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Comparable translucency as a function of veneers thickness for multi layered zirconia

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ABSTRACT
Objectives of the study: to compare the effect of two different thicknesses on the translucency of four different veneering materials.
Materials and methods: Two typodont of upper right central incisors were prepared with incisal lap design , 20 laminate veneers with 0.3mm thickness and another 20 samples with 0.5 mm thicknesses were fabricated from Zircad Prime, DD cubex^2 ML, coprasupreme Symphony, IPS e.max CAD(10 samples from each material and 5 samples with each thickness) using CAD/CAM system . Then the translucency of each sample was tested by using (3nh) colorimeter device.
Results: The mean of translucency parameter(TP) between the examined groups is viewed as E.max group (16.82) scored the highest TP followed by DD group (12.6) then ZP group (12.34) and finally WP group (12.1) showed the lowest value. For all the materials , samples with 0.3 mm thickness showed higher TP value than those with 0.5mm thickness.
Conclusions: lithium disilicate material (E.max) showed the highest TP values than zirconia based ceramics materials which means that lithium disilicate (E.max) is more translucent than zirconia and even so the thickness of the used material has significant effect on the translucency.
Keywords: Translucency parameter , yttria, Laminate veneers , Zirconia ceramic.

I. INTRODUCTION

Esthetics is a philosophy which concerns specially with the dental arch's appearance , also it is the art of using artificial materials to replace dental tissues to become well camouflaged and be seen as natural dental tissues. Such goal can be achieved by well studying of the shape, colour, surface properties and translucency of the restorative material [1].

Translucency is the property of permitting the passage of light and scattering it in a way makes the complete picture can't be seen clearly. So, translucency lies between the complete opacity and transparency. It can be adjusted by controlling the absorption, reflection, scattering and transmission of light through the material. Translucency can be optimized by lowering the reflectance and increasing the light scattering and transmission [2].

Translucency has been underestimated by many researchers despite it is the element which gives a more natural looking appearance to the restoration. Patient's increased demand for more natural looking restorations has led to the development of metal free materials. High degree of translucency closer to the natural teeth can be achieved by using metal free cores with one layer restoration [3].

Zirconia materials has been rapidly revolutionized to accomplish the request for a material which combines the mechanical properties of porcelain fused to metal (PFM) materials ,esthetic and high degree of biocompatibility of the glass ceramics. Although zirconia ceramics can reflect the color, similar to the natural tooth, unfortunately it has greater degree of opacity due to the increased light scattering caused by porosity, difference in refractive index between the crystal particles and matrix and lack of homogeneity in crystals distribution .Zirconia has been developed greatly by the addition of yettria (3%,4% and 5% or combination of different percentage in the same blank) and resulted in increased translucency which become closer to that of lithium disilicate material [4].

Translucency parameter (TP) is defined as the difference in color of a material with uniform thickness over black and white backgrounds [5].

Preservation of dental hard tissues is critical on preparation for ceramic veneer. Labial reduction between 0.3 to 0.5 mm is recommended ,which approximate the thickness of enamel in the cervical area, however, reduction more than 0.5 mm may lead to dentin exposure cervically [6].

Transmittance related reversely to the thickness . So , as the thickness increased the transmittance will be decreased .Therefore, thickness represents a key factor controlling light transmittance [7]. Wang et al (2013) stated that light transmission of dental ceramics was significantly affected by both type of material and their thickness; there translucency parameter was increased as the thickness decreased[8].

The purpose of this study was to study the effect of different thicknesses on translucency of multilayered zirconia. The null hypotheses tested was that different thicknesses have no significant effect on the translucency of multilayered zirconia.

II. MATERIALS AND METHODS :

2.1 Selection of the teeth:

A typodont of upper right central incisors was selected for preparation to receive the laminate veneers. This tooth was selected because it is the most commonly to be veneered due to their liability to get fractured due to trauma, carious lesion or abnormal shape (malformation) [9].

2.2 Sample grouping:

Forty laminate veneer was fabricated from four different materials, 10 veneers from E-max (control group) and another 30 samples from (Zircad Prime , DD cubeX2 ML, CopraSupreme Symphony10 samples from each material) , each group was further subdivided into two subgroups of 5 samples according to their thickness (either 0.3 mm or 0.5mm).

