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Original research

Resistance of CAD/CAM material surfaces to aging: a comparison of translucency, gloss, and roughness

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Purpose
This study aimed to evaluate the effects of artificial aging on the surface properties of CAD/CAM restorative materials by assessing changes in translucency, gloss, and surface roughness.

Materials and Methods
Three CAD/CAM materials were tested: Cerasmart, Vita Enamic, and Initial LRF. Specimens were prepared and polished using three different finishing and polishing systems: Optiglaze Color, OptraFine Polishing System, and Vita Enamic Polishing Set Clinical. Surface roughness was measured using a non-contact laser profilometer. Translucency was evaluated with a UV-Vis spectrophotometer, and gloss was determined using a glossmeter. The specimens were stored in 0.02-N citric acid solution for seven days and subjected to a toothbrush abrasion procedure. All surface parameter measurements were repeated after aging.

Results
Before aging, the OptraFine Polishing System provided the smoothest surfaces for Cerasmart and Vita Enamic, while Optiglaze Color resulted in the smoothest surfaces for Initial LRF. After aging, a significant decrease in light transmittance was observed in all materials regardless of the finishing and polishing method used ($p<0.014$ for Cerasmart, $p = 0.001$ for Vita Enamic/Initial LRF before aging; $p<0.001$ for Cerasmart/Vita Enamic, $p = 0.003$ for Initial LRF after aging). Statistically significant differences in surface roughness (Ra, Rz, and Sa values) were found among the polishing methods for all materials ($p<0.001$). Optiglaze Color consistently resulted in the highest gloss values across all materials.

Conclusion
Aging had a significant impact on the surface properties of CAD/CAM materials, with variations depending on the material type and polishing system used. Light transmission decreased significantly in all materials after aging. The choice of finishing and polishing technique plays a critical role in maintaining the aesthetic properties of CAD/CAM materials over time.

Keywords: *CAD/CAM, surface roughness, light transmission, gloss, aging*

Introduction

Digital workflows enable clinicians to complete indirect restorations in a single appointment. This is made possible by materials that eliminate the need for firing processes such as crystallization, glazing, or sintering, thereby reducing fabrication time. However, the milling process does not produce a fully smooth surface suitable for cementation (1). Achieving esthetic harmony in restorations depends on shade matching, stability, and surface quality (2).

Surface finishing and polishing techniques are essential for creating glossy and smooth surfaces that resemble natural teeth (3, 4). Various mechanical polishing protocols, including polishing kits and polishing

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pastes, are recommended by manufacturers for esthetic CAD/CAM materials (5).

Although translucency and light transmittance are related, they have distinct meanings in restorative materials. Translucency refers to the amount of light that is transmitted or diffusely reflected through a turbid medium. In contrast, light transmittance describes the passage of light, either diffuse or direct, through a material, depending on its thickness (6). While closely related, these terms emphasize different aspects of light interaction with dental materials and are crucial for understanding their optical properties (6).

Surface finishing and polishing techniques enhance smoothness and gloss (7). Smoother surfaces reduce plaque retention and antagonist wear, making the material more biocompatible. Additionally, smoother surfaces are less prone to discoloration, which affects the long-term esthetics of the restoration (7, 8). Besides their esthetic benefits, well-polished surfaces tend to exhibit fewer mechanical and esthetic issues (7).

Chemical degradation can alter the superficial characteristics of dental materials, increasing their susceptibility to mechanical failure and compromising long-term clinical performance (9,10). Aging in the oral cavity occurs due to dietary exposure and mechanical stress, which can be simulated in vitro through immersion in food-simulating liquids (FSL) (11,12). Abrasive toothbrushing is another critical factor influencing surface properties (13). Several studies have examined the effects of brushing on wear resistance in restorative materials, assessing variables such as brushing duration, applied force, and the relative dentin abrasiveness (RDA) of toothpaste (14-19). However, limited information is available on the combined effects of FSL exposure and toothbrush abrasion on the surface texture and optical properties of CAD/CAM materials treated with different finishing and polishing techniques (20).

Dental CAD/CAM materials are increasingly used for their esthetic properties and durability. However, the aging process in the oral environment, caused by exposure to chemical, thermal, and mechanical stresses, can affect their performance. While previous studies have reported varying degrees of degradation in dental materials under these conditions, there is still limited data on how different polishing techniques influence surface properties after aging. This study aims to address this gap by evaluating the effects of aging on the surface properties of CAD/CAM restorative materials, including gloss, roughness, and translucency, following different finishing protocols. The null hypothesis states that "the surface and optical properties of the tested materials are not affected by the polishing methods, immersion conditions, or brushing simulations.

