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ORIGINAL ARTICLE

Color stability of precolored and extrinsically colored monolithic multilayered polychromatic zirconia: Effects of surface finishing and aging

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Abstract

Purpose: To explore the impact of zirconia types, coloring methods, and surface finishing on the color stability of monolithic multilayered polychromatic zirconia after artificial aging, including thermocycling and simulated toothbrushing.

Materials and Methods: Eighty square-shaped zirconia samples were divided into 2 types (M3Y-TZP and M6Y-PSZ), further categorized based on coloring methods (precolored and extrinsically colored) and surface finishing techniques (mechanical polishing or glazing). The color stability was assessed using the CIEDE2000 formula. Artificial aging was simulated via thermocycling and toothbrushing. All samples were analyzed with a spectrophotometer to determine the post-aging color changes (ΔE_{00}). The ΔE_{00} were interpreted and classified using the 50:50% perceptibility threshold (PT) and the 50:50% acceptability threshold (AT). Comparisons between groups for ΔE_{00} differences were performed using three-way ANOVA, with pairwise comparisons facilitated by Fisher's protected least significant difference test, $\alpha = 0.05$.

Results: The study results indicated significant impacts of zirconia type, coloring method, and surface finishing on color stability. The M6Y groups experienced significantly greater color changes (6.61 ± 1.63) compared to the M3Y groups (3.40 ± 2.24), $p < 0.0001$. For both types of zirconia, extrinsically colored samples exhibited significantly higher ΔE_{00} when mechanically polished ($p = 0.004$). However, surface finishing had no significant effect on ΔE_{00} in precolored samples of either zirconia material ($p = 1.000$). The evaluation and categorization of ΔE_{00} variations indicated that nearly all color changes in the M6Y groups, regardless of being precolored, extrinsically colored, polished, or glazed, were deemed extremely unacceptable (Grade 1). In contrast, the M3Y groups showed more acceptable results, with the majority of color changes classified as moderately unacceptable (Grade 3).

Conclusions: The color stability of multilayered polychromatic zirconia is influenced by the type of material, extrinsic coloring, and the chosen surface treatment post-artificial aging. The translucent 6Y-PSZ exhibited lower color stability, especially with only mechanical polishing. For the fabrication of M3Y-TZP and 6Y-PSZ monolithic multilayered polychromatic zirconia restorations, extrinsic coloring should be paired with glazing to maintain color stability. Conversely, in the absence of extrinsic coloring, both glazing and mechanical polishing are effective in preserving color stability.

KEYWORDS
artificial aging, color stability, multilayered polychromatic zirconia, surface finishing, zirconia formulations

To enhance zirconia characteristics, researchers have explored different formulations of zirconia by adding varying amounts of yttria (Y_2O_3).[1–4] When 3 mol% of yttria is incorporated into zirconia, it forms tetragonal zirconia polycrystal (TZP), which exhibits higher strength but lower translucency.[5–7] In the past, the monochromatic (white) 3Y-TZP presented challenges in achieving the desired esthetic characterization of restorations, necessitating additional coloring methods such as intrinsic or extrinsic coloring, along with the use of veneering material.[8,3]

Veneered zirconia restorations have been widely used in clinical practice but have encountered issues such as breakage and chipping of the veneering material, leading to a decline in their utilization.[9–11] These challenges prompted the exploration of alternative solutions to enhance the esthetic appeal of zirconia restorations while maintaining their strength. As a result, partially stabilized zirconia (PSZ), containing 3% to 8% of yttria, was developed.[12–14] As the yttria content increases in 4Y-PSZ, 5Y-PSZ, and 6Y-PSZ, the cubic phase content in zirconia also increases, leading to improved translucency. Although this modification compromises strength, it allows for the application of esthetic monolithic zirconia restorations.[12–16] Since 2015, a new type of zirconia, precolored multilayered polychromatic zirconia (such as M3Y, M4Y, M5Y, and M6Y), was introduced as a solution to the esthetic challenges of traditional monochromatic white zirconia.[15] This new generation of the material consists of several precolored layers of zirconia with the same composition, which are laminated together.[16–19] In multilayered polychromatic hybrid zirconia, such as M3Y-4Y, M3Y-5Y, and M4Y-5Y, the M3Y or M4Y layers offer higher strength, while the 5Y layers provide enhanced translucency for clinical applications.[15–19] The use of precolored monolithic multilayered polychromatic zirconia (PMMP-Zr) has gained popularity in dental restorations due to its combination of fracture resistance (from monolithic restoration design), biocompatibility, and improved esthetics (from precolored multilayered polychromatic design).[16,17] This innovative zirconia material exhibits gradient effects that resemble natural enamel and dentin, enhancing the overall esthetic appearance of the restoration.[16,17]