2:3 Preparation of the typodonts :

For standardization of the preparation , silicone index was used to guide the preparation. The index was made by taking pre-preparation impression for typodonts using silicone rubber base (DUROSIL S - C Silicone Putty type 0) (heavy body). The impression was sectioned vertically to get a side view of the preparation to guide the incisal and labial reduction (incisocervically) as shown in (Figure 1 A).A special kit of burs for veneer preparations was used for preparation. The preparation was done with labial reduction and incisal overlap design using high speed turbine(NSK) .The preparation started by (1 mm) incisal reduction using GF844 bur by making three guiding grooves in the incisal edge and then connected to get smooth flat surface . Labial reduction follows the incisal reduction by making three guiding grooves on the labial surface by using 868B(020) bur for 0.5 mm reduction and 868B(014) bur for 0.3 mm reduction . Labial reduction then extended incisally to be continuous with the incisal reduction an extended cervically and ended 1mm above the cementoenamel junction(CEJ).The depth of reduction was checked by using digital caliper (Mitutoyo,japan). Palatal reduction was done 1mm below the incisal edge with chamfer finishing line. After completing the preparation the silicon guide was used to check the depth and the extension of the preparation as shown in Figure (1 B and C) [25].

2:4 Fabrication of the metal dies:

The prepared typodonts was scanned by using scanner (UP3D,China) to obtain a digital image which was then printed into wax pattern by using special wax block (Zotiondental , China) milled by using CAD/CAM (UP3D,China) to obtain accurate design of the dies. The wax dies was then processed through wax elimination technique and converted into metal dies made of nickel chromium Ni/Cr alloy (Reade International Corp.,USA) (Figure 1 D). After finishing and polishing using polishing discs , the metal die was scanned again to obtain a new digital image on which the design of the final laminate veneer was done (Figure 1 E)[15].

2.5 Sample preparation:

2.5.1. Lithium disilicate ceramic samples:

According to the manufacturer instructions the blank was cut and milled with continuous water irrigation then crystallization cycle started at 840°C for 25 minutes using Programat 310 CS furnace (Ivoclar-Vivadent, Schaan, Liechtenstein.) to obtain the final lithium disilicate structure. Then the samples were set over the tray for 10 minutes to cool down ,the tray helps to store the heat and allow slow and tension-free cooling of the lithium disilicate material [10].

2.5.2. Zirconia ceramic samples:

A block of each material was mounted in the milling machine and 5 laminate veneer of each thickness were milled in dry condition using diamond-coated burs for cutting zirconia. When a milling process completed , a fine tungsten carbide burs (SAIMENG,China) were used to separate the samples from the zirconia blank. The margins of the samples were finished and smoothed by using football-shaped and fissure burs of NuSmile ZR Adjustment Bur Kit **(**Houston, USA) to remove any flaus or irregularities on the margins of the samples. Later, samples then placed into the furnace (sintering furnace Programat S1 1600) within a firing tray to complete the sintering process that done according to the manufacture instruction) in between 1400 to 1600◦C temperature according to the type of the material for 2.5 h . Then the outer surface of the sintered samples was polished, cleaned and dried. This procedure was used to eliminate any flaws or defects on the surface of the samples [11] (Figure 1 F).

2.6 Positioning guide :

To ensure that the colorimeter evaluated the same area of the tooth every time, 'positioning guide' was fabricated from self-cure acrylic resin. Two markings lines were placed on either side of the sample to position the sample incisocervically and other two markings were placed at the upper side of the guide to position the samples mesiodistally [12] (Figure 2 C&D).

2.7 Colorimetric analysis :

For doing the colorimetric analysis, it should be done on black and white background. Two metal dies for each group of the samples was selected . One die was painted with white coloring spray to represent the white background and the other die was painted with black coloring spray to represent the black background. Each sample was placed alternatively on the black and white painted dies and measuring was done by taking three readings of the labial surface in each time and the mean of these reading was taken . Testing was done by the same operator and the colorimeter was calibrated after every 20 measurements [13] (Figure 2 A&B).

The color of each sample was measured using 3nh colorimeter according to the Commission Internationale de l'Eclairage (CIE) system, in which the degree color change is evaluated based on three coordinates; L* (lightness), a* (red–green coordinate) and b* (blue–- yellow coordinate).

