



Journal of Medical Sciences

ISSN 1682-4474

science
alert

ANSI*net*
an open access publisher
<http://ansinet.com>

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued eight times per year on paper and in electronic format.

For further information about this article or if you need reprints, please contact:

J. Ghanbarzadeh
Department of Prosthodontics,
Faculty of Dentistry and Dental
Research Center,
Mashhad University of Medical
Sciences,
Post Code 91735, P.O. Box 984,
Vakilabad Blvd, Mashhad, Iran

J. Med. Sci., 8 (1): 77-80
1st January, 2008

The Influence of Repeated Firing on Color Stability of Two Porcelain Types

¹J. Ghanbarzadeh, ¹M.R. Sabooni and ²N. Amiri Tehrani

The aim of this study was to evaluate the effect of repeated firings on the color stability of Vita VMK95 and Ivoclar IPS classic metal ceramic porcelain systems using a colorimetric. In this experimental *in vitro* study, 24 disc-shaped specimens, 10 mm in diameter with a 0.3 mm base metal alloy (Supercast) thickness were prepared and two types of porcelains, a 0.2 mm opaque and a one millimeter dentine porcelain (Shade A3) thickness, were applied on them. Samples were fired one, three and six times. Color measurement was carried out after each firing using a colorimeter (Minolta, CR-10) and data were expressed in Commission Internationale l'Eclairage (CIE-LAB) system coordinates. In this study, the parametric paired t-test was used to analyze the data. After six times of firing the L*, a* and b* parameters were significantly different, before and after aging, for Vita VMK95 (respectively p = 0.043, p = 0.002, p<0.001); however for Ivoclar IPS classic, only a* parameter was significant difference before and after aging (p<0.001). After repeated firing, color stability of Ivoclar IPS classic was better than Vita VMK95 porcelain.

Key words: Repeated firing, color stability, porcelain

¹Department of Prosthodontics, Faculty of Dentistry,
The Center of Mashhad Dental Research,
Mashhad University of Medical Sciences, Mashhad, Iran
²Department of Pedodontics, Faculty of Dentistry,
Zahedan University of Medical Sciences, Zahedan, Iran

INTRODUCTION

Color matching between ceramic restorations and natural teeth has been a major challenge in dentistry. A dentist is commonly satisfied with the selection of shade; however, the completed restoration frequently does not match the shade guide (Uludag *et al.*, 2007). Several factors affecting the color match, such as translucency, opalescence, fluorescence, surface texture and shape. Dentin constitutes the bulk of a tooth and is largely responsible for its color (Craig *et al.*, 2004; Powers and Sakaguchi, 2006). The color in a natural tooth occurs from the light directly reflected from the dentin which has already experienced some internal reflection (Uludag *et al.*, 2007). The popularity of metal-ceramic restorations is largely due to the predictable strength achieved with reasonable esthetics. The esthetic appearance of a metal ceramic restoration is related to the margin design, the alloy used and the skill of the ceramist (Rosentiel *et al.*, 2006). Color stability of a porcelain powder under firing cycles, additional to its suitable physical characteristics, has an important role in the esthetic of metal ceramic crown (Uludag *et al.*, 2007).

In the study of Rosentiel and Johnston (1988), the effect of some parameters such as; firing temperature, condensation technique, liquid modeling on the color stability of metal ceramic restoration have been measured. According to this study, restorations conducted from different kinds of porcelain showed significant color difference, while parameters such as firing temperature and condensation technique have little impact on the color of porcelain.

In O'Brien *et al.* (1991) study which was on four different porcelain types, the mean color difference was reported to be one ($\Delta E = 1$) after six time of firing compared to three times firing. According to Baumann and Schiffered (1994), a suitable shade selection in a beauty restoration considered as an important step in dentistry treatment. In this study on three porcelains including Bio bond, Sinter porcelain II and Glass porcelain Dicor, the brightness (L^*) porcelain didn't change under the influence of Glaze, which red-green (a^*) value appeared redder and blue-yellow (b^*) value appeared bluer.

Douglas and Przybylska (1999) tried to predict the dentin ceramic thickness to get the desirable color for Vintage and VMK 95 porcelain. They were reported that the thickness of ceramic in less or equal 2 mm in all the porcelain systems has better color match than those of metal ceramic system. Wu and Zhou (2004) investigated the effect of repeated firing on the color of titanium bonded porcelain. The results of this study revealed that in the Dentsply Detrey Ti bond porcelain there were

substantial changes only in a a^* value among color parameters after ten times of firing. It also showed that shade variability in all samples after repeated firings was always less than one ($\Delta E < 1$); therefore, repeated firing does not have any effect on the color stability on titanium bonded porcelain.

The main objective of this study was to evaluate the effect of repeated firings on the color of Vita VMK 95 and Ivoclar IPS Classic in metal ceramic restorations using a colorimeter.

