, and before treatment, tooth brushing was performed for 15 seconds per tooth using a general detergent with no hydrogen peroxide and a powered toothbrush. The toothbrush was washed in running water and stored.

2. Research method

1) Baseline color measurement

The color of teeth was measured using VITA Easyshade[®] Advance V, the color was measured using the “Averaged” mode, which is a mode for measuring several times and obtaining an average value.

At this time, all the colors were recorded by VITA classical A1-D4[®] and by VITA SYSTEM 3D-MASTER[®] (Figure 2).

2) Apply tooth whitening gel

(1) Experimental group: Wipe the experimental group of teeth clean with gauze. Then, 1 syringe for experimental group containing hydrogen peroxide was put into a bottle for experimental group 2 containing the gel component, and the mix-

ture was thoroughly mixed to prepare a tooth whitening gel. The prepared tooth whitening gel was applied evenly to buccal side of teeth of the experimental group using the brush provided and stored until dry (Figure 3). After one minute, the artificial saliva was sprayed in a spray form and stored in a 36.5°C incubator, and after 30 minutes, rinsed with running water, wrapped in gauze moistened with artificial saliva, and placed in a 6-well plate. The lid of the 6-well plate was slightly covered only in the incubator so that air could pass through it, and then stored in a 36.5°C incubator.

(2) Positive control group (control 1 group): Wipe the positive control group of teeth clean with gauze. Then the positive control group tooth whitening gel provided in gel form was evenly applied to the experimental group using the provided brush and stored until dry. After one minute, the artificial saliva was sprayed in a spray form and stored in a 36.5°C incubator, and after 30 minutes, rinsed with running water, wrapped in gauze moistened with artificial saliva, and placed in a 6-well plate. The lid of the 6-well plate was slightly covered only in the incubator so that air could pass through it, and then stored in a 36.5°C incubator.



Figure 2. Shade checking by VITA Easyshade[®] Advance V.



Figure 3. Application of toothwhitening gel.

(3) Negative control group (control 2 group): Wipe the experimental group of teeth clean with gauze. Then, 1 syringe for negative control group containing hydrogen peroxide was put into a bottle for negative control group 2 containing the gel component, and the mixture was thoroughly mixed to prepare a tooth whitening gel. The prepared tooth whitening gel was applied evenly to buccal side of tooth of the experimental group using the brush provided and stored until dry (Figure 3). After one minute, the artificial saliva was sprayed in a spray form and stored in a 36.5°C incubator. After 30 minutes, it was rinsed with running water, wrapped in gauze moistened with artificial saliva, placed in a 6-well plate. The lid of the 6-well plate was slightly covered only in the incubator so that air could pass through it, and then stored in a 36.5°C incubator.

3) Tooth whitening gel repeat application

Tooth whitening gel application was repeated twice a day for a total of 2 weeks.

4) Color measurement after treatment

The color measurement after treatment is 2. 1). Baseline color measurement was performed in the same manner. The measurement time was 1 week after treatment and 2 weeks after treatment.

5) Statistical processing

In the case of color by VITA classical A1-D4[®], VITA color was given by 16 steps according to the order of lightness and evaluated by the difference between the steps before and after tooth whitening gel treatment. In the case of color, the brightness value was used for statistical processing.

The final change brightness of each group two weeks using the IBM SPSS ver. 23.0 (IBM Co., Armonk, NY, USA); statistical analysis was performed with significance verified using the one way ANOVA test and the paired t-test with respect to the difference.

Results

1. Changes in color of teeth

Table 2, 3, and 4 show changes in tooth color for each group.

2. Variation of brightness in each group by VITA classical A1-D4[®]

Brightness modulation of the tooth according to the VITA classical A1-D4[®] measurement is shown in Table 5 and Figure 4.