Materials and Methods

Sample characteristics

Three CAD/CAM materials were examined: a hybrid ceramic (Cerasmart 270, GC Dental Products Europe, Leuven, Belgium), a polymer-infiltrated ceramic (Vita Enamic, Vita Zahnfabrik, Bad Sackingen, Germany), and a leucite-reinforced feldspar ceramic (Initial LRF, GC Dental Products Europe, Leuven, Belgium). A description of the materials, according to the manufacturer's specifications, is given in Table 1. A total of 120 plate-shaped specimens (12×14×1 mm) were prepared using a water-cooled precision saw (Micracut 151, Metkon, Bursa, Turkey) and polished with 600- to 1000-grit silicon carbide paper under running water for 60 seconds.

Study groups

The specimens were divided into four groups based on the finishing and polishing method used: Group-1 (G1): Control (no additional finishing or polishing), Group-2 (G2): Optiglaze Color (GC Corporation, Leuven, Belgium), Group-3 (G3): OptraFine Diamond Polishing System used for 20 sec-

Table 1. *Materials used in this study.*

Material	Composition	Manufacturer	Lot Number
Cerasmart (Nanoceramic)	Bis-MEPP, UDMA, DMA, 71% SiO_2, Barium glass	GC Corporation, Tokyo, Japan	2005111
Vita Enamic (Polymer infiltrated Ceramic)	14% UDMA, TEGDMA, 58-63% SiO_2, 20-23% Al_2O_3, 9-11% Na_2O, 4-6% K_2O, 0.5-2% B_2O_3, ZrO_2< %1, CaO <%1	VITA Zahnfabrik, Bad Säckingen, Germany	83410
Initial LRF (Leucite-reinforced feldspar ceramic)	70-80 vol%. Crystalline phase (1.5-3 µm leucite cystals)	GC Corporation, Tokyo, Japan	1905221
Optiglaze Color	PMMA MMA Photoinhibitor Silica filler	GC Corporation, Tokyo, Japan	2003201
Vita Enamic Polishing Set Clinical	NA	VITA Zahnfabrik, Bad Säckingen, Germany	E81570
OptraFine Diamond Polishing System	Synthetic rubber, diamond granules, titanium dioxide. Polishing paste: diamond powders dissolved in glycerin, sodium lauryl sulfate, propylene glycol	Ivoclar Vivadent, Schaan, Liechtenstein	ZL0068
Diapolisher Paste	NA	GC Corporation, Tokyo, Japan	1911011

PMMA: Poly-methyl-methacrylate; **MMA:** Methyl-methacrylate; **UDMA:** Urethane-dimethacrylate; **TEGDMA:** Triethylene-glycol-dimethacrylate; **Bis-MEPP:** 2,2-Bis (4-methacryloxypolyethoxyphenyl)propane; **DMA:** Dimethacrylate; **SiO_2:** Silicon-oxide; **Al_2O_3:** Alumina-oxide; **Na_2O:** Sodium-oxide; **K_2O:** Potassium-oxide; **B_2O_3:** Boron-oxide; **ZrO_2:** Zirconium-oxide; **CaO**: Calcium-oxide; **NA:** Not available onds (Ivoclar Vivadent, Schaan, Liechtenstein), Group-4 (G4): Vita Enamic Polishing Set Clinical + DiaPolisher Paste for 20 seconds (GC Corporation, Leuven, Belgium).

Surface preparation

For group 2, specimens were underwent 50 µm Al_2O_3 particle abrasion (Basic Eco, Renfert GmbH, 7847, Hilzingen, Germany) and followed by ultrasonic cleaning. Then, a silane coupling agent (Ceramic Primer II; GC Corp) was applied and air-dried. A light-polymerized glazing agent (Optiglaze; GC Corp) was applied to the surface and polymerized for 90 seconds using an LED dual-mode light curing unit (Labolight Duo; GC Corp).

Rubber cups were used for manual finishing in Groups 3 and 4, and they were replaced after every four samples. Finishing followed the manufacturer's guidelines and was achieved with a contra-angle handpiece (Kavo INTRAmatic 20CN, Kavo, Biberach, Germany) under water cooling. The same operator conducted all finishing and polishing procedures. The polishing and glazing techniques used are outlined in Table 2.

Artificial aging

The artificial aging procedure was performed by immersing individual specimens in beakers containing 10 ml of 0.02 N citric acid for seven days at 36.5°C (20,21). Following immersion, the specimens were ultrasonically cleaned and subjected to a brushing simulation using an electronic toothbrush (Triumph Professional Care, Oral B Braun GmbH; Germany) for four minutes with a low-abrasion toothpaste (Relative Dentin Abrasivity RDA:34) (ProNamel, Sensodyne) mixed with distilled water (1:1). The brushing force was standardized at 2 N using a custom holder to replicate clinical conditions. To simulate one month of toothbrushing, the samples were brushed for 4 minutes, as the average brushing time per tooth is approximately 8 seconds, based on two 2-minute brushing sessions per day for a person with 32 teeth (22). The brush head chosen was Oral-B Sensitive (Oral-B, Germany), with indicator bristles that have lost their color to indicate when they need to be replaced.

