ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

*International Journal of Dental Science and Innovative Research (IJDSIR)*

*IJDSIR : Dental Publication Service*

*Available Online at: www.ijdsir.com*

*Volume – 4, Issue – 4, July - 2021, Page No. : 488 - 497*

# The effect of ceramic thickness on the colour and translucency of all ceramic restoration: A Systematic Review

[1]Dr Mitangi Talati, Post graduate student, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

[2]Dr Pankaj Patel, HOD and Professor, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

[3]Dr Aumkar Trivedi, Reader, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

[4]Dr. Bhakti Choudhari, Post graduate student, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

[5]Dr Aesha Shah, Post graduate student, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

[6]Dr Aneri Patel, Senior lecturer, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

**Corresponding Author:** Dr Mitangi Talati, Post graduate student, Department of prosthodontics and crown & bridge, Goenka research institute of dental science, Gandhinagar, India.

**Citation of this Article:** Dr Mitangi Talati, Dr Pankaj Patel, Dr Aumkar Trivedi, Dr. Bhakti Choudhari, Dr Aesha Shah, Dr Aneri Patel, “The effect of ceramic thickness on the colour and translucency of all ceramic restoration: A Systematic Review”, IJDSIR- July - 2021, Vol. – 4, Issue - 4, P. No. 488 – 497.



**Type of Publication:** Review Article

**Conflicts of Interest:** Nil

## Abstract

**Purpose:** the aim of the present review was to evaluate the effect of ceramic thickness on the colour and translucency of all ceramic restoration.

**Material and methods:** This systematic review was based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. The study question was determined according to PICO (population, intervention, comparison and outcome). This systematic review search covered the PubMed, Science direct, Wiley online library as well as the Web search Google Scholar databases for the period from 2010 to 2020. 985 articles were found and 30 studies were selected and their full text was provided. Studies that did not assess the thicknesses of the ceramic were excluded which left 11 articles to be included for data extraction.

**Summary:** Within the limitations of the present systematic review showed that different ceramic had different optical properties at different thickness. It was found that optical characteristics and the translucency of

the final restorations were influenced by ceramic thickness and showed that final colour of all ceramic restorations can be affected by several factors.

**Keywords:** all-ceramic, fixed dental prosthesis, Thickness, Color, translucency, translucency parameter

**Introduction**

In dentistry esthetic restorations are concerned specially with the appearance of dental arches and replacement of missing dental tissues by artificial materials. [1] Optimally matching the esthetics of natural teeth with those of artificial teeth is a significant challenge in dentistry. [2] Metal ceramics have been evolved with the increased demands of patients for esthetics. [1]

On the other end metal ceramic restorations have an esthetic limit because of their metal substructure and their use has been gradually decreased.[3] At the same time, all-ceramic restorations have become more popular because of ceramic materials having excellent esthetics, no metal substructure and acceptable mechanical properties. So, have been advocated rather than traditional metal ceramic restorations. [4]

Ceramic systems have been evolved to allow the fabrication of crowns with better esthetics. [5] Translucency is the element that adds a life-like appearance to the restoration and improved esthetic. [6] It is one of the primary factors in controlling the esthetic outcome of ceramic restorations. It can be adjusted by controlling the absorption, reflection, scattering and transmission of light through the material. [7,8]

Spectrophotometer or a spectroradiometer have been used to assess aesthetic properties of dental restorative materials using the Commission Internationale de l'Eclairage (CIE) L*a*b* system. The L* value is a measure of the lightness of an object, a* value is a measure of redness (positive value) or greenness (negative value), and the b* value is a measure of yellowness (positive value) or blueness (negative value). [9,10]

Zirconia restoration has to be similar with natural tooth which is important to attain colour match for translucency and shade, [11, 12] but achieving optimal esthetic with these restorations is still challenging.[2]

The monolithic zirconia is the good option in esthetics which has excellent mechanical properties, like flexural strength and fracture toughness.