Table 2. Tooth color change of experimental group

Tooth No.	Tooth color						Lightness value					
	Base		After 1 week		After 2 weeks		Base		After 1 week		After 2 weeks	
	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b
1	5M2	C4	2M3	B3	2M3	B3	5	16	2	11	2	11
2	2M3	A3.5	2M3	A3	1M2	A3	2	12	2	9	1	9
3	3M3	A3.5	2M3	B3	2M3	B3	3	12	2	11	2	11
4	3M3	A3.5	1M2	A1	1M2	A3	3	12	1	2	1	9
5	4M3	A3.5	3M3	A3	2M3	A3	4	12	3	9	2	9
6	4M3	C4	3M3	B4	2M3	A3.5	4	16	3	13	2	12
7	3M3	B4	2M3	A3.5	2M3	A3.5	3	13	2	12	2	12
8	3M3	B4	2M3	A3.5	2M3	A3.5	3	13	2	12	2	12
9	3M3	A3.5	2M3	B3	2M3	B3	3	12	2	11	2	11
10	3M3	C3	2M3	B2	1M2	A1	3	14	2	3	1	2
11	3M3	C4	2M3	A3.5	1M2	A2	3	16	2	12	1	5
12	3M3	A3.5	2M2	A3	1M2	A3	3	12	2	9	1	9
13	3M3	A3.5	1M2	A3	2M2	A3	3	12	1	9	2	9
14	3M3	A3.5	1M2	A3	2M3	A3	3	12	1	9	2	9
15	4M3	C4	3M3	C3	2M3	A3.5	4	16	3	14	2	12
16	4R2.5	A3.5	2M3	A3	2M3	B3	4	12	2	9	2	11
17	3M3	A3.5	2M3	A1	1M2	A1	3	12	2	2	1	2
18	3M3	A3.5	2M3	A3	2M3	C1	3	12	2	9	2	6
19	5M2	A3.5	2M3	B3	2M3	B3	5	12	2	11	2	11
20	5M3	C4	4M3	A4	2M3	B3	5	16	4	15	2	11

^aVITA SYSTEM 3D-MASTER[®], ^bVITA classical A1-D4[®].

Table 3. Tooth color change of control 1 group (positive)

Tooth No.	Tooth color						Lightness value					
	Base		After 1 week		After 2 weeks		Base		After 1 week		After 2 weeks	
	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b
1	2M3	A3	2M3	A3	2M3	A3	2	9	2	9	2	9
2	3M3	A3.5	2M3	B3	2M3	D3	3	12	2	11	2	10
3	5M3	C4	3M3	A3.5	3M3	A3.5	5	16	3	12	3	12
4	3M3	A3.5	3M3	A3.5	3M3	A3.5	3	12	3	12	3	12
5	3M3	B4	3M3	B3	2M3	B3	3	13	3	11	2	11
6	3M3	C4	3M3	B4	2M3	A3.5	3	16	3	13	2	12
7	3M3	A3.5	2M3	A3.5	2M3	A3.5	3	12	2	12	2	12
8	3M3	B4	2M3	A3.5	2M3	A3.5	3	13	2	12	2	12
9	4M3	A4	3M3	B3	2M3	D3	4	15	3	11	2	10
10	3M3	A3.5	3M3	B3	2M3	D3	3	12	3	11	2	10
11	5M3	A4	3M3	A3.5	3M3	A3.5	5	15	3	12	3	12
12	4M3	C3	2M3	B3	2M3	B3	4	14	2	11	2	11
13	4M3	C3	3M3	A3.5	3M3	A3.5	4	14	3	12	3	12
14	3M3	A4	3M3	B3	2M3	D3	3	15	3	11	2	10
15	4M3	A4	3M3	B3	3M3	A3	4	15	3	11	3	9
16	2M3	B3	1M2	A3	2M3	A3	2	11	1	9	2	9
17	2M3	B3	2M3	B3	2M3	B3	2	11	2	11	2	11
18	4M3	A4	3M3	A3.5	3M3	A3.5	4	15	3	12	3	12
19	4M3	A4	3M3	A3.5	2M3	D3	4	15	3	12	2	10
20	4R2.5	A4	2M3	B3	2M3	B3	4	15	2	11	2	11