Despite the esthetic improvements achieved with PMMP-Zr, there are situations where extrinsic coloring may still be necessary to achieve optimal esthetic outcomes.[17,20–22] The initial color and the long-term color stability are important for the restoration's appearance.[23,24] When measuring color stability with color differences (ΔE_{00}), determined by the CIEDE2000 equation, four components are considered: lightness, chroma, hue, and hue rotation.[25,26] The perceptibility threshold (PT) refers to the point at which a color change becomes perceptible, while the acceptability threshold (AT) represents the extent to which a color change is deemed acceptable. In dentistry, these thresholds may vary, but acceptable values have been associated with a 50:50 PT of $\Delta E_{00} = 0.8$ and a 50:50 AT of $\Delta E_{00} = 1.8$.[27,28]

A restoration is exposed to different pH levels in the mouth, as well as varying temperatures and mechanical abrasion during chewing and brushing. For patient satisfaction, the restoration must exhibit satisfactory color stability under these conditions.[27] The color stability of restorations can be influenced by a variety of factors, ranging from manufacturing methods to exposures in the oral environment.[22,23] Some studies have focused on comparing the color stability of zirconia restorations under different surface treatments (mechanically polished vs. glazed). Their findings suggest that surface treatments have the potential to influence the color of monolithic zirconia restorations.[28–32] It is worth noting that previous studies often overlooked the correlation between PMMP-Zr restorations and extrinsically-colored ones. This is an important oversight since the choice of surface treatment can significantly influence the color and spectral distribution of monolithic zirconia restorations.

Since the use of PMMP-Zr restorations is a recent trend in dentistry, this study aimed to investigate the impacts of surface finishing techniques (mechanical polishing vs. glazing), types of precolored zirconia (M3Y-TZP and M6Y-PSZ), and extrinsic coloring on the color stability of monolithic multilayered polychromatic zirconia after artificial aging (including thermocycling and simulated toothbrushing simulation). The null hypothesis of this study was that the materials, extrinsic coloring, and surface finishing have no effect on the color stability of multilayered polychromatic zirconia.

MATERIALS AND METHODS

Using an (8 × 8 × 3 mm) STL file, a total of 80 square-shaped zirconia samples (N = 80) were prepared and divided into 8 groups, each consisting of 10 samples (n = 10). The research group allocations are listed in Table 1. Specifically, the M6Y-PSZ groups were milled from polychromatic, ultra-highly translucent zirconia (Nacera Pearl Q3 Multi-Shade, A-Light, and A-Dark; DOCERAM Medical Ceramics, Dortmund, Germany). Within this group, 20 samples (M6Y-Precolored-PS and M6Y-Precolored-GZ) were milled in A3 shade (Nacera Pearl Q3 Multi-Shade, A-Dark), and the remaining 20 samples (M6Y-Excolored-PS and M6Y-Excolored-GZ) were milled in A1 shade (Nacera Pearl Q3 Multi-Shade, A-Light). The M3Y-TZP groups were milled from polychromatic, translucent zirconia (Nacera Pearl Multi-Shade, A-blank; DOCERAM Medical Ceramics, Dortmund, Germany). Within these groups, 20 samples (M3Y-Precolored-PS and M3Y-Precolored-GZ) were milled in the A3 shade portion of CAD-CAM blank, while the other

TABLE 1 Research group allocations.

