The Effect of Chemical Disinfectants on the Color of a Porcelain Shade Guide

Aws S. ArRejaie

Department of Substitutive Dental Sciences, College of Dentistry, University of Dammam

Abstract:

Objective: To evaluate the effect of long term utilization of chemical disinfectants on the color of porcelain shade guides.

Methodology: three chemical disinfectants were used in this study: Minuten spray, Lysol ICQuaternary Disinfectant Cleaner (QDC), and Lysol IC Ready to Use Disinfectant Cleaner (RDC). Simulation of disinfecting cycles for one year, two years, and three years were done on Vita 3D master shade guide. Color differences were determined by visual inspection and analyzing ΔE.

Results: ΔE values were significantly below the perceptible (ΔE=1) and the clinically acceptable (ΔE=3.7) thresholds.

Conclusions: Simulated utilization of Minuten Spray, Lysol IC (QDC), and Lysol (RDC) disinfectants for up to three years didn't cause a clinically significant difference in the color of VITA Toothguide 3D-Master Shade Guide.

Correspondence:

Aws S. ArRejaie, BDS, CAGS, DSCD, FRCDC
Assistant Professor
Department of Substitutive Dental Sciences,
College of Dentistry,
University of Dammam
P.O. Box 1982, Dammam 31441,
Dammam, Saudi Arabia
Phone: +966133331403;
Fax: +966138572624
Mobile: +966555461157
E-mail: aarrjaie@UD.edu.sa

Introduction:

At the present time, "Hollywood smile" and "Celebrities' smile" are two commonly used terms to state patients' expectations to restorative dentists. These market driven demands have pushed the development of new esthetic materials to meet those expectations. It has also pushed restorative dentists and prosthodontists to overcome several practical challenges to produce satisfactory final treatment. One of those major challenges is color selection, and how to transfer this information to the dental laboratory.

There are several methods and devices that can be used by dentists for color selection. [1] They are mainly divided into visual and instrumental devices. [2] Digital instruments, such as, Vita Easyshadespectrophotometer have shown to be more accurate and more reproducible than conventional visual examination. [3-4] Nevertheless, conventional shade matching techniques are still considered the most common and the preferable used technique to select the color due to its simplicity and accessibility. [5] Even with its popularity, it has been revealed that it is both inconsistence and not accurate. [6-7] Primarily, due to that color perception in nature is considered inconsistent and relatively inaccurate. It was reported that color selection can vary between different genders. It can also differ among different dentists and by the same dentist at different intervals. [6-9] There have also been reported discrepancies related within similar shade tab from the same manufacturer, and also between different shade guide systems. [10-11]

Therefore, absolute care must be followed in performing shade matching including handling and sterilization of the shade guide itself. Manufacturer's recommendation for sterilization of conventional shade guide includes chemical disinfectants with solutions that doesn't include component of phenol or methyl ethyl ketone. [12] Therefore, the purpose of this study is to evaluate the long term effect of chemical disinfection on the color of porcelain shade guide.

Materials and Methods:

VITA Toothguide 3D-Master Shade Guide (VITA Zahnfabrik H. Rauter GmbH & Co. KG D-79713 Bad Sackingen, Germany) was used in this study. Five shade tabs were selected according to the following: 1M2, 2M2, 3M2, 4M2, and 5M2 respectively in order to include wide range of different color values. Three types of disinfectant solutions have been used in this study: Minuten Spray (Arabian Products Factory for Medical Disinfectants, Riyadh, Saudi Arabia), Lysol IC brand Quaternary Disinfectant Cleaner (QDC) (Reckitt Benckiser Professional, NJ, U.S.A), and Lysol IC brand Ready To Use Disinfectant Cleaner (RDC) (Reckitt Benckiser Professional, NJ, U.S.A). According to the Material Safety Data Sheets of those disinfectants, MinutenSpray is clear in appearance and colorless, Lysol IC (QDC) is amber in color, and Lysol IC (RDC) is clear in appearance and colorless.

Initially, Tabs were visually inspected by a general dentist to detect any color defects. Selected shade tabs weredivided into five groups, for which those will receive treatmentwere mounted in a Styrofoam plate and handled according to table 1.

