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Translucency Of Different Types Of Zirconia Ceramic- An In-Vitro Study

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ABSTRACT
Aim: The aim of this study was to evaluate and compare the translucency of three different zirconia ceramics with lithium disilicate glass-ceramic, in two different thicknesses.
Setting and Design: Experimental study design.
*Material and Methods: 10mm × 10mm size 16 specimens with 0.5mm and 1mm thicknesses were made from 3 different zirconia (ceramill zolid fx SHT, VITA YZ HT, and UPCERA HT) and lithium disilicate, (IPS e.max Press HT). CIE L*a*b* values were measured with the help of a spectrophotometer and the translucency parameter (TP) was calculated.*
Statistical analysis used: Statistical analysis was performed using one-way ANOVA followed by the post hoc LSD test (α =0.05). Independent sample t-test analysis was done to compare the translucency values.
Results: Lithium disilicate was significantly more translucent than the zirconia-based all-ceramic systems (P<0.05). Among the zirconia-based ceramic systems, no statistical significance was found. There was also an increase in TP with a decrease in thickness, with a statistically significant difference.
Conclusions: Lithium disilicate proved to be more translucent than zirconia ceramics in both the studied thicknesses. The translucency of all materials decreased with an increase in thickness.
Keywords: *Translucent zirconia, Translucency Parameter, Lithium disilicate, Spectrophotometer*

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I. INTRODUCTION

We can achieve the life-like appearance for a restoration by choosing the appropriate translucent ceramic.[1] Esthetics is primarily controlled by translucency and is very crucial in selecting restorative materials.[2] Throughout the years, porcelain fused to metal restorations offer a long history of clinical success due to high strength.[3] Zirconium oxide ceramics have evolved as a material with good esthetics, superior biocompatibility and mechanical properties alike porcelain fused to metal restorations.[4] But zirconia has the drawback of being opaque. The opacity is due to various factors like difference in grain size with the wavelength of light, refractive index discrepancy between grain particles and matrix, different phases of zirconia with different refractive indices, and the existence of pores and impurities. [5,6] All these causes scattering of light rather than its transmittance and lead to the opaque appearance.[6] Many attempts have been tried to improve translucency. These include reducing grain size to nano-scale level, boosting yttria content, raising sintering temperature, and lessening pores and impurities.[7]

Translucency of ceramics was found to be significantly influenced by both material and thickness. [8,9] Translucency parameter [10] and contrast ratio [8,11] are the commonly used parameters to measure the translucency of dental materials. [8,12,9,13] The effect of ceramic thickness on translucency has been researched by many authors. [9,14,15] Wang *et al.* [9] in a study concluded that, translucency parameter was significantly influenced by both material and thickness and translucency increases as thickness decreases, but the amount of change was material dependant. Antonson and Anusavice[16] found out a positive linear correlation between contrast ratio and thickness. In clinical scenario, ceramic restorations of varied thicknesses are required, which in turn depends upon the different conditions of the tooth to be restored. [17,18]

Since conventional zirconia was opaque, newer translucent variants have been recently developed. Studies on some of these newer translucent zirconia have shown that they are more translucent than conventional zirconia.[19] Whether these translucent zirconia have similar or superior esthetics when compared with lithium disilicate glass ceramic need to be investigated. Therefore, the aim of this study was to investigate the translucency parameter of 3 types of translucent zirconia and compare it with that of lithium disilicate glass ceramics, which remains as the aesthetic gold standard [4]. The null hypothesis was that the translucency of 3 different types of translucent zirconia ceramics is similar to that of lithium disilicate glass ceramic.

II. MATERIAL AND METHODS

In the present study, 3 types of zirconia-based all-ceramic systems and one type of lithium disilicate were evaluated for assessing the translucency. Materials studied are given in table 1.

Fabrication of zirconia specimens

Rectangular blocks of cross-section 10 x 12 mm were sectioned from all the three zirconia blanks, which were non-coloured (white). These pre-sintered zirconia blocks were then secured on a lathe (Variable speed lathe, Shanghai, China) and sectioned again with the help of a carbide disc [Figure 1]. Sixteen specimens of 12 x 12 x 0.625mm and another sixteen specimens of 12 x 12 x 1.25mm were obtained for each group of zirconia.

Each group of zirconia specimens were immersed in ultrasonic bath (Digital ultrasonic cleaner, Shenzhen, China) filled with distilled water and cleansed for 10 minutes, and then dried.