Lithium disilicate glass ceramic has more favorable mechanical and optical properties compared with conventional dental porcelains. Moreover, it has been considered superior in terms of translucency, but it has mechanical properties that are inferior compared with zirconia. [13]

There are five methods which currently used for the fabrication of all-ceramic restorations: (1) condensation and sintering, (2) casting and ceramming, (3) Heat pressing, (4) slip casting, and (5) computer-aided design/computer-assisted manufacturing.[9]

To match natural tooth structure, color and surface texture there are factors which influences all-ceramic restorations like translucency, porcelain layering technique [14], shade [15], thickness [16] and luting agent [17] through layering of core and veneer ceramics. [18] Even when an adequate ceramic thickness exists, clinical shade matches are typically hard to achieve. Moreover, in order to effectively implement the layering technique for all-ceramic restorations, clinician must recognize [9, 19] the effects of core and veneer ceramics on the final layered color of restorations.

It is necessary to determine the factors affecting the translucency of ceramic restorations in order to predict the treatment result, the present study was undertaken to systematically review articles on the effect of ceramic

thickness on the colour and translucency of all ceramic restoration.

**Material and methods**

**Study design:** In this systematic review, it includes in vitro studies on the effect of ceramic thickness on the colour and translucency of all ceramic restoration were investigated. There are following inclusion and exclusion criteria:

Inclusion criteria

- Published in English language
- In vitro stud
- Study of all ceramic restorations
- Study with test group used a ceramic layer of different thicknesses.
- Comparison of ceramic groups
- Selected articles from 2010 to 2020.

Exclusion criteria

- Systematic review study
- Case report
- Evaluation of results based on questionnaires
- Human studies
- Articles older than ten years

This systematic review was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) 2010 guidelines. The PICO strategy (population, intervention, comparison, and outcome) was used for study.

The primary issue addressed in the present study was the effect of ceramic thickness on the colour and translucency of all ceramic restoration

**Search strategy**

This systematic review search covered the following databases: MEDLINE (National Library of Medicine) via PubMed, Science direct, Wiley online library as well as the Web search Google Scholar sources dated between January 2010 and April 2020.

The medical keywords used as search terms based on PICO are listed in following.

Keywords used as search terms based on PICO: -

**Population**

Crown OR dental crown OR tooth crown OR jacket crown OR full jacket crown OR all-ceramic OR dental prosthesis OR single crown OR single unit OR fixed prosthesis OR fixed restoration OR fixed prosthodontics OR fixed dental prosthesis OR FDP OR tooth reconstruction.

Intervention

Thickness OR layer OR dentin porcelain OR ceramic OR liner. OR core

Comparison

Not indicated

Outcome Color OR shade OR translucency OR CIE OR spectrophotometer OR colorimeter OR transparency OR illusion OR translucency parameter

**Screening and selection**

An electronic search was done based on above keywords; 985 articles were found. The articles were reviewed and screened based on titles and abstracts, 30 studies included by reading title and abstract. The full text articles were then assessed and evaluated from that 11 full text articles were selected by evaluating inclusion and exclusion criteria.

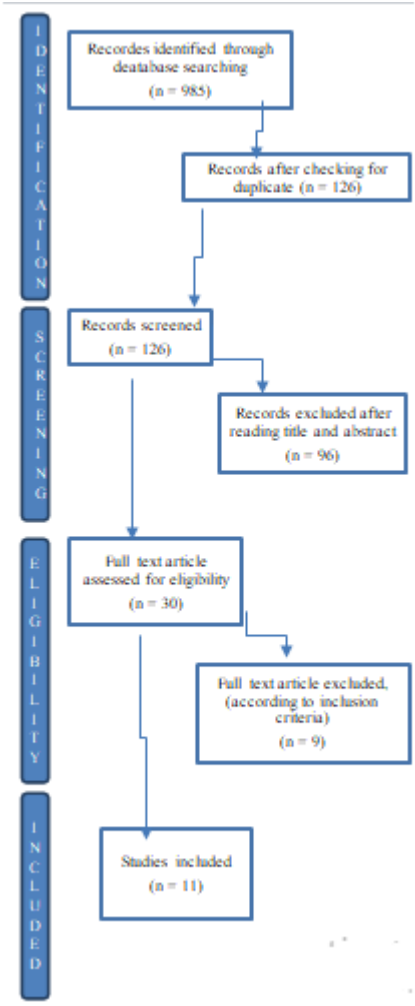


Fig. 1: Flowchart of study selection

**Result**

The electronic literature search found 985 articles as shown in Figure 1. After examination of the title and the abstract, 30 studies were selected and their full text was provided. Next, studies that did not assess the thicknesses of the ceramic were excluded. A total of 11 studies were finally included in the present systematic review.

