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# An In Vitro Prosthodontic Evaluation of the Effect of Mouth Rinses on the Translucency of Monolithic and Multi-layered Yttria-Stabilized Zirconia

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**ABSTRACT**

The aesthetic performance of zirconia restorations depends greatly on their optical properties, particularly translucency, which can be influenced by various chemical exposures in the oral environment. This in vitro study aimed to evaluate the effect of different immersion solutions on the translucency of two types of zirconia materials. A total of 30 zirconia specimens (n = 15 per group) were prepared: Group A comprised monolithic zirconia, while Group B consisted of multilayered yttria-stabilized zirconia. Each group was divided into three subgroups (n = 5) and immersed in one of three solutions: distilled water (DW), chlorhexidine (CHX), or 0% alcohol mouthwash. Translucency parameters (TP) were measured before and after immersion using a spectrophotometer based on the CIELab system. Statistical analysis was conducted using GraphPad Instat software with significance set at $p < 0.05$. The results revealed that immersion in CHX caused the most significant increase in TP change in both groups, with monolithic zirconia (Group A) showing the highest overall change. Two-way ANOVA indicated that the immersion solution had a statistically significant effect on translucency ($p < 0.0001$), while the type of zirconia showed no significant main effect ($p = 0.0779$). These findings suggest that translucency changes are more dependent on the immersion media than the zirconia composition itself. Clinicians should consider the long-term aesthetic implications of chemical exposure on zirconia restorations, especially when prescribing disinfectant mouthwashes.

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## INTRODUCTION

Zirconia has emerged as one of the most widely used materials in fixed dental prosthodontics due to its excellent mechanical strength, biocompatibility, and favorable esthetic properties. Among these aesthetic parameters, translucency plays a critical role in achieving a natural appearance, particularly in anterior restorations. However, the optical behavior of zirconia may be influenced by various environmental factors, including exposure to different chemical solutions commonly found in the oral cavity [1,2].

Daily oral hygiene routines involve the use of various mouthwashes, some of which contain active ingredients like chlorhexidine or essential oils, while others are alcohol-free formulations. These solutions may interact with the surface and subsurface layers of zirconia, potentially altering its optical characteristics. Distilled water is often used as a control medium in experimental studies to evaluate baseline changes in material properties without the influence of active chemical agents [3-5].

The long-term exposure of zirconia to such chemical environments raises concerns about possible degradation of its translucency, which may compromise its esthetic function over time. This study aims to investigate the effect of immersion in different commonly used oral rinses—specifically, ANTIPLACA 0% alcohol, chlorhexidine mouthwash, and distilled water—on the translucency of zirconia samples. Understanding these effects is essential for optimizing material selection and advising patients on the appropriate use of oral hygiene products in the context of ceramic restorations [6-8].

## METHODS

### *Fabrication of specimens*

A total of 30 zirconia specimens were prepared from the 2 tested CAD/CAM ceramic material groups (n = 15). The specimens from each group were divided into 3 subgroups (n = 5) according to the assigned staining solution (ANTIPLACA 0%Alcohol, chlorhexidine Mouthwash, and distilled water (control) (Health Aqua, Alexandria, Egypt) as shown in Table 1. The samples were immersed in plastic vials containing either 20 mL of the solution,

The vials were sealed to prevent the evaporation of the solutions and kept for seven days at 37°C in an

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incubator (CBM. Torre Picenardi (CR), Model 431/V, Italy). The immersion mediums were refreshed every day to prevent the growth and proliferation of microorganisms as bacteria or yeast. The solutions were agitated twice a day to prevent the precipitation of staining solution particles. Samples were washed with distilled water, dabbed with gauze, and dried with absorbent paper after the immersion period.

