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IMPACT OF TWO DIFFERENT THICKNESSES OF ULTRA TRANSLUCENT AND SUPER HIGH TRANSLUCENT ZIRCONIA ON COLOR: IN VITRO STUDY

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ABSTRACT

INTRODUCTION: Monolithic Zirconia materials are a great innovation in esthetic and restorative dentistry, where nowadays they are accepted as a veneer material where it can affect depth of the preparation, translucency, and shade of the final veneer.
OBJECTIVES: to investigate the effect of different thicknesses of Ultra and Super high Translucent Monolithic Zirconia on the translucency and the change in the final color from the selected Vita Classical shade.
MATERIALS AND METHODS: This in vitro study consisted of three groups(n=48); Three groups were tested according to different thicknesses of the material to be used: (Group I) (UTML) Katana (preshaded). (Group II) (STML) DD cubeX2 ML 98 (preshaded). (Group III) (ST) DD cubeX2 98(white). Each group was divided into two subgroups at different thicknesses of 0.5 mm and 0.7 mm. Each subgroup consisted of eight specimens of zirconia that were cut in the form of a disk. The shade was determined digitally using Easy shade V spectrophotometer.
RESULTS: The color was affected by the type of the Monolithic Zirconia while the translucency was significantly affected by the thickness and the type of Monolithic Zirconia. There was a significant increase in the Transparency Parameter of the Monolithic Zirconia specimens as we decrease the thickness of the specimen (p value < 0.05).
CONCLUSION: Within the limitations of this study, Ultra Translucent Multilayered was shown to have the highest transparency parameter among the different thicknesses where the 0.7 mm was the minimum thickness required for monolithic zirconia to achieve the corresponding Vita classical shade.

KEYWORDS: Monolithic Zirconia, Transparency parameter (TP), Color difference (ΔE) .
RUNNING TITLE: Effect of thickness on color of Monolithic Zirconia.

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INTRODUCTION

In the last few years, companies and researchers have made great efforts to produce dental ceramics with similarity for physical and mechanical properties of natural teeth (1-3). This has resulted in invention of different types of dental ceramics such as feldspathic ceramics, leucite, lithium disilicate, fluorapatite glass ceramics, zirconia ceramics, zirconia reinforced lithium silicate (4-6) and hybrid ceramics (7-9). Different types of all-ceramic restoration such as laminate veneer, glass ceramic, and zirconia restorations have been employed in dentistry. (10) Ceramic material should have two main requirements: excellent mechanical property and adquate esthetics (11,12) where, all ceramic restorations allow greater light transmission thus improving the optical properties A ceramic with these two important features would work efficiently in the oral environment while providing a similar tooth appearance (13).The esthetic appearance of ceramic restorations and its ability to perfectly blend with the natural appearance of the natural dentition is greatly linked (14).

There are several factors affecting the acceptable esthetic appearance of ceramic restorations according to the clinical situation; the suitable ceramic material (15), thickness (16) and its shade (17) also zirconia restoration features can impact the resulting color and translucency. All these factors with corresponding to its mechanical properties (18-21).

The main disadvantage of zirconia-based type is its low esthetic performance due to its opaqueness and it is in ability to achieve acceptable transparency (22). However, there are many modifications in the composition, manufacturing processes and laboratory procedures were done that have led to the development monolithic zirconia with superior translucency. Ultra-Translucent (UT) and Super high Translucent (ST) zirconia, both are available in multilayer products Ultra Translucent Multilayer (UTML) and Super Translucent Multilayer (STML).

Color and translucency are essential elements in matching ceramic restorations with natural teeth (23). Translucency parameter (TP) is one of the most common optical properties that are investigated for monolithic zirconia ceramics.

The esthetic value of all ceramic restorations is not only affected by the intrinsic translucency and shade of the restorative material but also by its thickness, surface glaze and texture. Monolithic zirconia restorations are rough. Therefore, glazing is required to provide the best biological and esthetic integration. After glazing the ceramic surface, it gives a higher strength, smoothness and stability in color and translucency (24-26).

