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# Translucency of Different Dental Ceramics of Varying Thickness Using A Spectrophotometer

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## Abstract

**Introduction:** The translucency of the core ceramic material has been identified as one of the primary factors in controlling esthetics and a necessity consideration in the selection of material. Among the dental ceramics conventional feldspathic ceramic, is still considered the most esthetically pleasing ceramic material, due to its colour refinement and translucency. The subsurface reflection of light of lithium disilicate (L-DIS) and other glass-ceramic, appears dull white in colour.

**Aim**: The purpose of this study is to investigate the relationship between translucency of different dental ceramics of varying thickness.

**Material and methods:** A total of 75 samples of 3 ceramic materials IPS E Max Press HT (Ivoclar Vivadent), IPS E Max Press LT (Ivoclar Vivadent) and Vita Mark II (VITA Zahnfabrik) were fabricated with lost wax technique and CAD/CAM technique. A spectrophotometer was used to measure the translucency parameter (ΔE) of ceramics with varying thickness ranging from 0.3mm to 2mm. The values thus obtained were subjected to statistical analysis. Differences in the outcome variables between different ceramics and thickness were calculated using one way ANOVA.

**Results:** Vita Mark II presented higher mean significant ΔE (31.92) compared to IPS Emax HT (27.16) and IPS Emax LT (22.34) at $P \leq 0.001$. Vita Mark II group with the least thickness (0.3mm) showed the highest mean significant ΔE (31.92) and as the thickness increased translucency decreased with the least mean significant ΔE (20.28) for IPS Emax LT at 2mm thickness.

**Conclusion**: Both material and thickness significantly influenced the translucency of dental ceramics. The translucency of the Vita Mark II was found to be more

compared to the IPS Emax HT and IPS Emax LT. As thickness decreased, the translucency of all materials increased exponentially.

**Keywords:** Ceramics, Esthetics, Spectrophotometer, Translucency.

**Introduction**

Dental ceramics represent a pivotal aspect of modern dentistry, seamlessly blending artistry with science to create durable, aesthetically pleasing restorations. These materials, derived from a combination of inorganic compounds and carefully formulated mixtures, serve as essential components in various dental procedures, ranging from crowns and bridges to veneers and implants.[18]

The term "aesthetic" refers to something that is pleasing to the eyes. Missing anterior teeth can significantly impact a person's appearance, leading to an unappealing look that often affects their confidence, particularly among younger individuals.[21,24]

The evolution of dental ceramics has witnessed a remarkable journey, driven by advancements in materials science and innovative manufacturing techniques. Originally, ceramics were primarily chosen for their biocompatibility and strength, but contemporary formulations now prioritize natural appearance and compatibility with surrounding tissues, ensuring restorations that harmonize seamlessly with the patient's smile.[15] The versatility of dental ceramics extends beyond their functional attributes; they offer a spectrum of shades, translucencies, and opacities, allowing clinicians to tailor restorations to individual patient needs. Moreover, the advent of computer-aided design and manufacturing (CAD/CAM) has revolutionized the fabrication process, enabling precise customization and rapid turnaround times.

The raising demand for Improved and detailed esthetics has shifted the dentistry to the use of ceramic systems as alternatives to metal-ceramic restorations. The properties of the natural teeth should match the one to be restored to achieve the desired esthetic outcome.[12] A unique characteristic for that is translucency. A translucent material allows the fraction of light that is not reflected to penetrate its surface where it is mainly scattered and transmitted. In particular, subsurface light scattering is important for mimicking the natural appearance of hard dental tissues.[1,2]

When restoring a tooth with severe discoloration, using "through and through" restorations, or closing a large diastema where there isn't enough tooth structure to properly reflect and transmit light, shade matching is crucial for achieving an acceptable color[18]. In these cases, the ceramic restoration's ability to mask the underlying darkness is important, as achieving a successful aesthetic outcome without shadowing is challenging unless the dark structure beneath is well covered[27] Therefore, determining the minimum thickness of a ceramic restoration that can effectively block a black background is valuable in clinical treatments. It has been suggested that glass-ceramic restorations should be at least 2.0 mm thick, while feldspathic with the minimum of 0.3 mm provide adequate masking ability.