Group name	Zirconia material	Shade	Surface finishing
M6Y-precolored-PS	M6Y-PSZ	Milled as A3	Polishing
M6Y-precolored-GZ	M6Y-PSZ	Milled as A3	Glazing
M6Y-excolored-PS	M6Y-PSZ	Milled as A1 and extrinsically colored to A3	Polishing
M6Y-excolored-GZ	M6Y-PSZ	Milled as A1 and extrinsically colored to A3	Glazing
M3Y-precolored-PS	M3Y-TZP	Milled as A3	Polishing
M3Y-precolored-GZ	M3Y-TZP	Milled as A3	Glazing
M3Y-excolored-PS	M3Y-TZP	Milled as A1 and extrinsically colored to A3	Polishing
M3Y-excolored-GZ	M3Y-TZP	Milled as A1 and extrinsically colored to A3	Glazing

20 samples (M3Y-Excolored-PS and M3Y-Excolored-GZ) were milled in the A1 shade portion of blank (Table 1). The samples were then categorized into eight groups ($n = 10$) based on zirconia type (M3Y or M6Y), shade (precolored or extrinsically colored), and surface finishing (mechanical polishing or glazing).

All samples were milled using a five-axis milling machine (MODELA MDX-50; Roland DGA Corporation, Irvine, CA). To ensure uniform shape and surface, initial polishing was performed on all samples using a metallographic grinding and polishing machine (DS20; LECO Corp, Saint Joseph, MI) with 1200-grit silicon carbide paper under cool water. In the groups M6Y-Precolored-PS, M6Y-Precolored-GZ, M3Y-Precolored-PS, and M3Y-Precolored-GZ, the samples were milled in A3 shade, and underwent either hand polishing or glazing surface treatments. For groups M6Y-Precolored-PS and M3Y-Precolored-PS, hand polishing was carried out using medium and fine polishers (Dialite ZR Polishers; Brasseler, Savannah, GA) for a recommended duration of 30 s at 5000–7000 RPM. In contrast, groups M6Y-Precolored-GZ and M3Y-Precolored-GZ only underwent glazing, with the application of a thin layer of glaze spray (VITA Akzent Plus Fluoglaze LT Spray; VITA North America, Yorba Linda, CA) from a distance of 15 cm, followed by firing according to the manufacturer's instructions.

In groups M6Y-Excolored-PS, M6Y-Excolored-GZ, M3Y-Excolored-PS, and M3Y-Excolored-GZ, the samples were milled in A1 shade, extrinsically colored to A3 shade, and underwent either hand polishing or glazing surface treatments. The extrinsic coloring was performed by using a 1:1 powder-to-liquid ratio of the extrinsic characterization material (VITA Akzent Plus Chroma Stains Paste kit VITA classical A1-D4; VITA North America). The mixture, consisting of 0.24 g of the powder and three drops of the liquid, was carefully applied with a brushing motion, pressing from top to bottom to prevent air bubble entrapment. After extrinsic coloring, groups M6Y-Excolored-GZ and M3Y-Excolored-GZ underwent glazing following the aforementioned procedure. All procedures were carried out by a single skilled laboratory technician. Following extrinsic coloring, hand polishing was performed on groups M6Y-Excolored-PS and M3Y-Excolored-PS.