The translucency parameter (TP) was obtained by calculating the color difference of the sample over the white and black background as follows[14]:

TP=[(Lw* - Lb*)2 + (aw* - ab*)2 + (bw* - bb*)2]1/2

Whereas :

L_b represents lightness on black background

L_w represents lightness on white background

a_b represents red–green axis on black background

a_w represents red–green axis on white background

b_b represents blue- yellow axis on black background

b_w represents blue- yellow axis on white background

III. RESULTS :

3.1 Effect of different material types with same thickness on translucency:

Regarding TP value of samples with 0.5mm thickness, one-way ANOVA of the four types of veneered restorations showed that there was a significance difference between all the groups (p0.05) as shown in Table (1).

To determine the level of significant , Duncan's Multiple Range was done and showed that the TP value of E-max group was significantly the highest among all the groups. For ZP and DD groups, there were not significant different between them . While WP group scored the lowest TP value as shown in Figure (3).

Regarding TP value of samples with 0.3mm thickness , One-way ANOVA of the four types of veneered restorations showed that there was a significance difference between all the groups (p0.05) as shown in Table (1).

To determine the level of significant , Duncan's Multiple Range Test was done and showed that the TP value of E-max group was significantly the highest among all the groups. For ZP , WP and DD groups, there were not significant different between these groups as shown in Figure (3).

3.2 Effect of different thicknesses of the same material on translucency:

Statistical analysis was done for the studied thicknesses of different materials (Figure 4). Applying independent samples T test for each material revealed that TP value for samples with 0.3mm thickness were significantly higher than samples with 0.5mm thickness and this result is applied for all the examined materials (p0.05).

IV. DISCUSSION :

The magnitude of TP was measured in this study to demonstrate the clinical effect of ceramic veneer thickness on the final shade of the specimens.

The translucency measurement on a coping directly is of greater clinical relevance when compared to measurements done on samples with 3D engineered shapes, such as squares ,tablets or discs. The samples were fabricated with minimum thickness recommended by the manufacturer. Tests were performed on metal abutments to standardize the samples and also to eliminate disadvantages associated with natural teeth such as variations in shape , size, and structural variations caused by the age of the patient or even the storage condition of the extracted teeth [15]. Also the samples was done without glazing to avoid their negative effect on translucency of veneered restoration by increasing light reflection and brightness of the samples surface probably as a result of transformation in the oxidic components responsible for chromatic coordinates [16].

Two thicknesses were studied to test the relationship between translucency and thickness. Two thicknesses were cut from each material starting from 0.3 mm as it is indicated for zirconia veneers , 0.5mm as minimum thickness of IPS E.max CAD [17].

A significant difference was found between the two thicknesses for all the examined materials . For E-max material TP values were (14.36 for 0.5 mm) and (16.82 for 0.3 mm) , for DD material TP values were (11.97 for 0.5 mm) and (12.6 for 0.3 mm) , for WP material TP values were (11.03 for 0.5 mm) and (12.12 for 0.3 mm) , for ZP material TP values were (11.94 for 0.5 mm) and (12.3 for 0.3 mm) as shown in Figure (4) . These findings were advocated with Esraa et al (2018) and Abdelbary et al (2016) in which they stated that translucency of ceramics materials is a function of their thickness and can be explained as the thickness increased there will be more light absorption and scattering but within accepted limit that will not affect the degree of transparency of the material , while thinner ceramic permits more light transmission with lower degree of absorption and scattering , which is related to the fewer interactions at the light/grain boundary (18,19,20).

For 0.5mm thickness , E-max materials scored the highest TP values (14.36) and showed significant difference with the other examined materials (WP, ZP and DD) as shown in Table (1) and Figure (3), which can be explained by the large amount in content of glass phase in E-max material , while WP material scored the lowest TP values (11.03) as shown in Table (1) and Figure (3) which is related to the higher percentage of tetragonal phase in content and less regularly arranged crystals responsible for higher scattering and reflectance of the light and thus tend to appear more opaque (21).

For 0.3 mm thickness , also E-max material scored the highest TP value (16.82) and showed significant difference with the other zirconia materials as shown in Table (1) and Figure (3) and also could be due to the large amount in content of glass phase . While different zirconia materials scored lower TP value than E-max material and showed no significant difference between each other as shown in Table (1) and Figure (3). This result is may be due to the arrangement of crystals and the degree of phase transformation occurs within zirconia materials which causes higher scattering and reflection of the light than E-max material (22).