Therefore, the purpose of this in vitro study; is to study, the final color obtained when Vita Classical shade guide was applied for 0.5mm & 0.7mm thicknesses of ultra and super high translucent Monolithic Zirconia from companies other than Vita company, the null hypothesis is that the thickness of Monolithic Zirconia ceramic would not affect its final color and the Vita Classical shade guide would be compatible with other types of zirconia.

MATERIALS AND METHODS

- This in vitro study included three groups **16 discs** per group (number of groups=3) (Total sample size = 48 discs):
- This study will include 3 groups:

  Group I (n=16): Katana UTML. (Preshaded) (8 specimens of each thickness 0.5 mm &0.7 mm thickness),group II (n=16): DD cubeX^2 ML 98.(Preshaded) (8 specimens of each thickness 0.5 mm & 0.7 mm thickness),group III (n=16): DD cubeX^2 98. (White) (8 specimens of each thickness 0.5 mm & 0.7 mm thickness).
- Materials used in this study include:

- Ultra-Translucent Multilayer zirconia (katana) (Japan).
- Super high Translucent Multilayer zirconia (DD cube X^2 98ML) (Germany).
- Super high Translucent zirconia (DD cube X^2 98) (Germany).
- A2 shade liquid DD proshade C Dental Direkt GmbH).
- 3M Filtek Z350 XT Composite resin shade A2 .
- Glaze of katana UTML (Japan) zirconia CZR-press.
- Glaze of Super high Translucent (Germany) DD nature ZR.

Preparation and coloring of Zirconia specimens'

Forty eight discs For the three groups of diameter 10 mm were prepared, (24 specimens of thickness 0.5 equally were distributed 8 specimens for each subgroup for the three groups) and (24 specimens of thickness 0.7 equally were distributed 8 specimens for each subgroup of the three groups) were designed and milled (DWX-52D, Roland DGA Co, California, USA) and The milled discs were sintered by a sintering furnace (Mihm-Vogt high temperature furnace, Mihm-Vogt Gmbh & Co, Germany) according to the manufacturer's instructions for each group as follow:

Group I was sintered at 1550 °C for 2h followed by application of its glaze (CZR – press) at 850 °C and so we will obtain the required shade A_2,group II was sintered at 1450 °C for 2h followed by application of its glaze (DD nature ZR) at 850 °C and so we will obtain the required shade A_2,group III A_2 shade produced through colorization DD proshade C Dental Direkt GmbH) immersing for 5 seconds then dryness for 45 minutes under a lamp. The specimens were sintered at a maximum temperature of 1520 °C for 12 hours in a sintering furnace followed by application of its glaze (DD nature ZR) at 850 °C and so we will obtain the required shade A_2. The thickness was checked for accuracy using 6- inch stainless steel digital caliper.

Preparation of shade A_2 composite discs

A disc of 10 mm diameter of dental composite shade A2 was fabricated. A silicone putty impression material was applied in aluminum ring to be flushed with its edges and 0.7 mm of zirconia disk was dipped to be flushed with the surface to make a mold for the composite resin of 10 mm diameter and 0.7 mm thickness, zirconia disk was removed after the set of silicone impression material, the composite resin was applied in the mold and covered with celluloid strip to the surface to obtain smooth composite surface. The composite was polymerized with a light-polymerizing unit with an intensity of 800 mW/cm2 for 40 seconds.

Testing of Shade

The shade tab A_2 of a VITA classical shade guide was selected. The shade tab CIE Lab values was measured at the center of its middle third with the VITA Easy shade V spectrophotometer and considered as the CIE Lab values of this control shade at the day light (L*=81.1, a*=0.3, b*=22.4).

Transparency parameters (TP) and Shade determination were conducted 3 times for each specimen, and the CIE Lab values were recorded. Color difference values (ΔE) were calculated to compare the CIE Lab values of a specimen with the CIE Lab values of the control color.

The following formula was used to calculate (ΔE):

$(\Delta E) = [(L_2 - L_1)^2 + (a_2 - a_1)^2 + (B_2 - B_1)^2]^{1/2}$.

The following formula was used to calculate (TP):

$(TP) = [(L_{Black} - L_{White})^2 + (a_{Black} - a_{White})^2 + (B_{Black} - B_{White})^2]^{1/2}$.

