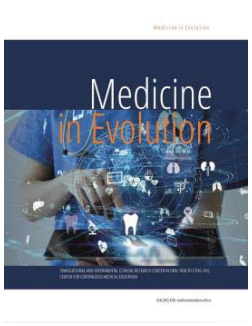
Shade evaluation of pressed ceramic and milled zirconia crowns. A qualitative study.



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Abstract

Despite high aesthetics, shade of full ceramic restoration can be a difficult task specially in case of anterior single crown restorations.

For the first group, ten ceramic crowns for anterior teeth were made from IPS e.max Cem. The pressed ceramic cores were veneered with feldspathic ceramic IPS e.max.Ceram. For the second group were milled ten samples zirconium oxide cores and veneered with feldspathic ceramic IPS e.max.Ceram. The evaluation of core influence over the final shade is checked with a spectrophotometer and standard shade guide.

The shades of the samples of two groups were registered in three areas of the buccal surface: third incisal, third middle and third cervical. The shades were digitally registered with Vita Easy Shade Compact and with standard Vital Classical shade guide.

Samples that require accurately individualized aesthetics may encounter final shade modification.

The digital system for shade registration have high precision and avoid human error.

Keywords: Pressed ceramic, zirconia, spectrophotometer

INTRODUCTION

Restorative prosthodontic uses dental materials which accomplish two main features: aesthetics and mechanical resistance [1]. Research and development in the field of dental materials introduced performant and highly aesthetic dental materials [2, 3].

Though zirconia is a very popular dental material, the white shade limits the natural appearance of the restauration and for this reason, the shaded zirconia blocs and pigments for veneering ceramic can be used to achieve a natural appearance. Some researches state that the pigments may negatively affect the mechanical characteristics of zirconia [4]. Many researches of the last decades were dedicated to dental materials shades [5.6]. CAD-CAM a promising technology is currently used in prosthodontics and with limitation in orthodontics and surgery [6]. The type of zirconia and the thickness of the veneering ceramic [7] can influence aesthetic aspect of prosthetic restoration made on zirconium cores and veneered with ceramic [8]. The use of zirconium based on Ytriu in the restauration of anterior teeth is limited because of the optical properties of this material. The low translucency and high opacity of zirconia may have a direct impact over aesthetics [9, 10]. The polycrystalline ceramic has a complex optic characteristic at direct and indirect light [7]. The shade of dental materials and dental hard tissue are check with classic shade guides, or digital devices, which register, and process the information collected after scanning the dental tissue or dental material [11, 12] Spectrophotometer is designed to quantify the light reflected by an object and identify in this way the object's shade [13].

MATERIAL AND METHODS

Pressed and milled cores were made with the same CAD-CAM technology. The samples of first group were made from zirconia and veneered with ceramic. The cast was scanned with Vinyl scanner (Smart Optics) which is compatible with the Exocad software that can work for the CAD system. First, in the software are chosen the teeth, then the limit of the marginal preparation is selected. It is also stetted the thickness for the luting cement (fig.1). The crowns digital design is made after a selection from the library. The software is reducing the size of the crown until the restauration perfectly fits to the abutment and to dental arch size but in the same time is calculating the needed space for veneering ceramic.

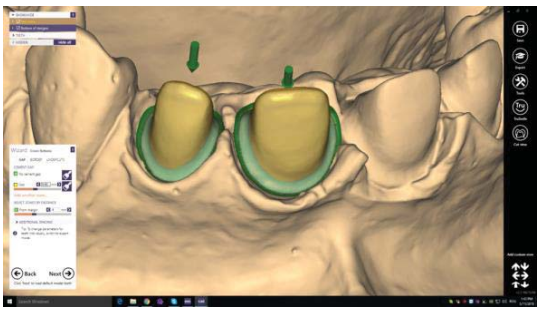

Figure 1. Digital design of the zirconia coping on the scanned cast

After the design is done, the information and parameters are imported in the CAM software. For this study was used the shaded zirconia IPS e.max ZirCad (Ivoclar Vivadent, Schann, Lichtenstein), shade LT2 which is compatible with the shade of veneering ceramic. After the disc is scanned is settled the milling strategy and it is made a simulation to verify the collected and settled data (fig.2).