The Translucency Parameter (TP) was introduced to evaluate the translucency of maxillofacial elastomers. Johnston and Reisbick employed a reflectance model to define the colours used in determining TP for esthetic restorative resins. TP is directly determined by comparing the colours of specimens against black and white backgrounds. The key factors affecting TP (specimen thickness and the reflectance parameters of black and white backgrounds) showed only minor



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variation. TP is considered to correlate directly with common visual assessments and has become one of the most commonly used methods for comparing the relative translucency of dental materials.[20]

Feldspathic ceramic is composed of a glassy matrix with embedded crystalline particles. This microstructure gives it the ability to transmit light while also scattering it, mimicking the optical behaviour of natural enamel.[7] The translucent quality of feldspathic ceramic allows it to blend seamlessly with adjacent natural teeth, resulting in aesthetically pleasing restorations. Feldspathic ceramic is composed of a glassy matrix with embedded crystalline particles. This microstructure gives it the ability to transmit light while also scattering it, mimicking the optical behaviour of natural enamel. The translucent quality of feldspathic ceramic allows it to blend seamlessly with adjacent natural teeth, resulting in aesthetically pleasing restorations.[20]

Feldspathic dental porcelain interacts with light in a favourable way, offering desirable aesthetic qualities. However, it lacks sufficient strength.[20] Due to this limitation, porcelain has traditionally been supported by a metal substructure, making ceramo-metal crowns the predominant choice for restorations over the past three to four decades. Despite their widespread use, these crowns do not fully meet aesthetic requirements because of the underlying metal substructure.[21]

In recent years, advancements in dental materials have led to the development of newer ceramics with even higher translucency, such as lithium disilicate. However, feldspathic ceramic

remains a popular choice, particularly in situations where precise customization and aesthetics are paramount.

Therefore, the purpose of the study was to investigate the translucency parameter of lithium disilicate and feldspathic ceramics according to different thicknesses.

## Material and Methods

A total of 75 samples of IPS E Max Press HT (Ivoclar Vivadent), IPS E Max Press LT (Ivoclar Vivadent) and Vita Mark II (VITA Zahnfabrik) of shade B1, 10 mm in diameter and 5 different thickness of 0.3mm, 0.5mm, 1mm, 1.5mm and 2mm were fabricated with lost wax technique and CAD/CAM technique. To obtain the equal measurements, customized silicon moulds (Fig. 1) was used with the required thickness and diameter. Wax pattern was fabricated for the specimens to be pressed using the silicone mould.

The total samples were divided into 3 main groups according to the ceramic material and named HT for IPS E Max Press HT (Fig. 4.A), LT for IPS E Max Press LT (Fig. 4.B) and VM for Vita Mark II (Fig. 4.C). Each group was further divided into 5 sub-groups of 5 samples each according to the thickness.

Thickness of each material was measured and verified with the vernier calliper (Aero Space, India). All the specimens were cleaned with distilled water to remove any dirt or residues and air dried before subjecting to the spectrophotometric analysis.

**Testing the specimens:** All the specimens were subjected to the spectrophotometric analysis using the CM-5 Spectrophotometer (Konica Minolta) (Fig. 3) to obtain the International Commission on Illumination (CIE) L*a*b* values. Instrument is calibrated automatically with each start up to maintain its high accuracy and performance. L* represents the lightness/darkness of a colour, a* is a measure of redness (positive) or greenness (negative) and b* is a measure of yellowness (positive) or blueness (negative).



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The translucency parameter (TP) values were then calculated with the help of the following equation

TP = [(L*w-L*b)2+(a*w-a*b)2 + (b*w-b*b)2]1/2. The data were captured by the CIElab color system. Mean values of L*, a*, and b* were calculated, and then the ΔE values were used to compare the color difference between the different samples.

