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Original research

EFFECT OF SURFACE FINISHING METHODS AND AGING ON SURFACE ROUGHNESS AND OPTICAL PROPERTIES OF ZIRCONIA-REINFORCED LITHIUM SILICATE GLASS-CERAMIC

*Gülce Alp
Gülce M. Subaşı

ORCID IDs of the authors:
0000-0003-1751-9207
0000-0002-2510-9745

[1] Department of Prosthetic Dentistry, Faculty of Dentistry, Istanbul Okan University, İstanbul Turkey.
[2] Department of Prosthetic Dentistry, Faculty of Dentistry, Kütahya Sağlık Bilimleri University, Kütahya, Turkey.

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ABSTRACT

Objectives: The effects of three different surface finishing methods and aging on the surface roughness and optical properties of zirconia-reinforced lithium silicate (ZLS) glass-ceramic were investigated.

Materials and Methods: Rectangular specimens (0.6 mm thickness) were sliced from ZLS blocks (N=36). Three different types of surface finishing [glazing combined with crystallization (ZLS-CF) or after crystallization (ZLS-G) and polishing (ZLS-P)] (n=12) and 5000 thermocycles were applied. Three sets of measurements were performed before and after aging to determine the color coordinates and surface roughness (Ra) by using a colorimeter and profilometer, respectively. The mean surface roughness (Ra) values were calculated. Color differences and translucency parameter (TP) values were calculated using the color difference ΔE_{ab} and TP formulas. One-way ANOVA was used to analyze the color difference, translucency, and surface roughness values (α=.05).

Results: Significant differences in the ΔE values were not observed (p=.736) for specimens with different types of surface finishing. A significant difference was observed between the translucency values for different surface finishing groups before aging (p<.001). A significant difference in the surface roughness data between samples with different kinds of surface finishing was observed both before and after aging (p<.001). The ZLS-P group exhibited lowest surface roughness values before and after aging (p<.001). A positive significant correlation between the ΔE and translucency change values was observed in both the ZLS-G (p=.005) and ZLS-P (p<.001) groups.

Conclusions: The surface finishing type did not affect the color change of ZLS glass-ceramic. The translucency values for different surface finished ZLS glass-ceramic specimens changed before aging. After aging, the surface finishing did not affect the translucency of ZLS glass-ceramic. All tested groups exhibited surface roughness values higher than the plaque accumulation threshold (Ra=0.2 mm).

Keywords: Ceramics, color, surface properties

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***Corresponding Author**
Istanbul Okan Üniversitesi Diş Hekimliği Fakültesi Protetik Diş Tedavisi ABD Tuzla Yerleşkesi, Akfirat Tuzla Istanbul, Turkey.
Phone: +90 505 4538813 **E-mail:** gulce165@hotmail.com

INTRODUCTION

Clinical selection of appropriate restoration material is essential for ensuring clinical success.[1] Monolithic computer-aided design and computer-aided manufacturing (CAD-CAM) materials are presented to satisfy demand for esthetically acceptable restorations with better optical and physical properties.[2-4] Zirconia, glass ceramics (feldspathic, lithium disilicate, and zirconia-reinforced lithium silicate), and ceramic/glass polymer materials are some monolithic CAD-CAM materials that are currently available.[4]

Among these materials, zirconia-reinforced lithium silicate glass-ceramic (ZLS) was introduced as a novel monolithic CAD-CAM material for the construction of crowns, implant suprastructures, inlays, and onlays.[5-7] Currently, two different ZLS glass-ceramics (VITA Suprinity PC and Celtra Duo) are available with different sizes of lithium metasilicate crystals.[8] Both of these ZLS glass-ceramics claimed to combine the optical properties of glass ceramics (56-64% silica content) and mechanical properties of zirconia (8-14% zirconia content).[5,8,9] These materials have a fine-grained (0.5-0.7 μm)[5] and uniform microstructure[10] with characteristic needle-shaped crystals.[11] The crystal phase content of ZLS glass-ceramics (40–50%) is lower than that in lithium disilicate glass ceramic (70%).[12,13] In addition, these materials have optical and physical properties that are comparable to those of lithium disilicate[12,13] and fulfill the esthetic requirements through their enhanced translucency and different shade options.[11]