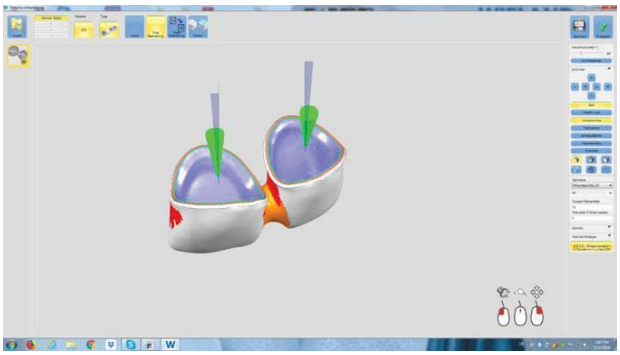

Figure 2. The chosen milling strategy

Zenotec Select Hybrid (Wieland Dental, Germany) milling device was engaged for the milling technological procedure, two cores are milled in 25 minutes. The cores and rods are cut from the disc with dedicated high speed burs and the surface finished. After the milling process, zirconium has a chalk like aspect and need to be sintered for 8 hours and 44 minutes at 1500^0C.

Samples of group 2, pressed ceramic, were made on the same digital design. The pattern of the cores are milled in wax. Zenotec Select Hybrid (Wieland Dental, Germany) combines a computer numerical control (CNC) milling system and uses five simultaneous milling axes. The wax pattern is placed on the wax disc and the milling process can start. One coping of 2 elements is milled in 10 minutes.

The cores milled in wax were invested with JP Vest, Just Pressables, UK investment material and liquid. LT A2 (Low Translucency A2) shade was used for all the samples. The ceramic ingot is placed in the Programmat EP 3000 (Ivoclar Vivadent, Schaan, Lichtenstein) are heated and pressed by an isolated piston -to avoid the ceramic bonding to the piston. After slow cooling the investment material is removed through sandblasting with Al_2O_2 250 μm at a pressure of 2 Barr.

a. 

Figure 3a. zirconia copping

b. 

Figure 3b. Pressed ceramic coping

The core of both zirconia and pressed ceramic samples were veneered with feldspathic IPS e.max Cem (Ivoclar Vivadent). It was painted a layer of Opal Effect followed by sintering with Foundation program at 750^0C. For the veneered dentin were used three types of ceramic: Deep Dentin A2 is laid on the entire core surface and Deep Dentin A1 for the lobules; these two ceramics were sintered together at 750^0C with the Dentin/Incisal program (Fig.4). The last sintered ceramic layer was Enamel Transpa neutral.

For the shade individualization were used pigments. It was used a combination between Opal Effect Violet- pigment with violet shade and Opal Effect 1 –pigment with yellow shade and Powe Incisal 1 combined with Transpa Neutral – pigment with blue shade (Fig. 4). These layers were sintered at 750˚C. If it was necessary, the ceramic was processed after sintering. The last layer of ceramic was Enamel Transpa neutral 1/3 ceramic and the rest Power Incisal 1 followed by sintering. The last layer was the glaze Ivocolor followed by sintering with the proper programme.

Figure 4. Ceramic layering

RESULTS

Spectrophotometer VITA Easyshade Compact was engaged in the shade evaluation of pressed veneered ceramic and zirconia veneered crowns. The shade registrations are made in three areas of the buccal surface of all samples: third cervical, third middle and third incisal. (Fig 5.a, b and Fig. 6.a, b). The registered results are compared with the ones registered with Classical Vita shade guide.

Figure 5a. Shade registration for zirconia crowns

Figure 5b. Shade of sample 5 group 2

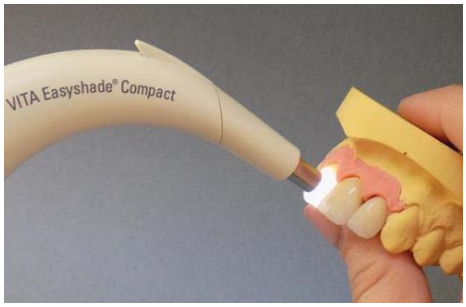

Figure 6a. Shade registration-pressed ceramic crowns

Figure 6b. Shade of sample 2 group 1

Spectrophotometer's registering probe is placed perpendicular and in full contact with the crown. The device can register the main shade of the crown but in the same time have the option to register the shade of third cervical, third middle and third incisal area. After the same criteria was used the shade registration with Vital Classical shade guide.