Specimens were then sintered in a sintering furnace (ceramill therm 3, Amann Girrbach, Koblach, Austria) according to manufacturer's instructions. Specimens were taken in an oversized dimension in-order to compensate for the sintering shrinkage, so as to obtain specimens in the dimensions of 10 x 10 x 0.5mm and 10 x 10 x 1mm.

Finishing and polishing were done with polishing discs (Eve rotary grinding and polishing instruments, Keltern, Germany) on a micromotor at 15,000 rpm. At the end of the process, the thicknesses of specimens were confirmed with a digital vernier calliper.

Fabrication of lithium disilicate glass ceramic specimens

Pattern resin sheets (Pattern Resin LS, GC America, USA) were prepared by pressing two glass plates with a controlled spacer of 0.5mm and 1mm thicknesses [Figures 2A, 2B].

The thicknesses of the sheets thus obtained were verified with the help of a digital vernier calliper and they were sectioned. Sixteen specimens with 10 x 10 x 0.5mm and 16 specimens with 10 x 10 x 1mm were obtained.

These resin patterns were eventually invested in a phosphate-bonded investment, IPS PressVest Premium (Ivoclar Vivadent, Schaan, Liechtenstein) and burn-out was carried out using a furnace (Sirio, Italy) at 900ºC.

After inserting the e.max ingots, the resin patterns were heat-pressed (Programat P300, Ivoclar Vivadent, Schaan, Liechtenstein), and then left at room temperature for 60 minutes.

Manual finishing and polishing were done with the help of diamond impregnated abrasives (EVE rotary grinding and polishing instruments, Keltern, Germany). At the end of the process, the thicknesses of specimens were confirmed with a digital vernier calliper and 16 specimens with the dimensions of 10 x 10 x 0.5mm and 16 specimens with the dimensions of 10 x 10 x 1mm were obtained. All the specimens were immersed in ultrasonic bath (Digital ultrasonic cleaner, Shenzhen, China) filled with distilled water and cleansed for 10 minutes.

Grouping of the specimens

All the specimens of both zirconia and lithium disilicate were grouped into four as Group Ceramill, Group Vita, Group Upcera and Group e.max and each group is again subdivided based on thicknesses 0.5mm and 1mm into subgroups A and B respectively.

Translucency measurement

A spectrophotometer VITA Easyshade V (VITA Zahnfabrik, Bad säckingen, Germany) was used to evaluate the translucency. The CIE L*a*b* values of each specimen were measured on a white and then on a black background [Figure 3]. Measurements were repeated three times for each specimen on each background at three different locations and the mean CIE L*a*b* values were recorded for both backgrounds.

Translucency parameter was obtained by calculating the color difference between the specimen over the white background and black background using the following equation.[10]

$[(L^*_B - L^*_W)^2 + (a^*_B - a^*_W)^2 + (b^*_B - b^*_W)^2]^{1/2}$

where L* refers to the lightness.

a* refers to redness to greenness.

b* refers to yellowness to blueness.

Subscript B corresponds to the colour coordinates over the black background and subscript W corresponds to the white background.

III. RESULTS

The mean translucency parameter was highest for subgroup A of Group e.max (21.02) and lowest for subgroup B of Group Vita (8.73). The mean and standard deviation of different groups were analysed by one-way ANOVA [Table 2], showed statistically significant difference (P<0.05).

Post hoc LSD test revealed significant differences between group e.max and other 3 zirconia groups in both thicknesses [Table 3].

Independent sample *t*-test analysis was done to compare the mean translucency values of each group in both 0.5mm and 1mm thicknesses [Table 4], showed a statistically significant difference and TP values increased with decrease in thickness.

IV. DISCUSSION

The results of the study showed that there is statistically significant difference in TP values between group e.max and the 3 zirconia groups and between 0.5mm and 1mm thickness in all groups. Hence, the null hypothesis that the translucency parameter of lithium disilicate is similar to that of zirconia was rejected.

Wang *et al.* [9] conducted a study that was in support with the present study that, TP was significantly influenced by both material and thicknesses. Corresponding results were found by Baldissara *et al.* [20] who concluded that the lithium disilicate glass ceramic was significantly greater in translucency than zirconia-based core materials. Heffernan *et al.* [8] concluded that the translucency of ceramics depends on different crystalline compositions.