The roughness, smoothness and surface quality of a restoration material is important for ensuring a desired esthetic appearance and long-term clinical succes[14,15] because rough surfaces have an impact on discoloration[16], shade matching[17], plaque accumulation, wear against opposite restoration materials or teeth,[18] and the tactile perception of the patient.[19] Well-finished surfaces were reported to cause fewer technical and esthetic problems by providing the material with tougher, glossier, and more stable translucency[3] and color.[20,21] In addition, the light reflects and diffuses from an irregular and rough surface, which alters the restoration color.[22] The surface roughness of the restoration materials is affected by different factors and conditions.[17,18] A clinically acceptable Ra threshold for prostheses was reported to be 0.2 μm.[23] Excessive microbial adhesion and plaque formation occur when Ra>0.2 μm.[23]

Optical characteristics like color stability, translucency, and opalescence must be considered during the selection of materials for maintaining esthetics.[6,24] The optical characteristics of restoration materials were reported to be affected by the material structure and surface texture, thickness, material and background shade, manufacturing technique, luting agent,[24,25] and aging.[26] Color changes throughout the functional lifetime negatively affect the survival and quality of restorations,[27] thus restoration materials must be stain resistant for long-term use.[15] Optimal translucency is also required for the restorations to provide a natural appearance and the desired esthetic outcome.[3,28] Knowledge of the translucency of restoration materials is clinically important, especially when rehabilitating discolored teeth.[28] Therefore, knowledge of the translucency and color stability of ZLS glass-ceramic is required in order to achieve clinical success.[3,28]

Restoration surfaces can be finished by using various glazing and polishing techniques.[15] Although manufacturers recommend different glazing procedures combined with crystallization or after crystallization and polishing for ZLS glass-ceramics, it is uncertain whether glazing combined with crystallization or after crystallization or polishing provide more appropriate color stability, translucency, and surface roughness. Therefore, this study aimed to evaluate the effects of three different surface finishing methods (glazing combined with crystallization or after crystallization and polishing) and aging on the surface roughness, color stability, and translucency of ZLS glass-ceramic. The first null hypothesis was that the type of surface finishing would not affect the color stability of ZLS glass-ceramic. The second null hypothesis was that the type of surface finishing, and aging would not affect the translucency of ZLS glass-ceramic. The third null hypothesis was that the type of surface finishing and aging would not affect the surface roughness of ZLS glass-ceramic.

MATERIALS AND METHODS

The color stability, translucency, and surface roughness values of zirconia-reinforced lithium silicate glass-ceramic (Vita Suprinity PC, VITA Zahnfabrik, Bad Sackingen, Germany) (ZLS) (Table 1) (N=36) were evaluated before and after aging.

Table 1. Materials used

Material	Code	Manufacturer	Lot No.
VITA Suprinity PC	ZLS	VITA Zahnfabrik, Bad Sackingen, Germany	36851
VITA AKZENT Plus GLAZE LT	GLZ-P	VITA Zahnfabrik, Bad Sackingen, Germany	51800
VITA AKZENT Plus GLAZE LT SPRAY	GLZ-S	VITA Zahnfabrik, Bad Sackingen, Germany	E65960
VITA SUPRINITY Polishing Set Technical	POL	VITA Zahnfabrik, Bad Sackingen, Germany	E42530

ZLS: zirconia-reinforced lithium silicate glass-ceramic.

ZLS glass-ceramic blocks were sliced into rectangular specimens (0.6±0.03 mm in thickness) under water (Vari/cut VC-50, Leco Corporation, St Josephs, MI, USA). According to the manufacturer's advice, the specimens were cleaned (15 minutes) with distilled water (Sultan 600 ProSonic 600-MTH, Mexico) in an ultrasonic cleaning device and dried. The specimens were then separated in three surface finishing groups: Group 1: glazing combined with crystallization (ZLS-combination firing, ZLS-CF), Group 2: glazing after crystallization (ZLS-glazed, ZLS-G), and Group 3: polishing (ZLS-polished, ZLS-P). All surface finishing procedures were applied to the top surface of each specimen by the same operator (G.A.).

