Original Article

Color Stability of Polished and Glazed Dental Porcelain in Chlorhexidine

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Abstract

Background and Aim: Discoloration is a major concern with regard to the use of tooth-colored restorations. Type of restorative material and surface treatment are believed to play a role in this regard. This study sought to compare the color change of glazed and polished dental porcelain after 30 days of immersion in chlorhexidine (CHX).

Materials and Methods: In this in vitro, experimental study, 20 discs with 10 mm diameter and 2 mm thickness were fabricated of A1 shade of Noritake porcelain using a gypsum mold. All samples had one opaque layer. They were then randomly divided into two groups of 10. Glaze powder was added to porcelain in group 1, and group 2 was polished using a polishing kit. The CIE L*a*b color parameters of samples were then measured using a spectrophotometer. All samples were immersed in 0.02% chlorhexidine solution for 30 days and color parameters were then measured again. Change in each color parameter was compared between the two groups (polished and glazed) using t-test.

Results: After 30 days of immersion in CHX, ΔE was 0.76±0.16 in the glazed and 0.89±0.16 in the polished group. The difference in this regard between the two groups was not significant (P=0.092).

Conclusion: Both polishing and glazing confer optimal color stability to dental porcelain.

Key Words: Chlorhexidine, Color, Dental Porcelain, Dental Polishing

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Introduction

Replacement of the lost teeth has always been a concern for patients and clinicians. Different materials are used for fabrication of prosthetic restorations; among which, porcelain is highly popular due to its excellent esthetics, natural look and high translucency [1]. Porcelain restorations have good color stability; however, their discoloration has also been reported, which may be intrinsic or extrinsic. Intrinsic discoloration is related to innate characteristics of the materials in composition of porcelain while extrinsic discoloration is due to the accumulation of stains on the porcelain surface, which depends on the level of smoothness of the surface and presence/absence of porosities [2].

Discoloration of tooth-colored restorations over time is a major concern for both clinicians and patients [3]. Use of prosthetic restorations has greatly increased and their discoloration over time can compromise esthetics and decrease patient satisfaction [3]. In case of occurrence of color

change, most patients demand replacement of restoration, which results in damage to tooth structure and is time consuming and costly [4].

Spectrophotometry is commonly used for color assessment since it provides accurate and reproducible information about the spectral reflectance curve as a function of wavelength [5]. Glazing, polishing, auto-glazing and reglazing are performed to prevent or minimize discoloration of tooth-colored restorations [6]. Glazing and polishing are the two most commonly used techniques to prevent discoloration of dental ceramics. These techniques confer higher esthetics and color stability to ceramic restorations.

In glazing, a glossy layer is created on the porcelain surface by heat. This can be done by heating the porcelain itself or by applying the glazing powder on the porcelain surface followed by heating [7]. Glazing increases the fracture strength and decreases the wear of restoration since it fills the porosities on the porcelain surface [8]. In polishing, the porcelain surface undergoes polishing by a series of polishing discs containing sub-micron abrasives to obtain a smooth surface. Several polishing kits are available in the market for polishing of dental ceramics [7].

A previous study showed that glazed ceramics have a smoother surface and higher color stability compared to polished ceramics [9]. However, another study demonstrated that polishing can provide a surface as smooth as a glazed surface and can even yield higher esthetics [10].

Considering the existing controversy regarding the color stability of glazed and polished dental ceramics and the diversity of the available polishing and glazing systems, this study sought to compare the color stability of glazed and polished dental porcelain in chlorhexidine (CHX) solution.

Materials and Methods

This in vitro, experimental study was conducted on 20 discs measuring 10 mm in diameter and 2 mm in thickness fabricated of A1 shade of Noritake porcelain (Kuraray Noritake Dental Inc., Aichi, Japan).

Sample size was calculated to be 10 samples in each group according to previous studies by Kara et al, [11] and Atay et al, [12] and considering alpha=0.05, beta=0.2, standard deviation of 0.33 and lowest mean ΔE of 0.85 using two level factorial design feature of Minitab software.