A threshold for acceptability ($\Delta E \leq 3.3$) was proposed to check the difference in color (22).

Data management and statistical analysis

Data were analyzed using IBM SPSS statistical software (version 23) and significance was set at p value < 0.05. Normality was checked using descriptive statistics, plots (histogram, boxplots) and tests of normality. All quantitative variables showed normal distribution, so means and standard deviations (SD) were calculated, and parametric tests were used. Numbers and percentages were calculated for qualitative variables (final shade) and comparison was done using chi-square test. One-way ANOVA was used for comparing Transparency Parameter coordinates of the three study groups (different materials), and the six study subgroups (different materials with different thicknesses) at different parts of the specimen. T-test was used for comparing the two different thicknesses at different parts of the specimen. Multivariate analysis of variance (MANOVA) was used to assess the effect of different materials and thicknesses on the final color (ΔE). Regression coefficients (B), 95% confidence intervals (CI) and adjusted R^2 were calculated.

RESULTS

1. **Transparency Parameter coordinates of the three study groups tested on white and black paper.**

When comparing the Transparency Parameter between the three groups at three different areas bottom, middle and upper areas (Table 1, Figure 1, 2)

There is a significant difference in TP at the middle area for the three groups. The TP at the middle area for (group I) (21.60 ± 2.07), for (group II) (19.67 ± 2.32) and for (group III) (21.40 ± 1.62) by applying Paired-t test showed that there was a highly statistically significant difference**(P value=0.02)**. The average TP (group I) (21.67 ± 1.95), the average TP (group II) (20.28 ± 1.90) and the average TP (group III) (21.68 ± 1.85) by applying Paired-t test showed that there was no statistically significant difference (**P value=0.07).** Group I had the highest transparency parameter TP at the middle part of the discs than the other two groups.

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Table (1): Transparency Parameter coordinates of the three study groups tested on white and black paper.

Part of the specimen	Color coordinates		Group I (n=16)	Group II (n=16)	Group III (n=16)	One-Way ANOVA P value
			Mean ± SD			
Bottom	White paper	L*	97.54 ± 1.24^{a}	96.45 ± 1.54^{a}	93.43 ± 0.90^{b}	**<0.001***
		a*	1.27 ± 0.43^{a}	2.10 ± 0.47^{b}	0.73 ± 0.35^{c}	**<0.001***
		b*	21.56 ± 2.41^{a}	15.85 ± 2.18^{b}	24.49 ± 4.96^{a}	**<0.001***
	Black paper	L*	77.33 ± 1.95^{a}	77.27 ± 1.09^{a}	74.19 ± 2.11^{b}	**<0.001***
		a*	2.19 ± 0.59^{a}	3.46 ± 0.44^{b}	1.86 ± 1.25^{a}	**<0.001***
		b*	13.55 ± 2.38^{a}	8.48 ± 1.84^{b}	14.29 ± 4.57^{a}	**<0.001***
	TP		21.68 ± 2.13	20.58 ± 1.74	21.72 ± 2.34	0.23
Middle	White paper	L*	97.85 ± 1.35^{a}	95.82 ± 1.72^{b}	93.16 ± 0.77^{c}	**<0.001***
		a*	1.83 ± 0.47^{a}	2.60 ± 0.54^{b}	0.82 ± 0.46^{c}	**<0.001***
		b*	18.85 ± 2.30^{a}	14.33 ± 2.09^{b}	23.86 ± 4.88^{c}	**<0.001***
	Black paper	L*	77.64 ± 1.98^{a}	77.22 ± 1.06^{a}	74.03 ± 1.99^{b}	**<0.001***
		a*	2.65 ± 0.47^{a}	3.69 ± 0.49^{b}	1.94 ± 1.10^{a}	**<0.001***
		b*	11.35 ± 2.05^{a}	7.73 ± 1.67^{b}	14.43 ± 4.58^{c}	**<0.001***
	TP		21.60 ± 2.07^{a}	19.67 ± 2.32^{b}	21.40 ± 1.62^{a,b}	**0.02***
Upper	White paper	L*	99.19 ± 0.79^{a}	97.61 ± 1.13^{b}	93.56 ± 0.91^{c}	**<0.001***
		a*	2.01 ± 0.45^{a}	2.91 ± 0.49^{b}	0.79 ± 0.45^{c}	**<0.001***
		b*	16.81 ± 1.80^{a}	12.88 ± 1.90^{b}	23.75 ± 4.77^{c}	**<0.001***
	Black paper	L*	78.68 ± 1.97^{a}	78.10 ± 1.23^{a}	73.94 ± 2.27^{b}	**<0.001***
		a*	2.72 ± 0.40^{a}	3.84 ± 0.55^{b}	2.01 ± 1.25^{a}	**<0.001***
		b*	9.89 ± 1.76^{a}	6.67 ± 1.81^{b}	14.56 ± 4.78^{c}	**<0.001***
	TP		21.75 ± 1.87	20.59 ± 2.13	21.92 ± 2.04	0.14
Average of the 3 parts	White paper	L*	98.19 ± 1.00^{a}	96.63 ± 1.37^{b}	93.38 ± 0.78^{c}	**<0.001***
		a*	1.70 ± 2.54^{a}	2.54 ± 0.49^{b}	0.78 ± 0.39^{c}	**<0.001***
		b*	19.07 ± 2.11^{a}	14.35 ± 2.02^{b}	24.03 ± 4.82^{c}	**<0.001***
	Black paper	L*	77.88 ± 1.90^{a}	77.52 ± 0.99^{a}	74.05 ± 2.09^{b}	**<0.001***
		a*	2.52 ± 0.47^{a}	3.67 ± 0.47^{b}	1.94 ± 1.25^{a}	**<0.001***
		b*	11.60 ± 1.98^{a}	7.62 ± 1.70^{b}	14.43 ± 4.55^{c}	**<0.001***
	TP		21.67 ± 1.95	20.28 ± 1.90	21.68 ± 1.85	0.07

