

Effect of Chemical Corrosion on Color Change of Veneering Ceramics

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ABSTRACT

Objectives: To compare the effect of chemical corrosion on color change of different veneering ceramics of auto glazed and polished surfaces.

Materials and Methods: Twenty ceramic disks (8x2mm) were fabricated from A2 shaded veneering ceramics (e-max Ceram, Zirkozahn, Noritake CerabienZR, Vita VM13, Finesse) in a special mold and divided into 2 groups of auto glaze and mechanical polishing (n=10). The specimens were subjected to in vitro corrosion (pH4,5-pH7-pH9 in water at 37 ± 2°C for 18h and 4% acetic acid solution pH=2,4 at 80 ± 2°C for 18h). Color measurements were made according to the CIE L*a*b* system before and after corrosion tests. The data were statistically analyzed by ANOVA and TukeyHSD test ($\alpha=0.05$). Multiple comparisons between pH groups of each ceramic were computed by t-test.

Results: The results of the ANOVA indicate that the surface finishing techniques effected the color change ($p<.005$). Polished groups showed significantly higher ΔE values than auto glazed groups especially at pH 2,4. Surface techniques significantly affected the color parameters of ceramics ($p<.005$). ΔE values of different ceramic groups were not significantly affected by pH changes in the same group ($p>.005$).

Conclusion: Color of ceramic material could be changed depending on surface finishing methods and abrasiveness of chemical medium. The rate of color change also depends on the brand of ceramic material.

Keywords: Chemical corrosion, Veneering, Color

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INTRODUCTION

All-ceramic restorations, having no metal substructure, allow superior translucency and can be used in areas of high esthetic demand since the metal and opaque porcelain, restrict potential use of porcelain fused to metal restorations. A challenge in the success of these restorations is color assessment and reproducibility since color has become the most important determinant of dental esthetics. Surface characteristics may affect the color change and surface roughness of ceramic material. Glazing and surface finishing methods not only affect the surface roughness of restorative material but also affect the outcome of restoration color and the production of

an acceptable color match. After the adjustment of glazed porcelain surfaces, the surfaces are roughened and must be deglazed or polished with different porcelain polishing systems to improve the esthetic appearance and strength of the porcelain restorations [1]. A smooth surface texture is important for the color of the restoration, since a smooth surface will reflect a greater amount of light than a rough surface [2,3]. Besides the surface finishing methods, differences in the composition, microstructure and environmental conditions will also affect the degree of corrosion degradation, surface roughness and color in an aqueous environment [4]. The aqueous environment of the mouth may lead to degradation of dental ceramics when they are exposed to aqueous solutions or erosive agents [5,6]. This, occurs as a result of leaching of alkaline ions [7,8]. Consequences of ceramic degradation include coarseness of the exposed surface, resulting plaque accumulation, promotion of wear to the antagonist teeth or restorative materials, and change in the color of dental porcelains, thereby compromising the esthetic appearance of ceramic restorations [9]. The consumption of acidic food and sour fruits and drinks results in dental erosion [10,11]. However, the effect of acidic foods and

sour fruits and drinks on ceramic restorations has not been well documented. A rough or irregular texture surface will reflect an irregular and diffuse pattern of light, which will modify the color of the restoration [11]. Color change (ΔE) mathematically expresses the amount of difference between the Commission Internationale de l'Eclairage (CIE) $L^*a^*b^*$ coordinates of different specimens or the same specimen at different instances [12]. The human eye has a limited capability to perceive color differences. It cannot perceive ΔE values less than 1 [13]. ΔE values between 1 and 3.3 represent a perceptible and clinically acceptable range. ΔE values of 3.3 and higher are reported to be unacceptable under clinical conditions [14]. A ΔE value of 3.3 has been used as the upper limit in several studies concerning the perceptibility of color differences [15]. Kim et al. [16] stated that surface topography influenced the color of porcelain, especially the CIE L^* value. Although glazed surfaces appeared whiter, the CIE L^* value measured with the specular component excluded (SCE) geometry was lower than that of polished surfaces. Also, it was reported that after glazing, the CIE a^* and b^* values of the porcelain increased.

The aim of this study was to compare the effect of surface finishing methods and chemical corrosion on color of different veneering ceramics.

MATERIALS AND METHODS

40 ceramic disks (8 mm in diameter and 2 mm in height) were fabricated from Zirkozahn, Noritake Cerabien ZR, e-max Ceram, Vita VM13 and Finesse veneering ceramics. Ceramic powder was mixed with a brush on a glass plate. The mold was filled with the mixture and condensed. Excess liquid was removed by a piece of adsorbent paper. The mold was removed after condensation leaving the non-sintered test specimen on

the firing tray. All specimens were sintered in a calibrated oven according to the manufacturer's protocol by the same experienced dental technician. Test surfaces were ground using 1000 SiC paper on a rotating disc at 150 rev/min. Test specimens were ultrasonically cleaned in distilled water and divided in two groups of auto glaze and polishing (n=20). Autoglaze was applied according to the manufacturer's instructions. Polishing was applied with a slow-speed hand piece rotating at approximately 10,000 rpm. Mechanical polishing was applied with Shofu All Ceramic Finishing and Polishing wheels by using a slow-speed hand piece rotating at approximately 10,000 rpm as recommended by the manufacturer.

