COMPARATIVE EVALUATION OF LIGHT TRANSMITTANCE OF THREE HIGH TRANSLUCENCY MONOLITHIC ZIRCONIA

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ABSTRACT:

Context: Original article- invitro study

Aims: This study was aimed to compare the light transmittance of three newer high translucency monolithic zirconia systems. **Methods and Material**: The monolithic zirconia systems were divided into three groups: Group 1: ZIRKON ICE-HT, Group 2: PRETTAU ANTERIOR and Group 3: CERAMILL ZOLID HT. From each group 5 specimens were fabricated (15mm X 15mm X 1mm) by handmilling. Each group were sintered according to manufacturer's instructions and glazed. Specimens were mounted on a black board and light transmittance for each specimen was obtained using Digital SpectroHazemeter with transmittance mode. The light transmittance value were obtained in percentage. **Statistical analysis used**: The measured percentage of transmittance were analyzed with Two Way-ANOVA and Tukey test ($p<0.05$). **Results**: There was no significant difference between group 1 and group 3($p>0.05$). Group 2 – Prettau Anterior showed significantly higher light transmittance than group 1 and group 3($p<0.05$). There were no significant difference between the specimens in each group ($p>0.05$). **Conclusions**: Within the limitations of this pilot study, it can be concluded that the newer zirconia system -Prettau anterior has an improved light transmittance when compared with the other high translucency monolithic zirconia systems.

INTRODUCTION:

Ceramic has been the material of choice for esthetic restoration, due to the durable physical and optical properties.All ceramic restorations combine the esthetic veneering porcelain with stronger

ceramic core for highly demanding esthetic management.(1) How ever studies on all ceramic restoration have listed cohesive failure of the veneering porcelain as the primary cause.(2-4)

The need for veneering over high strength ceramic and subsequent cohesive failure was eliminated with the introduction of monolithic Zirconia. The white opaque nature of monolithic zirconia limited their use as posterior restorations. Manufacturers have introduced monolithic zirconia with higher translucency to expand their use to the esthetic region. Translucency is defined as the relative amount of light transmission or diffuse reflectance from a substrate surface through turbid medium.(5) Translucency is an important factor apart from the color of the restoration to produce life like finish. The translucency is dependent on the chemical nature of the crystals, size of the particles, microstructure, pores, impurities and sintering temperature.(6) In a study by Li Jang et al in 2011 stated that partially nanostructured powders (ZrO_2-3 mol.%Y_2O_2) sintered densely at 1350-1500°C produced higher translucency.(7). With the introduction of numerous high translucency monolithic zirconiain the market, this study aims at comparing the light transmittance of three high translucency monolithic zirconia.

Materials and Methods:

Specimen Preparation:

Five presintered discs of size 15 mm X 15 mm and 1±0.2 mm thickness were fabricated by handmilling for each of following monolithic high translucency zirconia systems. Group I- ZirkonICE(Zirkon Zahn,Italy), Group II- Prettau Anterior(Zirkon Zahn, Italy) and Group III- CermillZoid (AmannGirrbach, Germany). All the discs were fabricated with the shade corresponding A2 Vita shade guide. A total of fifteen specimens (n=5 per group) were polished to a flat surface with diamond-impregnated discs. The thickness was standardized using a digital caliper before sintering.(Figure 1) Specimens were embedded with alumina refractory beads in alumina crucible. The sintering procedure for each group was adapted according to manufacturer's recommendations.

Group I- Heat up phase –room temperature to 1500°C at 8°C/min, dwell time – 2 hrs -Cooling phase – final temperature to room temperature at 8°C/min

Group II- Heat up phase – room temperature to 1450°C at 5°C/min, dwell time – 2 hrs

- Cooling phase – final temperature to room temperature at 5°C/min

Group III- Heat up phase – room temperature to 1450°C at 7 K/min, dwell time – 2 hrs

- Cooling phase – final temperature to room temperature at 5°C/min.

Sintered discs were obtained and finished on both sides with diamond polishing paste to achieve smooth finished surfaces. The sintered discs were then mounted on a black board such that the black

board covers the edges of the discs allowing the transmission of light through the center of the disc. (Figure 2).