MATERIALS AND METHODS

This study was conducted at the Center of Mashhad Dental Research of Mashhad University of Medical Science in 2005. In this experimental *in vitro* study, two porcelains of Vita VMK95 and Ivoclar IPS Classic from ceramometal porcelain group were used. All the samples were of shade A3 (Douglas and Przybylska, 1999). Almost 65% of chosen colors in clinical trials are in color group A3. In order to prepare the samples, metal disks were used to apply the porcelain on top of porcelain. By using 0.5 mm thickness wax sheets (Crop dental casting in plate), ring-shape specimens with 10 mm diameter were prepared. Begovest B gypsum was used for investing. After burning out the samples, casting was done using Supercast base-metal alloy. After gradual cooling of cylinders in the room temperature, samples were cleaned by sandblast and their surface was flattened by stone mullets. Three reference points were prepared at the back of each disk for the measuring the thickness with 1.2 round bur. After coding and preparing the final samples, their thicknesses were measured by gauge. Thickness of each disk was measured twice, once in opaque and then in dentin firing. The porcelain firing procedures were carried out according manufacturer's instructions.

After degazing, opaque was baked in two steps. In the first step a very thin layer (wash) and in the second step the complete masking of the color of the metal by opaque were performed. The furnace temperature was different for two different type of porcelain. After the second process, the thickness of the sample was measured and the thickness of opaque was reduced to level of 0.2 mm. Applying dentin with brush technique was performed too. According to the importance of the number of firings in this study, they prepared dentin in a much higher thickness that it was needed and to get the thickness of 1.5 mm of dentin. The thickness of each sample decreased using diamond burs. Twelve samples were made of each porcelain type.

Color measurement of each sample was carried out using a colorimeter machine (Minolta, CR-10) and data

were expressed in Commission Internationale l'Eclairage (CIE-LAB) system. After the first color evaluation, the samples were fired in the furnace for three more times. The furnace temperature in all the other firing cycles was adjusted according to Vita and Ivoclar porcelain correction temperature as well as temperatures recommended by the manufacture. After three times of firing, the color test was done under the same condition as before.

Finally the samples were placed in the furnace for three additional firings under the previous condition and then their color was measured. The collected results from experiment including L*, a* and b* were analyzed using statistical paired t-test.

RESULTS

To evaluate the result after and before the firing, paired t-test was applied. In this test, the mean of L*, a* and b* after the third and sixth firing cycles were compared to the same parameters after the first cycle (Table 1, 2).

According to the results, for Vita VMK95 porcelain the amount of L* only after the sixth firing was significantly different (p = 0.043). While for a*, the difference between the first and the third firing (p = 0.021) and the difference between the first and the sixth firing (p = 0.002) were significantly different. For b* parameter, there was a statistical difference in the first and the third firing (p = 0.015) and also between the first and the sixth firing (p<0.001).

Table 2 shows the results of paired t-test for Ivoclar IPS Classic porcelain. In Ivoclar IPS Classic porcelain L* and a* values did not show any significant difference during the repeated firing, but b* value showed a significant difference between the first and sixth firing cycles (p<0.001).

To evaluate the color difference as a function of the repeated firing cycles, the mean color difference (ΔE) was measured on every samples after each firing cycles. Therefore a color difference between the first and third firing (ΔE 1-3) as well as the color difference between the first and the sixth firing were notified.

Table 3 shows the mean color difference (ΔE) for two porcelains used in this study. The paired t-test indicated that ΔE 1-6 were more than ΔE 1-3 in both porcelains. The paired t-test with independent samples showed that ΔE 1-3 in Vita VMK95 porcelain was bigger than ΔE 1-3 in Ivoclar IPS Classic porcelain; but the mean color difference between the first and the sixth firing (ΔE 1-6) did not have any statistical difference between two porcelains.

DISCUSSION

One of the common errors by dental technicians is repeated firing due to the errors during what to achieve a suitable form and pattern in metal-ceramic crowns. Mclean called this error the most common error by technicians. Increase in the number of firings may increase the danger of devitrification (Uludag *et al.*, 2007). Paired t-test indicated that the color difference in Vita VMK95

Table 1: The comparison of the mean of L*, a* and b* after repeated firing for Vita VMK95 porcelain

Values	Firing time			Paired t-test	
	Mean±SD after the first firing	Mean±SD after the third firing	Mean±SD after the sixth firing	Between the first and the third firing	Between the first and the sixth firing
L*	72.41±1.23	72.79±1.08	73.15±1.30	0.203	0.043 [#]
a*	1.22±0.95	0.40±1.06	0.12±1.01	0.021 [#]	0.002 [#]
b*	12.94±1.30	11.79±1.03	10.54±1.10	0.015 [#]	<0.001 [#]

[#]: Significant

Table 2: The comparison of the mean of L*, a* and b* after repeated firing for Ivoclar IPS classic porcelain

Values	Firing time			Paired t-test	
	Mean±SD after the first firing	Mean±SD after the third firing	Mean±SD after the sixth firing	Between the first and the third firing	Between the first and the sixth firing
L*	70.27±0.96	70.55±0.91	70.67±1.00	0.432	0.319
a*	0.70±0.54	0.39±0.74	0.41±0.74	0.181	0.150
b*	12.12±0.91	11.96±0.98	10.46±1.16	0.603	<0.001 [#]

