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The Influence of Co-Cr Thickness on The Color Parameters of Metalo-Ceramic System

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الخلاصة

الاهداف: سُمك معدن الكوبلت كروميوم تحت الخزف في نظامِ الخزف المعدني يُمْكِنُ أَنْ يُؤثّرَ على مقاييس اللونَ. تَحرّتْ هذه الدراسةِ تأثيرَ السُمكِ المختلفِ للمعدن على مقاييس اللونَ. **المواد وطرائق العمل:** تم صنع ثلاثون عينة من المعدن (10x10) مليمترِ طول ، وعرض، على التوالي بتَغيير السُمكِ (0.3، 0.5، 1) مليمتر، تم اختيار (A1, A3.5) مِنْ البنيةِ الخزفيةِ ثم بناءها على المربعاتِ المعدنيةِ خمسة عيناتْ لِكُلّ سُمك، وتم إختبلوها بواسطة colorimeter لقيَاْس مقاييس اللونَ. **النَتائِج:** اظهرت النتائج ان هناك زيادة هامة في متوسط قيمة (L* مِنْ 0.3)سُمكِ مليمترِ المعدنيِ لكلا اللونين على حساب السُمكين الآخرينِ للمعدن في (P <0.05). **الاستنتاجات:** كان هناك زيادة في (قيم L* للسمك 0.3)مليمترِ، لم يكن للسُمك المعدني تأثيرُ على قِيَم (b* a*).

ABSTRACT

Aims: The thickness of Co-Cr metal beneath the ceramic in the metalo-ceramic system can affect the color parameters. This study investigated the effect of different thicknesses of Co-Cr plate on the color parameters**. Materials and method**: Thirty square Co-Cr samples were made (10x10)mm length, width, respectively with varying thickness (0.3, 0.5, 1)mm, two shades (A1, A3.5) of ceramic build on the metal squares five of each thickness, and they were tested by colorimeter to measure the color parameters. **Results**: Mean L*value of 0.3mm metal thickness of both shades have shown a significant increase on expense of other thicknesses at (P>0.05). **Conclusions**: L* values were increased with the decrease in the metal thickness to a value near the opaque layer thickness, and decreased with the increase of metal thickness up to five folds of opaque layer thickness, metal thickness had no effect on the means of a*b* values**.**

Key words: color parameters, metalo-ceramic, cobalt chromium.

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INTRODUCTION

Many authors have investigated the use of telescopic removable partial dentures in the oral rehabilitation such treatment suggests the use of combination of ceramic crown to retain the removable partial dentures.[1] Despite the evolution and constant progress in the use of all ceramic restorations[2] metal-ceramic restorations are till now considered a good option for oral prosthetic treatment[3-7] because of their mechanical strength.[8,9] The use of different types of alloys for these restorations became more popular in the 1960s, because of high cost of gold alloys. These alloys have a high mechanical properties like rigidity that permits the fabrication of thin metal frames.[10] Nickel-chromium and cobalt-chromium alloys are the most used due to their low cost and high rigidity.[11,12]All-ceramic restorations that permit light transmission are the material of choice when translucency is required to achieve an esthetic match with the adjacent dentition.[13] The translucency and color are partially affecting the esthetic of restoration.[14]) The shade of ceramic restorations is determined not only by the color of the ceramic, but also by the thickness of the ceramic, the thickness and the color of the luting agent, the thickness of the metal frame and the color of the underlying tooth structure.[15] The natural appearance is a desire and to achieve a natural appearance of the ceramic restoration, it is necessary to incorporate layers of porcelain of different opacity and shade (opaque, dentine, and glaze). The ceramic layers thickness and the combination has been shown to affect the final appearance of all-ceramic, and metal-ceramic restorations.[16-20] One of the main goals in the industries when it deals with the colorant agents is to find the correct proportions of the coloring agents to achieve the final desired goal. Trial and error techniques is one of the most famous methods in measuring the exact color match, the computer color matching (CCM) is widely used method to measure the color between two objects.[21] This method can help inexperienced persons in color matching, where it is more convenient than trial-error method, accurate, and time saving.[22]

Aims of the study:

This study investigated the effect of different thicknesses of Co-Cr plate on the color parameters. This was achieved by simulating what happens in the laboratories when the metal thickness increase on expense of the ceramic part, where in this case the ceramic part thickness will decrease due to the increase in the metal thickness.