Group I: UTML (Katana) (Pre-shaded)
Group II: STML (DD cube×2 ML 98) (Pre-shaded)
Group III: ST (DD cube×2 98) (White)
*statistically significant at p value < 0.05

^{a,b,c} different superscripted letters denote statistically significant differences between groups using Bonferroni adjustment for multiple pairwise comparisons

Supplementary Table (1): Materials used in the study

Material	Manufacturer	Composition (Wt. %)	Batch Number	Reference no
UTML	Kuraray Noritake Dental, Tokyo, Japan	$ZrO_2 + HfO_2$ 87–92% $Y2O_3$ 8–11% other oxides 0-2%	GS1-128 0120	125-3343
DD cube x2 98MLZirconia STML	Dental Direkt GmbH, Germany	$ZrO_2 + HfO_2 \geq$ 99,0 $Y_2O_3 < 10$ $Al_2O_3 < 0.01$ Other oxides< 1.0	1,234	G852001
Super high translucent zirconia DD cube x2 98). (white)	Dental Direkt GmbH, Germany	$ZrO_2 + HfO_2 \geq$ 99,0 $Y_2O_3 < 10$ $Al_2O_3 < 0.01$ Other oxides< 1.0	1,237	G713

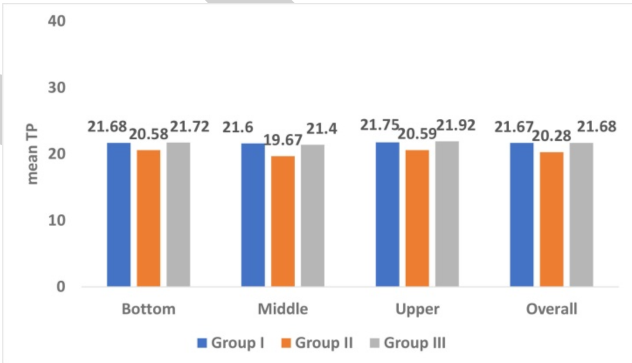

Figure (1): Transparency Parameter (TP) at different parts of the specimen in the three study groups tested on white and black paper