All discs were fabricated by the same operator. In order to standardize the discs, a gypsum mold was used for their fabrication. Gypsum mold was fabricated using a wax pattern with dimensions similar to those of discs. After fabricating the mold, one layer of opaque porcelain was applied to the mold and it was transferred to Vita Vacumat 200 furnace (Vita Zahnfabrik, Bad Säckingen, Germany). Opaque porcelain was heated under vacuum with an initial temperature of 600°C, which increased to 940°C within three minutes and maintained at this temperature for one minute. After cooling, porcelain baking was done in three phases in order for the discs not to undergo transformation due to shrinkage. Porcelain powder was first heated at an initial temperature of 600°C under vacuum and the temperature increased to 930°C within six minutes. It remained at this temperature for one minute and then the discs were allowed to cool down for six minutes. In the next step, temperature raised to 920°C within six minutes and maintained at this temperature for one minute. The discs were then cooled down for six minutes. In the next step, the temperature increased to 910°C within six minutes, remained at this temperature for one minute and cooled down for six minutes. After cooling, samples were polished for 30 seconds using silicon discs (Eva Silicon Polishers, medium grit; Ernst Vetter GmbH, Pforzheim, Germany). All samples were polished for 30 seconds to obtain an acceptably smooth surface. Next, they were randomly divided into two groups (n=10).

Group 1: Glaze powder was applied on the surface of porcelain samples and they were transferred to a furnace with initial temperature of 600°C. The temperature was reached to 940°C within three minutes and the samples were kept at this temperature for one minute. The samples were then cooled down.

Group 2: The samples were polished with Eva kit (Eva Silicon Polishers; Ernst Vetter GmbH, Pforzheim, Germany). Coarse-grit polisher was first used, followed by medium grit, fine grit and X-fine grit polishers under water coolant. Next, baseline color parameters of samples were measured using S900 spectrophotometer (Ihara

U.S., Inc., CA, USA). Each group was then immersed in 200 mL of 0.02% CHX solution (Iran Najo, Tehran, Iran) such that each sample was at the center of the container and had no contact with the walls. The solutions were refreshed every three days in order to prevent precipitation. After 30 days of immersion, color parameters were measured again by the same spectrophotometer. Prior to measurements, the samples were cleaned with a tooth brush for five minutes and dried with a paper towel. The samples were placed at the center of device and direct light was irradiated on them. The reflected light was analyzed using the CIE L*a*b* color system where L* indicates lightness, a* indicates redness-greenness and b* indicates yellowness-blueness. Color change was calculated using the formula below:

$$\sqrt{(\Delta E=\Delta L) + (\Delta a) + (\Delta b)}$$

The color change data were then converted to NBS units using the formula below to facilitate comparison with clinical studies.

NBS unit=E* x 0.92

According to NBS units, color change was classified as follows:

0.0-0.5: Insignificant change
0.5-1.5: Small change
1.5-3.0: Perceptible change
3.0-6.0: Significant change
6.0-12.0: Highly significant change
12.0 and higher: Conversion to another color

Change in each color parameter was compared between the two groups (polished and glazed) using t-test.

Results

Diagram 1 shows the color change (ΔE) of the two groups. As shown in Diagram 1, ΔE was 0.76±0.16 in the glazed and 0.89±0.16 in the polished group (Table 1). T-test showed no difference in ΔE between the two groups (P=0.092).

Repeated measures ANOVA compared each parameter within one group (polished or glazed) and showed that the deference between "L" at baseline and "L" after 30 days, and, "b" at baseline compared to "b" after 30 days (P<0.001) was significant, but the "a" parameter did not show any significant change after 30 days (P =0.506).

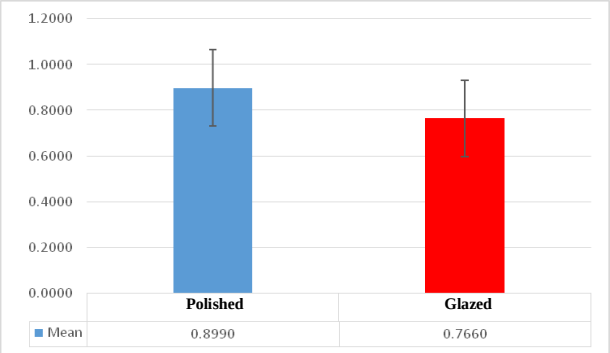

Diagram 1. Color change in the polished and glazed porcelain groups

T-test showed no significant difference in any parameter including ΔL, Δa and Δb between the two groups of polished and glazed (P>0.05, Table 2).

Table 3 shows color change of dental porcelain according to NBS units based on the type of surface treatment. As seen in Table 3, in the polished group, two samples (20%) had color change >1.5 while in the glazed group, one sample had color change >1.5.

