http://dx.doi.org/10.1590/1981-86372023002520220075

| ORIGINAL

Translucency and masking ability of a translucent zirconia with different thicknesses over dark backgrounds

Translucidez e capacidade de mascaramento de uma zircônia translúcida com diferentes espessuras sobre substratos escuros

Renan Vaz **MACHRY**[1] 0000-0002-4658-9717
Michele Mirian **MAY**[1] 0000-0001-8107-3145
Ana Carolina **CADORE-RODRIGUES**[1] 0000-0002-7957-0350
Letícia Borges **JACQUES**[1] 0000-0002-0281-779X
Liliana Gressler **MAY**[1] 0000-0002-4572-6142

ABSTRACT

Objectives: To evaluate the translucency, contrast ratio and masking ability of a translucent zirconia with different thicknesses. **Methods**: Disc shaped specimens (n= 3) with 10 mm (Ø) x 1.5 mm, 1 mm and 0.7 mm (thickness) were manufactured simulating all-ceramic simplified restorations. Substrate discs (n= 2; Ø: 10 mm; thickness: 2 mm) were simulated with composite resin shades: A2 (positive control) and C4; and metal alloys: silver (Ni-Cr) and golden (Cu-Al). Optical properties of the 9 translucent zirconia specimens placed on the 3 different substrates were analyzed by a spectrophotometer. The color variation (*ΔE00*) between each ceramic structure over the positive control substrate (A2) and over the dark backgrounds (C4, silvery, golden) were obtained as to their ceramic masking ability and subjected to non-parametric Kruskal Wallis test (5%). The translucency parameter (TP00) and contrast ratio (CR) of the different thicknesses of the ceramic discs were also collected and analyzed by one-way ANOVA and the Tukey test (5%). **Results**: The translucent zirconia showed greater opacity in the thickness of 1.5 mm, although it was not statistically different between 0.7 and 1.0 mm. All dark backgrounds significantly affected the final color of the simplified restoration in all evaluated thicknesses. However, the increase in ceramic thickness showed a decrease in *ΔE00* values for all substrates. **Conclusion**: The translucent zirconia was not able to mask the dark substrates, independent of the evaluated thickness.

Indexing terms: Ceramics. Color. Composite Resins. Computer-aided design.

RESUMO

Objetivos*: Avaliar a translucidez, razão de contraste e capacidade de mascaramento de uma zircônia translúcida com diferentes espessuras.* ***Métodos****: Espécimes em forma de disco (n= 3) com 10 mm (Ø) x 1,5 mm, 1 mm e 0,7 mm (espessura) foram confeccionados simulando restaurações simplificadas em cerâmica pura. Discos de substrato (n= 2; Ø: 10 mm; espessura: 2 mm) foram simulados com as cores de resina composta: A2 (controle positivo) e C4; e ligas metálicas: prata (Ni-Cr) e ouro (Cu-Al). As propriedades ópticas*

[1] Universidade Federal de Santa Maria, Programa de Pós-Graduação em Ciências Odontológicas, Ênfase em Prótese Dentária. Av. Roraima, 1000, Prédio 26F, 97105-900, Santa Maria, RS, Brasil. Correspondence to: RV Machry. E-mail: <renanmachry@gmail.com>.

How to cite this article

Machry RV, May MM, Cadore-Rodrigues AC, Jacques LB, May LG. Translucency and masking ability of a translucent zirconia with different thicknesses over dark backgrounds. RGO, Rev Gaúch Odontol. 2023;71:e20230025. http://dx.doi.org/10.1590/1981-86372023002520220075

dos 9 espécimes de zircônia translúcida posicionados nos 3 substratos diferentes foram analisadas por um espectrofotômetro. A variação de cor (ΔE00) entre cada espécime cerâmico sobre o substrato controle positivo (A2) e sobre os fundos escuros (C4, prateado, dourado) foi calculada quanto à capacidade de mascaramento da cerâmica e submetida ao teste não paramétrico de Kruskal Wallis (5%). O parâmetro de translucidez (TP00) e a razão de contraste (CR) das diferentes espessuras dos discos cerâmicos também foram coletados e analisados por ANOVA de uma via e teste de Tukey (5%). ***Resultados****: A zircônia translúcida apresentou maior opacidade na espessura de 1,5 mm, embora não tenha sido estatisticamente diferente entre 0,7 e 1,0 mm. Todos os fundos escuros afetaram significativamente a cor final da restauração simplificada em todas as espessuras avaliadas. No entanto, o aumento da espessura da cerâmica mostrou uma diminuição nos valores de ΔE00 para todos os substratos.* ***Conclusão****: A zircônia translúcida não foi capaz de mascarar os substratos escuros, independente da espessura avaliada.*