The effect of veneering thickness on the color of ceramic restorations were investigated in studies. The results of these studies are summarized in Table 1. The most common ceramic type used was IPS Empress made using the pressing technique. Different ceramic thicknesses (0.2 to 2.0 mm) were also investigated.

**Discussion**

All-ceramic restoration has become more popular in the last 10 years due to its excellent biocompatibility, good esthetic and natural appearance.[20] Ceramic materials must provide optical and mechanical characteristics for the fabrication of esthetic restorations, similar to those of natural teeth.[24]Though enamel and dentin have inherent translucency, matching ceramic restorations aesthetically should not involve only shape and texture but also the reproduction of the optical characteristics of teeth with adjacent natural teeth. [25, 26]

The translucency of ceramics is an important factor for achieving good esthetics and is influenced by both ceramic material and thickness. It is also affected by fabrication technique, material composition, and illuminants. [21, 27, 28]

Table 1 Summary of studies evaluating effect of ceramic thickness on restoration color and translucency

| Authors | Year | Specimens | Ceramic type | Ceramic thicknesses | Results |
|---|---|---|---|---|---|
| Jung et al [9] | 2010 | 27 specimens for each ceramic | IPS e.max Press (EM), Lava | 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00 mm | Increases in dentin porcelain thickness resulted in gradual decreases in L*and gradual increases in a* and b*. |

| | | | | | |
|---|---|---|---|---|---|
| Wang et al [4] | 2013 | 6 specimens for each glass ceramic<br><br>5 specimens for each zirconia ceramic | IPS e.max Press HO, MO, LT, HT, IPS e.max CAD LT, and MO (Lithium disilicate glass ceramic).<br>AvanteZ Dentin (AZD) and Trans (AZT) (Leucite-free glass ceramic).<br>Cercon Base (CRB), Zenotec Zr Bridge (ZNT), Lava Standard (LVS), Lava Standard FS3 (LVF) and Lava Plus High Translucency (LVP) (Zirconia ceramic). | glass ceramics: every 0.2 mm from 2.0 to 1.0 mm and every 0.1 mm from 1.0 to 0.6 mm. zirconia ceramics: every 0.1 mm between 1.0 and 0.4 mm. | The translucency parameter (TP) of dental ceramics was significantly influenced by both material and thickness. The translucency of all materials increased as the thickness decreased. |
| Dikicier et al [20] | 2014 | 30 specimens for each ceramic | In-Ceram Alumina (IC), EM, Katana | 0.5, 0.8, 1.0 mm | For all ceramic systems, the a* values increased as the thickness of the core increased. Conversely, L* and b* values decreased as increases in core porcelain thickness. |
| Jeong et al [21] | 2015 | 7 specimens for each ceramic | IPS e.max Zirpress, Initial IQ, Rosetta UltraPress | Core: 0.5, 0.7, 1.0mm<br>Veneer: 1.0, 0.8, 0.5mm | Combination of 0.7-mm veneer thickness and 0.8-mm core thickness exhibited the lowest value of transmittance. As the veneer thickness was decreased further, the value of transmittance increases. |
| Harada et al | 2016 | 5 specimens for | Prettau Anterior, | 0.5mm, 1.0mm | All materials were |