The Shapiro-Wilk test was used to evaluate the distribution of the data. One-way analysis of variance (ANOVA) was used to determine the statistical significance of the TPs of the materials.

**Results**

Data were entered into a Microsoft Excel spreadsheet and checked for any discrepancies. The analysis was conducted using SPSS software version 26.0. The Shapiro-Wilk test was used to evaluate the distribution of the data. Since the data followed a normal distribution, a one-way analysis of variance (ANOVA) was performed, as there were five groups. This analysis assessed whether there were any differences in translucency measurements of dental ceramics at different thicknesses. In cases where significant differences were detected, post hoc pairwise comparisons were performed using the Bonferroni test. The level of statistical significance was set at less than 0.05. Summarized data were presented in the form of tables and graphs.

It was found that the ΔE values for the VM group was more than the LT and HT group. The order of decreasing translucency was VM1 (32.2) > VM2 (31.4) > VM3 (30.7) > VM4 (30.0) > VM5 (28.7) > HT1 (27.6) > HT2 (26.8) > HT3 (25.3) > HT4 (24.7) > HT5 (23.6) > LT1 (22.4) > LT2 (22.3) > LT3 (21.4) > LT4 (21.1) > LT5 (20.4). This shows that lithium disilicate glass ceramics (IPS E Max) are more opaque when compared to feldspathic ceramics (Vita Mark II), and among lithium disilicate glass ceramics the high translucent (HT) was more better in terms of translucency than that of low translucent (LT). In relation to the thickness there was significant decrease in the translucency with the increase in the thickness of the material.

One-way ANOVA results (Table 3) suggest that there are significant differences in translucency measurements among the groups at different thicknesses of dental ceramics. This indicates that the choice of ceramic material and thickness can significantly impact translucency, which is an important consideration in dental prosthetics and restorative dentistry.

Table 1 shows the statistics (mean and SD) related to translucency of different ceramics of various thickness. Table 2 shows the Spectrophotometric analysis of different ceramic at different thickness.

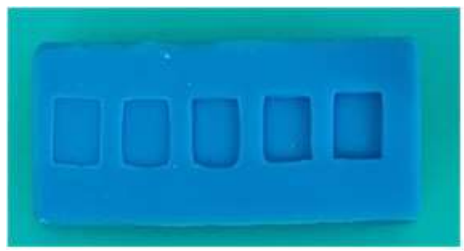

Figure 1: Silicone mould

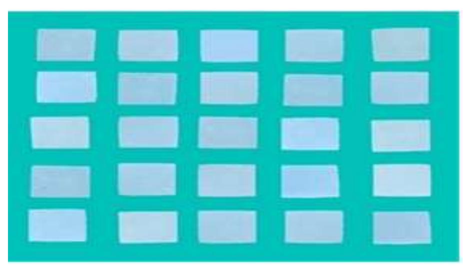

Figure 2: Wax pattern


Figure 3: CM-5 Spectrophotometer



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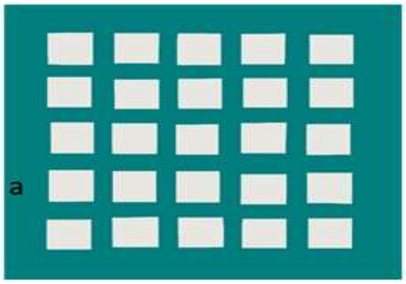