Termos de indexação*: cerâmicas. Cor. Resinas compostas. Desenho assistido por computador.*

INTRODUCTION

Dentistry currently has different materials for prosthetic rehabilitation of dental elements with extensive coronary destruction [1]. Yttrium-stabilized zirconia (YSZ) has been used to manufacture all-ceramic restorations to avoid the risk of chipping, which is one of the main reported failures of bilayer-based of fixed dental prostheses (FDPs) with zirconia infrastructure [2,3]. The use of a new class of ceramic material, namely third generation zirconia, has been proposed for use in restorative dentistry [2].

In comparison to the second generation, the newest generation of zirconia contains an increased percentage of yttrium oxide resulting in the presence of cubic phase in its crystalline microstructure [2]. The cubic crystals have a higher volume compared to tetragonal crystals, allowing the light to scatter less strongly at the grain boundaries and making the material more translucent [2]. Moreover, the presence of crystals in the cubic phase presents greater isotropy in its composition when compared to crystals stabilized in the tetragonal form of previous generations, thereby significantly influencing translucency [2]. The third generation used in all-ceramic restorations is less translucent than glass ceramics, but also less sensitive to the variation of thickness in terms of translucency [4,5].

Reproducing natural characteristics of teeth is an important aspect that influences the success of restorative dental treatments. The esthetic success of a ceramic restoration not only depends on its size, shape and texture, but also on optical properties such as translucency and color [6,7]. In this sense, a ceramic system with more translucent characteristics provides a natural appearance due to greater light transmission through the restoration. However, the final color of more translucent ceramics could easily be influenced by the shade of the underlying structures [7]. Prosthetic preparations may be done on different materials such as composite resin, metal alloys and dentin reminiscent, presenting significant differences in mechanical behavior and esthetic parameters between these options [8].

Moreover, another clinical advantage of fixed prostheses in all-ceramic zirconia is the significantly reduced material thickness compared to conventionally produced ceramics or other all-ceramic ceramics [4]. This can allow all-ceramic restorations to have minimal thickness, presenting satisfactory behavior under load application and consequently greater preservation of the remaining dental structure [9]. However, it is imperative to evaluate the translucency degree of the translucent zirconia and their ability to mask the substrates when applied in different restoration thicknesses.

Therefore, the aim of this study was to compare the contrast ratio and the translucency parameter of translucent zirconia-based restorations with different thicknesses, as well as to evaluate their influence in masking substrates with different color and materials. The null hypotheses of this study are: (1) no translucency difference may be observed in different thicknesses of zirconia simplified restorations; and (2) different thicknesses promote similar masking of substrates with different colors and materials.

METHODS

This in vitro study had a design with the following two factors: all-ceramic zirconia thickness (in three levels - 1.5 mm, 1 mm and 0.7 mm) and substrates (in three levels - C4, silvery and golden). The A2 substrate was used as control.

The materials (commercial name, manufacturers, batch numbers and composition) used in this study are described in table 1.

Table 1. Commercial name, manufacturer, batch number and composition of the materials used in this in vitro study.

Material	Commercial name, manufacturer (batch number)	Composition
Zirconia	IPS e.Max ZirCAD MT Multi, Ivoclar Vivadent (W82689)	ZrO_2 86 – 93.5 wt%, Y_2O_3 > 6.5 % – ≤ 8.0 wt%, HfO_2 ≤ 5.0 wt%, Al_2O_3 ≤ 1.0 wt%, other oxides ≤ 1.0 wt%
Composite Resin	Z350, 3M ESPE (A2:761679; C4: 1812600567)	UDMA, Bis-GMA, Bis-EMA, PEGDMA, TEGDMA, Silica, Zirconia
Silvery Metallic alloy	4all, Ivoclar Vivadent (T32718)	Ni 61.4%, Cr 25.7%, Mo 11.0%, Si 1.5%, Mn <1.0%, Al <1.0%, C <1.0%
Golden Metallic alloy	Golden Cast, Talmax (10010180220)	Al 9%, Cr 4%, Si 2%, Cu: Balance