| | | | | | |
|---|---|---|---|---|---|
| [13] | | each ceramic | BruxZir, Katana High-translucency (HT), Katana Supertranslucency (ST), and Katana Ultratranslucency (UT), Lithium disilicate e.max CAD LT (low translucency) | | significantly different from each other, except for between BruxZir and Katana HT, and among Prettau Anterior, Katana ST and Katana UT which were significantly more translucent than all other zirconias and less translucent than e-max CAD LT for both thicknesses. |
| Pires et al [5] | 2016 | 20 specimens for each ceramic | IPS e.max Press LT (low translucency) and HO (high opacity) | 1.5mm, 2.0mm | The colour difference (ΔE) of ceramic HO were lower than those of ceramic LT. |
| Kang et al [3] | 2017 | 7 specimens for each ceramic | IPS e.max CAD, IPS Empress CAD, IPS e.max ceram, IPS Empress Esthetic veneer. | Core: 0.8, 1.0, 1.2mm Veneer: 0.3, 0.5, 0.7mm | ΔE increases as the thickness of the core decreases. |
| Tabatabaian et al [22] | 2017 | 10 specimens for each thickness | IPS e.max Press | 0.4, 0.6, 0.8mm | Increase in the thickness from 0.4 to 0.8 mm decreased the ΔE values. |
| Juaila et al [1] | 2018 | 24 specimens for each ceramic | IPS e.max (EMHT), IPS e.max (EMLT), Ultratranslucency Zirconia (UTZ), Top-translucency Zirconia (TTZ), Supertranslucency Zirconia (STZ), and High-translucency Zirconia (HTZ) | 0.4, 0.6, 1.0mm | Group EMHT (9.10 ± 1.45) scored the highest TP followed by group EMLT (8.36 ± 1.42) then group UTZ (6.66 ± 2.49), TTZ (6.25 ± 0.95), STZ (4.93 ± 0.96) and HTZ (4.83 ± 1.34) showed the lowest value. |
| Motamedi et | 2018 | 10 specimens for | DD cube X, Copra | 0.7, 0.9, and 1.1 mm | To achieve an acceptable |

| | | | | | |
|---|---|---|---|---|---|
| el [2] | | each thickness | Smile | | final color, the minimum thickness of a monolithic zirconia ceramic should be 0.9 mm |
| Bayindir et al [23] | 2019 | 20 specimens for each thickness | Katana HT | 0.5, 1.0, 1.5, 2.0 mm | TP values significantly increased with the decrease in thickness from 2.0 mm to 0.5 mm |

Clinically, the important aspect of esthetic dental restoration is an appropriate color combination. According to some studies, the esthetic success and optical properties of all-ceramic restorations are not only depending upon ceramic thickness [18, 29], but several factors involved in affecting the translucency of dental ceramics, such as surface characteristics [30], number of firings [31], luting agent [32, 33] and color shade [34]. Most all-ceramic systems require the combination of two layers of ceramic material, such as a 'core' with high opacity and a more translucent 'veneer'. [20] Dozic´ et al [18] found significant correlation between the thickness ratio of porcelain system within 1 mm and color coordinates a* and b* and reported that the thickness of 0.7mm is sufficient to mask the influence of background color on the final color of layered ceramic restoration. Shokry et al [29] in his study reported that ΔE (color difference) value depends on the total thickness of ceramic materials and there is significant contribution of core and veneer thickness on optical parameter of the specimen. In studies that reported the results of color difference (ΔE) Dikicier et al [20], Kang et al [3] and Tabatabaian et al [22] showed that ΔE decreases as core and veneering thickness increases.

But, study by Jung et al [9] reported that ΔE increases as the ceramic thickness increases. According to study by Pires et al [5] the ΔE values of ceramic HO were lower than those of ceramic LT. They also confirmed the importance of the optical characteristics like translucency and opacity for ceramic, regardless of the other variables analysed for thickness. Motamedi et el [2] showed significant differences in the CIELab and ΔE values related to zirconia thickness. They found that increase in the zirconia thickness will decrease the effects on the colour. To achieve an acceptable final colour, the minimum thickness of a monolithic zirconia ceramic should be 0.9 mm. But according to Alqahtani et al [17] the use of 0.7mm thicknesses of ceramic specimens have decreased ΔE values in comparison with 0.5mm thicknesses.

Dikicier et al [20] studied on the effect of thickness on color parameters and reported that L* decreases as the core thickness increases. Jung et al [9] studied IPS Empress ceramic and reported that with increased core thickness there is increased in the a* and b* parameters and decreased L*.

According to Ghulman and Awad [35], at the highest 1.5 mm crown thickness, there was no significant difference between natural teeth and crowns constructed from different ceramic materials. In studies that reported the results of translucency parameter (TP), Wang et al [4], Jeong et al [21] and Bayindir et al [23] showed that TP values increases as core and veneering thickness decreases. Harada et al [13] found that all materials used for in vitro study were significantly different from each

other, in which Katana UT were significantly more translucent than all other zirconia and less translucent than e-max CAD LT for both thicknesses.