These result were in agreement with Almalki et al (2019) , Esraa et al (2018), Nassary Zadeh et al., (2018) (20, 23,24).

The hypothesis of the study stated that the translucency of different zirconia groups will not be affected by the thickness of the samples . This hypothesis was rejected because the different thickness for all types of zirconia materials showed a significant different in TP value.

V. CONCLUSION:

Within the limitation of this study, laminate veneers fabricated from lithium disilicate still the best materials with the highest level of translucency compared to different types of zirconia material . Also , thickness has significant effect on TP for all the examined materials .

Conflict of interest :

There is no conflict of interest.

REFERENCES :

[1]. Rosenstiel S, Land M, Fujimoto. J. Contemporary fixed prosthodontics. St. Louis, Mo:Mosby Elsevier; 2006. p. 774.
[2]. Turgut S, Bagis B, Turkaslan S, Bagis Y. Effect of ultraviolet aging on translucency of resin-cemented ceramic veneers: an in vitro study. J Prosthodont 2013;23(1):39–44.
[3]. Tuncel İ, Turp I, Üşümez A. Evaluation of translucency of monolithic zirconia and framework zirconia materials. J Adv Prosthodont 2016;8(3):181.
[4]. Tuncel I, Eroglu E, Sari T, Usumez A. The effect of coloring liquids on the translucency of zirconia framework. J Adv Prosthodont 2013;5:448–51.
[5]. Johnston WM, Ma T, Kienle BH. Translucency parameter of colorants for maxillofacial prostheses. Int J Prosthod 1995;8:79–86.
[6]. Linhares L.A., PottmaierL.F. and Lopes G.C.Fracture resistance of veneers in premolars. Eur J Dent**.** 2019;12(2):191-198.
[7]. Rasetto FH, Driscoll CF, Prestipino V, Masri R, von Fraunhofer JA. Light transmission through all-ceramic dental materials: a pilot study. J Prosthet Dent. 2004;91(5):441-6.
[8]. Wang F, Takahashi H, Iwasaki N. Translucency of dental ceramics with different thicknesses. The Journal of Prosthetic Dentistry. 2013;110(1):14-20.
[9]. Mclaren, Edward , Lesage, Brian. (2011). Feldspathic veneers: What are their indications?. Compendium of continuing education in dentistry (Jamesburg, N.J. : 1995). 32. 44-9.
[10]. L. Culp, E.A. McLaren. Lithium disilicate: the restorative material of multiple options .Comp Contin Educ Dent, 2010 31 , pp. 716-720 22, 24-5.
[11]. Taqa, Amer & Nayif, Ma'an & Hasan, Nadia.. Adhesion to Zirconia Restorations

a Problem Can Be Solved. International Journal of Enhanced Research in Medicines & Dental Care (IJERMDC), 2019 2349-1590.

[12]. Ajit Suryakant Jankar, Yogesh Kale, Swati Pustake, Shobha Bijjaragi, and Bhushan Pustake. Spectrophotometric Study of the Effect of Luting Agents on the Resultant Shade of Ceramic Veneers. J Clin Diagn Res. 2015 Sep; 9(9): ZC56–ZC60.

[13]. 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 Aug;120(2):269-275.

[14]. Turgut S, Bagis B, Ayaz EA. Achieving the desired colour in discoloured teeth, using leucite-based cad-cam laminate Systems. J Dent.; (2014) 42(1):68-74.

[15]. Zlatanovska, K. A., Dimova, C., Gigovski, N., Korunoska-Stevkovska, V., & Longurova, N.: Fracture localization of porcelain veneers with different preparation designs. J Med Sci. 2019 ;7(10):1675–79.

[16]. Manuela-Maria Manziuc , Cristina Gasparik , Alexandru V. Burde , Horaţiu A. Colosi , Marius Negucioiu ,Diana Dudea Effect of glazing on translucency, color, and surface roughness of monolithic zirconia materials. J Esthet Restor Dent. 2019. Sep;31(5):478-485.

[17]. Reich S, Wichmann M, Nkenke E, Proeschel P. Clinical fit of all-ceramic three-unit fixed partial dentures, generated with three different CAD/CAM systems. Eur J Oral Sci 2005;113(2):174–9.