Surface topography

All samples in the group were first washed in an ultrasonic bath with deionized water for 5 minutes. The surface topography of the samples before and after aging was analyzed using the PS50 non-contact 3D profilometer (Nanovea, 6 Morgan Ste 156, Irvine, CA, USA). In this way, Ra, Rz, and Sa values were determined and recorded (Figure 1, Figure 2, Figure 3 and Figure 4). A state-of-the-art optical pen with superior white light axial chromatism is used in this non-contact laser profilometer. A 4 mm×4 mm scanning area was selected, and scanning was performed in 20-micrometer increments in the X and Y directions at a speed of 0.1 mm/s. MountainsMap Professional software version 6.2.7487 (Digital Surf) was used to generate 3D surface topographies and evaluate profile roughness. For each sample, 11 measurements were taken, and an arithmetic mean of surface roughness (Ra/Rz) was obtained.

Light transmittance

The light transmittance of all samples was measured at a wavelength of 555 nm using a UV-Vis spectrophotometer (Varian Cary 50, Varian, Inc., CA, USA) before and after the aging processes. Percent transmittance values were recorded at 555 nm, and four repeated measurements were performed for each sample, with the average being calculated.

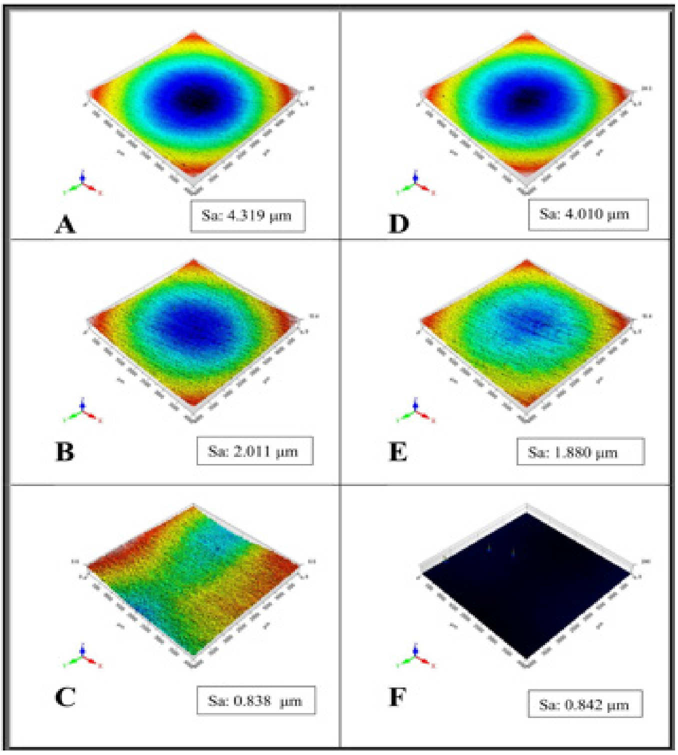

Figure 1. *Group 1 (Control) treated samples before and after aging, respectively, 3D images, from top to bottom Cerasmart (A-D), Vita Enamic (B-E), Initial Lrf (C-F).*

Table 2. *Applied groups, polishing systems, manufacturer, and application stages.*

Groups	Surface Treatments	Manufacturer	Stages
1	SiC papers (600, 800, 1000)	Würth Group, Künzelsau, Germany	3 stages (60 seconds for each stage)
2	Optiglaze Color	GC Corporation, Tokyo, Japan	One Stage System
3	OptraFine Diamond Polishing System	Ivoclar Vivadent, Schaan, Liechtenstein	3-stage polishing system [light-dark blue (9.000 rpm/ 20 seconds)] + polish (6.000 rpm)
4	Vita Enamic Polishing Set Clinical + Diapolisher Paste	VITA Zahnfabrik, Bad Säckingen, Germany / GC Corporation, Tokyo, Japan	Two-stage system [pink (9.000 rpm/20 seconds) and gray (6.000 rpm/20 seconds)] + polishing paste (9.000 rpm)