Discussion

This study assessed the color stability of glazed and polished porcelain samples. The results showed that color change was not significantly different between the two groups after 30 days of immersion in CHX. The magnitude of discoloration was clinically acceptable in the two groups. Color parameters were assessed based on the CIE L*a*b* system. In this system, ΔL indicates lightness. The Δa parameter indicates redness-greenness. Positive changes are towards redness and negative changes are towards greenness. The Δb parameter indicates yellowness-blueness. Positive changes in Δb parameter indicate yellowness and negative changes indicate blueness. According to Table 1, Although after statistical analysis, change in Δa was not significant in the two groups, in our experiment the changes in Δa parameter were towards positive in the polished group, which means that the samples became more red, and changes in Δa parameter were slightly towards

Table 1. Changes in color parameters based on the type of surface treatment

Parameter \ Type of treatment	Polished	Glazed
ΔL	-0.500±0.442	-0.421±0.381
Δa	0.024±0.155	-0.013±0.073
Δb	0.599±0.168	0.536±0.117
ΔE	0.899±0.166	0.766±0.167

Table 2. Difference in ΔL, ΔE, ΔA and ΔB between the polished and glazed groups

Parameter	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ΔL	0.674	-0.07900	0.18481
Δa	0.506	0.03700	0.05457
Δb	0.346	0.06300	0.06506
ΔE	0.092	0.13300	0.07481

Table 3. Frequency of NBS units based on the type of surface treatment

Surface treatment/NBS	0.5-1.5	1.5-3
Polished	80%	20%
Glazed	90%	10%

negative in the glazed group, which means the samples became more green. On the other hand, ΔL shifted towards the negative in both groups, which indicates darkening and changes in Δb parameter were slightly towards yellowness.

Atay et al. [12] evaluated VMK feldspathic porcelain in over-glazed and polished groups. They subjected the samples to accelerated aging for 150 and 300 hours and reported that ΔE of over-glazed group was less than that of polished group. But both groups had clinically acceptable color change. Their findings were in agreement with ours. However, ΔE values in their study were smaller than the values in our study, which may be attributed to different storage conditions and duration of storage of samples. Lee et al. [13] compared polished and glazed porcelain. They subjected the samples to accelerated aging and after 100 hours, measured the color parameters using a spectrophotometer. They reported that color change was greater in the polished compared to the glazed group; however, this difference was not significant; which was similar to our findings. Changes in color in both groups were within the clinically acceptable range. Yilmaz et al. [14] evaluated polished and glazed Ceramco II

porcelain and reported a significant difference in color change between the two groups, which was in contrast to our findings. The difference between the results of the two studies may be attributed to different types of porcelains used and different methodologies since they immersed the samples in methylene blue and measured color parameters by a colorimeter, which has lower accuracy than spectrophotometry used in our study.

Samra et al. [15] evaluated the color change of glazed ceramic following immersion in coffee solution for one, seven and 15 days. They measured the color parameters and reported that ΔL shifted towards negative, which means darkening. This finding was similar to the shift noted in ΔL in our study. The Δa parameter shifted towards redness in their study, which was not similar to changes noted in Δa in our study. The Δb parameter in their study shifted towards blueness; whereas, in our study, the Δb parameter shifted towards yellowness. The direction of shift in ΔL values in their study was similar to our study but the magnitudes were different, which may be due to difference in solutions used since they immersed the samples in coffee while we immersed them in CHX.

In the current study, we converted the obtained color values to the ISCC-NBS units in order to relate the magnitude of color change recorded by the spectrophotometer to a clinical environment and this was a strength of our study. Comparison of glazing and polishing, which are two commonly used techniques, was another strength of this study. Also, color change was assessed using a spectrophotometer, which is the most reliable tool for this purpose and has been used in many previous studies [2,16]. Also, in our study, the examiner was blinded to the group allocation of samples and thus, there was no bias.

One limitation of this study was its in vitro design, which limits the generalization of results to the clinical setting. Polishing process was another limitation of our study because this process is performed by a technician, and expertise of the technician can affect the results. However, we tried to minimize this effect since all samples were polished by one calibrated operator.

In the current study the difference between the two groups was not significant. Repetition of tests in vivo and longer storage time may yield significant results [17]. Khaledi et al. [18] evaluated the effect of CHX on color stability of porcelain with three different surface treatments and concluded that polished porcelain specimens exhibited greater color change compared to the glazed porcelain specimens (P=0.001), which has been different from our findings. The difference between the results of the two studies can be attributed to different types of porcelains used and different durations of storage in chlorhexidine.

Hee-Kyung et al. [19] studied the effect of polishing and glazing on color and spectral distribution of monolithic zirconia and reported a significant difference in CIE b between the polished and glazed subgroups in each group. Color differences between the subgroups of polished and glazed were within the perceptibility threshold (ΔEab< 3.7) in most groups. Polishing and glazing both decreased the lightness, while glazing increased the yellowness of monolithic zirconia, which was different from our results. Different types of porcelains and methods used may explain the difference in the results.