The specimens were then ultrasonically cleaned with distilled water and dried with a blast of air for 30 seconds before color measurements. Color parameters (L^*,a^*,b^*) were measured using a dental spectrophotometer according to the CIE $L^*a^*b^*$ color system. Following first color measurements, specimens were subjected to corrosion procedure at different pH and temperatures. In the water corrosion experiments, the specimens were placed in the shaking equipment and exposed to gentle rocking for 18 hours at 37°C in solutions with pH values of 4.5-7 and 9. In the acid corrosion experiments, we modified the conditions of ISO Standard 6872 [17]. According to the standard, all specimens were momentarily exposed to 4% acetic acid at 80°C, and corrosion solution temperature was gradually increased to 80°C for reducing the risk of surface micro crack formation. A single ceramic specimen and 17 mL of corrosive medium were added to each of the polyethylene corrosion bottles, and the bottles were sealed with a screw cap. The bottles were then placed in an oven, and the temperature was increased until reaching the final temperatures of 37°C and 80°C. To avoid a steady-state situation at the surface of the test specimens, we subjected them to gentle rocking during

Table 1: One-way ANOVA results for comparison of ΔE values.

	Sum of squares	df	Mean square	F P
Between groups	47.2	6	7.1	445. .001
Within groups	1.2	61	0.01	
Total	48.4	67		

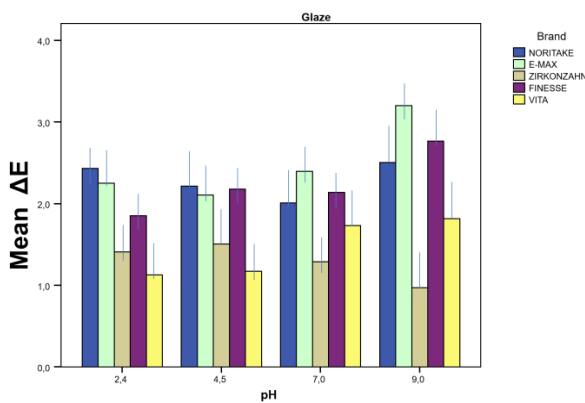


Figure 1: Mean ΔE values and standard deviations of auto glazed groups.

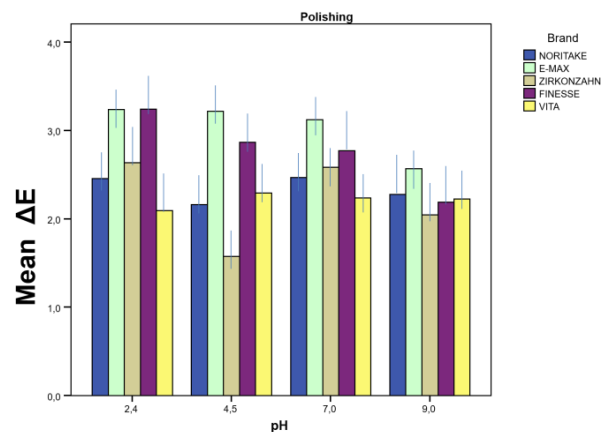


Figure 2: Mean ΔE values and standard deviations of polished groups.

the entire corrosion process in the oven.6 after cooling to room temperature, the specimens were removed from the bottles, rinsed in distilled water, dried, and a new color analysis was performed. The data were statistically analyzed by ANOVA and Tukey HSD test $\alpha = .05$. Multiple comparisons between pH groups of each ceramic were computed by t-test.

RESULTS AND DISCUSSION

The mean ΔE values and SDs of the auto glazed and polished groups are presented in Figure 1 and Figure 2 respectively. ΔE values ranged from 1.03 to 3.36. The results of ANOVA [Table 1] indicate that the surface finishing techniques effected the color change [$P < .001$]. Polished groups showed significantly higher ΔE values than auto glazed groups especially at pH 2,4. Lowest ΔE was calculated for glazed Zirkonzahn and highest ΔE was for polished E-max groups. ΔE values of different ceramic groups were not significantly affected by pH changes in the same group [$p > .005$].

Color stability is considered the most clinical significant property for all dental materials because color changes refer to aging or damaging of the restorative materials. The results of this study represent that surface layer obtained by different finishing methods effects the color durability rather than pH changes, since same surface textures showed insignificant changes at various pH degrees. On the other hand, higher ΔE changes of polishing groups may be an indicator of decreased durability of materials.

Change in the color of dental porcelains compromise the esthetic appearance of porcelain restorations resulting plaque accumulation and threatening wear to the antagonist teeth. The consumption of acidic food and drinks results in dental erosion. The erosive effect of the foods and drinks on enamel occurs by the dissolution of apatite crystals. However, the effect of acidic foods, fruits and drinks on porcelain restorations has not been well documented. In the present study, pH value of acetic acid (2.4) represents a clinically realistic value because low pH values have been recorded in sub plaque areas and in common beverages such as carbonated soft drinks (pH 2.5), citrus juice (pH 3.3), and coffee (pH 4.8). Although acetic acid has been found to be a weak organic acid, it was still fairly corrosive to glass, that can be clearly seen on polished samples of this study causing higher ΔE values for all ceramic brands. Autoglaze groups creating a glass rich superficial layer have higher color durability against all pH values.

In this *in vitro* study, the most significant finding was that all types of ceramics could show color changes in acidic agents. However, there were some limitations to this study. This study did not account for the role of

saliva. The effect of acidic food or drinks will be reduced because of dilution effects and through the action of buffering systems. The oral cavity presents a more complex testing environment.

CONCLUSION

Color parameters of ceramic material could be changed depending on surface finishing methods and abrasiveness of chemical medium. The rate of color change also depends on the brand of ceramic material. Different ceramic materials were differently affected by the corrosive solution. Ceramics are known to be durable and inert but oral conditions have great effect on their survival.

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