Figure 4(a): Vita Mark II Samples fabricated

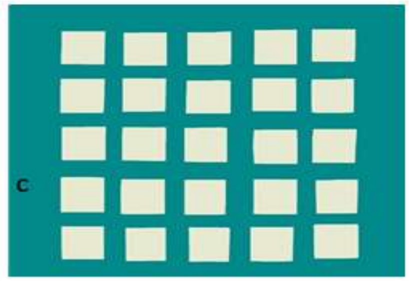


Figure 4(c): E Max LT Samples fabricated

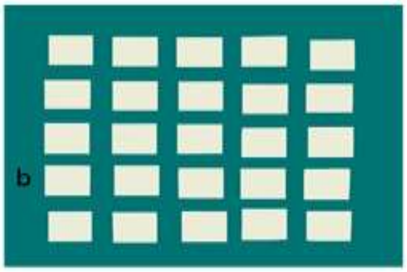


Figure 4(b): E Max HT Samples fabricated

Table 1: Translucency Measurements of Dental Ceramics at Different Thicknesses

| Thickness | Feldspathic | | Lithium disilicate_HT | | Lithium disilicate_LT | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| 0.3mm | 31.92 | .38 | 27.16 | .36 | 22.34 | .05 |
| 0.5mm | 30.64 | .43 | 26.26 | .41 | 22.02 | .41 |
| 1mm | 30.00 | .51 | 24.98 | .29 | 21.30 | .10 |
| 1.5mm | 29.28 | .57 | 23.62 | .62 | 20.68 | .38 |
| 2mm | 28.36 | .34 | 23.44 | .15 | 20.28 | .13 |

Table 2: Descriptive statistics include the mean, standard deviation, standard error, and 95% confidence intervals for each group and thickness category, along with the minimum and maximum values.

| | | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | | |
| 0.3 mm | F | 5 | 31.9200 | .38341 | .17146 | 31.4439 | 32.3961 | 31.50 | 32.20 |
| | L_HT | 5 | 27.1600 | .35777 | .16000 | 26.7158 | 27.6042 | 26.60 | 27.60 |
| | L_LT | 5 | 22.3400 | .05477 | .02449 | 22.2720 | 22.4080 | 22.30 | 22.40 |
| | Total | 15 | 27.1400 | 4.05811 | 1.04780 | 24.8927 | 29.3873 | 22.30 | 32.20 |
| 0.5 mm | F | 5 | 30.6400 | .42778 | .19131 | 30.1088 | 31.1712 | 30.40 | 31.40 |
| | L_HT | 5 | 26.2600 | .40988 | .18330 | 25.7511 | 26.7689 | 25.80 | 26.80 |
| | L_LT | 5 | 22.0200 | .40866 | .18276 | 21.5126 | 22.5274 | 21.30 | 22.30 |
| | Total | 15 | 26.3067 | 3.66303 | .94579 | 24.2781 | 28.3352 | 21.30 | 31.40 |



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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 mm | F | 5 | 30<0.00010 | .50990 | .22804 | 29.3669 | 30.6331 | 29.30 | 30.70 |
| | L_HT | 5 | 24.9800 | .29496 | .13191 | 24.6138 | 25.3462 | 24.70 | 25.30 |
| | L_LT | 5 | 21.3000 | .10000 | .04472 | 21.1758 | 21.4242 | 21.20 | 21.40 |
| | Total | 15 | 25.4267 | 3.70472 | .95655 | 23.3751 | 27.4783 | 21.20 | 30.70 |
| 1.5 mm | F | 5 | 29.2800 | .57184 | .25573 | 28.5700 | 29.9900 | 28.70 | 30.00 |
| | L_HT | 5 | 23.6200 | .62209 | .27821 | 22.8476 | 24.3924 | 23.20 | 24.70 |
| | L_LT | 5 | 20.6800 | .38341 | .17146 | 20.2039 | 21.1561 | 20.40 | 21.10 |
| | Total | 15 | 24.5267 | 3.72740 | .96241 | 22.4625 | 26.5908 | 20.40 | 30.00 |
| 2 mm | F | 5 | 28.3600 | .33615 | .15033 | 27.9426 | 28.7774 | 27.80 | 28.70 |
| | L_HT | 5 | 23.4400 | .15166 | .06782 | 23.2517 | 23.6283 | 23.20 | 23.60 |
| | L_LT | 5 | 20.2800 | .13038 | .05831 | 20.1181 | 20.4419 | 20.10 | 20.40 |
| | Total | 15 | 24.0267 | 3.44766 | .89018 | 22.1174 | 25.9359 | 20.10 | 28.70 |

Table 3: Analysis of Variance (ANOVA) for Translucency Measurements of Dental Ceramics at Different Thicknesses