Table 1: Disinfection treatments

SN	Solution	Treatment
1	**None (Control)**	None (Control)
2	**Distilled water**	Rinsed and wiped dry
3	**Minuten Spray**	Sprayed until wet and allowed to sit one minute and then rinsed with water and wiped dry
4	**Lysol IC (QDC)**	Dipped for 10 minutes and wiped dry
5	**Lysol IC (RDC)**	Dipped for 10 minutes and wiped dry

The 7000A Color-EyeSpectrophotometer (X-rite, GrandRapide, MI, USA) was used in this study. Calibration was done before each reading, and each specimen was mounted with a dark background according to the manufacturer's recommendations. Shade tabs were placed on a specific specimen holder to stabilize the sample, and toensurethat the same area (middle third) was tested for each measurement. Data were collected by averaging three readings of each shade tab at the same time.

To simulate the annual usage of a shade guide, current utilization was observed in the clinics at College of Dentistry, University of Dammam and it was averaged that shade guides were used once daily for five business days a week and 20 days a month. It was consequentlyassumed that shade guides will undergo 240 disinfection cycles per year. Therefore, readings and visual inspections were done at base line, after 240 disinfection cycles to simulate one year, after 480 cycles to simulate 2 years, and after 720 cycles to simulate three years. Shade tabs were also visually inspected and compared by the same evaluator to the control group for any detectable changes.

For evaluation of the color stability, color difference (ΔE) and color variables(ΔL*, Δa*, and Δb*) of shade tabs for each evaluation period relative to baseline color were calculated according to the following formula[13].

$$\Delta E_{Lab*} = [(\Delta L*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

Data of the results were then analyzed using SPSS statistical software (IBM SPSS Statistics, Armonk, New York, USA). A descriptive statistics were used to compare symmetric variables with regards to their standard deviation, mean, median and range.

Results:

Color differences were calculated after one, two, and three years simulated by using ΔE approach. Readings were repeated for the same specimens after baseline, one, two, and three. Therefore, a repeated measure ANOVA was used to check for statistical significance. The four groups were tested for any changes relative to baseline and the results are presented in table 2. There was no statistical significance between baseline and the subsequent years.

Table 2: Mean (SD)ΔE by evaluation period

Evaluation period	Treatment groups			
	Distilled Water	**Minuten Spray**	**LYSOL IC (QDC)**	**LYSOL IC (RDC)**
1st year	0.19 (0.14)	0.36 (0.69)	0.32 (0.1)	0.47 (0.11)
2nd year	0.11 (0.07)	0.14 (0.19)	0.28 (0.05)	0.33 (0.08)
3rd year	0.10 (0.07)	0.29 (0.098)	0.27 (0.15)	0.173 (0.17)

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It is also important to evaluate the changes occurred within the color components (L^*, a^* and b^*) which can be seen in table 3. A significant increase in L^*value was observed from the baseline evaluation (2-factor repeated measures ANOVA was used; p=0.002). Analysis was performed in depth to find any significance in the results. Base line data were compared with each year results (year 1, 2 and 3) by using repeated measures ANOVA. Further statistical analysis revealed that there was significant increase with

LYSOL IC (QDC) comparing 1st and 2nd yearto baseline (Holm-Sidak Post Hoc test; p=0.049 and 0.02 respectively),and significant increase with LYSOL IC (RDC) after 1st & 2nd year compared to baseline (Holm-Sidak Post Hoc test; p=0.002 and 0.006 respectively). Same statistical test was also used for group treated withMinuten Spray, and showed significant increase after three years as compared to baseline (p = 0.05).

Similar statistical analysis were done in the a* and b* values. Two way repeated measures ANOVA was used with no detected significant differences to see the effect of long term disinfection and to compare different treatment groups to baseline.

Table 3: Mean (SD) of various color components for each treatment by evaluation period

Treatment groups & evaluation period	Color Components (L*a*b*)		
	L* Mean(SD)	a* Mean(SD)	b* Mean(SD)
Distilled Water			
Baseline	66.14(5.47)	2.42(1.74)	14.57(2.35)
1st year	66.33(5.46)	2.39(1.72)	14.54(2.36)
2nd year	66.20(5.39)	2.38(1.74)	14.48(2.43)
3rd year	66.24(5.45)	2.40(1.72)	14.56(2.34)
MINUTEN SPRAY			
Baseline	66.16(5.72)	2.34(1.66)	14.55(1.99)
1st year	65.95(5.38)	2.31(1.72)	14.26(2.38)
2nd year	66.28(5.54)	2.36(1.67)	14.48(2.11)
3rd year	66.44(5.71)	2.34(1.66)	14.49(1.97)
LYSOL IC (QDC)			
Baseline	65.94(5.23)	2.40(1.81)	14.59(2.6)
1st year	66.24(5.31)	2.37(1.80)	14.48(2.54)
2nd year	66.20(5.29)	2.35(1.82)	14.49(2.59)
3rd year	66.19(5.19)	2.36(1.80)	14.49(2.57)
LYSOL IC (RDC)			
Standard	66.01(5.26)	2.37(1.79)	14.47(2.55)