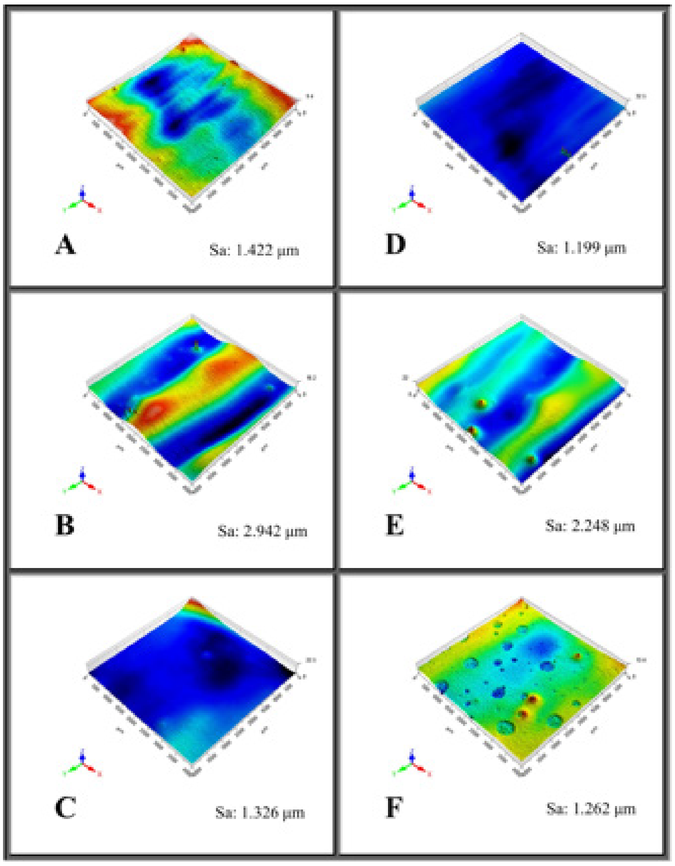

Figure 2. *Group 2 (Optiglaze) treated samples before and after aging, respectively, 3D images, from top to bottom Cerasmart (A-D), Vita Enamic (B-E), Initial Lrf (C-F).*

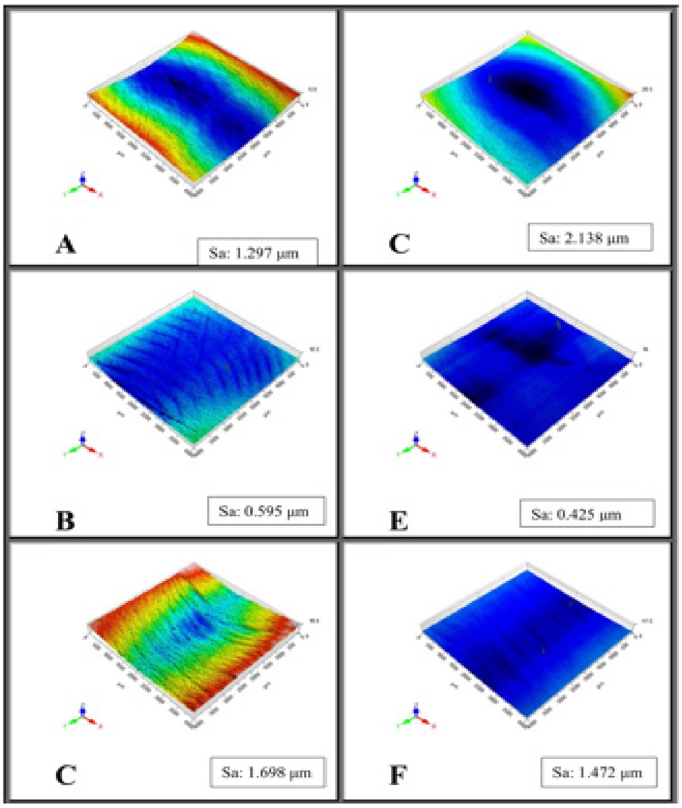

Figure 3. *Group 3 (OptraFine) treated samples before and after aging, respectively, 3D images, from top to bottom Cerasmart (A-D), Vita Enamic (B-E), Initial Lrf (C-F).*

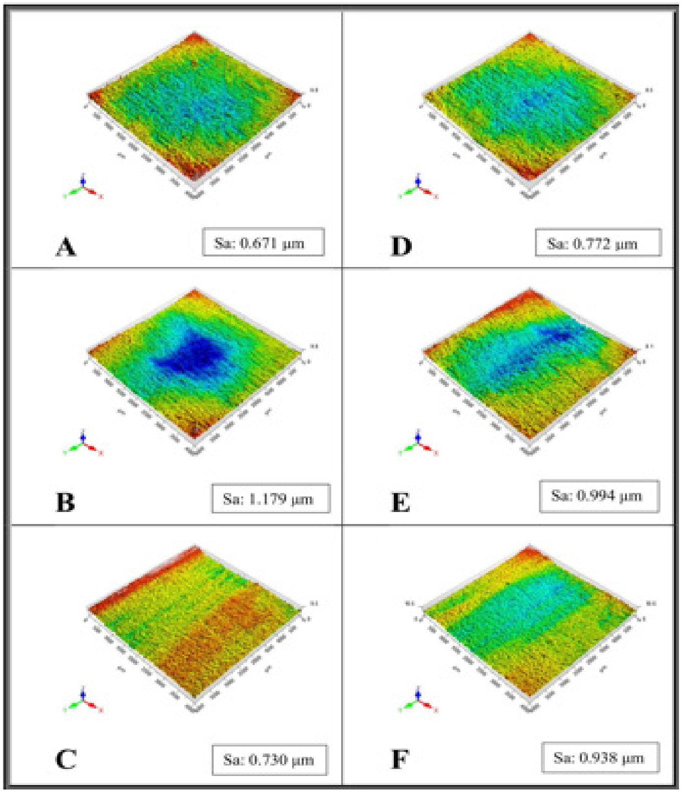

Figure 4. *Group 4 (Vita Enamic) treated samples before and after aging, respectively, 3D images, from top to bottom Cerasmart (A-D), Vita Enamic (B-E), Initial Lrf (C-F).*

Surface gloss

Surface gloss was measured before and after aging using a gloss meter (Novo-Gloss 60°, Rhopoint, East Sussex, UK) at a reflection angle of 60°. Three measurements were taken for each specimen, and the average was recorded as the gloss unit (GU) value. The gloss meter was calibrated with a black reference chart of known gloss value. A positioning mold was used to secure the gloss meter and block external light, ensuring consistent measurements at the same point on each specimen.