MATERIALS AND METHODS

Thirty specimens of Metal plates were fabricated from sheets of wax. These square samples (10x10xT) (length, width, and thickness respectively) were sprued and invested in a phosphate-bonded investment (Biosint-supra, Degussa, Germany) (4 specimens in each ring), according to manufactures instruction. The alloys (Biosil, Degussa, Germany) were melted in crucibles [23]. The metal was melted in broken arm centrifuge (Motor-cast, Degussa, Germany) using gas-oxygen torch[23] Then, the side to which the porcelain was bonded further grinded with carbide bur in one direction and polished with rubber disks[23]. The metal square samples were divided according to their thickness value (T) into three groups (0.3, 0.5, 1)mm. These samples were subdivided into two major groups according to the shade of porcelain (A1 and A3.5) that would be build on the metal, where each one of (A1, A3.5) groups contained five samples with metal squares of 0.3mm thickness, five samples of metal squares with 0.5mm thickness, and five metal squares with 1mm thickness, the metal samples were oxidized in an (Ivoclar, oven, programat X1, Germany) with the criteria shown in Table (1) according to the manufacturer instruction, sandblasted in the sandblasting machine (Perstrahl 2, Degussa, ,Germany)with aluminum oxide (125 µm) this procedure were standardized with device that kept the metal samples at a constant distance (4.5 cm) from the sandblaster nozzle at 6-7bar of pressure with the nozzle at 90º angle to the metal surface for 30 second[24] , and then they were oxidized Table(1)

Table (1): standard IPS classic program of firing recommendation of Ivoclar oven
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	Stand by temperature °C	Closing time minute	Temperature increase rate °C/min	Holding Temperature °C	Holding time min	Total Time min
Oxidation	403	0.30	140	980	1	6.15
Opaque	403	6	80	980	1	9.11
Dentine	403	4	60	980	1	10.40
Glaze	403	4	60	980	1	10.15

The porcelain then build on the metal samples with (10x10)mm length, and width of porcelain, the application of porcelain started with the application of opaque layer 0.2mm thickness. Then the dentine layer were applied on the metal square plates which were placed in special mold made from acrylic resin (10X10X2)mm length, width, and depth respectively to obtain uniform thickness of the metal-porcelain samples (2mm) for all the samples, sintered in the oven as shown in Table (1), the thickness of the metal samples, and the porcelain that covers completely one side of the metal were optimized with the use of digital vernier(0.0001mm accuracy) at five different locations access ceramic was removed by special diamond burs, this will simulate what happens when the thickness of metal increase on expense of the ceramic layer in a real restoration and vice versa. Finally, the glaze layer were applied on the porcelain as the final step of porcelain build up process as shown in Table (1). For all prepared specimens, color was measured using a colorimeter (Easy shade, vita company, Germany). Color observations were performed using one illumination light. The color values h, b, and c that were collected from the colorimeter were transformed into their corresponding L*a*and b* respectively, by Photoshop computer program to facilitate the statistical analysis, the statistical examination were carried out by using SPSS program using ANOVA and Duncan's multiple range tests.

RESULTS

Descriptive statistics (mean, standard deviation, standard error, minimum, and maximum mean) for color parameters of each group have been shown in Table(2).

Table (2): descriptive statistics of the color parameters f the two groups.

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
A1L	1mm	5	85.00	.707	.316	84	86
	0.5mm	5	86.40	2.702	1.208	82	89
	0.3mm	5	90.60	1.673	.748	88	92
	Total	15	85.65	2.033	.455	82	89
A1a	1mm	5	-17.20	.837	.374	-18	-16
	0.5mm	5	-17.60	1.517	.678	-19	-15
	0.3mm	5	-17.20	.837	.374	-18	-16
	Total	15	-17.25	.967	.216	-19	-15
A1b	1mm	5	23.60	.894	.400	22	24
	0.5mm	5	24.40	2.510	1.122	20	26
	0.3mm	5	23.60	1.517	.678	21	25
	Total	15	24.55	2.012	.450	20	29
A3.5L	1mm	5	76.20	.837	.374	75	77
	0.5mm	5	75.00	3.162	1.414	71	79
	0.3mm	5	89.40	.857	.394	88	90
	Total	15	74.45	3.980	.890	63	79
A3.5a	1mm	5	-19.20	1.304	.583	-20	-17
	0.5mm	5	-18.40	1.817	.812	-20	-16
	0.3mm	5	-17.80	1.643	.735	-19	-15
	Total	15	-18.65	1.531	.342	-20	-15
A3.5b	1mm	5	34.40	2.702	1.208	30	37
	0.5mm	5	32.80	3.633	1.625	29	37
	0.3mm	5	32.40	3.647	1.631	26	35
	Total	15	34.15	3.483	.779	26	40