^aVITA SYSTEM 3D-MASTER[®], ^bVITA classical A1-D4[®].**Table 4.** Tooth color change of control 2 group (negative)

Tooth No.	Tooth color						Lightness value					
	Base		After 1 week		After 2 weeks		Base		After 1 week		After 2 weeks	
	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b	3D ^a	Classic ^b
1	2M2	B3	2M2	B3	2M2	B3	2	11	2	11	2	11
2	3M3	A3.5	3M3	B3	3M3	B3	3	12	3	11	3	11
3	3M3	A3.5	3M3	B3	3M3	B3	3	12	3	11	3	11
4	4M3	A4	4M3	B4	3M3	A4	4	15	4	13	3	15
5	4M3	A4	4M3	A4	3M3	C3	4	15	4	15	3	14
6	3M3	A3.5	3M3	B3	3M3	A3.5	3	12	3	11	3	12
7	3M3	A3.5	3M3	B3	3M3	B3	3	12	3	11	3	11
8	4M3	A4	3M3	C3	3M3	B3	4	15	3	14	3	11
9	4M3	A4	4M3	C3	3M3	B4	4	15	4	14	3	13
10	4M3	A4	4M3	C3	3M3	B4	4	15	4	14	3	13
11	2M3	B3	2M2	B3	2M2	A3	2	11	2	11	2	9
12	3M3	B3	2M3	B3	2M3	B3	3	11	2	11	2	11
13	3M3	A3.5	3M3	A3.5	3M3	B3	3	12	3	12	3	11
14	3M3	A3.5	3M3	B3	3M3	B3	3	12	3	11	3	11
15	4MC	A4	4M3	A4	3M3	A4	4	15	4	15	3	15
16	4R2.5	A4	3M3	A3.5	3M3	A3.5	4	15	3	12	3	12
17	3M3	A3.5	3M3	A3.5	3M3	A3.5	3	12	3	12	3	12
18	3M3	A4	3M3	C3	3M3	B4	3	15	3	14	3	13
19	4M3	A4	3M3	B3	3M3	A3.5	4	15	3	11	3	12
20	4M3	C4	4M3	A4	4M3	A4	4	16	4	15	4	15

^aVITA SYSTEM 3D-MASTER[®], ^bVITA classical A1-D4[®].

Table 5. The changes of lightness by VITA classical A1-D4[®] shade checking

Group	Base	After 1 week	After 2 weeks
Exp. (n=20)	13.20±1.74	9.60±3.60 ^{a**}	9.15±3.10 ^{a**}
Cont 1. (n=20)	13.50±1.93	11.30±0.98 ^{b**}	10.85±1.14 ^{b**}
Cont 2. (n=20)	13.40±1.79	12.80±1.47 ^c	12.65±1.57 ^c
p-value	0.869	<0.001	<0.001

Values are presented as mean ± standard deviation. p-value by one way ANOVA test. Exp.: experimental group, Cont 1.: control 1 group (positive), Cont 2.: control 2 group (negative). ^{abc}Means with the same letter are not significantly different. ^{**}p<0.01 by paired t-test between base and after.

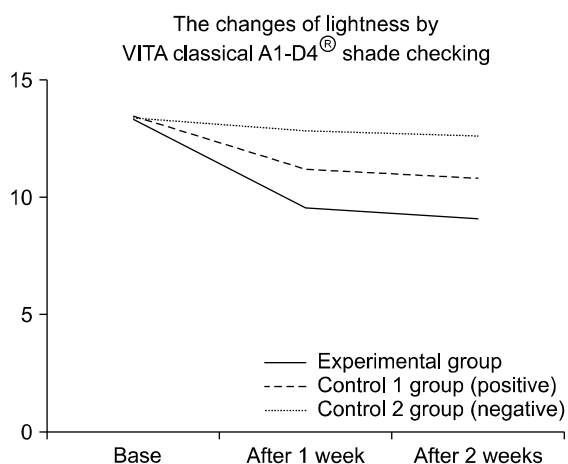


Figure 4. The changes of lightness by VITA classical A1-D4[®] shade checking.