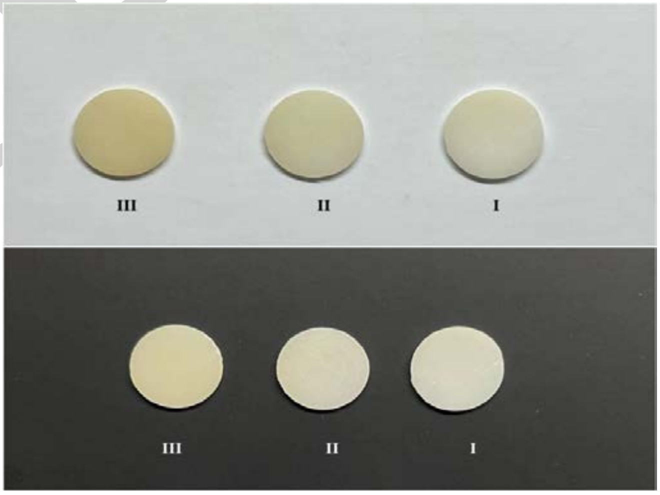

Figure (2): Transparency Parameter (TP) at different parts of specimens of different thicknesses tested on white and black paper

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The average TP (group I) (21.67 ± 1.95), the average TP (group II) (20.28 ± 1.90) and the average TP (group III) (21.68 ± 1.85) by applying Paired-t test showed that there was no statistically significant difference (**P value=0.07).** Group I had the highest transparency parameter TP at the middle part of the discs than the other two groups.

2. Transparency Parameter coordinates of different specimen thicknesses tested on white and black paper.

When comparing the transparency parameter between the different thicknesses of all the specimens at three different areas bottom, middle and upper areas (Table 2, Figure 3). The average TP for 0.5 mm thickness (22.89 ± 1.07) while (19.53 ± 0.97) for 0.7 mm thickness by applying Paired-t test showed that there was a highly statistically significant difference (**P value<0.001).**

Table (2): Transparency Parameter coordinates of different specimen thicknesses tested on white and black paper

Part of the specimen	Color coordinates		0.5 mm (n= 24)	0.7 mm (n= 24)	T-test P value
			Mean ± SD		
Bottom	White paper	L*	96.44 ± 2.24	95.17 ± 1.88	**0.04***
		a*	1.53 ± 0.74	1.20 ± 0.64	0.11
		b*	18.63 ± 3.28	22.64 ± 5.53	**0.004***
	Black paper	L*	75.05 ± 2.27	77.47 ± 1.56	**<0.001***
		a*	2.98 ± 0.66	2.03 ± 1.21	**0.002***
		b*	10.20 ± 2.73	14.02 ± 4.28	**0.001***
	TP		22.99 ± 1.55	19.66 ± 0.96	**<0.001***
Middle	White paper	L*	96.30 ± 2.51	94.92 ± 1.98	**0.04***
		a*	1.98 ± 0.85	1.51 ± 0.86	0.06
		b*	17.01 ± 3.16	21.02 ± 5.92	**0.006***
	Black paper	L*	75.19 ± 2.33	77.40 ± 1.81	**0.001***
		a*	3.24 ± 0.65	2.28 ± 1.25	**0.002***
		b*	9.13 ± 2.35	13.20 ± 4.44	**<0.001***
	TP		22.60 ± 1.15	19.17 ± 1.44	**<0.001***
Upper	White paper	L*	97.23 ± 2.62	96.35 ± 2.50	0.24
		a*	2.10 ± 0.95	1.70 ± 1.01	0.17
		b*	16.20 ± 3.58	19.43 ± 6.58	**0.04***
	Black paper	L*	75.70 ± 3.06	78.12 ± 1.94	**0.002***
		a*	3.32 ± 0.72	2.39 ± 1.24	**0.003***
		b*	8.30 ± 2.43	12.44 ± 5.10	**0.001***
	TP		23.07 ± 1.08	19.77 ± 1.35	**<0.001***
Average of the 3 parts	White paper	L*	96.66 ± 2.40	95.48 ± 2.04	0.07
		a*	1.87 ± 0.82	1.47 ± 0.83	0.10
		b*	17.28 ± 3.25	21.03 ± 5.96	**0.01***
	Black paper	L*	75.31 ± 2.51	77.66 ± 1.69	**<0.001***
		a*	3.18 ± 0.66	2.24 ± 1.22	**0.002***
		b*	9.21 ± 2.37	13.22 ± 4.49	**<0.001***
	TP		22.89 ± 1.07	19.53 ± 0.97	**<0.001***