ZLS-CF group (n=12): Glaze spray (VITA AKZENT Plus GLAZE LT SPRAY, VITA Zahnfabrik, Bad Sackingen, Germany) was shaken thoroughly before being applied to each specimen and was sprayed on the top surface of the specimens at a distance of 10-15 cm as a single layer, according to the manufacturer's recommendations. Combination firing was subsequently performed (Programat P310, Ivoclar Vivadent AG, Liechtenstein, Austria) (840 °C, 8 minutes).

ZLS-G group (n=12): These specimens were fully crystallized (Programat P310, Ivoclar Vivadent AG, Liechtenstein, Austria) (840 °C, 8 minutes). After crystallization firing, glaze material (VITA AKZENT Plus Glaze LT powder, VITA Zahnfabrik, Bad Sackingen, Germany) was applied as a single thin layer and glaze firing was performed (800 °C, 60 seconds).

ZLS-P group (n=12): These specimens were fully crystallized (Programat P310, Ivoclar Vivadent AG, Liechtenstein, Austria) (840 °C, 8 minutes). The specimens were then manually polished with a handpiece at slow-speed using recommended 2-stage (pink and gray) diamond-coated laboratory polishing burs (VITA Suprinity Polishing Set Technical, VITA Zahnfabrik, Bad Sackingen, Germany). First, the specimens were pre-polished with a pink assortment (10000 rpm) and then polished with a gray assortment (7000 rpm) to produce higher gloss. All polishing assortments were handled in one direction under mild force.

A caliper (Model number NB60; Mitutoyo American Corporation, Providence, RI, USA) was used to measure the ultimate thickness of each ZLS specimen. Afterwards, the specimens were kept in distilled water (37 °C) for 24 hours before measuring the baseline color and surface roughness. Baseline color measurements were gathered using the color parameters acquired from the CIELab (Commission Internationale De L'éclairage L*, a*, b*) color space relating to D65 CIE illumination and CIE Standard Human Observer (2°) with a colorimeter (Minolta CR 321, Konica Minolta, Tokyo, Japan).[29] L*, a*, and b* values were measured on two different backings. The CIE values were L*=19.74, a*=-0.78, and b*=0.11 on a black backing and the CIE values were L*=78.02, a*=-6.0, b*=-0.5) on a white backing for wavelengths ranging from 400 to 700 nm.[30] The colorimeter was calibrated before gathering measurements for each specimen (CIE L*=93.05, a*=-4.85, and b*=6.95), and the color measurements were gathered from the middle of each ZLS specimen. Measurements were repeated three times consecutively for each ZLS specimen, and the average L*, a*, and b* values were recorded.

The color difference (ΔE) for each ZLS specimen on the white backing after aging was calculated using the following CIELab formula:[29]

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

ΔL*, Δa*, and Δb* represent the difference in lightness or darkness, red-green axis, and yellow-blue axis, respectively.

The color difference values over a black and a white backing were used in the following equation to calculate the translucency parameter (TP):[31]

$$TP=[(L_B^*-L_W^*)^2 + (a_B^*-a_W^*)^2 + (b_B^*-b_W^*)^2]^{1/2}$$

B represented the color coordinates over a black backing and W represented the color coordinates over a white backing.

Ultrasonic cleaning was applied again (Sultan 600 ProSonic 600-MTH, Mexico) (10 minutes) before gathering surface roughness measurements. The surface roughness was measured 3 times for all specimens with a contact profilometer (Mitutoyo Surftest SV-2100, Mitutoyo Corporation, Minatoku, Japan) after calibration (5.5 mm tracing length, 0.8 mm cut-off length, and 1 mm/s stylus speed). The average Ra values were calculated.[32]

Following baseline color and surface roughness measurements, an aging procedure consisting of 5000 thermocycles was applied to all ZLS specimens (MTE-101, Moddental, Esetron Smart Robotecnologies, Ankara, Turkey; distilled water, 5 °C/55 °C, 30 seconds dwell duration, 10 seconds bath transfer duration).[6] Color, translucency, and surface roughness measurements were gathered again for all ZLS specimens after thermocycling.

The color difference, translucency, and surface roughness values were analyzed statistically (SPSS Statistics for Windows v17.0, IBM SPSS Statics, New York, USA). The color difference values, translucency, and surface roughness were analyzed using the one-way analysis of variance (ANOVA). Post-hoc analysis was computed with Tukey's honest significant difference (HSD) test. Correlations between color difference, translucency, and surface roughness values were computed using Spearman correlation analysis (α=.05).