3. Variation of brightness in each group by VITA SYSTEM 3D-MASTER[®]

Brightness modulation of the tooth according to the VITA SYSTEM 3D-MASTER[®] measurement is shown in Table 6 and Figure 5.

Discussion

In the latter half of the 20th century, humanity has enjoyed the abundance of life due to the development of industry, and as the environment changes, the area of interest in teeth is also widening. It is considered to be an institution that not only regards teeth as an important organ for chewing and pronunciation, but also plays an important role in beauty.

It is presumed that the mechanism in which the peroxide substance exhibits the tooth whitening effect is to increase the intra-tooth movement of the ions and oxidize the reducing substance, which is the coloring cause [9-11]. High concentrations of hydrogen peroxide increase the tooth whitening effect, but

Table 6. The changes of lightness value by VITA SYSTEM 3D-MASTER[®] checking

Group	Base	After 1 week	After 2 weeks
Exp. (n=20)	3.45±0.83	2.10±0.72 ^{a**}	1.70±0.47 ^{a**}
Cont 1. (n=20)	3.40±0.88	2.55±0.60 ^{b**}	2.30±0.47 ^{b**}
Cont 2. (n=20)	3.35±0.67	3.20±0.62 ^c	3.05±0.39 ^c
p-value	0.925	<0.001	<0.001

Values are presented as mean ± standard deviation. p-value by one way ANOVA test. Exp.: experimental group, Cont 1.: control 1 group (positive), Cont 2.: control 2 group (negative). ^{abc}Means with the same letter are not significantly different. ^{**}p<0.01 by paired t-test between base and after.

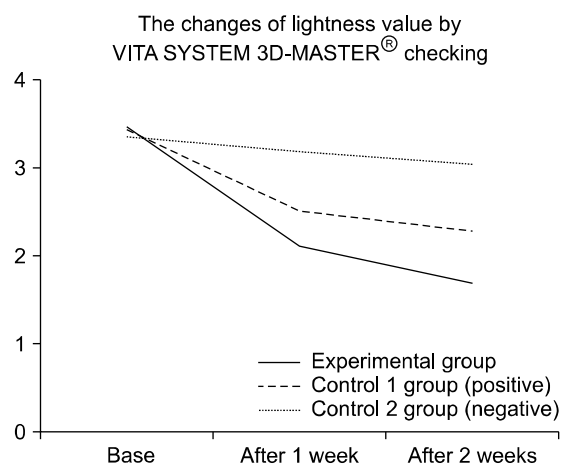


Figure 5. The changes of lightness value by VITA SYSTEM 3D-MASTER[®] checking.

it is reported that side effects cause tooth hypersensitivity [10-13]. Although the mechanism by which hydrogen peroxide causes the hypersensitivity of teeth has not been precisely clarified yet, hydrogen peroxide penetrates into enamel, dentin, and dental pulp, and the concentration of hydrogen peroxide used is high [14,15]. In the case of teeth with restorative material rather than natural teeth, It is considered that the hydrogen peroxide penetrating through the dental surface stimulates the dental pulp through dentinal tubule.

The effect of tooth whitening is generally evaluated by measuring the color difference before and after whitening. In this study, Shadescan and other equipment have been widely used. Recently, equipment such as VITA Easyshade[®] Advance V, which can be easily used in the clinic, have been used in this study.

The clinical approach to tooth whitening of discolored teeth can be roughly divided into three methods.