[18]. O. Abdelbary, M. Wahsh, A. Sherif, T. Salah, Effect of accelerated aging on translucency of monolithic zirconia, Future Dental Journal, Volume 2, Issue 2, 2016, Pages 65-69, ISSN 2314-7180.

[19]. Zhang Y. Making yttria-stabilized tetragonal zirconia translucent. Dent Mater. 2014;30(10):1195-1203.

[20]. Esraa Al-Juailaa,∗, Essam Osmana, Lucette Segaana, Mohammed Shrebatya, Ehab A. Farghalyb. Comparison of translucency for different thicknesses of recent types of esthetic zirconia ceramics versus conventional ceramics. Future Dental Journal (2018) 297–301.

[21]. Barizon KT, Bergeron C, Vargas MA, Qian F, Cobb DS, Gratton DG, Geraldeli S. Ceramic materials for porcelain veneers: part II. Effect of material, shade, and thickness on translucency. J Prosthet Dent. 2014 Oct;112(4):864-70.

[22]. Harada A, Nakamura K, Inagaki R, et al. Fracture resistance of monolithic zirconia molar crowns with reduced thickness. Acta Odontol Scand. 2015;73(8):602-608.

[23]. Nassary Zadeh P, Lümkemann N, Sener B, Eichberger M, Stawarczyk B. Flexural strength, fracture toughness, and translucency of cubic/tetragonal zirconia materials. J Prosthet Dent. 2018 Dec;120(6):948-954.

[24]. Almalki, A. N., Almusined, M. M., Alqunayan, T. I., & Alahmari, A. A. The comparative preference between zirconia and e-max among dentists in Saudi Arabia. International Journal of Medicine in Developing Countries, 2019;3(6):536–541.

[25]. Silveira, R. C., Cruz, L. O., Marcondes, C., Rodrigues, D. C., Carolyna, D., & Freitas, R. De.(2020): Influence of types of designs of dental structure preparations for a esthetic treatments with ceramic laminates – literature review. **Int J Recent Scic Res**. 11(03):37901–10.

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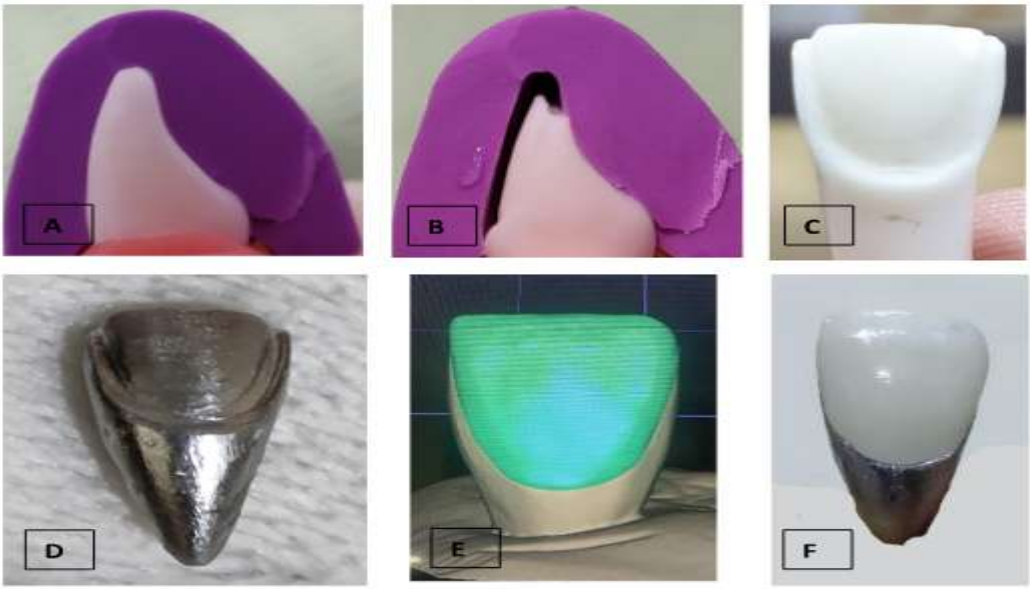

Figure(1): Steps of veneer fabrication A) Silicone guide impression B) Side view of the index. C:) Prepared typodont. D) Metal die E) Final design of the laminate veneer F) Laminate veneer on the metal die.