[#]: Significant

Table 3: The mean color difference (ΔE) for two porcelains

Porcelain	ΔE		Paired t-test p-value
	ΔE 1-3 Mean±SD	ΔE 1-6 Mean±SD	
Vita VMK95	2.72±1.03	3.26±1.74	0.056
Ivoclar IPS classic	1.95±1.00	2.51±1.08	0.033 [#]
Independent t-test p-value	0.031 [#]	0.066	

[#]: Significant

porcelain in all the L*, a* and b* values were significant, but in Ivoclar IPS Classic porcelain this difference just in b* value was significant. The increase and decrease of these values (L*, a* and b*) in both porcelains were the same but the amount of this changes was higher in Vita VMK95 than in Ivoclar IPS Classic.

The study of Uludag *et al.* (2007) investigated the effects of repeated firing of In-Ceram and IPS Empress porcelains on the color of full porcelain crowns and concluded that an increase in the number of repeated firing resulted in a change in color parameters of L*, a* and b*.

In the present study, investigation on color parameters from colorimeter machine indicates that an increase in the number of firing (in both of two porcelains) results in an appreciable increase in L* parameter and decrease in a*. Two changes were remarkable during the first 3 firing in Vita VMK95 porcelain and resulted in greener color have. b* value decreases as a result after repeated firing and the samples were bluer than yellow. Cho *et al.* (2006) in a study on Vita Omega 900 indicated that translucency and the color of restorations after surface staining and repeated firings have substantial differences, but chroma did not have any substantial changes.

The comparison of color difference in the present study shows that the mean color difference (ΔE) in Ivoclar IPS Classic porcelain is less than Vita VMK95 (Table 3). According to this comparison, it can be seen that the color difference (ΔE) in Vita VMK95 only after 6 times of goes beyond our expectation ($\Delta E.2.7$). it is necessary to mention, that the Ivoclar's manufacture claims that no devitrification would happen on IPS Classic products even after repeated firing. The results of this study, using Paired t-test (Table 2), verifies the manufacture's success in this subject. Although with the increase of the number of firings, the mean of color difference (ΔE) increases from 1.9, after three firings, to 2.51 in the sixth firing, totally Ivoclar IPS Classic porcelain shows higher color stability during the repeated firings compared to Vita VMK95 porcelain.

The colorimeter machine used in this study was able to show the minimum changes. In this study, by stabilizing and balancing the color area on the samples it was tried to minimize the errors during the colorimetric measurements besides of decrease the effect of surrounding's light on the color. This experiment was held under the stable light and in special hours of day light.

CONCLUSION

In the limitation of this study, it has been shown that:

- An increase in the number of firings, increased the value and the hue appears greener and bluer after repeated firings.
- Color changes are higher in Vita VMK95 than in Ivoclar IPS Classic porcelain, so Ivoclar IPS Classic porcelain has higher color stability.

REFERENCES

- Baumarn, M.A. and E.B. Schiffered, 1994. Color determination in dental ceramics. *Schweiz-Monatsschr-Zahnmed*, 104 (4): 423-429.
- Cho, M.S., Y.K. Lee, B.S. Lim and Y.J. Lim, 2006. Changes in optical properties of enamel porcelain after repeated external staining. *J. Prosthet. Dent.*, 95 (6): 437-443.
- Craig, R.G., J.M. Powers and J.C. Wataha, 2004. *Dental Materials Properties and Manipulations*. 8th Edn. Mosby Co, China, pp: 299-303.
- Douglas, R.D. and M. Przybylska, 1999. Predicting porcelain thickness required for dental shade matches. *J. Prosthet. Dent.*, 82 (2): 143-149.
- O'Brien, W.J., K.S. Kay, K. Benke and C.L. Groh, 1991. Sources of color variation on firing porcelain. *Dent. Mater.*, 7 (3): 170-173.
- Powers, J.M. and R.L. Sakaguchi, 2006. *Craig's Restorative Dental Materials*. 12th Edn. St. Louis: Mosby Elsevier, pp: 446-451.
- Rosenstiel, S.F. and W.M. Johnston, 1988. The effects of manipulative variables on the color of ceramic metal restorations. *J. Prosthet. Dent.*, 60 (3): 297-303.
- Rosentiel, S.F., M.F. Land and J. Fujimoto, 2006. *Contemporary Fixed Prosthodontics*. 4th Edn. St. Louis: Mosby, pp: 740-773.
- Uludag, B., A. Usumez, V. Sahin, K. Eser and E. Ercoban, 2007. The effect of ceramic thickness and number of firings on the color of ceramic systems: An *in vitro* study. *J. Prosthet. Dent.*, 97 (1): 25-31.
- Wu, X.M. and Z. Zhou, 2004. Color stability of porcelain-fused-to-titanium restorations after repeated firings. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao*, 26 (4): 423-425.