The first is how to use tooth whitening toothpaste, tooth whitening strips, and so on without the dentist's prescription

(over-the-counter tooth whitening products).

The second is prescribed at-home bleaching procedures which involve the application of a low concentration of hydrogen peroxide or carbimide peroxide to individual bleaching trays under the prescription of a dentist (prescribed at-home bleaching procedures).

Finally, there is in-office bleaching procedures by a dentist. Each procedure has advantages and disadvantages, and all three methods are recommended to be used in combination for the treatment of tooth discoloration.

Recently, over-the-counter tooth whitening products such as tooth whitening toothpaste and tooth whitening strips have become very popular, and do not require a dentist's prescription. The effect of whitening is low, therefore we tried to evaluate the tooth whitening effect of a newly developed nail polish-type hydroperoxide whitening gel on the improvement of tooth brightness compared to a conventional tooth whitening gel.

First, The lightness according to the color of VITA classical[®] A1-D4 was brightened from 13.20 ± 1.74 to 9.60 ± 3.60 after 1 week, to 9.15 ± 3.10 after 2 weeks, In the positive control group, the change from 13.50 ± 1.93 to 11.30 ± 0.98 after 1 week and 10.85 ± 1.14 after 2 weeks. And in the negative control group, the change from 13.40 ± 1.79 to 12.80 ± 1.47 after one week and 12.65 ± 1.57 after two weeks. In a experimental group and a positive control group it showed a statistically significant level, and then splashes tooth whitening gel applied ($p < 0.01$). There was no statistically significant difference in lightness between the three groups according to the color of VITA classical[®] A1-D4, but the experimental group was significantly brighter after two weeks and after 1 week ($p < 0.05$).

Brightness according to VITA SYSTEM[®] 3D-MASTER color was increased from 3.45 ± 0.83 to 2.10 ± 0.72 after 1 week and 1.70 ± 0.47 after 2 weeks in the experimental group. In the positive control group, it changed from 3.40 ± 0.88 to 2.55 ± 0.60 (after 1 week) and 2.30 ± 0.47 (after 2 weeks), and in negative control group from 3.35 ± 0.67 to 3.20 ± 0.62 (after one week) and 3.05 ± 0.39 (after two weeks). In a experimental group and a positive control group, it showed a statistically level difference ($p < 0.01$). There was no statistically significant difference in brightness between the three groups according to VITA SYSTEM[®] 3D-MASTER color, but the experimental group was significantly brighter after two weeks after 1 week ($p < 0.05$).

Through the above results, when performing teeth whitening using peroxide whitening gel nail polish in a new form, It is suggested that a method of applying a nail polish type of hydrogen peroxide whitening gel for a more effective at-home tooth whitening of the teeth is similar to or better than the conventional tooth whitening gel.

Conclusion

The authors divided into 20 experimental cow teeth (60 cow teeth), positive control group and negative control group, and each tooth was treated with tooth whitening gel for 2 weeks. The change of tooth brightness was measured before, 1 week, and 2 weeks after the start of tooth application to confirm the effectiveness of a recently developed nail polish type of hydrogen peroxide tooth whitening gel among commercialized tooth whitening gels for home use.

And the following results were obtained.

(1) The lightness according to the color of VITA classical[®] A1-D4 was brightened from 13.20 ± 1.74 to 9.60 ± 3.60 after 1 week, to 9.15 ± 3.10 after 2 weeks, In the positive control group, the change from 13.50 ± 1.93 to 11.30 ± 0.98 after 1 week and 10.85 ± 1.14 after 2 weeks. And in the negative control group, the change from 13.40 ± 1.79 to 12.80 ± 1.47 after one week and 12.65 ± 1.57 after two weeks. In a experimental group and a positive control group it showed a statistically significant level, and then splashes tooth whitening gel applied ($p < 0.01$). There was no statistically significant difference in lightness between the three groups according to the color of VITA classical[®] A1-D4, but the experimental group was statistically significantly brighter after two weeks after 1 week ($p < 0.05$).