Thermocycling and tooth brushing simulation were done in this study for artificial aging. Using distilled water at 5 and 55°C for 15 seconds at a time, samples underwent 5000 cycles in thermocycles (THE-1100; SD Mechatronik, Feldkirchen-Westerham, Germany) with a dwell time of 30 s. A soft toothbrush (Colgate SlimSoft; Colgate-Palmolive Company, New York, NY) and a mixture of cleaning slurry was used in a toothbrush simulator (TBS) (Toothbrush Simulator MEV4T 10XY; Odeme Dental Research, Luzerna, Brazil) for 5000 cycles at 37°C. The cleaning slurry was prepared with a weight ratio of 25 g of toothpaste (Colgate Fluoride Toothpaste; Colgate-Palmolive Company, New York, NY) and 40 g of distilled water.[33–35]

All samples were measured with a spectrophotometer (CM-2600d; Konica Minolta Sensing Americas Inc, Ramsey, NJ) to determine the color differences (ΔE_{00}) after artificial aging. The CIELAB coordinates (L*, a*, and b*) were recorded at baseline (R1) and after exposing all the samples to thermocycling and tooth brushing simulation (R2).[33–35] The specimen was surrounded by a diffused grey backdrop in accordance with the ISO 7491:2000 criteria for color stability tests, an international standard that specified a method for determining the color stability of dental materials.[33] The spectrophotometer was equipped with an illuminated viewfinder to correctly place the tip (Ø3mm) on the area to be measured on the samples. The ΔE_{00} of all specimens were analyzed with the color measurement before and after the artificial aging according to the CIEDE2000 color-difference equation (ΔE_{00}).[24]

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T\left(\frac{\Delta C'}{k_C S_C}\right)\left(\frac{\Delta H'}{k_H S_H}\right)}$$

A value of 0.8 was set for the 50:50% PT and 1.8 was set for the 50:50% AT to compare changes in ΔE_{00}, following ISO standard (ISO/TR 28642).[34] The color discrepancies in ΔE_{00} were interpreted and classified through 50:50% PT and 50:50% AT as follows; Grade 5 represented an excellent match ($\Delta E_{00} \leq$ PT or $\Delta E_{00} \leq 0.8$), Grade 4 was deemed an acceptable match ($\Delta E_{00}>$ PT but $\leq$ AT or $0.8< \Delta E_{00} \leq$

TABLE 2 Interpretation of color differences among teeth and tooth-colored materials through 50:50% perceptibility (PT) and 50:50% acceptability threshold (AT).[28]

Threshold rating	Interpretation	ΔE_{00} range
≤PT	(5) Excellent match	≤0.8
>PT, ≤AT	(4) Acceptable match	>0.8, ≤1.8
>AT, ≤AT × 2	(3) Mismatch type [a]	>1.8, ≤3.6
>AT × 2, ≤AT × 3	(2) Mismatch type [b]	>3.6, ≤5.4
>AT × 3	(1) Mismatch type [c]	>5.4

Mismatch types: [a] = moderately unacceptable; [b] = clearly unacceptable; [c] = extremely unacceptable.

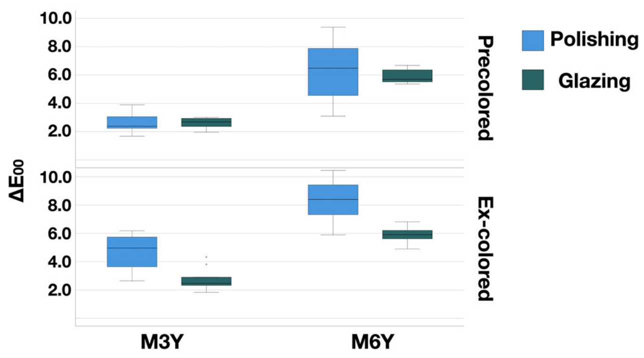

FIGURE 1 Boxplot illustrates the spread and differences of samples' ΔE_{00}.

1.8). Grades 3 to 1 were associated with mismatch types; with Grade 3 being moderately unacceptable (ΔE_{00}> AT but ≤ AT × 2 or 1.8< ΔE_{00} ≤3.6), Grade 2 as clearly unacceptable (ΔE_{00} > AT × 2 but ≤ AT × 3 or 3.6 < ΔE_{00} ≤ 5.4), and Grade 1 as extremely unacceptable (ΔE_{00} > AT × 3 or ΔE_{00} > 5.4) (Table 2).[28]

The means and standard deviations of ΔE_{00}, as well as the color discrepancies classifications, were summarized for each group. With a sample size of 10 specimens per group, the study had an 80% power to detect an effect size of 1.325 for differences between any two groups. This was based on two-sample t-test calculations using a two-sided 5% significance level for each test. Comparisons between groups regarding differences in color change were conducted using three-way ANOVA. Pairwise comparisons between groups were carried out using Fisher's Protected Least Significant Differences. A 5% significance level was applied for all tests (SAS; SAS Institute Inc, Cary, NC).