RESULTS

According to the 1-way ANOVA results (Table 2), no statistically significant difference was observed between the ΔE values for two different surface finishing groups (p=.736).

Table 2. ΔE values for groups with different types of surface finishing

Group	Mean ±SD
ZLS-G	2.90 ±1.56^a
ZLS-P	3.04 ±1.45^a
ZLS-CF	3.43 ±2.01^a
P (1-way ANOVA)	.736

ZLS: zirconia-reinforced lithium silicate glass-ceramic, ZLS-G: ZLS-glazed, ZLS-P: ZLS-polished, ZLS-CF: ZLS-combination firing, SD: Standard deviation. Superscripts indicate that there is no significant difference between groups (*p*>.05) based on 1-way ANOVA results.

According to the 1-way ANOVA results (Table 3), there was a statistically significant difference between the translucency values for groups with different types of surface finishing before aging (p<.001), whereas there was no statistically significant difference between the translucency values for groups with different types of surface finishing after aging (p>.05).

Table 3. Translucency values for groups with different types of surface finishing

Group	Before aging Mean ±SD	After aging Mean ±SD	*p*[*]
ZLS-G	9.23 ±2.50$^{\mathbf{a1}}$	10.37 ±0.80$^{\mathbf{a1}}$	.182
ZLS-P	12.98 ±0.59$^{\mathbf{b1}}$	10.49 ±1.12$^{\mathbf{a2}}$	.002
ZLS-CF	7.83 ±1.45$^{\mathbf{a1}}$	11.55 ±2.54$^{\mathbf{a2}}$	.002
p (1-way ANOVA)	.000	.177	

ZLS: zirconia-reinforced lithium silicate glass-ceramic, ZLS-G: ZLS-glazed, ZLS-P: ZLS-polished, ZLS-CF: ZLS-combination firing, SD: Standard deviation. Different superscript numbers in the same row and different superscript letters in same column indicate significant differences between the surface finish values in these groups (*p*<.05) based on 1-way ANOVA results. [*]Wilcoxon test.

The ZLS-P group exhibited statistically significant higher translucency values than the ZLS-G and ZLS-CF groups (p<.001) before aging. The translucency values of the aged and unaged samples were compared; the ZLS-P group showed statistically lower translucency values after aging (p=.002), whereas the ZLS-CF group showed statistically significant higher translucency values after aging (p=.002).

According to the 1-way ANOVA results, a statistically significant difference between the surface roughness values for groups with different kinds of surface finishing was observed before and after aging (p<.001) (Table 4). The ZLS-P group exhibited statistically significant lower surface roughness values than the ZLS-G and ZLS-CF groups before and after aging (p<.001). Regarding surface roughness, the ZLS-G (p=.003) and ZLS-CF (p=.017) groups showed statistically significantly higher surface roughness values after aging.

Table 4. Surface roughness (µm) values for groups with different types of surface finishing

Group	Before aging Mean ±SD	After aging Mean ±SD	*p**
ZLS-G	0.78 ±0.16^{b1}	0.93 ±0.13^{b2}	.003
ZLS-P	0.27 ±0.08^{a1}	0.33 ±0.14^{a1}	.266
ZLS-CF	0.64 ±0.31^{b1}	0.73 ±0.34^{b2}	.017
p (1-way ANOVA)	.000	.000	

ZLS: zirconia-reinforced lithium silicate glass-ceramic, ZLS-G: ZLS-glazed, ZLS-P: ZLS-polished, ZLS-CF: ZLS-combination firing, SD: Standard deviation. Different superscript numbers in the same row and different superscript letters in same column indicate significant differences between the surface finish values in these groups (*p*<.05) based on 1-way ANOVA results. *Wilcoxon test.

With respect to the Spearman correlation analysis results, a positive significant correlation was observed between the ΔE and translucency change values (before and after aging) for the ZLS-glazed (p=.005) and ZLS-polished (p<.001) groups. No significant correlation was observed between the ΔE and roughness change values (before and after aging) and between the translucency (before and after aging) and roughness changes (before and after aging) in all groups (p>.05).