1st year	66.46(5.32)	2.41(1.81)	14.61(2.49)
2nd year	66.34(5.25)	2.38(1.81)	14.54(2.63)
3rd year	66.18(4.93)	2.36(1.84)	14.50(2.7)

Discussion:

The hypothesis of this study was that the chemical disinfectants have no effect on the color of the porcelain shade guide. The results have confirmed the mentioned hypothesis.

VITA Tooth guide 3D-Master Shade Guide was introduced in the late 1990s. It is considered one of the most reliable tools used for shade selection compared to the other similar products. [9,14] Manufacturer's recommendations for cleaning and sterilization include autoclaving and disinfecting. Chemical disinfecting is the preferable technique at the clinics of College of Dentistry, University of Dammam due to its convenience, practicality and less damaging to the shade guide.

7000A Color-EyeSpectrophotometersystem was used in this study. It is a bench top system that uses pulsed xenon illumination with spectral range of 360-750nm. [15] The 7000A Color-Eye Spectrophotometer measures the colors of each shade tab based on the CIE L* a* b* color space system. L* is the Lightness variable, and decreased L* value means a darker shade and vice versa. Values a* and b* represents Chroma, and they direct the color to certain direction on the red/green and yellow/blue axes. Decreased a* value means more green and increased b* means more yellow.

ΔE was used in this study to analyze the color difference before and after disinfecting. It represents the distance between two measured colors, where the bigger the ΔE the bigger the difference. Therefore, it is essential to define the threshold for determining whether the difference is of any significance. Most of the literatures have interrupted the ΔE values into two thresholds[16]: perceptible and acceptable. The perceptible threshold ranges from 0.4 to 3.7, and the acceptable threshold ranges from 2- 4. [16] However, the most referred to as the value for perceptible threshold is 1, [17] and the most referred to as the acceptable threshold to be 3.7. [18]

Maximum ΔE value in this study was 0.47 which is below the perceptible and the clinical threshold. Looking at the pattern of ΔE results in this study, we can see that the maximum effect of disinfectants takes place within the first year of usage. Subsequently, it would decrease in year two and year three except in one group. Alshethri [19] found similar conclusions on Vitapan Classical shade guide using Minuten Spray. The highest ΔE value was 0.86 which is also below the perceptible threshold. He also found that the maximum effect occurred after 1 year of disinfection, but he did 480 disinfection cycles per year. Pohjola [20] also examined the effect of a disinfectant (Cavicide) on Vitapan classical shade guide and found that the maximum color difference ΔE was 2.5 after two years. Yet, visual inspection in his study concluded that the difference is not perceptible.

ΔE can be a helpful tool in detecting and finding color differences. Nevertheless, it still has its own limitation. It doesn't show the direction of the change in the color space. Therefore, further evaluation into the L* a * b* is necessary.

The study showed no significant changes along the evaluation period for a* and b* values. There is a significant increase in the L* value with Minuten Spray, Lysol (QDC) and Lysol IC (RDC). Increased L* value reflects a lighter color. This noticed difference after disinfection might be related to the ingredients of the disinfectant. According to the Material Safety Data Sheets, Minuten Spray and Lysol IC (RDC) are ethanol based (30-60%), and Lysol (QDC) has Didecyl Dimethyl Ammonium Chloride (7-13%) and small traces of ethanol (1-2.5%). However, those differences are of no clinical values due to that ΔE is below the perceptible or the acceptable threshold. Alshethri in his study have noted some significant difference in a* values in some shades with no significant difference in other color components. It is may be related to that this study used another shade guide with different shades arrangement and fabrication.

There were no detectable differences with visual inspection between the treated shade

guides and the control group. This was reported also with Pohjola in his study, but Alshethri found 17% difference after one year and 28% differenceafter two years.

Conclusion:

Within the limitation of this study, it was found that utilization of Minuten Spray, Lysol IC (QDC), and Lysol (RDC) for up to three simulated years didn't cause a clinically significant difference in the color of VITA Toothguide 3D-Master Shade Guide after simulated.

Conflict of interest:

The author declares that he has no conflict of interest.

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