RESULTS

Descriptive statistics including mean and standard deviation of ΔE_{00} are shown in Tables 3 and 4. A boxplot was used to graphically demonstrate the data (Figure 1). The factors of zirconia material [$F(1, 72) = 76.7$, $p < 0.0001$], extrinsic coloring [$F(1,72) = 11.9$, $p = 0.0009$], and surface finishing [$F(1,72) = 15.9$, $p = 0.0002$] and the interaction between extrinsic coloring and surface finishing [$F(1,72) = 10.7$, $p = 0.0017$] had shown statistically significant effects on the ΔE_{00}. When comparing two zirconia materials, M6Y groups (6.61 ± 1.63) showed significantly more color changes than the M3Y groups (3.40 ± 2.24), $p < 0.0001$ (Table 4). The impact of coloring conditions (precolored or extrinsically colored) was compared with the considerations of their significant interactions with surface finishing conditions (polishing or glazing). In both zirconia materials, the extrinsically colored samples showed significantly higher ΔE_{00} when they were mechanically polished (M6Y-Excolored-PS: 8.29 ±1.47 vs. M6Y-Excolored-GZ: 5.88 ± 0.61, $p = 0.031$; and M3Y-Excolored-PS: 5.64 ± 3.64 vs. M3Y-Excolored-GZ: 2.75 ± 0.77, $p = 0.004$). In contrast, in both zirconia materials under the precolored condition, surface finishing did not show significant effects on the ΔE_{00} (M6Y-Precolored-PS: 6.41 ±2.07 vs. M6Y-Precolored-GZ: 5.86 ± 0.46, $p = 0.995$; and M3Y-Precolored-PS: 2.60 ± 0.65 vs. M3Y-Precolored-GZ: 2.63 ± 0.35, $p = 1.000$).

The assessment and categorization of variations in ΔE_{00} among the study groups, based on a 50:50% PT and 50:50% AT, are presented in Table 3. In the M6Y groups, nearly all color changes, whether the samples were precolored, extrinsically colored, polished, or glazed, were classified as falling within the extremely unacceptable mismatch category (Grade 1). Additionally, 20% and 10% were deemed clearly unacceptable mismatch (Grade 2) for precolored polished and glazed M6Y samples, respectively, while 20% of extrinsically colored glazed samples were also categorized as clearly unacceptable mismatches (Grade 2). Moreover, 10% of precolored polished samples were rated as moderately unacceptable mismatches (Grade 3). Conversely, the M3Y groups exhibited more favorable outcomes, with the majority of color changes falling within the moderately unacceptable mismatch category (Grade 3). Specifically, all glazed precolored M3Y samples (100%) and a majority of polished precolored M3Y samples (80%) fell into this category. Additionally, a significant proportion of glazed (80%) and a smaller proportion of polished (20%) extrinsically colored M3Y samples were also rated as moderately unacceptable mismatches.

DISCUSSION

Within the oral cavity, dental restorations are subjected to a multitude of environmental factors, encompassing exposure to saliva and moisture, the potential for erosive processes driven by pH fluctuations and pigmented beverages, exposure to a spectrum of temperatures, and susceptibility to abrasion stemming from mechanical forces during brushing.[36,37] This study aimed to evaluate the effect of surface finish (mechanical polishing and glazing) on the color stability of multilayered polychromatic zirconia (M6Y-PSZ and M3Y-TZP) in terms of their color stability in two cases: precolored at A3 versus extrinsically colored to A3. The null hypothesis was rejected, indicating significant effects of zirconia materials, coloring methods, and surface treatments on the color

TABLE 3 Descriptive statistics (mean ± standard deviation) and color match classification percentages of the samples' ΔE_{00}.