(2) There was no statistically significant difference in lightness between the three groups according to the color of VITA classical[®] A1-D4, but the experimental group was significantly brighter after two weeks and after 1 week ($p < 0.05$).

(3) Brightness according to VITA SYSTEM[®] 3D-MASTER color was increased from 3.45 ± 0.83 to 2.10 ± 0.72 after 1 week and 1.70 ± 0.47 after 2 weeks in the experimental group. In the positive control group, it changed from 3.40 ± 0.88 to 2.55 ± 0.60 (after 1 week) and 2.30 ± 0.47 (after 2 weeks), and in negative control group from 3.35 ± 0.67 to 3.20 ± 0.62 (after one week) and 3.05 ± 0.39 (after two weeks). In a experimental group and a positive control group, it showed a statistically level difference ($p < 0.01$).

(4) There was no statistically significant difference in brightness between the three groups according to VITA SYSTEM[®] 3D-MASTER color, but the experimental group was significantly brighter after two weeks and after 1 week ($p < 0.05$).

Through the above results, tooth whitening using a new type of nail polish hydrogen peroxide whitening gel showed similar or better lightness than the existing tooth whitening gel. Therefore, a method of applying a whitening gel is recommended for more effective whitening.

References

1. Kim JB, Paik DI, Shin SC, Choi EG, Shin SC, Kwon HK, et al. Clinical preventive dentistry. 3rd ed. Seoul: Komoonsa; 2000: 327-32.
2. Harris NO, García-Godoy F. Primary preventive dentistry. 5th ed. Stamford: Appleton & Lange; 1999:41-297.
3. Kim JB, Choi EG. Public health dentistry. 4th ed. Seoul: Komoonsa; 2004:71-7.
4. Kenneth WA, Barry GD. Esthetic dentistry. 2nd ed. St. Louis: Mosby; 2001:27-37.
5. Mount GJ, Hume WR. Preservation and restoration of tooth structure. Seoul: DaehanNarae Publishing; 2000:185-94.
6. Kondo R. Toothwhitening. Seoul: DaehanNarae Publishing; 2000:3-94.
7. Yama M. Dental esthetics. Seoul: Quintessence; 2002:152-9.
8. McGuckin RS, Babin JF, Meyer BJ. Alterations in human enamel surface morphology following vital bleaching. *J Prosthet Dent* 1992;68:754-60.
9. Hoh WJ, Shin SC, Cho JW, Lee SY, Kong YM, Kim MS, et al. Effect of tooth whitening according to the application frequency of 22% hydrogen peroxide with plasma arc light. *Int J Clin Prev Dent* 2007;3:101-10.
10. Lee JM, Shin SC, Cho JW, Choi YH, Moon YM, Jung SJ, et al. Tooth whitening effect according to the concentration of hydrogen peroxide. *Int J Clin Prev Dent* 2007;3:38-48.
11. Attin T, Kielbassa AM, Schwanenberg M, Hellwig E. Effect of fluoride treatment on remineralization of bleached enamel. *J Oral Rehabil* 1997;24:282-6.
12. Nam CO. Tooth whitening: what's the difference, white & bright? *Int J Clin Prev Dent* 2005;1:50-3.
13. Kim KY, Shin SC, Cho JW, Lee CH, Lee JY, Lyoo YJ. The effect of the plasma arc light on tooth whitening. *Int J Clin Prev Dent* 2006;2:145-56.
14. Jung MA. A case report on the professional tooth whitening for 58 years old woman. *Int J Clin Prev Dent* 2008;4:53-60.
15. Basting RT, Rodrigues AL Jr, Serra MC. The effects of seven carbamide peroxide bleaching agents on enamel microhardness over time. *J Am Dent Assoc* 2003;134:1335-42.