***Table 1. Composition and manufacturer of the tested oral rinse solutions***

| Oral rinse solution | Composition | Manufacturer |
|---|---|---|
| Chlorhexidine mouthwash | Aqua, Glycerin, PEG 40, Hydrogenated Castor Oil, Poloxamer407, Chlorhexidine Digluconate, Sodium Fluoride, Sodium Saccharin, Aroma, Allantoin, Sodium Benzoate, Alcohol, CI 16035, Limonene | Foramen SL Cantabria, Spain |
| Antiplaca 0% alcohol | Aqua, Propylene glycol, Hydrogenated Castor Oil, PEG 40, Citric acid, Cetylpyridinium Chloride, Sodium Fluoride, Sodium Saccharin, Sodium Benzoate, CI 42090, CI18965, Cinnamal | Foramen SL Cantabria, Spain |

The translucency of the materials was assessed both before and after staining. Fifteen disc-shaped specimens (10 mm × 1.5 mm) were prepared from two CAD/CAM restorative materials using a water-cooled low-speed diamond saw (IsoMet®; Buehler, Lake Bluff, USA). The thickness of all specimens was confirmed to be 1.5 ± 0.01 mm using a digital micrometer (Mastercraft Electronic Caliper; Canadian Tire Corporation Ltd., Toronto, Canada). Each specimen was then ultrasonically cleaned in distilled water for 10 minutes.

Translucency parameter (TP) measurements were conducted against white (CIE L*= 88.81, a*= -4.98, b*= 6.09) and black (CIE L*= 7.61, a*= 0.45, b*= 2.42) backgrounds under CIE standard illuminant D65. Samples were centrally placed on the measurement port and maintained in the same position for both backgrounds.

The TP values were calculated as the color difference between the measurements over the black and white backgrounds using the following equation:

$TP = [(Lb - Lw)^2 + (ab^* - aw^*)^2 + (bb^* - bw^*)^2]^{**½}$

where the subscripts “b” and “w” refer to color coordinates measured over the black and white backgrounds, respectively.

Hardness was determined by the indentation technique. Three indentations were made on each specimen at widely separated locations with a load of 500 grams for 20 seconds in a micro hardness tester.

### *Statistical analysis*

The mean and standard deviation were used to express the data. Following confirmation of homogeneity of variance and normal distribution of errors, a one-way analysis of variance was conducted, and if significant results were found, Turkey's post-hoc test was used. Between the main groups, a student’s t-test was conducted. The impact of each component (surface finish immersion solution) was compared using a two-way ANOVA. Software called GraphPad Instat (GraphPad, Inc.) was used for analyzing the findings for Windows. A value of P < 0.05 was considered statistically significant.

Sample size (n=15/group) was large enough to detect large effect sizes for main effects and pair-wise comparisons, with the satisfactory level of power set at 80% and a 95% confidence level.

## RESULTS

Translucency parameter change (TP), Translucency parameter percentage change (%) results (Mean±SD) for both groups before and after immersion in treatment solutions are summarized in Tables 2-5.

For Gr_1, it was found that the highest mean ± SD values of TP change were recorded with Chlorhexidine immersed subgroup (16.49 ± 1.36 %) followed by 0 alcohol immersed subgroup mean ± SD values (4.68± 1.46 %) mean while the lowest mean ± SD values were recorded with DW immersed subgroup (3.29 ± 1.1 %). The difference among subgroups was statistically significant as indicated by the ANOVA test (P=<0.0001<0.05), Table 2. Tukey’s post-hoc pair-wise test showed a non-significant (p>0.05) difference between (0 alcohol and DW) immersed subgroups as shown in Table 3.

For Gr_2, it was found that the highest mean ± SD values of TP change were recorded with Chlorhexidine immersed subgroup (11.486 ± 1.84 %) followed by DWimmersed subgroup mean ± SD values (8.95 ± 1.58 %) mean while the lowest mean ± SD values were recorded with 0 alcohol immersed subgroup (6.96 ± 1.42 %). The difference among subgroups was statistically significant as indicated by ANOVA, $p = 0.0875$; Table 2). Tukey’s post-hoc pair-wise test showed a non-significant (p>0.05) difference between (Chlorhexidine and DW) and (0 alcohol and DW) immersed subgroups as shown in table (3)

When comparing between groups for each immersion solution: For Chlorhexidine, Gr_1 showed a significantly higher TP percentage change (16.49 ± 1.36%) compared to Gr_2 (11.49 ± 1.84%) (*t*-test, $p = 0.0012$; Table 4). For 0% Alcohol, Gr_2 showed a significantly higher TP percentage change (6.96 ± 1.43%) compared to Gr_1 (4.68 ± 1.46%) (*t*-test, $p = 0.0368$; Table 4). For Distilled Water, Gr_2 again recorded significantly higher TP percentage change (8.95 ± 1.59%) compared to Gr_1

(3.29 ± 1.10%) (*t*-test, $p = 0.0002$; Table 4).
The total effect of the main group (regardless of immersion solution) showed no statistically significant difference between Gr_1 and Gr_2 (Two-way ANOVA, $p = 0.0779$; Table 5). However, the total effect of the immersion solution (irrespective of group) was statistically significant (Two-way ANOVA, $p < 0.0001$; Table 5), with the following trend: Chlorhexidine > Distilled Water ≥ 0% Alcohol. Finally, the interaction between group and solution was statistically significant (Two-way ANOVA interaction term, $p < 0.0001$; Table 6), indicating that the impact of immersion solution on TP change varied between the two groups.