Statistical analysis

Statistical analysis was performed using IBM SPSS 20.0 (IBM Corp., Armonk, NY, USA). Normal distribution was tested using Shapiro-Wilk and Kolmogorov-Smirnov tests. Normally distributed variables were expressed as mean ± standard deviation, while non-normally distributed variables were expressed as median (25th-75th percentile). Differences between groups were assessed with the Kruskal-Wallis test since normal distribution could not be assumed. The Dunn test was used for multiple comparisons. The Wilcoxon signed-rank test was used for dependent samples. Spearman correlation analysis was used to analyze the relationships between numerical variables. $p<0.05$ was considered as statistical significance.

Results

The results of Ra and Rz measurements are presented in Table 3. Statistically significant differences were found between polishing procedures for all materials (for Ra before aging: p<0.001 for Cerasmart/Initial LRF and p<0.01 for Vita Enamic; after aging: p=0.001 for Cerasmart/Vita Enamic and p<0.001 for Initial LRF; for Rz before and after aging: p<0.001 for all materials). In G2 (p=0.001 before aging / p<0.001 after aging), the Initial LRF had lower Ra values compared to Cerasmart (p=0.027) and Vita Enamic (p=0.001) before aging. However, after aging, Initial LRF showed higher Ra values. In G3, before aging, Initial LRF had higher values compared to Cerasmart (p<0.001) and Vita Enamic (p=0.005). Aging significantly affected Ra values in G2 (p<0.001), with the largest change observed for Initial LRF (p<0.001 for Cerasmart and Initial LRF / p=0.001 for Vita Enamic and Initial LRF).

The results of the Sa measurements are also shown in Table 3. Statistically significant differences were observed between polishing procedures for all materials (before aging, p<0.007 for Cerasmart and p<0.001 for Vita Enamic; after aging, p=0.001 for Cerasmart and p<0.001 for Vita Enamic/Initial LRF).

In G1, Initial LRF showed lower Sa values than Cerasmart. In G2, Initial LRF had lower Sa values than both Cerasmart and Vita Enamic before aging, while after aging, there was a significant difference between Initial LRF and Vita Enamic (p=0.011). In G3, Cerasmart initially showed higher Sa values than Vita Enamic, but after aging, it exhibited higher values than both Vita Enamic and Initial LRF. Vita Enamic showed lower Sa values than Cerasmart in G4. Aging significantly affected Sa values in G2 (p=0.011), with the largest change observed in Initial LRF.

Translucency measurement outcomes are presented in Table 4. Statistically significant differences were observed between polishing methods for all materials (before aging: p=0.014 for Cerasmart and p=0.001 for Vita Enamic/Initial LRF; after aging: p<0.001 for Cerasmart/Vita Enamic and p=0.003 for Initial LRF). For Cerasmart, G3 showed higher translucency values than G1 before aging (p=0.035). After aging, G3 and G4 exhibited higher values than G1 (p=0.001/p<0.001), and G3 showed higher values than G2 (p=0.001). For Vita Enamic, G4 exhibited higher translucency values than G3 before aging (p=0.001). After aging, G2 and G4 showed higher values than G1 (p<0.001), and G2 and G4 also showed higher values than G3 (p=0.030/p=0.003). For the Initial LRF, G2 showed higher translucency values than G1 and G4 before aging (p=0.003/P=0.002). After aging, G2 exhibited higher values than G1 and G3 (p=0.046/p=0.003).

Cerasmart showed higher translucency values in G1 and G3 compared to the other materials. Initial LRF exhibited lower values in G2 and G4 compared to the other materials. More significant declines in gloss and translucency values with aging were observed in Cerasmart in G1 and G2, Vita Enamic in G1 and G3, and Initial LRF in G3. These declines indicate that aging adversely affected the esthetic and optical properties of these materials, leading to a noticeable reduction in their performance.