Juaila et al [1] studied that Group EMHT (9.10 ± 1.45) scored the highest TP followed by group EMLT (8.36 ± 1.42) then group UTZ (6.66 ± 2.49), TTZ (6.25 ± 0.95), STZ (4.93 ± 0.96) and HTZ (4.83 ± 1.34) showed the lowest value. Bagis et al [27] studied that the chemical structures of the ceramic systems were more effective in determining the optical parameters than the fabrication techniques. The underlying tooth abutment color, cement color, and ceramic thickness significantly influenced the resulting optical color. In this review the only difference in reported results is related to the type of ceramic material investigated. It was showed that different ceramic had different optical properties at different thickness.

The method of in vitro studies, including the type of specimen and means of evaluating color change were different in different studies, which could affect the results. As in this review included only in vitro studies colour difference by clinical application have not been assessed.

The optical properties of the restorations can also get affected by the presence of saliva. Nevertheless, In vitro studies are helpful to evaluate which is most desirable; moreover, it is ideal for evaluating the effect of thickness on colour and translucency of all ceramic restoration. The purpose of this systematic review was to evaluate the effect of ceramic thickness on the color and translucency of all ceramic restoration. This was the review of in vitro studies with regard to several variables between the studies including method, type and commercial brand of ceramic, method of colour evaluation and background colour, it was not possible to compare the results of studies directly; thus, data were analysed descriptively.

**Conclusion**

Within the limitations of the present systematic review showed that final colour of all ceramic restorations can be affected by several factors. It was found that optical characteristics and the translucency of the final restorations were influenced by ceramic thickness. Further investigation should consider variables such as type of ceramic, fabrication method, colour of underlying surface, colour of background, the type and thickness of cement to determine the effect of ceramic thickness. Results obtained from in vitro studies should be verified and investigation of the colour stability of the ceramic should be done in clinical trials.

**Reference**

1. Juaila EA, Osman E. Comparison of translucency for different thicknesses of recent types of esthetic zirconia ceramics versus conventional ceramics - in vitro study. Future Dental Journal 2018; 4:297–301.
2. Tabatabaian F, Motamedi E. Effect of thickness of monolithic zirconia ceramic on final color. J Prosthet Dent 2018; 120:257-262.
3. Kang W, Park JK. Effects of core and veneer thicknesses on the color of CAD-CAM lithium disilicate ceramics. J Prosthet Dent 2017; 119:461-466.
4. Wang F, Takahashi H. Translucency of dental ceramics with different thicknesses. J Prosthet Dent 2013; 110:14-20.
5. Pires LA, Novais PMR. Effects of the type and thickness of ceramic, substrate, and cement on the optical color of a lithium disilicate ceramic. J Prosthet Dent 2016; 117:144-149.
6. 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