The TP value of human dentin with a thickness of 1.0 mm has been determined to be 16.4 and that of human enamel 18.7.[21] For 1mm thickness, group e.max has shown a TP value comparable to that of human dentin and enamel. However, for zirconia groups, the TP values at 1mm were less than that for human dentin and enamel. These results may add to the ability of glass ceramics to provide a better optical match to natural dentition.[22]

All the materials tested in this in-vitro study had shown some degree of translucency. The difference in translucency may be attributed to the different composition and the microstructure of the studied materials, [8,16] which may need future investigations. Another factor that contributes to translucency is the difference in refractive index between the crystals and the glassy matrix. Harianawala *et al.* [4] in his study found out that high translucency lithium disilicate showed the highest transmittance values (0.207759 Å), that can be attributed to the refractive index of lithium disilicate glass crystals similar to that of the glassy matrix. Also, the high translucency zirconia showed a significant increase in transmittance values (0.143969 Å) over that of conventional zirconia (0.065015 Å), which was due to the significantly reduced porosity, and uniform grain size seen with the translucent zirconia. There are various methods reported in the literature for obtaining more translucent zirconia like hot isostatic pressing, microwave sintering, and spark plasma sintering. [25,26,27]

This study concluded that, despite the significant improvement in translucency brought out by various techniques, high translucency zirconia has low translucency parameter values when compared with that of lithium disilicate glass ceramic.

There are certain limitations for this study. Specimens in coping form may be of high clinical significance compared to the square specimens in the study. This study dealt with only non-colored specimens, so shading or colouring could have influenced the translucency parameter values. Moreover, other variables like discoloured tooth, luting agents, veneering etc. may also influence the final shade of the restoration.

V. CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

1. The translucency parameter of lithium disilicate glass ceramic was found higher than all the translucent zirconia ceramics tested in this study.
2. In addition to the type of all-ceramics material, thickness also influenced the translucency parameter. The translucency increased as the thickness decreased.

Clinical implications

Ceramic selection should follow not only the mechanical properties but also the optical requirements of the tooth to be restored. Ceramic restorations of varied thicknesses may be required according to the clinical situation. The translucency parameters of all-ceramic materials vary with the type and the thickness of material used.

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Conflicts of interest

There are no conflicts of interest.

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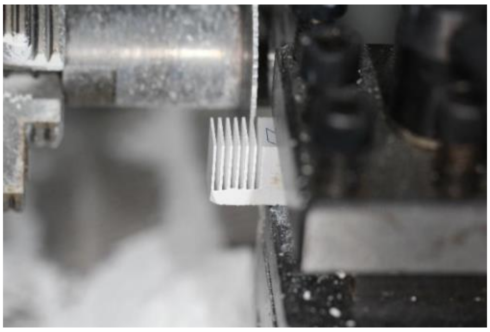

Figure 1

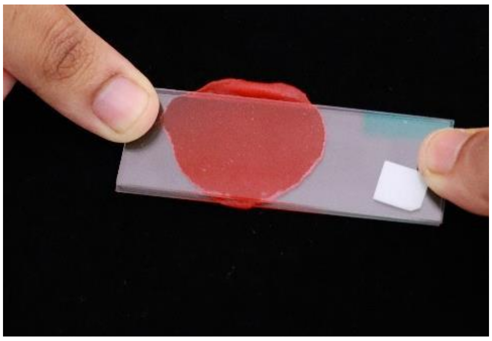

Figure 2A

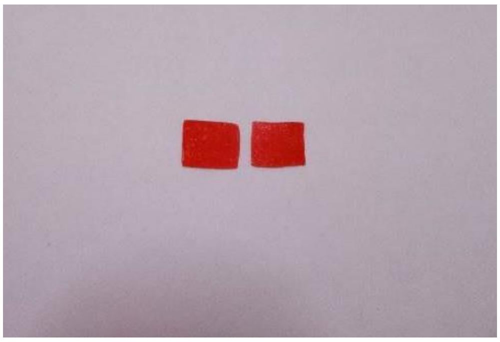

Figure 2B

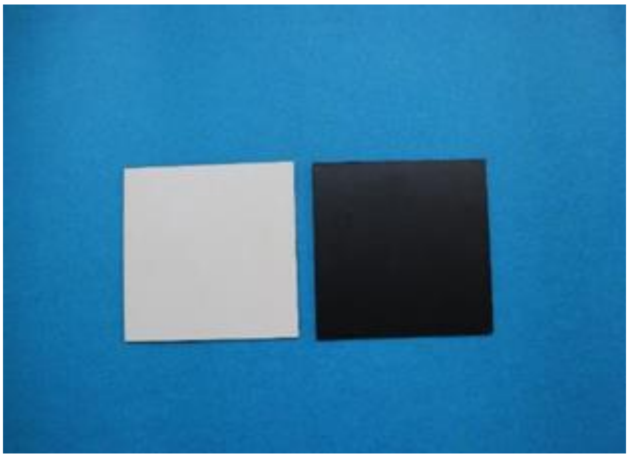

Figure 3