Preparation of ceramic discs

Pre-sintered blocks of translucent all-ceramic zirconia ceramic (IPS e.Max ZirCAD MT Multi; Ivoclar Vivadent, Schaan, Liechtenstein) were shaped into cylinders using 600-1200 grit SiC paper (3M, St Paul, USA) under water cooling. The resulting zirconia cylinder was then sectioned using a precision cutting machine (ISOMET 1000; Buehler, Lake Bluff, USA) and slices of 12 mm (Ø) x 1.86 mm, 1.2 mm and 0.87 mm (thickness) were obtained. The disc surfaces were polished with 1200 grit SiC paper to remove the irregularities inherent to cutting, and then sintered (Zyrcomat 6000 MS; Vita Zahnfabrik, Bad Sackingen, Germany) according to the manufacturer's instructions. After sintering contraction, the final dimensions of the discs were 10 mm x 1.5 mm, 1 mm and 0.7 mm simulating all-ceramic restorations. Any specimens presenting discrepancies in the dimensions above the recommended deviation (±0.1 mm) were discarded. Finally, 3 discs of each evaluated thickness (1.5 mm, 1.0 mm and 0.7 mm) were selected for the study (N= 9).

Preparation of substrate discs

The dental substrates were simulated with composite resin specimens of 2 mm thickness with shades A2 (positive control) and C4 (darkened dentin substrate). Composite resin discs (Tetric N-Ceram; Ivoclar Vivadent) were prepared using a metallic matrix (10 mm (Ø) x 2.0 mm thickness). Each increment was inserted using a #1 spatula (Golgran, São Caetano do Sul, São Paulo, Brazil) and photoactivated for 40 seconds (1200 mW/cm2, Radii-Cal; SDI, Bayswater, Australia). The last layer was covered with a polyester strip and compressed using a glass slide to obtain a flat surface. The sample was photoactivated through the glass plate with the polyester strip in contact with the surface of the composite resin.

Additional discs were fabricated from two metal alloys with silver and golden appearances. To do so, acrylic resin discs (Duralay; Reliance Dental, São Paulo, Brazil) were made using a metal matrix with a 10 mm in diameter and 2 mm of thickness. The discs were regularized on both sides with 400-1200 grit SiC paper (3M) and used as standard for casting silver (Ni-Cr; 4all White Ceramic Alloy; Ivoclar Vivadent) and golden alloys (Cu-Al; Golden Cast; Talmax, Curitiba, Paraná, Brazil). Finally, all the background specimens (composite- and metallic-based) were polished with 1200 grit SiC paper (3M) under water.

Optical measurements

A spectrophotometer SP60 (EX- Rite; Grand Rapids, Grand Rapids, USA) was used to evaluate the optical properties of the different ceramic thicknesses placed onto the different substrates to compare their translucency, contrast ratio and masking ability.

Measuring the color coordinates

The spectrophotometer was calibrated on the standard tiles provided by the manufacturer and the CIE L*a*b* color coordinates (*Commission Internationale de l'Éclairage*) of A2 shade zirconia all-ceramic specimens were subsequently measured over a gray background (CIE L*=50.30, a*=-1.41, b*=-2.37) (Mennon gray cards; Mennon photographic an technical Co, Beijing, China). Thus, a coupling substance (glycerol, $C_3H_8O_3$) (Vetec Química Fina Ltda, Rio de Janeiro, Brazil) with a refractive index of 1.47 was used to minimize light scattering by eliminating the presence of an air layer between the specimen and the background [10].

Color readings were conducted 3 times for each specimen, and the average of the CIE L*a*b* values was recorded.

Translucency parameter

The translucency parameter of translucent zirconia in each thickness (n= 3) was estimated by the difference between color coordinates measured over a white (CIE L*=93.07, a*=1.28, b*=5.25) (LENETA Card model 12H; Cor&Aparência, São Paulo, Brazil) and a black (CIE L*=27.94, a*=0.01, b*=0.03) (LENETA Card model 12H; Cor&Aparência) background (taking the average of three readings per coordinate) of different ceramic thicknesses, with the CIEDE2000 (1:1:1) color difference formula also being used to calculate the translucency parameter (TP_{00}):

$$TP_{00} = \left[\left(\frac{L'_B - L'_W}{KLSL}\right)^2 + \left(\frac{C'_B - C'_W}{KCSC}\right)^2 + \left(\frac{H'_B - H'_W}{KHSH}\right)^2 + RT\left(\frac{C'_B - C'_W}{KCSC}\right)\left(\frac{H'_B - H'_W}{KHSH}\right)\right]^{1/2}$$

In which: the subscripts "B" and "W" refer to lightness (L'), chroma (C') and hue (H') of the specimens over the black and the white backgrounds, respectively; RT is the rotation function which accounts for the interaction between chroma and hue differences in the blue region; SL, SC and SH are the weighting functions used to adjust the total color difference for variation in perceived magnitude with variation in the location of the color coordinate difference between two color readings; and KL, KC and KH are the correction terms for the experimental conditions. In this study, these parametric factors of the CIEDE2000 formula were set as 1 [11].