Results of one way ANOVA test Table (3) and Duncan's multiple range test have shown that (a, and b)*values had no significant differences for all groups and subgroups, while the L* values were the only parameter that were significantly different. In the first ceramic shade group (A1) L* value for 0.3mm thickness was significantly higher than that of (0.5,1mm) thicknesses Figure (1).

Table (3): One way ANOVA test results.

	Sum of Squares	df	Mean Square	F	p-value
A1L Between	14.950	2	4.983	6.254	.003
Groups	63.600	12	3.975		
Within Groups	78.550	14			
Total					
A1a Between	.950	2	.317	.302	.824
Groups	16.800	12	1.050		
Within Groups	17.750	14			
Total					
A1b Between	30.150	2	10.050	3.436	.042
Groups	46.800	12	2.925		
Within Groups	76.950	14			
Total					
Between Groups	182.150	2	60.717	8.177	.002
A3.5L	118.800	12	7.425		
Within Groups	300.950	14			
Total					
Between Groups	6.950	2	2.317	.986	.424
A3.5a	37.600	12	2.350		
Within Groups	44.550	14			
Total					
Between Groups A3.5b	65.350	2	21.783	2.110	.139
Within Groups	165.200	12	10.325		
Total	230.550	14			

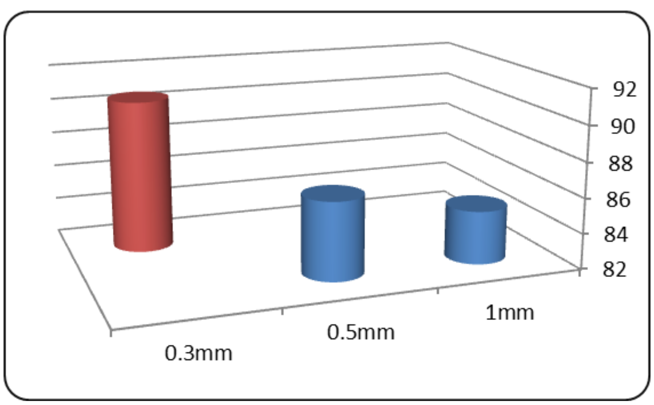

Figure (1) Duncan's multiple range test for L*color parameter of A1ceramic shade.

While the other color parameters (a, and b) there was insignificant difference between the three thicknesses. In the second ceramic shade group (A3.5) L* value for 0.3mm thickness was significantly 507 than that of (0.5,1mm) thicknesses Figure (2)

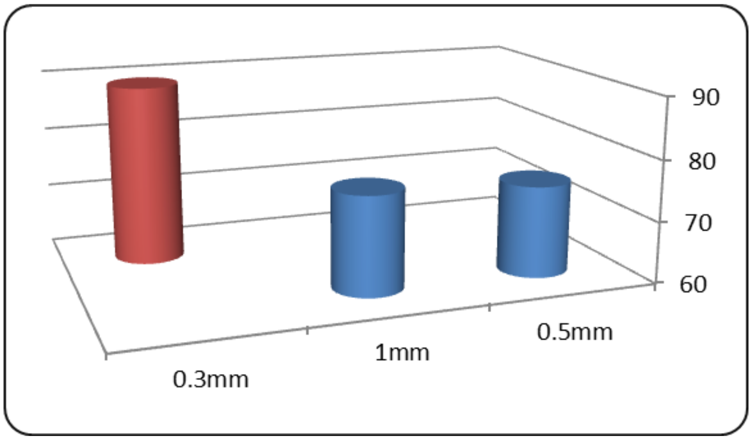

Figure (2): Duncan's multiple range test for L*color parameter of A3.5ceramic shade.