***Table 2. TP of monolithic zirconia samples in different media; values are expressed as the mean (SD) (Before)***

| **Gr_1** | **White** | | | **Black** | | | **Difference** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | L* | a* | b* | L* | a* | b* | ΔL | Δa | Δb | TP | |
| | 79.5 | 3.9 | 29 | 73.8 | 1.5 | 15.1 | -5.70 | -2.40 | -13.90 | 15.21 | |
| | 78.7 | 5.2 | 24.9 | 76.6 | 0.3 | 15.7 | -2.10 | -4.90 | -9.20 | 10.63 | |
| Chx | 75.7 | 8.1 | 28.2 | 77.1 | 0.5 | 11.2 | 1.40 | -7.60 | -17.00 | 18.67 | 15.08 |
| | 77.6 | 6 | 28.6 | 75.45 | 1 | 13.15 | -2.15 | -5.00 | -15.45 | 16.38 | |
| | 77.2 | 6.65 | 26.55 | 76.85 | 0.4 | 13.45 | -0.35 | -6.25 | -13.10 | 14.52 | |
| | 79 | 3.9 | 30 | 73.4 | 1.6 | 14.7 | -5.60 | -2.30 | -15.30 | 16.45 | |
| | 78.5 | 5.8 | 26.5 | 73.7 | 1 | 16.4 | -4.80 | -4.80 | -10.10 | 12.17 | |
| Anti | 75.9 | 8.6 | 28.3 | 77.4 | 0.5 | 12.2 | 1.50 | -8.10 | -16.10 | 18.09 | 15.61 |
| | 77.45 | 6.25 | 29.15 | 75.4 | 1.05 | 13.45 | -2.05 | -5.20 | -15.70 | 16.67 | |
| | 77.2 | 7.2 | 27.4 | 75.55 | 0.75 | 14.3 | -1.65 | -6.45 | -13.10 | 14.69 | |
| | 79.25 | 3.9 | 29.5 | 73.6 | 1.55 | 14.9 | -5.65 | -2.35 | -14.60 | 15.83 | |
| | 78.6 | 5.5 | 25.7 | 75.15 | 0.65 | 16.05 | -3.45 | -4.85 | -9.65 | 11.34 | |
| DW | 75.8 | 8.35 | 28.25 | 77.25 | 0.5 | 11.7 | 1.45 | -7.85 | -16.55 | 18.37 | 15.33 |
| | 77.525 | 6.125 | 28.875 | 75.425 | 1.025 | 13.3 | -2.10 | -5.10 | -15.58 | 16.52 | |
| | 77.2 | 6.925 | 26.975 | 76.2 | 0.575 | 13.875 | -1.00 | -6.35 | -13.10 | 14.59 | |