Group name	ΔE_{00} Mean ± standard deviation	Color match classification percentage 1	2	3	4	5
M6Y—Precolored—PS	6.41 ± 2.07	70%	20%	10%	0%	0%
M6Y—Precolored—GZ	5.86 ± 0.46	90%	10%	0%	0%	0%
M6Y—Excolored—PS	8.29 ± 1.47	100%	0%	0%	0%	0%
M6Y—Excolored—GZ	5.88 ± 0.61	80%	20%	0%	0%	0%
M3Y—Precolored—PS	2.60 ± 0.65	0%	10%	80%	10%	0%
M3Y—Precolored—GZ	2.63 ± 0.35	0%	0%	100%	0%	0%
M3Y—Excolored—PS	5.64 ± 3.64	30%	50%	20%	0%	0%
M3Y—Excolored—GZ	2.75 ± 0.77	0%	20%	80%	0%	0%

TABLE 4 Descriptive statistics (mean ± standard deviation) of the samples' ΔE_{00} stratified by the factors of zirconia material, shade, and surface finishing.

Groups	Mean ± standard deviation
M6Y	6.61 ± 1.63
M3Y	3.40 ± 2.24
Precolored	4.38 ± 2.09
Extrinsically colored	5.64 ± 2.78
Polished	5.74 ± 2.99
Glazed	4.28 ± 1.70

stability of multilayered polychromatic zirconia. Although these general results are consistent with previous studies, it is worth noting that no studies have specifically reported these findings in the context of multilayered polychromatic zirconia.[31,32,38]

According to Paravina et al.,[28] the CIEDE2000 values of ΔE between 0.8 and 1.8 are considered clinically acceptable, whereas values above that threshold are distinguishable to the layperson's eye. The same index was used in this study. These values correlate with the 50:50% perceptibility threshold (PT) at $\Delta E_{00} = 0.8$ and the 50:50% acceptability threshold (AT) at $\Delta E_{00} = 1.8$. A significant difference in ΔE_{00} between the two zirconia types was observed; the translucent M6Y-PSZ exhibited more color changes than the opaque M3Y-TZP. The observed difference in this research may be attributed to the variations in microstructure and composition of the two types of zirconia. Translucent zirconia contains more alumina and less zirconium dioxide, rendering it more translucent but also more susceptible to color changes. The relative percentage of tetragonal and cubic phases also plays a role in color stability.[18,19,39] These findings are comparable to those of previous studies. Nascimento et al. demonstrated that hydrothermal degradation, followed by immersion in beverages, altered the color of high-translucency 5Y-TZP.[40] Bayestehtarat et al. analyzed the color and surface roughness of extrinsically colored 3Y-TZP monolithic zirconia specimens after thermocycling and toothbrushing, and found that changes in color and surface roughness across all experimental groups did not pass the thresholds for perceptibility and acceptability and, therefore, were not clinically significant.[41]

Mechanical polishing significantly affected the color changes in both types of zirconia. In a previous study about color stability following standardized grinding, it was found that material reduction of more than 165 µm for the precolored zirconia should be avoided to ensure acceptable color of restorations.[42] Mechanically polished zirconia exhibited higher ΔE_{00} values compared to glazed zirconia. Furthermore, mechanically polished translucent M6Y-PSZ displayed higher ΔE_{00} values than opaque M3Y-TZP under both pre-colored and extrinsically-colored conditions. Comparing these findings with those from older studies, it is evident that mechanical polishing can alter the surface roughness and optical properties of zirconia ceramic restorations, resulting in color changes. It was noted in a previous study that ΔE values were higher for polished specimens as opposed to those that were glazed.[43] Another study indicated that polished groups underwent more degradation and color changes than glazed groups after undergoing brushing cycles with monolithic zirconia.[44] While glazing as a surface treatment appears to maintain better color stability than mechanical polishing, a loss of surface gloss in glazed restorations has been observed. This could imply that the glazing process leads to a smoother surface, which is less susceptible to color changes, although it may be more significantly affected in terms of gloss during brushing cycles.[44]