The same protocol is applied for both groups of samples; group 1 – veneered pressed ceramic core (Table 1) and group 2- veneered zirconia core (Table 2). The main registered shades were A3 in third cervical, A2 in third middle and A1 in veneered zirconia core third incisal for veneered pressed ceramic core crowns (Table 1).

The matching shade of the veneered zirconia crowns with Vita Classical were A3.5 in the third cervical, A2 for third middle and A1 for third incisal area (Tabel 2).

Only three samples of both groups registered differences only in the third cervical area. Possible due to more thicker layer of veneering ceramic and quantity of pigment.

Table 1. Group 1.- veneered pressed ceramic crown registered with Vita Easy Shade and Vital Classical

Sample No.	Thrid Cervical Easy Shade Compact	Third Middle Easy Shade Compact	Third Incisal Easy Shade Compact	Vita Classical Shade Guide
1	A3	A2	A1	Identic
2	A3	A2	A1	Identic
3	A3	A2	A1	A3,5, A2, A1
4	A3	A3	A2	Identic
5	A3	A2	A1	Identic
6	A3,5	A3	A2	Identic
7	A3,5	A3	A2	Identic
8	A3	A2	A1	Identic
9	A3	A2	A1	Identic
10	A3	A2	A1	Identic

Table 2. Group 2 Shade of zirconia veneered crowns registered with Vita Easy Shade and Vital Classical

Sample No.	Thrid Cervical Easy Shade Compact	Third Middle Easy Shade Compact	Third Incisal Easy Shade Compact	Vita Classical Shade Guide
1	A3	A2	A1	Identic
2	A3.5	A2	A1	Identic
3	A3	A2	A1	Identic
4	A3,5	A3	A2	Identic
5	A3	A2	A1	Identic
6	A3,5	A2	A1	A3, A2,A1
7	A3,5	A2	A1	Identic
8	A3,5	A2	A2	A3, A2,A1
9	A3,5	A2	A1	Identic
10	A3,5	A2	A1	Identic

DISCUSSIONS

Dental materials and modern technologies can achieve highly aesthetic indirect restauration, which can accurately reproduce the natural morphology and shades. Indirect restorations of anterior teeth demand beyond good mechanical properties also precise ceramic layering techniques for high mechanical and optical properties [14, 15, 16]. For achieving natural tooth appearance dental ceramic need to fulfil the optical characteristics of natural teeth like translucency, opacity, reflection are the consequence of partial transmission of light. The sintering process may influence the translucency especially if pigments are layered. The thickness of core and veneering ceramic may directly influence the shade. [17, 18].

Specific to the spetrophotometer measurents is the light emitid by the measuring tip is reflected by the tooth surface back in the spectrophotometer. Measuring color in a translucent incisal edge can produce a false result because of the amount of grey shade perceived by the spectrophotometer can be influenced.

The Classical Vita shade guide is a standard widely used shade guide with sixteen shades that are covering the natural shades of the teeth. The disadvantage of colour registration with this guide is related to the light source and the human error. [19]

Veneering ceramic has a great impact over aesthetics, especially for zirconia crown. Zirconia is highly opaque, has a dominant white shade and the natural translucencies of

enamel is difficult to be reproduced. A shaded zirconia core can compensate this disadvantage and associated with veneering ceramic are obtained aesthetical results [20, 21].

IPS e.max Cem (Ivoclar Vivadent) is available in several shades and translucencies and a correct layering can have an excellent aesthetic appearance. Total ceramic thickness can affect the translucency. If the ceramic thickness is increased, the translucency will minimized mainly in the third incisal [22].

CONCLUSIONS

One sample of the first group (sample no 3) - veneered pressed ceramic core registered a different shade A3,5 in the third cervical at the Vita Easy Shade Compact spectrophotometer shade registration.

Two samples of the second group veneered zirconia core registered A3 with Vita Classical and A3.5 with Vita Easy Shade Compact spectrophotometer. The difference in shade was also in the third cervical.

The quantity of pigments and thickness of veneering ceramic may influence the shade.

The veneered pressed ceramic crowns have better optical appearance and aesthetics due to the chemical composition and optical properties. There are no chromatic significantly differences between the two groups due to the use new generation of shaded zirconia. The application of pigments can influence the final shade of the crowns for both groups. The digital system for colour registration have their advantages, are used for shade registration and validation, and eliminates the human errors.