***Table 3. TP of monolithic zirconia samples in different media; values are expressed as the mean (SD) (AFTER)***

| Gr_1 | **White** | | | **Black** | | | **Difference** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | L* | a* | b* | L* | a* | b* | ΔL | Δa | Δb | TP | |
| | 77.4 | 5.6 | 27.9 | 74.4 | 0.1 | 12.6 | -3.00 | -5.50 | -15.30 | 16.53 | |
| | 77.2 | 5.3 | 26.8 | 71.5 | 2.3 | 18.7 | -5.70 | -3.00 | -8.10 | 10.35 | |
| Chx | 74.3 | 8.1 | 26.8 | 71.7 | 2.2 | 16.6 | -2.60 | -5.90 | -10.20 | 12.07 | 12.84 |
| | 75.85 | 6.85 | 27.35 | 73.05 | 1.15 | 14.6 | -2.80 | -5.70 | -12.75 | 14.24 | |
| | 75.75 | 6.7 | 26.8 | 71.6 | 2.25 | 17.65 | -4.15 | -4.45 | -9.15 | 10.99 | |
| | 74.4 | 8.9 | 26.4 | 72.3 | 1 | 15.1 | -2.10 | -7.90 | -11.30 | 13.95 | |
| | 77.8 | 5.5 | 26.8 | 73 | 0.7 | 17.7 | -4.80 | -4.80 | -9.10 | 11.35 | |
| Anti | 79.2 | 3.2 | 30.9 | 76.1 | 0.3 | 12 | -3.10 | -2.90 | -18.90 | 19.37 | 15.19 |
| | 76.8 | 6.05 | 28.65 | 74.2 | 0.65 | 13.55 | -2.60 | -5.40 | -15.10 | 16.25 | |
| | 78.5 | 4.35 | 28.85 | 74.55 | 0.5 | 14.85 | -3.95 | -3.85 | -14.00 | 15.05 | |
| | 78.2 | 4.2 | 30.3 | 73.6 | 1.3 | 14.9 | -4.60 | -2.90 | -15.40 | 16.33 | |
| | 77.8 | 5.4 | 25.2 | 77.2 | 0 | 12.6 | -0.60 | -5.40 | -12.60 | 13.72 | |
| DW | 74.4 | 8 | 26.5 | 76.8 | 0.8 | 10.8 | 2.40 | -7.20 | -15.70 | 17.44 | 15.13 |
| | 76.325 | 6.45 | 28 | 73.625 | 0.9 | 14.075 | -2.70 | -5.55 | -13.93 | 15.23 | |
| | 77.125 | 5.525 | 27.825 | 73.075 | 1.375 | 16.25 | -4.05 | -4.15 | -11.58 | 12.95 | |

***Table 4. TP of Yttria multi-layered zirconia samples in different media; values are expressed as the mean (SD). (BEFORE)***

| Gr_2 | **White** | | | **Black** | | | **Difference** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | L* | a* | b* | L* | a* | b* | ΔL | Δa | Δb | TP | |
| | 78.8 | 1.1 | 31.6 | 73.7 | -1.1 | 17.4 | -5.10 | -2.20 | -14.20 | 15.25 | |
| | 76.8 | 3.2 | 29.5 | 72.4 | 0.3 | 21.8 | -4.40 | -2.90 | -7.70 | 9.33 | |
| Chx | 71.5 | 7.6 | 37.5 | 75.4 | 0.1 | 17.3 | 3.90 | -7.50 | -20.20 | 21.90 | 15.85 |
| | 75.15 | 4.35 | 34.55 | 74.55 | -0.5 | 17.35 | -0.60 | -4.85 | -17.20 | 17.88 | |
| | 74.15 | 5.4 | 33.5 | 73.9 | 0.2 | 19.55 | -0.25 | -5.20 | -13.95 | 14.89 | |
| Anti | 82.4 | -0.3 | 29.5 | 73.2 | -0.8 | 14.6 | -9.20 | -0.50 | -14.90 | 17.52 | 18.75 |
| | 79.5 | 2.2 | 31.9 | 71.9 | 0.6 | 22 | -7.60 | -1.60 | -9.90 | 12.58 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 71.4 | 9 | 41.8 | 75.1 | 1.2 | 17.6 | 3.70 | -7.80 | -24.20 | 25.69 | |
| | 76.9 | 4.35 | 35.65 | 74.15 | 0.2 | 16.1 | -2.75 | -4.15 | -19.55 | 20.17 | |
| | 75.45 | 5.6 | 36.85 | 73.5 | 0.9 | 19.8 | -1.95 | -4.70 | -17.05 | 17.79 | |
| DW | 80.6 | 0.4 | 30.55 | 73.45 | -0.95 | 16 | -7.15 | -1.35 | -14.55 | 16.27 | 17.25 |
| | 78.15 | 2.7 | 30.7 | 72.15 | 0.45 | 21.9 | -6.00 | -2.25 | -8.80 | 10.89 | |
| | 71.45 | 8.3 | 39.65 | 75.25 | 0.65 | 17.45 | 3.80 | -7.65 | -22.20 | 23.79 | |
| | 76.025 | 4.35 | 35.1 | 74.35 | -0.15 | 16.725 | -1.68 | -4.50 | -18.38 | 18.99 | |
| | 74.8 | 5.5 | 35.175 | 73.7 | 0.55 | 19.675 | -1.10 | -4.95 | -15.50 | 16.31 | |