DISCUSSION

The first null hypothesis was accepted because the type of surface finishing (glazing combined with crystallization or after crystallization and polishing) had no significant effect on the color differences (p=.736). ZLS glass-ceramic contains 56%-64% glass content, which did not change after crystallization.[24] A possible explanation for not finding color differences is the color stability of the material with different types of surface finish, which can be attributed to the homogenous, fine crystalline structure of crystallized ZLS.[6]

The type of surface finishing affected the translucency values before aging (p<.001), and the ZLS-P group presented the highest translucency values (p<.001). The translucency values for the ZLS-P group significantly decreased after aging (p=.002), whereas the values for the ZLS-CF group significantly increased after aging (p=.002). Therefore, the second null hypothesis was rejected. In the ZLS-G (p=.005) and ZLS-P (p<.001) groups, a positive, statistically significant correlation between the ΔE and translucency change values (before and after aging) was observed. The difference in TP values due to glazing and polishing may be due to the glaze material and its application. Although controversial results were reported in the literature, the glaze material was reported to affect the TP and ΔE values.[15] In addition, the number of firings was reported to affect the TP and CIELab values.[33] In the present study, the specimens (except the ZLS-G group) were fired once. Although there was some difference in the number of firings, microstructure, grain size, and chemical composition among the glaze materials, no significant difference between the ZLS-CF and ZLS-G groups was observed in terms of the TP values before and after aging.

The type of surface finishing affected the surface roughness values before and after aging (p<.001). ZLS-P group presented the lowest surface roughness values before and after aging (p<.001). The surface roughness values of the ZLS-G (p=.003) and ZLS-CF (p=.017) groups significantly increased after aging. Therefore, the third null hypothesis was rejected.

Fully crystallized ZLS glass-ceramics can be cemented after milling and glazing or polishing, whereas pre-crystallized ZLS glass-ceramics require a further crystallization firing process combined with glazing, additional glazing, or polishing to reach its final esthetic and physical properties.[34] Studies reported in the literature investigated the surface characteristics and optical properties (glazing or polishing) of ZLS glass-ceramics.[6,11] However, data on the glazing efficiency with or without crystallization are limited.[6] Therefore, this study proposed that the effect of the combined firing process be evaluated.

Alp *et al.*[6] reported clinically acceptable color differences (<CIEDE2000 50% acceptability threshold, 1.8 units) for different surface-finished (glazing or polishing) ZLS glass-ceramics after coffee thermocycling. Kilinc and Turgut[15] also reported clinically acceptable color changes in ZLS glass-ceramics regardless of the type of surface finishing (control, manual polishing, or glazing). In parallel with these studies, the type of surface finishing did not affect the color change results in this study. The color change values were below the clinically acceptable limit for all groups (<3.7 ΔE units).[35] In addition, Kilinc and Turgut[15] reported that manual polishing techniques could produce similar results as glazing in terms of color stability, in parallel with the present study. In the light of these studies,[6,15] glazing combined with crystallization or after crystallization and polishing may be the surface finishing method of choice for ZLS glass-ceramics because all groups exhibited similar color changes.

Although translucency has clinical importance in the esthetics and natural appearance of restoration materials,[3,36] few studies have investigated TP values for ZLS glass-ceramic.[3] Sen *et al.*[28], Awad *et al.*[3], and Caprak *et al.*[37] evaluated the TP values for different CAD-CAM materials; Vita Suprinity (ZLS) showed the highest TP values in all of these studies. According to Awad *et al.*[3], better TP values for ZLS ceramic might be due to the high glass content that results from smaller silicate crystals in the lithium silicate glassy matrix.[3] Bahgat *et al.*[38] reported that the higher translucency of ZLS glass-ceramic might be due to its lower (0.5 μm) and more homogeneous crystalline structures (2 types). Riquieri *et al.*[34] also reported many differences in the microstructure of ZLS glass-ceramics before and after crystallization firing; zirconia grains decreased and nanocrystalline lithium metasilicate peaks (Li_2SiO_3) were more intense in X-ray diffraction after the crystallization firing process (CFP). Although microstructural differences in the ZLS glass-ceramic were not evaluated in the present study, the difference in TP values may be due to microstructural changes in the ZLS glass-ceramic and the glazing materials during firing. According to previously published research, the durability of glaze materials was suspected,[39] and different glaze materials like glazing spray were less effective at smoothing the surfaces because they were to unable to uniformly coat all surface irregularities.[40]

Alp *et al.*[6] reported that the type of surface finishing did not affect the translucency of ZLS, whereas coffee thermocycling reduced the translucency. Even though the clinical effect of this difference was unclear, the translucency of the ZLS-P and ZLS-CF groups changed after aging in the present study, in parallel with Alp et al's[6] study. In contrast, the type of surface finishing had an effect on TP before aging in the present study.