When the samples were precolored without any additional extrinsic coloring, no differences in ΔE_{00} values were observed among the glazed versus polished samples made from the same zirconia material (M6Y—Precolored—PS: 6.41 ±2.07 and M6Y—Precolored—GZ: 5.86 ±0.46, $p = 0.995$; M3Y—Precolored—PS: 2.60 ±0.65 and M3Y—Precolored—GZ: 2.63 ±0.35, $p = 1.000$). In contrast, with extrinsically colored samples, surface treatment played a significant role in color stability; both types of zirconia exhibited significantly higher ΔE_{00} values compared to their pre-colored or untreated counterparts (M6Y—Excolored—PS: 8.29 ±1.47 and M6Y—Excolored—GZ:5.88 ±0.61, $p = 0.031$; M3Y—Excolored—PS: 5.64 ±3.64 and M3Y—Excolored—GZ: 2.75 ±0.77, $p = 0.004$). This phenomenon aligns with previous research indicating that the color stability of extrinsically colored zirconia can be influenced by finishing techniques such as mechanical polishing, potentially resulting in demasking effects if an excessive amount of the color-infiltrated layer is removed.[45] One study examined the color stability of extrinsically colored monolithic zirconia following occlusal adjustment and noted that color differences increased linearly with the depth of material removal, with lighter and less saturated tooth colors being more significantly affected.[45] Inversely, another study assessed the impact of coloring technique and thickness on the color stability of pre-colored and extrinsically colored translucent zirconia after exposure to coffee thermocycling at various thicknesses. The results indicated that neither the shading technique nor the thickness significantly affected the color of translucent zirconia.[46]

The findings from this study carry clinical implications. Dentists and technicians should carefully consider zirconia selection, shading techniques, and surface treatments to achieve restorations that meet both esthetic and functional requirements. Understanding the nuanced impact of these factors on color stability empowers dental professionals to make informed choices that deliver long-lasting and aesthetically pleasing outcomes. In addition, these findings hold particular significance for dental laboratory technicians, as they play a pivotal role in the fabrication of dental restorations. When working with shaded zirconia, technicians should consider not only the initial shade but also the potential for color differences and the ability to correct or adjust the shade during the fabrication process. The limitations of this study include its focus on specific zirconia materials (M3Y-TZP and M6Y-PSZ), limiting generalizability to other translucent zirconia types or materials like lithium disilicate or layered zirconia. The artificial aging methods, such as thermocycling and simulated toothbrushing, may not fully replicate the complexity of oral conditions. More extended clinical studies exposing restorations to diverse oral factors are necessary for accurate insights. While the study used the comprehensive CIEDE2000 equation for color stability evaluation, it may not entirely capture subjective patient perceptions. Future research should integrate patient-reported outcomes for a more holistic assessment. Despite these limitations, the study underscores the intricate relationship between zirconia materials, extrinsic coloring, surface finishing, and color stability, emphasizing the need for careful consideration in the fabrication of monolithic multilayered polychromatic zirconia restorations. Continuous research is vital to stay abreast of advancements in restorative dentistry.

CONCLUSIONS

The color stability of monolithic multilayered polychromatic zirconia is affected by the material type, extrinsic coloring, and surface treatment after artificial aging. The translucent 6Y-PSZ and mechanical polishing surface treatment showed less color stability. When fabricating M3Y-TZP and 6Y-PSZ monolithic multilayered polychromatic zirconia restorations, if extrinsic coloring is desired, glazing is recommended as a surface treatment to maintain color stability. In contrast, if no extrinsic coloring is desired, both glazing and mechanical polishing provide similar color stability.

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