Figure(2): Steps of sample measurement A) black and white backgrounds B) samples on their corresponding dies C) positioning guide D) sample and device alignment .

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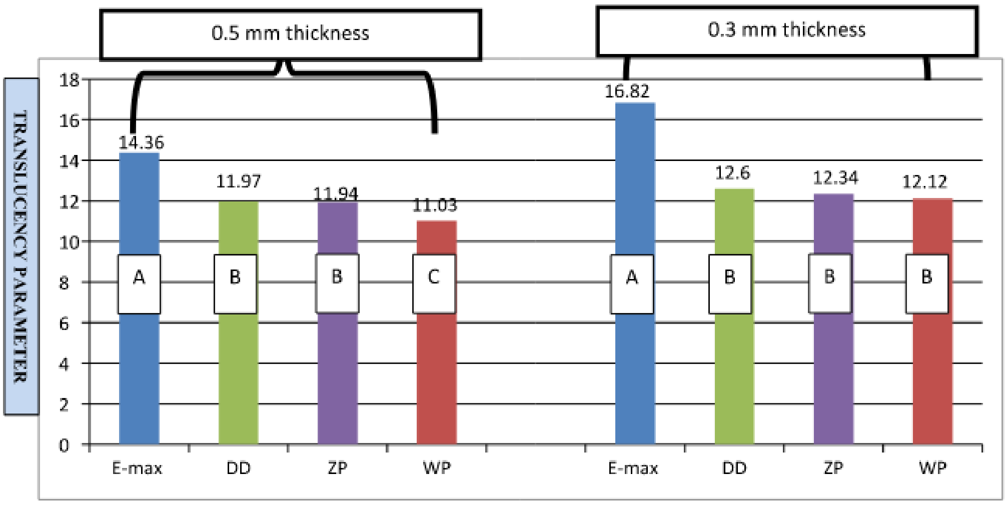
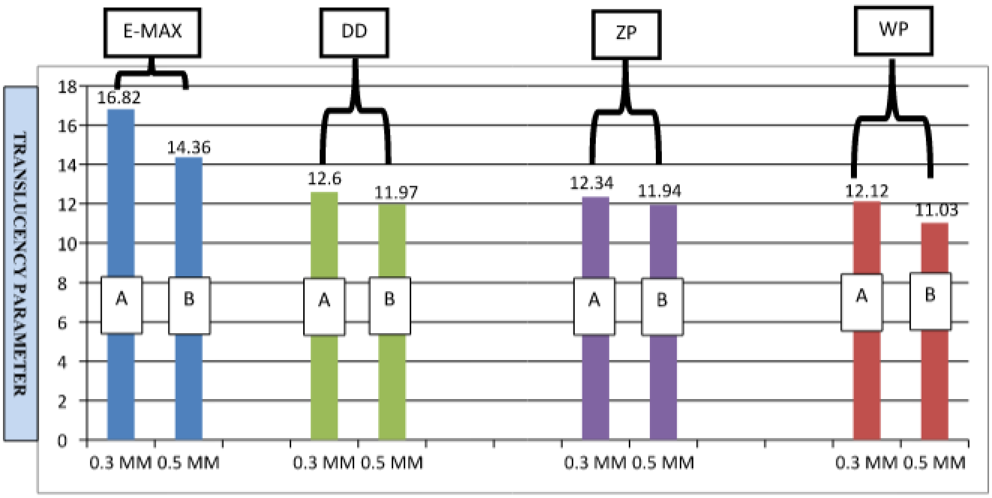


Figure (3): Column graph for Duncan's Multiple Range Test showing TP results of different materials with 0.3mm and 0.5mm thickness.



Figure(4) Column graph showing the effect of different thicknesses on translucency of different material.

Table (1) One-way ANOVA of the four types of veneered samples with 0.5 mm and 0.3mm .

Thickness	Source of variance	Sum of Squares	Df	Mean Square	F	Sig.
0.3 mm	Between Groups	41.581	3	13.860	36.356	.000
	Within Groups	6.100	16	.381		
	Total	47.680	19			
0.5 mm	Between Groups	92.323	3	30.774	46.221	.000
	Within Groups	10.653	16	.666		
	Total	102.976	19			