***Table 5. TP of Yttria multi-layered zirconia samples in different media; values are expressed as the mean (SD) (AFTER)***

| Gr_2 | White | | | Black | | | Difference | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | L* | a* | b* | L* | a* | b* | ΔL | Δa | Δb | TP | |
| Chx | 80 | -0.4 | 29.2 | 72.6 | -3.1 | 17.1 | -7.40 | -2.70 | -12.10 | 14.44 | 18.84 |
| | 75.9 | 3.1 | 29.7 | 71.7 | -0.6 | 19.7 | -4.20 | -3.70 | -10.00 | 11.46 | |
| | 70 | 7.5 | 44 | 74 | -0.4 | 16.9 | 4.00 | -7.90 | -27.10 | 28.51 | |
| | 75 | 3.55 | 36.6 | 73.3 | -1.75 | 17 | -1.70 | -5.30 | -19.60 | 20.37 | |
| | 72.95 | 5.3 | 36.85 | 72.85 | -0.5 | 18.3 | -0.10 | -5.80 | -18.55 | 19.44 | |
| Anti | 79 | -0.5 | 32.4 | 71.3 | -1.8 | 16.2 | -7.70 | -1.30 | -16.20 | 17.98 | 19.88 |
| | 75.3 | 3.9 | 29.3 | 71.2 | -0.8 | 20.7 | -4.10 | -4.70 | -8.60 | 10.62 | |
| | 69.6 | 6.9 | 43.9 | 74.3 | -0.1 | 16 | 4.70 | -7.00 | -27.90 | 29.15 | |
| | 74.3 | 3.2 | 38.15 | 72.8 | -0.95 | 16.1 | -1.50 | -4.15 | -22.05 | 22.49 | |
| | 72.45 | 5.4 | 36.6 | 72.75 | -0.45 | 18.35 | 0.30 | -5.85 | -18.25 | 19.17 | |
| DW | 82.9 | -1.3 | 26.7 | 73.3 | -1.5 | 14 | -9.60 | -0.20 | -12.70 | 15.92 | 17.68 |
| | 75.5 | 4.8 | 26.6 | 71.6 | -0.4 | 19.9 | -3.90 | -5.20 | -6.70 | 9.33 | |
| | 70.1 | 9.2 | 37 | 73.3 | 0.4 | 16.6 | 3.20 | -8.80 | -20.40 | 22.45 | |
| | 74.65 | 3.375 | 37.375 | 73.05 | -1.35 | 16.55 | -1.60 | -4.73 | -20.83 | 21.41 | |
| | 72.7 | 5.35 | 36.725 | 72.8 | -0.475 | 18.325 | 0.10 | -5.83 | -18.40 | 19.30 | |

***Table 6. Translucency parameter change (%) for both groups after immersion in treatment solutions***

| **Variable** | | **Treatment solution** | | | **ANOVA test** |
|---|---|---|---|---|---|
| | | **Chlorhexidine** | **0% Alcohol** | **Distilled water** | **P value** |
| **Gr_1** | Mean±SD | $16.49^{A} \pm 1.36$ | $4.68^{B} \pm 1.46$ | $3.29^{B} \pm 1.1$ | <0.0001* |
| | 95% CI (low-high) | 14.806 – 18.176 | 2.863 – 6.490 | 1.958 – 4.620 | |
| **Gr_2** | Mean±SD | $11.486^{A} \pm 1.840$ | $6.96^{B} \pm 1.429$ | $8.95^{AB} \pm 1.587$ | 0.0875 NS |
| | 95% CI (low-high) | 9.201 – 13.770 | 5.189 – 8.737 | 6.978 – 10.917 | |
| **t-test** | P value | 0.0012* | 0.0368* | 0.0002* | |

*Different subscript letters in the same row indicate a statistically significant difference between subgroups (p < 0.05). CI; confidence intervals. *; significant (p < 0.05). Ns; non-significant (p>0.05)*

## DISCUSSION

This study aimed to evaluate the effect of different immersion solutions on the translucency parameter (TP) of two types of zirconia: monolithic zirconia (Group A) and multilayered yttria-stabilized zirconia (Group B). The changes in TP values before and after immersion were analyzed to assess the influence of chlorhexidine (CHX), 0% alcohol solution, and distilled water (DW) on the esthetic properties of these restorative materials.