Table 4 presents the gloss measurement data, revealing statistically significant differences between polishing methods for all materials, both before and after aging (p<0.001

Table 3. *Median Ra , Rz, Sa values. The different capital letters indicate statistically significant differences between groups within the same row for the same parameter (Ra, Rz, Sa). Conversely, the same capital letters suggest that there is no statistically significant difference between the groups. Similarly, the different lowercase letters in the same column and time period (before and after aging) indicate statistically significant differences among the groups, while the same lowercase letters signify that there is no statistically significant difference within that column and time period.*

Block	Ra, Rz, Sa values		Group 1 (Control)		Group 2 (Optiglaze)		Group 3 (OptraFine Polishing)		Group 4 (Vita Enamic Polishing)	
Cerasmart	Ra	Before Aging	0.177	Aa	0.164	ABa	0.103	Ba	0.192	Aa
		After Aging	0.145	ABa	0.133	Aa	0.106	Aa	0.238	Ba
	Rz	Before Aging	1.009	Aa	0.732	ABab	0.505	Ba	1.033	Aa
		After Aging	0.776	ABa	0.6	Aa	0.588	Aa	1.262	Ba
	Sa	Before Aging	2.671	Aa	1.398	ABa	2.039	Aa	0.93	Ba
		After Aging	2.215	Aa	1.301	ABab	2.287	Aa	1.028	Ba
Vita Enamic	Ra	Before Aging	0.187	Aa	0.221	Aa	0.134	Ba	0.19	Aa
		After Aging	0.148	ABa	0.201	Aa	0.122	Ba	0.186	Aa
	Rz	Before Aging	1.031	Aa	0.891	ABa	0.724	Ba	1.027	Aa
		After Aging	0.823	ABa	0.766	Aa	0.662	Aa	0.987	Ba
	Sa	Before Aging	1.572	ACab	2.12	Aa	0.577	Bb	0.646	BCb
		After Aging	1.579	ABab	2.09	Aa	0.627	Bb	0.756	Bb
Initial Lrf	Ra	Before Aging	0.159	Aa	0.093	Bb	0.203	Ab	0.199	Aa
		After Aging	0.137	Aa	0.55	Bb	0.139	ACa	0.199	BCa
	Rz	Before Aging	0.896	Aa	0.44	Bb	1.135	Ab	1.064	Aa
		After Aging	0.82	Aa	3.028	Bb	0.81	Ab	1.08	ABa
	Sa	Before Aging	0.84	Ab	0.75	Ab	1.051	Aab	0.852	Aab
		After Aging	0.831	Ab	1.28	Bb	1.253	Bb	0.906	Aab

Table 4. *Median Translucency / Gloss values. The different capital letters indicate statistically significant differences between groups within the same row and for the same parameter (Translucency / Gloss). Conversely, the same capital letters suggest that there is no statistically significant difference between the groups. Smilarly, the different lowercase letters in the same column and time period (before and after aging) indicate statistically significant differences among the groups, while the same lowercase letters signify that there is no statistically significant difference within that column and time period.*

CAD/CAM Block	Translucency / Gloss Values		Group 1 (Control)		Group 2 (Optiglaze)		Group 3 (OptraFine Polishing)		Group 4 (Vita Enamic Polishing)	
Cerasmart	Translucency	Before Aging	9,696	Aa	10,074	ABa	10,854	Ba	10,763	ABa
		After Aging	1,877	Aa	2,054	ACa	7,265	Ba	4,717	BCa
	Gloss	Before Aging	21,5	Aab	88,15	Ba	71,25	BCa	28,65	ACa
		After Aging	29,17	Aa	84,75	Ba	66,65	Ca	43,85	ABCa
Vita Enamic	Translucency	Before Aging	7,447	ABb	7,953	ABa	6,782	Ab	8,383	Ba
		After Aging	1,153	Ab	3,908	Ba	1,907	Ab	5,031	Ba
	Gloss	Before Aging	15,35	Aa	86,95	Ba	48,45	Aab	30,85	Aa
		After Aging	21,8	Ab	76,8	Bb	50,7	BCab	43,9	ACa
Initial Lrf	Translucency	Before Aging	6,191	Ab	6,72	Bb	6,413	ABb	6,19	Ab
		After Aging	1,018	Ab	1,477	Bb	0,963	Ab	1,071	ABb
	Gloss	Before Aging	26,15	Ab	88,2	Ba	39,3	ABb	20,7	Aa
		After Aging	33	ACa	81,95	Bab	39,75	ABb	28,2	Cb

for all materials). Vita Enamic showed lower GU values for G1 compared to Initial LRF before aging and Initial LRF and Cerasmart after aging. Lower values were observed for G4 with Initial LRF after aging. Cerasmart showed greater changes in G2 and G3 compared to G1 and G4 with aging, while Vita Enamic and Initial LRF exhibited more changes in G2. Vita Enamic and Initial LRF exhibited greater changes in G2. In the time-dependent comparison, Cerasmart exhibited the most significant decline in performance, reflecting the greatest negative change among the evaluated materials.

Statistically significant changes in gloss values were observed for all materials with aging (Cerasmart: $p<0.001$, Vita Enamic: $p=0.002$, Initial LRF: $p=0.006$). In terms of translucency, aging had a statistically significant effect on all materials (Cerasmart and Vita Enamic: $p<0.001$, Initial LRF: $p=0.011$). For Ra and Rz values, significant changes were found in Cerasmart and Initial LRF (Cerasmart: Rz $p=0.008$, Initial LRF: Ra/Rz $p<0.001$). Regarding Sa values, a significant difference was observed only in the Initial LRF ($p=0.018$).