The translucency difference threshold for acceptance is $TAT_{00} = 2.62$, while translucency perceptibility threshold is $TPT_{00} = 0.62$, calculated at 50:50% level [11].

Contrast ratio

The contrast ratio (CR) of translucent zirconia in each thickness (n= 3) was obtained from the reflectance measured for each thickness of isolated ceramic and on the black and white backgrounds, according to the formula:

$$CR = \frac{YB}{YW}$$

In which: YB is the reflectance measure on a black background and YW is the reflectance measure on a white background [12]. An average of three readings were considered for each specimen. Differences greater than 0.07 between ceramic restorations are considered perceptible [12].

Evaluation of masking ability

The masking ability of translucent zirconia in each thickness (n= 3) was estimated by calculating the CIEDE2000 color variation (ΔE_{00}) between each ceramic structure over a light tooth-colored substrate (A2) and over the dark substrates (n= 2; C4, silver, golden), according to the CIEDE2000 equation used for the translucency parameter (TPθθ), as follows:

$$\Delta E_{00} = \left[\left(\frac{\Delta L'}{KLSL}\right)^2 + \left(\frac{\Delta C'}{KCSC}\right)^2 + \left(\frac{\Delta H'}{KHSH}\right)^2 + RT\left(\frac{\Delta C'}{KCSC}\right)\left(\frac{\Delta H'}{KHSH}\right)\right]^{1/2}$$

In which: ΔL', ΔC' and ΔH' are the differences in lightness, chroma, and hue between two sets of color coordinates; RT is the rotation function which accounts for the interaction between chroma and hue differences in the blue region; S_L, S_C and S_H are the weighting functions used to adjust the total color difference for variation in perceived magnitude with the variation in the location of the color coordinate difference between two color readings. The parametric factors K_L, K_C and K_H are correction terms for deviation from reference experimental conditions. These parametric factors of the CIEDE2000 formula were set as 1 in this study [13].

High ΔE_{00} values mean greater variation between the standard substrate (A2) and the evaluated dark substrate, and therefore demonstrate low masking ability of the restorative material. In this sense, small ΔE_{00} values are expected for a material to be defined with high masking ability. The color difference was considered as being perceived over values of ΔE_{00} = 0.81 (perceptibility threshold), and the color difference was considered acceptable up to ΔE_{00} = 1.77 (acceptability threshold) [14].

The CIE L*a*b* color coordinates of substrates were obtained for the A2 composite resin (CIE L*=72.65, a*=1.44, b* = 14.68), C4 composite resin (CIE L*=58.40, a*=3.98, b*= 19.45), silver (CIE L*=57.54, a*=0.58, b*=3.48) and golden metallic alloy (CIE L*=53.98, a*=3.48, b*=16.19).

The average values of CIE L* a* b* obtained for the thicknesses of 0.7, 1.0 and 1.5 mm over a light tooth-colored substrate (A2) were respectively: CIEL*=79.59, a*=0.32, b*=13.57; CIEL*=79.47, a*=0.88, b*=15.19; CIEL*=81.03, a*=1.01, and b*=16.71. These values were used as the standard for calculating the variation (ΔL', Δa', Δb') of L*, a* and b* among the different experimental substrates evaluated (C4 composite resin, silver and golden metallic alloy).

Data analysis

The statistical data analysis was performed using a statistical software program (IBM SPSS Software; IBM, New York, USA). Normality and homogeneity analyses were performed for masking ability data and presented non-normal distribution by the Shapiro-Wilk test. The Kruskal Wallis post-hoc test was used for statistical analysis considering the null hypothesis (the distribution of ΔE_{00} is the same across categories of group). The significance level was set at 5%.

One-way ANOVA and the Tukey test were used for statistical analysis of the translucency (TP_{00}) and contrast ratio (CR) to detect differences among the ceramic thicknesses. TP values can range from 0 (totally opaque) to 100 (totally transparent), and CR values can range from 0 (totally transparent) to 1.0 (totally opaque).