REFERENCES

1. Sen N, Olcer Y: Mechanical and optical properties of monolithic CAD-CAM restorative materials, J Prosthet Dent 2018 Apr;119(4):593-599
2. Vâlceanu SA: Noţiuni de estetică dentară, Timişoara 2010
3. Porojan L, Porojan S., Topală F., Savencu C.: Procedee computerizate aplicate în tehnologia protezelor dentare fixe, Ed. Eurobit Timişoara, 2015
4. Sedda M, Vichi A, Carrabba M, Capperucci A, Louca C, FerrariM: The journal of prosthetic dentistry „Influence of coloring procedure on flexural resistance of zirconia blocks". J Prosthet Dent. 2015 Jul;114(1):98-102
5. Chu SJ, Trushkowsky RD, Paravina RD: Dental color matching instruments and systems. Review of clinical and research aspects. J Dent 2010;38 Suppl 2:e2-16 2010 Aug 1
6. Paravina R, Stankovic D, Aleksov L, Mladenovic D, Ristic K. Problems in standard shade matching and reproduction procedure in dentistry: a review of the state of the art. Facta Universitatis, Serbia. 1997; 4(1):12-6
7. Miyazaki T, Hotta Y, Kunii J, Kuriyama S, Tamaki Y: A review of dental CAD/CAM: current status and future perspectives from 20 years of experience, Dent Mater J 2009 Jan;28(1):44-56
8. Hadjieva H, Dimova M: Visualization of the clinical observations in the different stages of the dental prosthetic treatment process. Pharmacologyonline. 2008 Aug 30;2:99 104
9. Kumagai N, Hirayama H, Finkelman MD, Nagai SI: The effect of translucency of Y-TZP based all ceramic crowns fabricated with different substructure designs. J Dent. 2013. 41(3):87-92
10. Habib SR, Al Shiddi IF: Comparison of shade of ceramic with three different zirconia substructures using spectrophotometer. The Journal of Contemporary Dental Practice, February 2015;16(2):135-140
11. Ayas GM, Ossman E, Segaan LG, Rayyan M, Joukhadar C: Influence of core color on final shade reproduction of zirconia crown in single central incisor situation – An in vivo study. J Clin Exp Dent. 2020 Jan; 12(1): e46–e51
12. Paravina RD: Performance assessment of dental shade guides. J Dent. 2009; 37(Supl 1):e15-20

13. ALGhazali N, Burnside G, Smith P.W, Preston A.J, Jarad F.D: Performance Assessment of Vita Easy Shade Spectrophotometer on Colour Measurement of Aesthetic Dental Materials, The European journal of prosthodontics and restorative dentistry, December 2011
14. Tabatabaian FJ: Color Aspect of Monolithic Zirconia Restorations: A Review of the Literature Prosthodont 2019 Mar;28(3):276-287
15. Pekkan G, Pekkan K, Bayindir BC, Özcan M, Karasu B: Factors affecting the translucency of monolithic zirconia ceramics: A review from materials science perspective. Dental Materials Journal 2020; 39(1): 1–8
16. Tabatabaian F: Color in Zirconia-Based Restorations and Related Factors: A Literature Review. Journal of Prosthodontics, Implants, Esthetic and Reconstructive Dentistry. 09 January 2018
17. Durkan R, Şimşek H, Gökay GD, Yilmaz B: Effects of sintering time on translucency and color of translucent zirconia ceramics, Journal of Esthetic and Restorative Dentistry 27 February 2021
18. Luo XP, Zhang L: Effect of veneering techniques on color and translucency of Y-TZP. J Prosthodont 2010;19:465e70
19. Todorov R, Yordanov R, Peev T, Zlatev S: Shade Guides used in the Dental Practice. Journal of IMAB - Annual Proceeding (Scientific Papers). 2020 Apr-Jun;26(2)
20. Willard A, Tien- Chu MG: The science and application of IPS e.Max dental ceramic. Journal of Medical Sciences, 2018, 34, 238-242
21. Zarone F, Ferrari M, Mangano FG, Leone R, Sorrentino R: Focus on Lithium Disilicate Ceramics, International Journal of Dentistry Volume 2016, Article ID 9840594
22. Kursoglu P, Pelin P, Karagoz F, Motro D: Translucency of ceramic material in different core-veneer combinations. The Journal of Prosthetic Dentistry,Volume 113, Issue 1, January 2015