Statistically significant differences in gloss values were observed only in G3 ($p=0.005$) following aging. For translucency, significant differences were found in G2 ($p=0.001$), G3 ($p<0.001$), and G4 ($p<0.001$) after aging. In terms of Ra values, a significant difference was observed only in G2 ($p<0.001$). Regarding Rz values, significant changes were found in G2 ($p<0.001$) and G4 ($p=0.01$). For Sa values, a significant difference was observed only in G2 ($p=0.011$).

Before aging, a positive correlation was observed between the Ra and Rz parameters ($r=0.919$), while an inverse correlation was found between Ra and gloss ($r=-0.346$), as well as between Rz and gloss ($r=-0.494$). Additionally, a moderate positive correlation was observed between Sa and translucency ($r=0.335$). After aging, a positive correlation was observed between gloss and translucency ($r=0.417$), Sa and translucency ($r=0.211$), and Ra and Rz ($r=0.905$). There was also a positive correlation between gloss and Sa after aging ($r=0.247$).

Discussion

In this research, the influence of aging on the optical and topographic properties of CAD/CAM materials following different surface finishing/polishing systems was investigated. Based on the results, the null hypothesis that "the surface and optical properties of the tested materials are not affected by the polishing methods, immersion conditions, or brushing simulations" was rejected. The findings demonstrate that both polishing procedures and aging significantly impact the surface roughness, topography, translucency, and gloss of CAD/CAM materials.

Dental materials are exposed to various factors in the oral cavity, including thermal, chemical, and mechanical processes, which may affect the surface quality (11,23). Acids such as citric and lactic acid are known to degrade resin matrices and filler particles, leading to material softening. Munusamy *et al*. (21) investigated the effects of food-simulating fluids on the surface roughness of CAD/CAM materials and concluded that they are susceptible to degradation by dietary solvents. Other studies (24-26) examining the effect of simulated gastric juice or citric acid on composite resins also addressed the acid's ability to soften the polymer matrix. This degradation, observed under SEM imaging, aligns with the findings of our study, where citric acid immersion significantly altered the roughness and topography of materials like Cerasmart and Initial LRF.

A study by Kara *et al*. (27) assessed the impact of different polishing systems on the surface characteristics of CAD/CAM restorative materials. Three hybrid ceramic materials Cerasmart, Lava Ultimate, and Shofu Block were polished using various systems. The Identoflex Ceramic Polish Kit provided the smoothest surfaces, while Optiglaze Color performed similarly to other polishing kits in some groups. These results are consistent with our findings, where alternative finishing/polishing procedures to glazing resulted in similarly smooth surfaces. Flury *et al*. (28) investigated the physical properties of CAD/CAM materials after different polishing systems and aging processes. They reported that CAD/CAM materials with lower hardness values and penetration modulus generally exhibited better polishability but were more susceptible to degradation. In this study, aging influenced the roughness parameters (Ra and Rz) for Cerasmart and Initial LRF, specifically with changes observed in the Rz values of Cerasmart and both Ra and Rz for Initial LRF. No significant differences were detected for Vita Enamic, and the Sa parameter was significantly affected only in Initial LRF, indicating a unique impact on surface topography for this material. These findings partially align with prior studies (21,28), showing that resin-based CAD/CAM materials may exhibit greater susceptibility to surface changes following aging. Tekçe *et al.* (29) found that glazed surfaces demonstrated smoother textures than non-glazed ones after thermal cycling. In our study, Optiglaze initially produced a smooth surface for Initial LRF, a leucite-reinforced glass-ceramic material. However, the observed differences in Sa after aging may be attributed to changes in the glaze layer. These material-specific responses emphasize the need for tailored maintenance strategies for different CAD/CAM restoratives, considering their unique composition and varying aging behavior.

Consistent with these findings, smaller craters and scratches were observed on the surface of the Initial LRF material treated with Optiglaze compared to other groups with wider flat areas. After aging, the craters created by glaze layer deformation were clearly visible. This may be due to the integration of low-temperature porcelain with the glassy phase during the glaze application, which fills surface irregularities.

Some studies have shown that increased roughness and topographic changes can affect light transmission (30,31). Changes in roughness can cause the material to appear more opaque, altering its optical and colorimetric properties. For instance, one study (31) found that polishing reduced roughness and increased light transmission, while glazing decreased translucency values (TP). In our study, Cerasmart showed the highest light transmission values, regardless of the polishing system, although light transmission decreased for all materials after aging. This is consistent with findings for Vita Enamic and Initial LRF, where finishing/polishing methods influenced the optical and esthetic properties of restorations.