Power analysis

An open-source calculator, available at www.openepi.com, was used to determine the power of this study by the means difference of the thicker (1.5 mm) and thinner (0.7 mm) specimens to translucency parameter, contrast ratio and masking ability. The achieved power was 100% by the normal approximation method with a 95% confidence interval for all evaluated parameters.

RESULTS

According to the TP_{00} and CR values (table 2), it can be noticed that the evaluated translucent zirconia showed a statistically significant lower opacity for the thicknesses of 0.7 mm and 1.0 mm, with no difference between them. Thus, a statistical difference was only observed for 1.5 mm compared to 0.7 and 1.0 mm. Considering the perceptibility thresholds values, both TP_{00} and CR presented differences considered perceptible between the different thicknesses (higher than 0.62 and 0.07, respectively), except when considering the CR between 0.7 and 1.0 mm.

Table 2. Values of translucency parameter (TP_{00} – mean and standard deviation), contrast ratio (CR - mean and standard deviation) and ΔE_{00} for studied zirconia ceramic thicknesses (mm) and substrates.

Thickness	TP_{00}	CR	Substrate	ΔE_{00}		
				Mean (SD)	**Minimum**	**Maximum**
0.7	21.30 (2.00)^{A}	0.45 (0.04)^{B}	C4	4.16 (0.04) ^{D}	4.11	4.24
			Ni-Cr	9.96 (0.24) ^{A}	9.60	10.23
			Cu-Al	8.65 (0.20) ^{B}	8.40	8.95
1.0	19.17 (1.64)^{A}	0.51 (0.04)^{B}	C4	3.34 (0.18) ^{E}	3.14	3.65
			Ni-Cr	8.08 (0.39) ^{B}	7.66	8.71
			Cu-Al	6.71 (0.60) ^{C}	5.85	7.55
1.5	13.64 (0.74)^{B}	0.65 (0.03)^{A}	C4	2.70 (0.33) ^{F}	2.41	3.26
			Ni-Cr	4.88 (0.80) ^{D}	3.85	5.63
			Cu-Al	3.93 (0.42) $^{D, E}$	3.26	4.53

Different letters indicate statistically significant differences ($P < .05$).

Considering the different substrates, ceramics over silver metallic alloy (Ni-Cr) resulted in the highest ΔE_{00}, however this value statistically decreased as the thickness of the restoration increased.

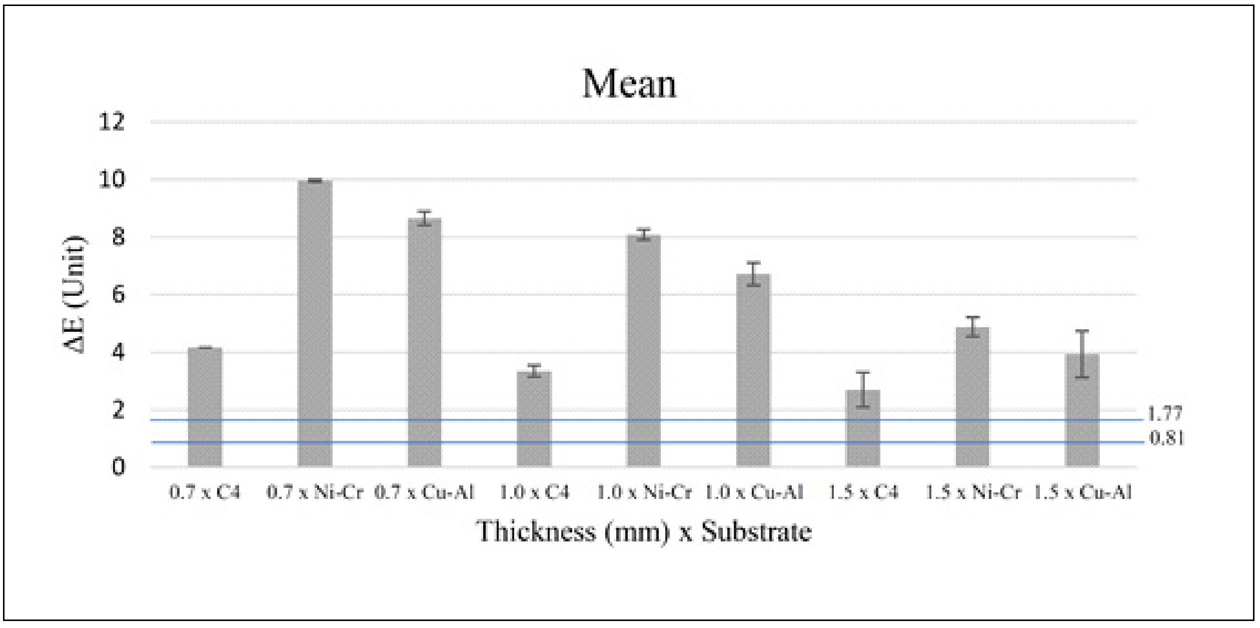

Figure 1. Means and standard deviations of the ΔE_{00} values for the thickness and substrate groups. $\Delta E_{00} = 0.81$ (perceptibility threshold), $\Delta E_{00} = 1.77$ (acceptability threshold).