*Statistically significant at p value < 0.05

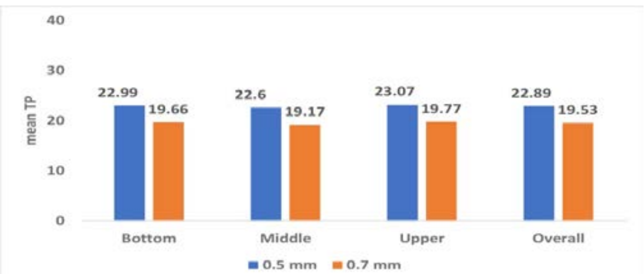

Figure (3): Group (I), Group (II) and Group (III) on a glossy white and black paper

Supplementary Table (2): Auxiliary materials used in the study.

Material	Manufacturer	Composition (Wt.%)
Glaze of katana UTML zirconia CZR-press	Kuraray Noritake Dental, Tokyo, Japan	Potassium alumino-silicate glass - Pigments - Glycerol - 1,3-Butanediol
Glaze of super high translucent DD nature ZR	Dental Direkt GmbH, Germany	Propylene glycol ≥ 90,0% Zinc chloride < 0,1% Glycerol < 30%
A2 shade liquid DD proshade C Dental Direkt GmbH).	Dental Direkt GmbH, Germany	Erbium(III)-chloride Iron(III)-chloride Hexahydrate hydrogen chloride
3M Filtek Z350 XT Composite resin shade A2	3M, ESPE and Filtek are trademarks of 3M or 3M ESPE	Average cluster particle size of 0.6 to 10 microns. The nanoinorganic filler loading is about 78.5% by weight (63.3% by volume).
Condenstation Silicone Speedex	Coltene, swizerland	Alkyl silicates 15 - < 20 % Dioctyltindineodecanoate 5 - < 10 %

3. Comparison of the final shade of different parts of the specimen in the three study groups

When comparing change in the final color from the selected Vita Classical shade for the three groups in the three different parts of the disc bottom, middle and upper areas. The shade A2 is most commonly in group III in the bottom, middle and upper area (56.3%) **P^{MC} <0.001**. (Table 3, Figure 4)

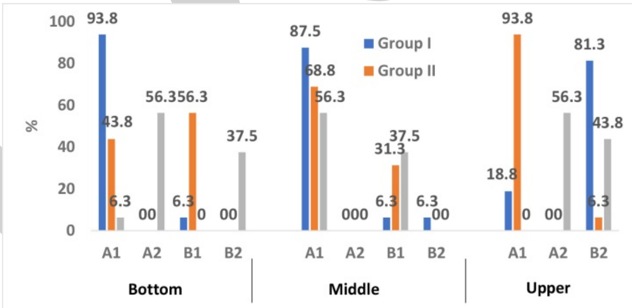

Figure (4): Final shade of different parts of the specimen in the three study groups

Table (3): Comparison of the final shade of different parts of the specimen in the three study groups

Part of the specimen	Shade	Group I (n=16)	Group II (n=16)	Group III (n= 16)	X^2 P value
		N (%)			
Upper	A1	15 (93.8%)	7 (43.8%)	1 (6.3%)	**P^{MC} <0.001***
	A2	0 (0%)	0 (0%)	9 (56.3%)	
	B1	1 (6.3%)	9 (56.3%)	0 (0%)	
	B2	0 (0%)	0 (0%)	6 (37.5%)	
Middle	A1	14 (87.5%)	11 (68.8%)	1 (6.3%)	**P^{MC} <0.001***
	A2	0 (0%)	0 (0%)	9 (56.3%)	
	B1	1 (6.3%)	5 (31.3%)	0 (0%)	
	B2	1 (6.3%)	0 (0%)	6 (37.5%)	
Bottom	A1	3 (18.8%)	15 (93.8%)	0 (0%)	**P^{MC} <0.001***
	A2	0 (0%)	0 (0%)	9 (56.3%)	
	B2	3 (81.3%)	1 (6.3%)	7 (43.8%)	