Gloss, which results from the geometric distribution of light reflected from a surface, is critical to the esthetic appearance of dental materials. Given that gloss measurements are standardized at a 60-degree angle that closely matches how individuals visually perceive surfaces, this angle was used in our study to obtain reliable results (32). Studies (33, 34) have reported that gloss values decrease after brushing, with corresponding increases in surface roughness values (Ra, Rz, Sa). In line with these findings, our study revealed that aging processes significantly affected the gloss and light transmission values of all materials. However, roughness parameters (Ra, Rz) showed significant changes only for Cerasmart and Vita Enamic, while Sa values exhibited a significant difference solely in the Initial LRF material.

The findings of this study have important clinical implications for the selection and maintenance of CAD/CAM restorative materials. The significant changes in gloss and translucency observed after aging suggest that these materials may lose their esthetic appeal over time due to surface degradation. This is critical, as these properties contribute to the material's natural appearance, which is often a primary concern for patients. The increase in surface roughness for Cerasmart and Initial LRF after aging could potentially lead to plaque accumulation and increased wear, negatively affecting the material's longevity and patient satisfaction. The distinct changes observed in Initial LRF after aging, especially in terms of Sa values, indicate that glaze materials may require periodic re-polishing or replacement to maintain their smooth surface and esthetic qualities. Understanding these aging effects enables clinicians to make more informed decisions about material selection in accordance with patient's requirements and anticipated restoration longevity. Additionally, regular follow-ups and potential maintenance, such as periodic re-polishing, may be necessary to sustain the esthetic and functional properties of these restorations over time.

Conclusion

Within the limitations of this study, it was concluded that for Cerasmart and VITA Enamic, the Optrafine Polishing System produced smoother surfaces than Optiglaze and the Vita Enamic Polishing Kit. The highest gloss values were observed in all materials treated with Optiglaze Color, regardless of the CAD/CAM material. The highest translucency values were recorded for Cerasmart, irrespective of the polishing system used. Aging resulted in a significant decrease in translucency for all materials.

Türkçe öz: *CAD/CAM materyallerin yüzeylerinin yaşlanmaya karşı direnci: ışık geçirgenliği, parlaklık ve pürüzlülüğün karşılaştırılması. Amaç: Bu çalışma, yapay yaşlandırmanın CAD/CAM restoratif materyallerinin yüzey özellikleri üzerindeki etkilerini, ışık geçirgenliği, parlaklık ve yüzey pürüzlülüğündeki değişiklikleri değerlendirerek incelemeyi amaçlamaktadır. Gereç ve Yöntem: Üç farklı CAD/CAM materyali test edilmiştir: Cerasmart, Vita Enamic ve Initial LRF. Örnekler, üç farklı bitirme ve parlatma sistemi kullanılarak hazırlanmış ve parlatılmıştır: Optiglaze Color, OptraFine Polishing System ve Vita Enamic Polishing Set Clinical. Yüzey pürüzlülüğü, temassız lazer profilometre ile ölçülmüştür. Işık geçirgenliği, UV-Vis spektrofotometre ile değerlendirilmiş ve parlaklık, parlaklık ölçer kullanılarak belirlenmiştir. Örnekler, 0.02-N sitrik asit çözeltisinde yedi gün boyunca bekletilmiş ve ardından diş fırçalama aşındırma prosedürüne tabi tutulmuştur. Tüm yüzey parametre ölçümleri yaşlandırma sonrası tekrarlanmıştır. Bulgular: Yaşlandırma öncesinde, OptraFine Polishing System, Cerasmart ve Vita Enamic için en pürüzsüz yüzeyleri sağlarken, Optiglaze Color, Initial LRF için en pürüzsüz yüzeyleri sağlamıştır. Yaşlandırma sonrasında, kullanılan bitirme ve parlatma yöntemi ne olursa olsun tüm malzemelerde ışık geçirgenliğinde önemli bir azalma gözlenmiştir (yaşlandırma öncesi Cerasmart için $p<0.014$ ve Vita Enamic/Initial LRF için $p = 0.001$; yaşlandırma sonrası Cerasmart/Vita Enamic için $p<0.001$ ve Initial LRF için $p = 0.003$). Tüm malzemelerde parlatma yöntemleri arasında yüzey pürüzlülüğü açısından (Ra, Rz ve Sa değerleri) istatistiksel olarak anlamlı farklılıklar bulunmuştur ($p<0.001$). Optiglaze Color, tüm malzemelerde en yüksek parlaklık değerlerini tutarlı bir şekilde sağlamıştır. Sonuç: Yaşlandırma, CAD/CAM materyallerinin yüzey özellikleri üzerinde önemli bir etkiye sahiptir ve bu etkiler, kullanılan malzeme türüne ve parlatma sistemine bağlı olarak değişkenlik göstermektedir. Tüm malzemelerde yaşlandırma sonrasında ışık geçirgenliği önemli ölçüde azalmıştır. Bitirme ve parlatma tekniğinin seçimi, CAD/CAM materyallerinin estetik özelliklerinin uzun vadede korunmasında kritik bir rol oynamaktadır. Anahtar Kelimeler: CAD/CAM, yüzey pürüzlülüğü, ışık geçirgenliği, parlaklık, yaşlandırma*

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