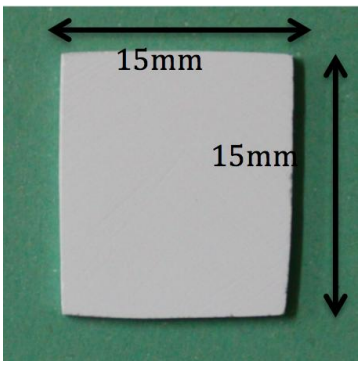

Figure 1: Presintered Zirconia discs

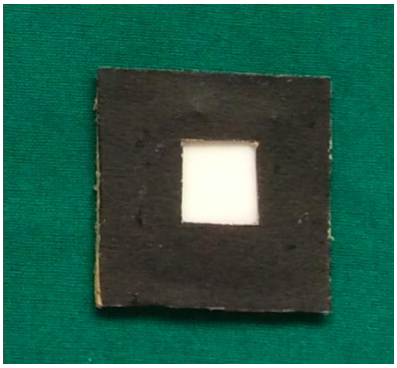

Figure 2: Sintered zirconia disc mounted on a black board

Light transmittance measurement:

The transmittance of specimens was evaluated using Digital Spherical SpectroHazemeter(ASTM D1003-BS2782 Diffusion system) with transmittance mode.(Figure 3). The SpectroHazemeter works on the same principle of spectrophotometer that has light source with specific wavelength (monochrome) and a photometer within an integrated sphere. The specimen is placed between the light source and the sphere just before the light enters the port.(Figure 3). The photo detector with in the sphere detects the voltage signal delivers it to a galvanometer from which the digital reading from the computer is acquired. The amount of light transmittance through the zirconia is obtained in unit percentage. (0 % - completely opaque, 100%- completely transparent).

Figure 3:Digital Spherical SpectroHazemeter

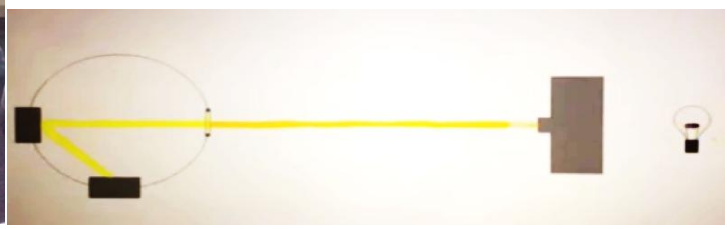

Figure 4: Illustration on the principle of Spectrohazemeter

Statistical Analysis:

Two-way analysis of variance (ANOVA) was performed to compare the light transmittance between the groups. Tukey test was done to determine the group with highest light transmittance with $\alpha = 0.05$ using SPSS11.0(SPSS Inc., Chicago,USA) Satistical software.

Results :

The light transmittance of three high translucency zirconia were shown in Table 1 and 2 .Transmittance of the zirconia ranged from 19.65% to 36.75%. As seen from the statistical result, there is a significant difference in light transmittance between the groups ($p<0.005$). And Tukey test showed that light transmittance was significantly higher in group II than group I and Group III. Table 3, 4

Group	Mean Light Transmittance	SD
Group I	20.5667	.57518
Group II	36.4167	.53463
Group III	23.3833	3.96779

Table 1 Descriptive Statistics of Light transmittance of three high translucency zirconia system

Tests of Between-Subjects Effects						
Dependent Variable: Values						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	6458.801	1	6458.801	978.071	0.001 *** Over All
	Error	13.207	2	6.604		
Group	Hypothesis	429.024	2	214.512	43.974	0.002 ** Between Groups
	Error	19.513	4	4.878		

Table 2: Two- Way ANOVA – Between the Groups

** - There is statistical significance difference between the Group I, Group II and Group III at 95% [p< 0.05]

Values			
Tukey			
Group	N	Subset	
		1	2
Group I	5	20.5667	
Group III	5	23.3833	
Group II	5		36.4167