In contrast, all ceramic thicknesses over substrate C4 had the lowest ΔE_{00}. However, the increase in thickness for both the C4 and golden metallic alloy (Cu-Al) had the same positive effect as in Ni-Cr, with a statistically significant difference among the thicknesses for all groups.

None of the specimens was able to reach the acceptability threshold value (ΔE_{00} = 1.77) for the masking ability of the different ceramic thicknesses in the evaluated substrates. Therefore, all specimens suffered color impairing, which is considered visually unacceptable (figure 1).

DISCUSSION

The present study demonstrated that all-ceramic restorations of translucent zirconia with thicknesses between 0.7 and 1.0 mm showed similar translucency, however being statistically different from the 1.5 mm of thickness. Thus, the first null hypothesis that no translucency difference may be observed in different thicknesses of zirconia simplified restorations was partially accepted.

It is known that all-ceramic prosthetic restorations can be made of different materials such as vitreous ceramic, indirect composite resin, polymer-infiltrated ceramic network and polycrystalline ceramic, with a significant difference in mechanical behavior between these options [1]. In this research line, current studies showing that polycrystalline ceramics can guarantee better resistance due to their composition of closely linked crystals which are capable of preventing crack propagation in the material, making them widely indicated materials for the posterior region [1,15].

However, the evolution of polycrystalline ceramics occurs in the sense of making them increasingly translucent, and thereby imitating dental tissues to allow this material to also be applied in the anterior region [2]. Translucency determines the relative amount of light that is absorbed, transmitted or reflected, which is an important factor in esthetics as it affects the natural appearance of restorations [16,17]. Nowadays, translucent zirconia has been shown to be a material with similar translucency and favorable for application in all-ceramic crowns without veneering, even when compared to lithium disilicate as the gold standard [18,19].

The translucency parameter can be defined and quantified based on the color difference between a uniform material onto white and black backgrounds [11,20]. In this study, we compared the translucency of zirconia in different thicknesses by calculating TP, and only the thicker one (1.5 mm) was found to have less translucency.

Thus, a perceptibility threshold is qualitatively considered when TP00 varies numerically by 0.62 between two groups. This occurred between the 0.7 and 1.0mm specimens, however the acceptability threshold must also be taken into account (TAT_{00} = 2.62), which shows that the variation in the TP_{00} values for the thinner specimens (0.7 and 1.0mm) was within the acceptability standard (TAT00 <2.62) [11].

Taking into account another parameter (CR), a translucency perception threshold of 0.07 is considered [12]. The differences between 0.7 and 1.0 mm were imperceptible, however they were perceptible for 1.5 mm. Wang et al. claim there is an exponential increase in the translucency of zirconia as the thickness is reduced [21]. This is partially true according to our results; however, this effect was not sufficiently different in the 0.3 mm which differentiates the two smallest thicknesses (0.7mm and 1.0mm) that were evaluated.

On the other hand, this color difference demonstrates that the greater thickness (1.5mm) of the restoration had less influence on its color when placed on the dark background. This point of view demonstrates another important characteristic of the optical propriety of ceramics, namely that the masking ability represents how much the restoration can have an esthetic result without interference from the substrate color to which it is cemented. This parameter must be observed according to how the human eye can perceive a color change, which is why the acceptability and perceptibility thresholds are used [14]. This information is of great importance when we consider that prosthetic preparations may be done on different materials such as composite resin, metal alloys, and darkened dentin reminiscent, presenting a significant difference of color and optical proprieties among these options [8]. Teeth without discoloration are generally best restored with a more translucent ceramic, while teeth with discoloration or metal post-and-core require an opaque ceramic material [21].