Group I: UTML (Katana) (Pre-shaded)
Group II: STML (DD cube×2 ML 98) (Pre-shaded)
Group III: ST (DD cube×2 98) (White)
X^2: Chi-squared test
P^{MC}: Monte Carlo corrected p value
*Statistically significant at p value < 0.05

Supplementary Table (3): Comparison of Transparency Parameter (TP) and color change (ΔE) in the three study groups with different thicknesses

			Group I	Group II	Group III	One-Way-ANOVA P value
			Mean ± SD			
0.5 mm	Bottom	TP	23.23 ± 1.82 a,b	21.89 ± 1.23 a	23.85 ± 0.88 b	0.03*
		ΔE	9.92 ± 1.95 a	12.10 ± 1.99 a	5.33 ± 1.26 b	<0.001*
	Middle	TP	23.24 ± 1.43 a	21.78 ± 0.78 b	22.79 ± 0.66 a,b	0.03*
		ΔE	8.84 ± 1.89 a	11.08 ± 1.90 b	5.35 ± 1.18 c	<0.001*
	Upper	TP	23.31 ± 1.13	22.45 ± 0.81	23.46 ± 1.09	0.13
		ΔE	7.61 ± 2.18 a,b	10.19 ± 2.43 a	5.21 ± 1.19 b	<0.001*
	Average of 3 parts	TP	23.26 ± 1.31 a	22.04 ± 0.66 b	23.36 ± 0.62 a	0.02*
		ΔE	8.79 ± 1.89 a	11.12 ± 1.95 b	5.30 ± 1.17 c	<0.001*
0.7 mm	Bottom	TP	20.12 ± 0.92	19.28 ± 1.07	16.59 ± 0.80	0.21
		ΔE	9.66 ± 1.41 a	11.26 ± 1.50 a	4.13 ± 1.86 b	<0.001*
	Middle	TP	19.95 ± 0.94 a	17.55 ± 0.81 b	20.01 ± 0.89 a	<0.001*
		ΔE	7.53 ± 1.78 a	10.19 ± 0.95 b	3.68 ± 2.11 c	<0.001*
	Upper	TP	20.18 ± 0.78 a,b	18.74 ± 1.09 a	20.38 ± 1.53 b	0.02*
		ΔE	6.37 ± 2.25 a	9.69 ± 1.30 b	4.59 ± 2.19 a	<0.001*
	Average of 3 parts	TP	20.08 ± 0.79 a	18.53 ± 0.51 b	19.99 ± 0.68 a	<0.001 *
		ΔE	7.85 ± 1.73 a	10.38 ± 0.97 b	4.13 ± 1.84 c	<0.001*

Group I: UTML (Katana) (Pre-shaded)
Group II: STML (DD cube×2 ML 98) (Pre-shaded)
Group III: ST (DD cube×2 98) (White)
*statistically significant at p value < 0.05

^{a,b,c} different letters denote statistically significant differences between groups using Bonferroni adjustment for multiple pairwise comparisons

DISCUSSION

The objectives of the current study were to investigate the effect of three different materials with different translucencies on the color potential, transparency parameter, how they were affected by the thickness of the specimens and methods of coloring used. The vita easy shade spectrophotometer was performed on the three different materials with two different thicknesses to check the required shade.

Many studies have defined the color reproduction ability of different ceramics (27) by calculating difference in color (ΔE) from the corresponding vita classical shade ,a spectrophotometer measures CIELab values of the restoration and the toothaccording to a formula, their color difference (ΔE) is determined. (21,28) Then the (ΔE) value is compared with a threshold for acceptability to determine whether the color difference is clinically acceptable. (21,29)

Translucency is a very important optical property for the appearance of a ceramic material (30). Translucency is the property by which a great portion of the transmitted light includes diffusion so that objects on the opposite side are not clearly seen. To quantify translucency, several optical properties are defined for a ceramic, with a specified thickness ranging commonly between 0.5 and 1 mm. These properties include visible light transmittance percentage (VLTP), translucency parameter (TP), and contrast ratio (CR) (30-32).