The results of this study revealed that the immersion media significantly affected the translucency of both zirconia types, though the degree of alteration varied between materials and immersion conditions. In Group A (monolithic zirconia), chlorhexidine resulted in the highest TP change (16.49 ± 1.36%), suggesting a pronounced alteration in translucency, while the smallest change was observed in the DW subgroup (3.29 ± 1.1%). These findings are consistent with earlier research indicating that CHX can cause surface degradation and staining of ceramic materials due to its cationic nature and interaction with the zirconia surface [9,10].

For Group B (multilayered Y-TZP), the greatest translucency change was also seen after CHX immersion (11.49 ± 1.84%), followed by DW (8.95 ± 1.59%) and 0% alcohol (6.96 ± 1.43%). Despite the overall similarity in trends between the two groups, Group A demonstrated significantly higher TP changes after CHX exposure compared to Group B (p = 0.0012). This suggests that monolithic zirconia might be more susceptible to surface interaction with CHX solutions than multilayered structures, possibly due to differences in microstructure, grain size, or sintering protocols [11,12].

When comparing the effects of 0% alcohol immersion, Group B exhibited significantly higher TP change than Group A (p = 0.0368). This could be attributed to the multilayered design of Group B, which might be more prone to surface roughening or hydration-induced changes under alcohol-free storage conditions [13].

Interestingly, DW, typically considered inert, also caused statistically significant TP changes in both groups, with Group B again exhibiting greater changes than Group A (p = 0.0002). This finding aligns with studies demonstrating that prolonged water storage can cause low-temperature degradation (LTD) in zirconia-based ceramics, leading to surface phase transformation and increased light scattering [14,15].

The overall statistical analysis using two-way ANOVA revealed that while immersion solutions had a significant main effect on TP change (p < 0.0001), the overall difference between the zirconia types was not statistically significant (p = 0.0779). This implies that the immersion media exerted a stronger influence on translucency than the material composition alone, although material-specific interactions with each solution did exist.

Among the immersion solutions, CHX consistently induced the highest translucency change, which raises concerns about its long-term effects on zirconia restorations, particularly monolithic zirconia. Previous research has corroborated these findings, reporting that CHX can alter the optical and mechanical properties of ceramics over time due to deposition of pigmented molecules and changes in surface roughness [16].

The clinical implications of these results are noteworthy. Given the importance of translucency in the esthetic success of zirconia restorations, especially in the anterior region, practitioners should consider the potential long-term impact of common oral solutions. CHX, despite its antimicrobial advantages, may compromise the visual integration of zirconia restorations over time. Alternative disinfection methods or shorter exposure periods might be advisable to preserve translucency [17].

Moreover, the differences observed between monolithic and multilayered zirconia suggest that material selection should be based not only on mechanical performance but also on anticipated exposure to chemical agents in the oral environment.

The relative resistance of multilayered Y-TZP to CHX-induced translucency changes might favor its use in esthetically demanding areas.

### *Limitations*

This in vitro study does not fully replicate the oral environment, which involves temperature changes, saliva, and mechanical forces. The use of a single zirconia brand and limited evaluation parameters may restrict the generalizability of the findings.

## CONCLUSION

Within the limitations of this in vitro study, it can be concluded that immersion in different chemical solutions significantly affects the translucency of zirconia-based restorative materials. Chlorhexidine demonstrated the most pronounced impact on translucency for both monolithic and multilayered yttria-stabilized zirconia, raising concerns about its long-term use in patients with zirconia restorations. Monolithic zirconia exhibited greater changes in translucency compared to multilayered zirconia when exposed to chlorhexidine, indicating a higher susceptibility of the monolithic structure to surface alterations. However, in 0% alcohol and distilled water immersion, multilayered zirconia showed more translucency changes than the monolithic type, suggesting that the microstructural composition and layering may influence the material's response to various oral environments. Overall, the immersion solution had a more substantial effect on translucency than the zirconia type itself. Future research should involve clinical or in situ studies under realistic oral conditions, including various zirconia materials. Clinicians should be cautious with prolonged use of chlorhexidine around zirconia restorations due to potential aesthetic impacts.

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