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 0.3 mm | Between Groups | 229.444 | 2 | 114.722 | 1238.007 | <0.0001 |
| | Within Groups | 1.112 | 12 | .093 | | |
| | Total | 230.556 | 14 | | | |
| 0.5 mm | Between Groups | 185.777 | 2 | 92.889 | 537.965 | <0.0001 |
| | Within Groups | 2.072 | 12 | .173 | | |
| | Total | 187.849 | 14 | | | |
| 1 mm | Between Groups | 190.721 | 2 | 95.361 | 801.350 | <0.0001 |
| | Within Groups | 1.428 | 12 | .119 | | |
| | Total | 192.149 | 14 | | | |
| 1.5 mm | Between Groups | 191.065 | 2 | 95.533 | 332.866 | <0.0001 |
| | Within Groups | 3.444 | 12 | .287 | | |
| | Total | 194.509 | 14 | | | |
| 2 mm | Between Groups | 165.797 | 2 | 82.899 | 1625.464 | <0.0001 |
| | Within Groups | .612 | 12 | .051 | | |
| | Total | 166.409 | 14 | | | |

**Conclusion**

Based on the findings of this in vitro study, the following conclusions were drawn:

1. The thickness of the ceramic impacts its translucency, with increased thickness leading to decreased translucency in the respective materials.
2. The choice of material also can enhance or diminish the translucency.
3. The selection of the most suitable ceramic material depends solely on the specific clinical situation.



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**References**


1. Johnston WM, Reisbick MH. Color and translucency changes during and after curing of esthetic restorative materials. Dental Materials. 1997 Mar 1;13(2):89-97.
2. Vichi A, Ferrari M, Davidson CL. Influence of ceramic and cement thickness on the masking of various types of opaque posts. The Journal of prosthetic dentistry.2000 Apr;83(4):412-7.
3. Heffernan MJ, Aquilino SA, Diaz-Arnold AM, Haselton DR, Stanford CM, Vargas MA. Relative translucency of six all-ceramic systems. Part I: core materials. The Journal of prosthetic dentistry. 2002 Jul 1;88(1):4-9.
4. Peixoto RT, Paulinelli VM, Sander HH, Lanza MD, Cury LA, Poletto LT. Light transmission through porcelain. Dental Materials. 2007 Nov 1;23(11):1363-8.
5. Baldissara P, Wandscher VF, Marchionatti AM, Parisi C, Monaco C, Ciocca L. Translucency of IPS e. max and cubic zirconia monolithic crowns. The Journal of prosthetic dentistry. 2018 Aug 1;120(2):269-75.
6. Pires-de FD, Casemiro LA, Garcia LD, Cruvinel DR. Color stability of dental ceramics submitted to artificial accelerated aging after repeated firings. The Journal of prosthetic dentistry. 2009 Jan 1;101(1):13-8.
7. Spink L. A comparison of absolute translucency and relative translucency of dental ceramics.
8. Li Q, Yu H, Wang YN. Spectrophotometric evaluation of the optical influence of core build-up composites on all-ceramic materials. Dental Materials. 2009 Feb 1;25(2):1586
9. Wang F, Takahashi H, Iwasaki N. Translucency of dental ceramics with different thicknesses. The Journal of prosthetic dentistry. 2013 Jul 1;110(1):14-20.
10. Pop-Ciutrila IS, Ghinea R, Dudea D, Ruiz-López J, Pérez MM, Colosi H. The effects of thickness and shade on translucency parameters of contemporary, esthetic dental ceramics. Journal of Esthetic and Restorative Dentistry. 2021 Jul;33(5):795-806.
11. Brodbelt RH, O'brien WJ, Fan PL. Translucency of dental porcelains. Journal of Dental Research. 1980 Jan;59(1):70-5.
12. Lim HN, Yu B, Lee YK. Spectroradiometric and spectrophotometric translucency of ceramic materials. The Journal of prosthetic dentistry. 2010 Oct 1;104(4):239-46.
13. Alnahdi A, Fan Y, Michalakis K, Giordano R. Color stability of pressed lithium disilicate ceramics under repeated firings evaluated by different methods. Int J Prosthodont. 2024 Mar 13;0(0):1-27.
14. Shadman N, Ebrahimi SF, Shoul MA, Kandi SG, Rostami S. The minimum thickness of a multilayer ceramic restoration required for masking dark background. Dent Res J (Isfahan). 2022 Apr 27;19:31.
15. Church Todd D, Jessup JP, Guillory VL, Vandewalle KS. Translucency and strength of high-translucency monolithic zirconium oxide materials. Gen Dent. 2017;65(1):48-52.
16. Wang J, Yang J, Lv K, Zhang H, Huang H, Jiang X. Can we use the translucency parameter to predict the CAD/CAM ceramic restoration aesthetic?.dental materials. 2023 Mar 1;39(3):e1-0.
17. Sravanthi Y, Ramani YV, Rathod AM, Ram SM, Turakhia H. The comparative evaluation of the translucency of crowns fabricated with three different all-ceramic materials: an in vitro study.