7. Peixoto RT, Paulinelli VM, Sander HH, Lanza MD, Cury LA, Poletto LT. Light transmission through porcelain. Dent Mater 2007; 23:1363-8
8. Tuncel İ, Turp I, Üşümez A. Evaluation of translucency of monolithic zirconia and framework zirconia materials. J Adv Prosthodont 2016; 8(3):181.
9. Son H, Kim W, Jun S, Kim Y, Ju S, Ahn J. Influence of dentin porcelain thickness on layered all-ceramic restoration color. J Dent 2010; 38:71–7.
10. Van der Burgt TP, Ten Bosch JJ, Borsboom PC, Kortsmit WJ. A comparison of new and conventional methods for quantification of tooth color. The Journal of prosthetic dentistry. 1990 Feb 1; 63(2):155-62.
11. Skyllouriotis AL, Yamamoto HL, Nathanson D. Masking properties of ceramics for veneer restorations. J Prosthet Dent 2017; 118:517-23.
12. Harada R, Takemoto S, Hattori M, Yoshinari M, Oda Y, Kawada E. The influence of colored zirconia on the optical properties of all-ceramic restorations. Dent Mater J 2015; 34:918-24
13. Harada K, Raigrodsk AJ. A comparative evaluation of the translucency of zirconias and lithium disilicate for monolithic restorations. J Prosthet Dent 2016; 116:257-263.
14. Grah CL, O'Brien WJ, Boenke KM. Differences in color between fired porcelain and shade guides. International Journal of Prosthodontics. 1992 Nov 1; 5(6)
15. Stavridakis MM, Dent M, Papazoglou E, Seghi RR, Johnston WM, Brantley WA. Effect of different high-palladium metal-ceramic alloys on the color of opaque and dentin porcelain. The Journal of prosthetic dentistry. 2004 Aug 31; 92(2):170-
16. Douglas RD, Przybylska M. Predicting porcelain thickness required for dental shade matches. The Journal of prosthetic dentistry. 1999 Aug 31; 82(2):143-9.
17. Alqahtani MQ, Aljurais RM, Alshaafi MM. The effects of different shades of resin luting cement on the color of ceramic veneers. Dental materials journal. 2012; 31(3):354-61.
18. Dozic A, Kleverlaan CJ, Meegdes M, van der Zel J, Feilzer AJ. The influence of porcelain layer thickness on the final shade of ceramic restorations. Journal of Prosthetic Dentistry 2003; 90:563–70.
19. Lee YK, Cha HS, Ahn JS. Layered colour of all-ceramic core and veneer ceramics. Journal of Prosthetic Dentistry 2007; 97:279–86.
20. Dikicier S, Ayyildiz S. Effect of varying core thicknesses and artificial aging on the color difference of different all-ceramic materials. Acta Odontologica Scandinavica. 2014; 1-7.
21. Jeong D, Bae SY. Translucency of zirconia-based pressable ceramics with different core and veneer thicknesses. J Prosthet Dent 2015; 115:768-772.
22. Tabatabaian F, Taghizade F. Effect of coping thickness and background type on the masking ability of a zirconia ceramic. J Prosthet Dent 2017; 119:159-165.
23. Bayindir F, Koseoglu M. The effect of restoration thickness and resin cement shade on the color and translucency of a high-translucent monolithic zirconia. J Prosthet Dent 2019; 123:149-154.
24. Kursoglu P, Motro PFK, Kazazoglu E. Translucency of ceramic material in different core-veneer combinations. J Prosthet Dent 2015; 113:48-53.
25. Xiong F, Chao Y, Zhu Z. Translucency of newly extracted maxillary central incisors at nine locations. J Prosthet Dent 2008; 100:11-7.

26. Yu B, Ahn JS, Lee YK. Measurement of translucency of tooth enamel and dentin. Acta Odontol Scand 2009; 67:57-64.
27. Bagis B, Turgut S. Optical properties of current ceramics systems for laminate veneers. J Dent 2013; 41:24-30.
28. Lim HN, Yu B, Lee YK. Spectroradiometric and spectrophotometric translucency of ceramic materials. J Prosthet Dent 2010; 104:239-46.
29. Shokry TE, Shen C, Elhosary MM, Elkhodary AM. Effect of core and veneer thicknesses on the color parameters of two all ceramic systems. J Prosthet Dent 2006; 95:124–9.
30. Yilmaz C, Korkmaz T, Demirkoprulu H, Ergun G, Ozkan Y. Color stability of glazed and polished dental porcelains. J Prosthodont 2008; 17:20–4.
31. Uludag B, Usumez A, Sahin V, Eser K, Ercoban E. The effect of ceramic thickness and number of firings on the color of ceramic systems: an in vitro study. J Prosthet Dent 2007;97: 25–31.
32. Chaiyabutr Y, Kois JC, Lebeau D, Nunokawa G. Effect of abutment tooth color, cement color, and ceramic thickness on the resulting optical color of a CAD/CAM glass-ceramic lithium disilicate-reinforced crown. J Prosthet Dent 2011; 105:83–90.
33. Dede DO, Armaganci A, Ceylan G, Cankaya S, Celik E. Influence of abutment material and luting cements color on the final color of all-ceramics. Acta Odontol Scand 2013;71: 1570–8.
34. Azer SS, Ayash GM, Johnston WM, Khalil MF, Rosentiel SF. Effect of esthetic core shades on the final color of IPS Empress all-ceramic crowns. J Prosthet Dent 2006; 96:397–401.
35. Ghulman MA, Awad MA. Color variation between matched and fabricated shades of different ceramics. Journal of Prosthodontics. 2013 Aug 1; 22(6):472-7.