Table 3: Tukey Test- Comparison of light transmittance between the groups

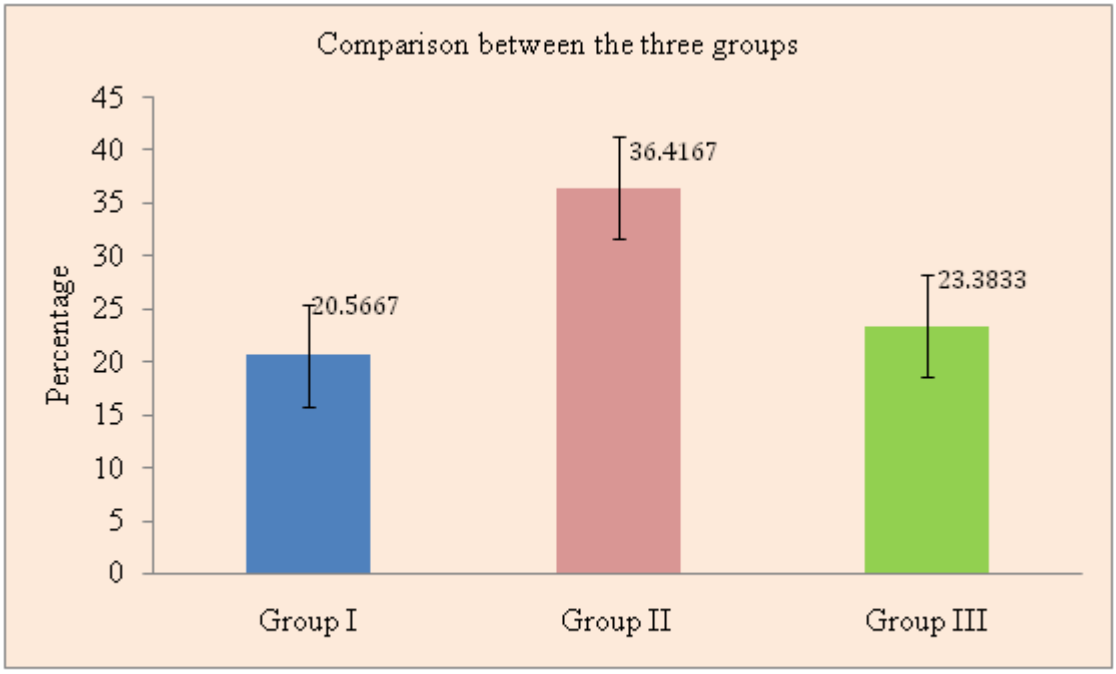

Table 4: Light Transmittance of the specimens in percentage.

Discussion:

Natural teeth demonstrate translucency, opalescence and fluorescence, which are the light dynamics that needs to be recreated to provide successful esthetic restoration. Translucency is an intermediary between complete opacity and complete transparency.(8) The quantitative measurement of translucency is obtained by measuring the transmittance of the material. Transmittance is a physical parameter representing the ability of light to pass through certain medium. Several factors influence the value of translucency such as the presence or absence of color, thickness of the material and surface texture.(9) In this study the shade was standardized among the group by selecting a standardized A2 Vita shade. As the Law of Lambert states, $T=e^{-\alpha x}$ states that the thickness of a material is inversely proportional to the transmittance.(6) Thus specimen thickness was standardized to 1 ±0.2 mm to eliminate their influence in light transmittance. One more important factor that influences quantification of light transmittance is Edge – loss. It is a phenomenon that occurs with

translucent materials whenever the light within the sample is scattered to the edges without being absorbed.(10,11) Therefore, the sensor does not detect this lost light. In this study mounting the specimen on a black board to prevent the scattering of the light eliminated the edge-loss effect.

Zirkon ICE and CeramillZolid are high translucent monolithic zirconia with their use restricted to posterior restorations. However the translucency was claimed to be better than zirconia, which were used for all ceramic substructure. A newer monolithic zirconia,PrettauAnterior,Zirkon Zahn ,Italy was introduced in 2015, indicated mainly for the anterior restorations, with higher translucency than other monolithic zirconia. However there is no literature on composition, manufacturing process and comparison of light transmittance of prettau anterior with other high translucency zirconia. In this study, light transmittance of Prettau Anterior was significantly higher than the other high translucency zirconia as claimed by the manufactures. This significant increase in translucency may be attributed to the increased sintering temperature, particle size, porosity, density, microstructure and impurities in zirconia. According to Li-Jang et al(7) light transmittance of zirconia increased with decrease in particle size. According to Carrabba et al 2017,(13) increase in translucency decreased the strength of the zirconia, and on the contrary to the previous study by Li Jang et al the translucency increased with increase in average grain size among the groups evaluated. In our study it is noted that the modification of microstructure of zirconia through patented processing have influenced the transmittance in Prettau anterior. The importance of esthetics to produce a successful restoration has become in the ever-growing trend in restorative dentistry. Multilayered zirconia incorporating the high translucency and pre-colored technology produced by the process of electro-deposition has been on research since 2013 and were recently introduced in the market in 2016. Further research on the factors that modify the translucency of zirconia, other optical properties and their influence on the mechanical properties, properties of newer multilayered zirconia is essential for a clinician to understand and provide a esthetically successful restoration.

Conclusion:

Within the limitation of the study, the newer Prettau Anterior, Zirkon Zhan had increased transmittance than the other high translucency monolithic zirconia

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