Our second null hypothesis regarding the masking ability of the evaluated ceramics was rejected, as the different thicknesses presented distinct masking ability when applied on substrates with different colors. On the other hand, our study demonstrated that the tested translucent zirconia was not able to mask the chosen substrates considering masking ability thresholds [14], even when the greater thickness (1.5mm) was used. This means that all the thicknesses of the evaluated translucent zirconia between a substrate with a standard color (A2) and the substrates with darkened colors (C4, Ni-Cr and Cu-Al alloys) had a color change above the acceptability and perceptibility thresholds.

In this sense, it is suggested to use an opaque cement which is capable of masking darkened backgrounds if this is intended [22]. In addition, different textures on the surface of the restorations could be applied to make it as natural as possible and consequently end up influencing the translucency [21]. In the case of polycrystalline ceramics, it is also necessary to prepare the cementation surface with air-abrasion of abrasive particles to promote micromechanical retention [23], thereby generating opacification of the air-abraded surface. However, both surfaces were polished in our study in order to provide standardization. Therefore, it can be questioned whether specific surface treatments could somehow promote better masking ability in these restorations.

As a limitation of our study, the non-use of a resin cement between the substrate and the ceramic may be questioned. However, our study aimed to specifically assess the capacity of ceramics without the influence of other materials. This fact must obviously be considered in a clinical context, and based on what was found in our study, it must be considered crucial for the esthetic success of the restoration, even in situations where there is the possibility of a greater zirconia thickness.

Finally, it is suggested that the translucency and masking ability are different optical properties of ceramic materials which should be known to guide clinical decisions for the material and thickness to be used. Although evolution seeks materials with high translucency, one must work with different shades and translucencies of ceramics to achieve the desired result. In the case of all-ceramic crowns made with machined translucent zirconia, it is important to carefully evaluate the substrate to avoid an esthetically unsatisfactory final treatment.

CONCLUSION

- The translucent zirconia showed lower translucency in the thickness of 1.5mm and was not significantly different between 0.7mm and 1.0mm.

- The increased thickness of the translucent zirconia was not able to produce sufficient masking ability of all-ceramic ceramic restorations according to acceptability and perceptibility thresholds.

Acknowledgements

This study was partially financed by the Brazilian National Council for Scientific and Technological Development, Brazil – CNPq (R.V.M. and A.C.C.R. post-doctoral scholarship; projects #151004/2022-6 and #150186/2023-1) and the Brazilian Federal Agency for Coordination of Improvement of Higher Education Personnel (CAPES) (Finance code 001). We especially thank Ivoclar Vivadent for donating the research materials, and finally we emphasize that those institutions had no role in the study design, data collection or analysis, decision to publish or in preparing the manuscript.

Collaborators

RV Machry, conceptualization, data curation, investigation, writing - original draft. MM May, AC Cadore-Rodrigues, investigation, methodology, writing - review & editing. LB Jacques, conceptualization, supervision, validation, writing - review & editing. LG May, conceptualization, supervision, project administration, resources, writing - review & editing.