Also, it should be noted that polishing highly depends on the patience and precision of the operator. Moreover, type and quality of polishing kits can affect the results. Future studies are required to assess the effect of longer storage times and different polishing kits and glazing procedures on color change of different types of dental porcelains.

Conclusion

Both polishing and glazing confer optimal color stability to dental porcelain within the clinically acceptable range.

References

1. Douglas RD. Color stability of new generation indirect resins for prosthodontic application. J Prosthet Dent. 2000 Feb;83(2):166-70.

2. Singh K, Suvarna S, Agnihotri Y, Sahoo S, Kumar P. Color stability of aesthetic restorative materials after exposure to commonly consumed beverages: A systematic review of literature. Eur J Prosthodont. 2014 Jan;2(1):15-22.

3. Koksal T, Dikbas I. Color stability of different denture teeth materials against various staining

agents. Dent Mater J. 2008 Jan;27(1):139-44.
4. Gordan VV, Riley JL 3rd, Geraldeli S, Rindal DB, Qvist V, Fellows JL, et al. Repair or replacement of defective restorations by dentists in The Dental Practice-Based Research Network. J Am Dent Assoc. 2012 Jun;143(6):593-601.
5. Gupta R, Prakash H, Shah N, Jain V. Spectrophotometric evaluation of color changes of various tooth colored veneering materials after exposure to commonly consumed beverages. J Indian Prosthodont Soc 2005 Apr;5(2):72-78.
6. Edge MJ, Wagner WC. Surface cracking identified in polished and self-glazed dental porcelain. J Prosthodont. 1994 Sep;3(3):130-3.
7. al-Wahadni A, Martin DM. Glazing and finishing dental porcelain: a literature review. J Can Dent Assoc. 1998 Sep;64(8):580-3.
8. Manjuran NG, Sreelal T. An in vitro study to identify a ceramic polishing protocol effecting smoothness superior to glazed surface. J Indian Prosthodont Soc. 2014 Sep;14(3):219-27.
9. Patterson CJ, McLundie AC, Stirrups DR, Taylor WG. Refinishing of porcelain by using a refinishing kit. J Prosthet Dent. 1991 Mar; 65(3): 383-8.
10. Wright MD, Masri R, Driscoll CF, Romberg E, Thompson GA, Runyan DA. Comparison of three systems for the polishing of an ultra-low fusing dental porcelain. J Prosthet Dent. 2004 Nov;92(5): 486-90.
11. Kara HB, Aykent F, Ozturk B. The effect of bleaching agents on the color stability of ceromer and porcelain restorative materials in vitro. Oper Dent. 2013 Jan-Feb;38(1):E1-8.
12. Atay A, Oruç S, Ozen J, Sipahi C. Effect of accelerated aging on the color stability of feldspathic ceramic treated with various surface treatments. Quintessence Int. 2008 Jul-Aug;39(7): 603-9.
13. Lee YK, El Zawahry M, Noaman KM, Powers JM. Effect of mouthwash and accelerated aging on the color stability of esthetic restorative materials. Am J Dent. 2000 Jun;13(3):159-61.
14. Yilmaz C, Korkmaz T, Demirköprülü H, Ergün G, Ozkan Y. Color stability of glazed and polished dental porcelains. J Prosthodont. 2008 Jan;17(1): 20-4.
15. Samra AP, Pereira SK, Delgado LC, Borges CP. Color stability evaluation of aesthetic restorative materials. Braz Oral Res. 2008 Jul-Sep; 22(3): 205-10.
16. Jain C, Bhargava A, Gupta S, Rath R, Nagpal A, Kumar P. Spectrophotometric evaluation of the color changes of different feldspathic porcelains after exposure to commonly consumed beverages. Eur J Dent. 2013 Apr;7(2):172-80.
17. Atay A, Karayazgan B, Ozkan Y, Akyil MS. Effect of colored beverages on the color stability of feldspathic porcelain subjected to various surface treatments. Quintessence Int. 2009 Jul-Aug; 40(7): e41-8.
18. Khaledi AA, Safari A, Adibi A, Adibi S. The effect of chlorhexidine mouth rinse on the colour stability of porcelain with three different surface treatments: An in vitro study. J Dent Biomater. 2014 Jun;1(1):3-8.
19. Kim HK, Kim SH, Lee JB, Han JS, Yeo IS. Effect of polishing and glazing on the color and spectral distribution of monolithic zirconia. J Adv Prosthodont. 2013 Aug;5(3):296-304.