Regarding the transparency parameter among the three groups there was only a significant difference at the middle area of all the three groups also the 0.5 mm had significantly higher TP than 0.7 mm in upper and middle parts of the specimen, whereas we increased the thickness from 0.5 mm thickness to 0.7 the TP decreases

There is an agreement with Sulaiman et al.,(2015) (33) who showed that the translucency is inversely proportion with the thickness of monolithic zirconia ,also Wang et al., (2013) (34)who reported that the translucency of dental ceramics was greatly affected by two important factors which are the material type and it's thickness. the translucency of all materials increased exponentially as the thickness decreased.Which also in agreement with Shamseddine et al., (2017) (35) who reported that as we increase the thickness between 0.6 and 0.8 mm and between 0.6 and 1 mm there is a difference in the TP.

The results for the transparency parameter for the three groups of the average of the bottom , middle and upper areas showed that group I was more translucent than group II and group III this might be due to difference in the category of translucency between the materials , material brand , methods of coloring either preshaded blanks or shaded by laboratory coloring and also its chemical nature where UTML had less percentage of ZrO_2 + HfO_2 than the other two groups, lower amounts of alumina, added dopant oxides were able to segregate at ZrO_2 grain boundaries in Y-TZP ceramics and dopant segregation was a decisive parameter in ensuring hydrothermal stability and high translucency(36-37)this coincide with and the higher Y_2O_3 content tended to raise the amount of cubic phase present in ZrO_2.

One of the ways to improve the color and translucency features of monolithic ZrO_2 was to increase the sintering temperature and time (38) which was found in group I and group III.

This study showed that (Group I) (UTML) Katana (preshaded) has the highest transparency parameter among the three groups either in the 0.5 mm thickness or 0.7 mm thickness which is in agreement with Harada et al., (2014) (39) who demonstrated that UTML has higher transmittance (T%) .

There is agreement with Shamseddine et al., (2017) (35) Who reported that theUTML material gives a more natural appearance than other monolithic zirconia restorations

There is no agreement with Wang et al., (2013) (34) showed The TP values of the glass ceramics ranged from 2.2 to 25.3 and the zirconia ceramics from 5.5 to 15.1 while in this study the TP for the Group I (UTML) Katana up to 23.26 ± 1.31 which is very close to the translucency of the glass ceramics.

Subaşı et al., (26) reported that at a thickness of 1.5 mm industrial colored zirconia showed a higher translucency value than preshaded monolithic zirconia where in this study the preshaded katana UTML showed a significantly higher translucency value than the white DD cube X^2 98 STML that was externally shaded by dipping technique at both 0.5 mm thickness and 0.7 mm thickness.

The results showed that the 0.7 mm thickness of group III super high translucent zirconia had the best results according to the selected Vita Classical shade guide (shade A_2) for the final color. when applied for all subgroups which is might be due to thickness effect from 0.5 mm to 0.7 mm the difference in color (ΔE) decreased towards the acceptable threshold, where the 0.7 mm thickness is the thickness of choice, there is no agreement with Tabatabaian et al., (2018) (13) who concluded that a minimum thickness of 0.9 mm was needed for color matching of high translucency monolithic zirconia ceramics, where in this study the minimum thickness for color matching is 0.7 mm thickness in group III super high translucent zirconia. The study is in agreement with Chien-MingKang et al., (2020) (40) who concluded that color accuracy was greatly affected by the type of monolithic multilayer precolored zirconia ceramic more than the thickness where as we increase the amount of yttria oxide resulted into increase in cubic phase that leads to increase in transparency and so it will lead to increase in the amount of light entering and scattering of zirconia so it will affect the final color and leads to color mismatch.

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LIMITATIONS OF THE STUDY

1. These results might not be reproducible in normal teeth according to variation in thickness and shade of the normal dentine.
2. We could Adding different thicknesses for the Multilayered specimens so we could achieve the optimum thickness for the corresponding shade.

CONCLUSIONS

Within the limitation of this study,

1- UTML was shown have the highest transparency parameter among the different thicknesses.
2- The minimum thickness of Monolithic Zirconia for shade matching was 0.7 mm.
3- Any increase in the thickness of the specimen will decrease the difference in color.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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