Subasi *et al.*[41] reported that color changes in ZLS glass-ceramic were significantly affected by its thickness (0.5, 0.7, and 1 mm), and ZLS glass-ceramic with 0.5 mm thickness exhibited unacceptable color changes (>CIEDE2000 50% acceptability threshold, 1.8 units). In contrast with the present study, the translucency was not affected by coffee thermocycling, whereas it was affected by material type and thicknesses; translucency decreased when the thickness of the material increased. Gunal and Ulusoy[24] also reported that different thicknesses (0.5 and 1 mm) of ZLS ceramic presented statistically significant differences in translucency, and the reduced thickness resulted in a significant increase in translucency. In the present study, the thickness of ZLS was 0.6 mm and thermocycling was applied in distilled water. The difference between color changes and the TP values in the present study and previous studies[24,41] might arise due to differences in the thickness of the ZLS material, different aging solutions, and different color measuring devices.

According to the manufacturer, zirconia dioxide particles in ZLS glass-ceramics provide good surface finishing and reinforce the ceramic structure by providing crack interruption through its small grains and homogeneously distributed structure.[11] Although various techniques and systems have been used to produce smooth ceramic surfaces, there is no standard protocol for optimal surface treatment of ZLS glass-ceramic[41], and conflicting results were reported in previous studies. It was repeatedly reported that the surface finishing[17], polishing, or glazing quality affect the surface roughness of ceramic materials differently.[21]

Vichi et al[21] evaluated the efficiency of different manual and furnace-based finishing systems on surface roughness and gloss of VITA Suprinity and IPS e.max CAD by applying glazing or polishing using the manufacturer's recommended polishing sets for 30 and 60 seconds, as well as paste and spray glaze materials. The researchers reported that polishing and glazing produced similar results with regard to roughness. However, lower roughness and higher gloss were produced in paste glazing than with spray glazing, and the polishing time affected the roughness. In contrast, no significant difference was found between surface roughness values of ZLS-CF and ZLS-G groups in the present study, in which glaze spray and powder were used, respectively. The ZLS-P group in the present study exhibited the lowest surface roughness values. This might be due to the higher content of zirconium dioxide, which was shown to allow the material to provide more effective polishing.[42] In addition, the type of surface finishing significantly affected the surface roughness of the ZLS glass-ceramic, and the surface roughness values increased with aging in the present study.

In contrast to the present study, Mota *et al.*[43] reported that glazed surfaces were smoother than polished surfaces based on their SEM and AFM images, and they recommended glazing after mechanical polishing for ZLS glass-ceramic. However, in parallel with the study of Vichi *et al.*[21], the mean surface roughness values were higher than the 0.2 μm thresholds, regardless of the type of surface finish. The ZLS-P group showed the lowest surface roughness values before and after aging, thus polishing may be preferred to glazing.

Different types of surface finishing were selected to mimic clinical conditions because there is no standard surface finishing procedure for ZLS glass-ceramic, and the manufacturer recommend all of these surface finishing procedures. The color change, translucency, and surface roughness of ZLS glass-ceramic were evaluated in this study, because all of these factors have an important effect on the esthetic success of a ceramic restoration.[41] Color values of ZLS material were measured using a colorimeter. A colorimeter is frequently used to measure ΔE values[44], but an edge-loss effect can be seen.[45] Similar to the study of Gürdal *et al.*[46], color changes and surface roughness were evaluated following 5000 thermocycles in distilled water, which corresponds to 6 months of aging.[47]

One of the limitations of the present study was that optical properties and surface roughness of ZLS glass-ceramic were not evaluated after coffee thermocycling. The coffee thermocycling might have a different effect on the color change of ZLS glass-ceramic. The color change of ZLS glass-ceramic may have been different from what can be observed in clinical conditions because no staining solution was used. The other limitation was that only one thickness was evaluated. One should recall that different thicknesses might also affect the color and translucency of the restoration. The third limitation was that the specimens were flat and no cementation procedure was applied. Color changes can be perceptible when cementation is applied. However, the effect of resin cements and underlying tooth color on the optical properties of ZLS glass-ceramic are other topics that should be investigated in further research.