REFERENCES

1. Silva LH da, Lima E de, Miranda RB de P, Favero SS, Lohbauer U, Cesar PF. Dental ceramics: a review of new materials and processing methods. Braz Oral Res. 2017;31(suppl 1):e58. https://doi.org/10.1590/1807-3107BOR-2017.vol31.0058
2. Stawarczyk B, Keul C, Eichberger M, Figge D, Edelhoff D, Lumkemann N. Three generations of zirconia: From veneered to monolithic. Part I. Quintessence Int. 2017;48(5):369-80. https://doi.org/10.3290/j.qi.a38057
3. Sailer I, Makarov NA, Thoma DS, Zwahlen M, Pjetursson BE. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part I: Single crowns (SCs). Dent Mater. 2015;31(6):603-23. https://doi.org/10.1016/j.dental.2015.02.011
4. Ilie N, Stawarczyk B. Quantification of the amount of blue light passing through monolithic zirconia with respect to thickness and polymerization conditions. J Prosthet Dent. 2015;113(2):114-21. https://doi.org/10.1016/j.prosdent.2014.08.013
5. Wang F, Takahashi H, Iwasaki N. Translucency of dental ceramics with different thicknesses. J Prosthet Dent. 2013;110(1):14-20. https://doi.org/10.1016/S0022-3913(13)60333-9
6. Spyropoulou PE, Giroux EC, Razzoog ME, Duff RE. Translucency of shaded zirconia core material. J Prosthet Dent. 2011;105(5):304-7. https://doi.org/10.1016/S0022-3913(11)60056-5
7. Dede DÖ, Sahin O, Özdemir OS, Yilmaz B, Celik E, Köroğlu AS. Influence of the color of composite resin foundation and luting cement on the final color of lithium disilicate ceramic systems. J Prosthet Dent. 2017;117(1):138-43. https://doi.org/10.1016/j.prosdent.2016.05.016
8. Creugers N, Mentink A, Fokkinga W, Kreulen C. 5-Year follow-up of a prospective clinical study on various types of core restorations. Int J Prosthodont. 2005;18(1):34-9. https://doi.org/10.1016/j.prosdent.2005.05.013
9. Nordahl N, Vult von Steyern P, Larsson C. Fracture strength of ceramic monolithic crown systems of different thickness. J Oral Sci. 2015;57(3):255-61. https://doi.org/10.2334/josnusd.57.255
10. Nogueira AD, Della Bona A. The effect of a coupling medium on color and translucency of CAD-CAM ceramics. J Dent. 2013;41:e18-23. https://doi.org/10.1016/j.jdent.2013.02.005
11. Salas M, Lucena C, Herrera LJ, Yebra A, Della Bona A, Pérez MM. Translucency thresholds for dental materials. Dent Mater. 2018;34(8):1168-74. https://doi.org/10.1016/j.dental.2018.05.001
12. Liu MC, Aquilino SA, Lund PS, Vargas MA, Diaz-Arnold AM, Gratton DG, et al. Human perception of dental porcelain translucency correlated to spectrophotometric measurements. J Prosthodont. 2010;19(3):187-93. https://doi.org/10.1111/j.1532-849X.2009.00542.x
13. Basso GR, Kodama AB, Pimentel AH, Kaizer MR, Bona A Della, Moraes RR, et al. Masking colored substrates using monolithic and bilayer CAD-CAM ceramic structures. Oper Dent. 2017;42(4):387-95. https://doi.org/10.2341/16-247-L
14. Paravina RD, Ghinea R, Herrera LJ, Bona AD, Igiel C, Linninger M, et al. Color difference thresholds in dentistry. J Esthet Restor Dent. 2015;27:S1-9. https://doi.org/10.1111/jerd.12149.
15. Venturini AB, Prochnow C, Pereira GKR, Segala RD, Kleverlaan CJ, Valandro LF. Fatigue performance of adhesively cemented glass-, hybrid- and resin-ceramic materials for CAD/CAM monolithic restorations. Dent Mater. 2019;35(4):534-42. https://doi.org/10.1016/j.dental.2019.01.013
16. Denry I, Kelly JR. State of the art of zirconia for dental applications. Dent Mater. 24(3):299-307. https://doi.org/10.1016/j.dental.2007.05.007
17. Vichi A, Carrabba M, Paravina R, Ferrari M. Translucency of ceramic materials for CEREC CAD/CAM system. J Esthet Restor Dent. 2014;26(4):224-31. https://doi.org/10.1111/jerd.12105
18. Baldissara P, Wandscher VF, Marchionatti AME, Parisi C, Monaco C, Ciocca L. Translucency of IPS e.max and cubic zirconia monolithic crowns. J Prosthet Dent. 2018; 120(2):269-275. https://doi.org/10.1016/j.prosdent.2017.09.007
19. Ayash GM, Ossman E, Segaan LG, Rayyan M, Joukhadar C. Influence of core color on final shade reproduction of zirconia crown in single central incisor situation - An in vivo study. J Clin Exp Dent. 2020;12(1):e46-51. https://doi.org/10.4317/jced.56401
20. Johnston WM, Ma T, Kienle BH. Translucency parameter of colorants for maxillofacial prostheses. Int J Prosthodont. 2015;8(1):79-86.
21. Wang H, Xiong F, Zhenhua L. Influence of varied surface texture of dentin porcelain on optical properties of porcelain specimens. J Prosthet Dent. 2011;105(4):242-8. https://doi.org/10.1016/S0022-3913(11)60039-5
22. Bacchi A, Boccardi S, Alessandretti R, Pereira GKR. Substrate masking ability of bilayer and monolithic ceramics used for complete crowns and the effect of association with an opaque resin-based luting agent. J Prosthodont Res. 2019;63(3):321-6. https://doi.org/10.1016/j.jpor.2019.01.005
23. Özcan M, Bernasconi M. Adhesion to zirconia used for dental restorations: a systematic review and meta-analysis. J Adhes Dent. 2015;17(1):7-26. https://doi.org/10.3290/j.jad.a33525

Received on: 2/9/2022
Approved on: 15/12/2022

Assistant editor: Fabiana Mantovani Gomes França