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Journal of clinical and diagnostic research: JCDR. 2015 Feb;9(2):ZC30.

18. Șoim A, Strîmbu M, Burde AV, Culic B, Dudea D, Gasparik C. Translucency and masking properties of two ceramic materials for heat-press technology. Journal of Esthetic and Restorative Dentistry. 2018 Mar;30(2):E18-23.
19. Saláta J, Fehér D, Borbély J, Ábrám E. Spectrophotometric examination of the optical properties of lithium-silicate glass-ceramics with different substrates. Journal of Dentistry. 2022 Jun 1;121:103966
20. Kim SJ, Son HH, Cho BH, Lee IB, Um CM. Translucency and masking ability of various opaque-shade composite resins. Journal of dentistry. 2009 Feb 1;37(2):102-7.
21. Yildirim B, Recen D, Tekeli Simsek A. Effect of cement color and tooth shaded background on the final color of lithium disilicate and zirconia-reinforced lithium silicate ceramics: An in vitro study. J Esthet Restor Dent 2020;19:1-7.
22. Awad D, Stawarczyk B, Liebermann A, Ilie N. Translucency of esthetic dental restorative CAD/CAM materials and composite resins with respect to thickness and surface roughness. The Journal of prosthetic dentistry. 2015 Jun 1;113(6):534-40.
23. PotDukhE SS, IyEr JM, Nadgere JB. Translucency and wear of pressable lithium disilicate and zirconia-reinforced lithium silicate glass-ceramics: An in-vitro study. Journal Of Clinical And Diagnostic Research. 2023 Jan 1;17(1):ZC36-9.
24. Lee YK. Criteria for clinical translucency evaluation of direct esthetic restorative materials. Restorative Dentistry & Endodontics. 2016 Aug;41(3):159.
25. Awad D, Stawarczyk B, Liebermann A, Ilie N. Translucency of esthetic dental restorative CAD/CAM materials and composite resins with respect to thickness and surface roughness. The Journal of prosthetic dentistry. 2015 Jun 1;113(6):534-40.
26. Lee YK. Changes in the translucency of porcelain and repairing resin composite by the illumination. Dental Materials. 2007 Apr 1;23(4):492-7.
27. Ahn JS, Lee YK. Difference in the translucency of all-ceramics by the illuminant. Dental materials. 2008 Nov 1;24(11):1539-44.
28. Morimoto S, Albanesi RB, Sesma N, Agra CM, Braga MM. Main Clinical Outcomes of Feldspathic Porcelain and Glass-Ceramic Laminate Veneers: A Systematic Review and Meta-Analysis of Survival and Complication Rates. International Journal of Prosthodontics. 2016 Jan 1;29(1).
29. Miller A, Long J, Miller B, Cole J. Comparison of fracture strengths of ceramometal crowns versus several all- ceramic crowns. J Prosthet Dent. 1995;68(1): 38-41.



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