CONCLUSIONS

The surface finishing type did not affect the color change of zirconia-reinforced lithium silicate glass-ceramic. The translucency values of zirconia-reinforced lithium silicate glass-ceramic with different types of surface finishing changed before aging, whereas after aging the type of surface finishing did not affect the translucency of zirconia reinforced lithium silicate glass-ceramic. The ZLS-CF group exhibited the lowest translucency values before aging, whereas this group exhibited the highest translucency values after aging. ZLS-P group exhibited the lowest surface roughness values, regardless of aging. The surface roughness values were higher than the plaque accumulation threshold (0.2 µm), regardless of the type of surface finish.

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CONFLICT OF INTEREST

None.

Yüzey Bitirme İşlemlerinin ve Yaşlandırmanın Zirkonya ile Güçlendirilmiş Lityum Silikat Cam-Seramik Materyalinin Optik Özellik ve Pürüzlülüğü Üzerindeki Etkileri

ÖZ

Amaç: *Bu çalışmanın amacı üç farklı yüzey bitirme yönteminin ve yaşlandırmanın, zirkonya ile güçlendirilmiş lityum silikat (ZLS) cam-seramiğin yüzey pürüzlülüğü ve optik özellikleri üzerindeki etkilerini araştırmaktır.* ***Gereç ve Yöntemler:*** *Dikdörtgen şeklindeki örnekler (0,6 mm kalınlıkta) ZLS bloklardan (N=36) kesildi. Üç farklı tipte yüzey bitirme işlemi [kristalizasyon ile birlikte glazür (ZLS-CF), kristalizasyon sonrası glazür (ZLS-G) ve polisaj (ZLS-P)] (n=12) ve 5000 termal siklus uygulandı. Yaşlandırma öncesi ve sonrasında üçer defa renk koordinatları ve yüzey pürüzlülüğü (Ra) ölçümleri kolorimetre ve profilometre cihazları kullanılarak yapıldı. Ortalama yüzey pürüzlülüğü (Ra) değerleri hesaplandı. Renk farklılıkları ve translusensi parametresi (TP) değerleri, ΔE_{ab} renk farklılığı ve TP formülleri kullanılarak hesaplandı. Renk farkı, translusensi ve yüzey pürüzlülük değerlerini analiz etmek için tek-yönlü ANOVA kullanıldı (α=,05).* ***Bulgular:*** *Farklı yüzey bitirme tiplerine sahip örneklerde ΔE değerlerinde anlamlı farklılıklar gözlenmedi (p=,736). Yaşlandırma öncesinde farklı tipteki yüzey bitirme gruplarında translusensi değerleri arasında anlamlı fark gözlendi (p<,001). Yaşlandırma öncesi ve sonrasında farklı tipteki yüzey bitirme gruplarında yüzey pürüzlülüğü verilerinde anlamlı fark gözlendi (p<,001). ZLS-P grubu yaşlandırma öncesi ve sonrası en düşük yüzey pürüzlülüğü değerlerini gösterdi (p<,001). Hem ZLS-G (p=,005) hem de ZLS-P (p<,001) gruplarında ΔE ve translusensi değişim değerleri arasında pozitif yönde anlamlı bir korelasyon bulundu.* ***Sonuçlar:*** *Yüzey bitirme tipi ZLS cam-seramiğin renk değişimini etkilemedi. Farklı yüzey bitirme işlemi uygulanan ZLS cam-seramik örneklerinde translusensi değerleri yaşlandırmadan önce değişirken, yaşlandırmadan sonra yüzey bitirme tipi ZLS cam-seramiğin translusensisini etkilemedi. Test edilen tüm gruplar, plak akümülasyon eşik değerinden daha yüksek yüzey pürüzlülüğü değerleri sergiledi (Ra=0,2 mm).* ***Anahtar Kelimeler:*** *Seramikler, renk, yüzey özellikleri.*

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