While the other color parameters (a, and b) there was insignificant difference between the three thicknesses.

DISCUSSIONS

This study has focused on the effect of metal thickness on the color parameters of ceramic layer on this metal, for this reason the thickness of the opaque layer were the same for each sample 0.2mm, and 1.3mm for the rest of ceramic layers, this will give us a clear look on the effect of metal thickness, especially when we know that there is an effect on the translucency (L*) value of both opaque thickness and ceramic thickness[(18)]). Results have shown that there is a significant increase in the means of L* value for both shades with the lowest metal thickness 0.3mm this can be explained by the absorption of the incident light that increase with the increase of metal thickness (core) and vice versa[(25),] however, this problem can be solved by increasing the opaque layer thickness, Dozic et al([18)] have investigated the effect increasing the opaque layer thickness and found that an increase in opaque layer up to 1mm could not completely mask the influence of the background. The mean of a*value did not vary significantly with varying metal thickness within the same shade, also there was no clear differences between the mean of a*value between the two selected shades this can be explained by small tendency of both colors to red as a part of color additives made by the manufacturer. All specimen did not exhibit any effect of thickness variation on the mean b*value, but when we compare between the readings of b*value of both shades we can see the tendency of b*value to increase in A3.5 group on expens 508 group, due to the fact that A3.5 shade appears more yellow in their pigment rather than A1 shade, that means higher yellow pigment in A3.5 shade in fact is the reason of this difference, and not the thickness of metal at all [18,26].

CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

1. L* values were increased with the decrease in the metal thickness to a value near the opaque layer thickness, and decreased with the increase of metal thickness up to five folds of opaque layer thickness.
2. Metal thickness had no effect on the means of a*b* values.

REFERENCES

1. Ramu C, Padmanabhan T.V., Jibran A.H. Prosthetic Rehabilitation of Maxillectomy Patient with Telescopic Dentures. Pakistan Oral & Dental Journal 2011;31(2):474-478.
2. Kumbuloglu O, User A, Toksavul S, Vallittu PK. Intra-oral adhesive systems for ceramic repairs: a comparison. Acta Odontol Scand 2003;61:268-72.
3. Chung KH, Hwang YC. Bond strengths of porcelain repair systems with various surface treatments. J Prosthet Dent 1997;78:267-74.
4. Frankenberger R, Kramer N, Sindel J. Repair strength of etched vs silicacoated metal-ceramic and all-ceramic restorations. Oper Dent 2000;25: 209-15.
5. Haselton DR, Diaz-Arnold AM, Dunne JT Jr. Shear bond strengths of 2 intraoral porcelain repair systems to porcelain or metal substrates. J Prosthet Dent 2001;86:526-31.
6. O¨ zcan M. Evaluation of alternative intraoral techniques for fractured ceramic-fused-to-metal restorations. J Oral Rehabil 2003;30:194-203.
7. O¨ zcan M, Niedermeier W. Clinical study on the reasons for and location of failures of metal-ceramic restorations and survival of repairs. Int J Prosthodont 2002;15:299-302.
8. Kelsey WP 3rd, Latta MA, Stanislav CM, Shaddy RS. Comparison of composite resin-to-porcelain bond strength with three adhesives. Dent Mater 2000;48:418-21.
9. Tulunoglu IF, Beydemir B. Resin shear strength to porcelain and a base metal alloy using two polymerization schemes. J Prosthet Dent 2000; 83:181-6.
10. Sced IR, McLean JW. The strength of metal/ceramic bonds with base metals containing chromium. A preliminary report. Br Dent J 1972;132:232-4.
11. Prado RA, Panzeri H, Fernandes Neto AJ, Neves FD, Silva MR, Mendonca G. Shear bond strength of dental porcelains to nickel-chromium alloys. Braz Dent J 2005 509 -6.
12. Mehulić K, Lauš-Šošić M , Schauper Z, Vojvodić D, Štefančić S. Influence of cast surface finishing process on metal-ceramic bond strength. Med Glas 2009; 6(2): 235-242.IVSL

13. Giordano RA. Dental ceramic restorative systems. Compend Contin Educ Dent 1996;17:779-94.
14. Kingery W, Bowen H, Uhlmann D. Introduction to ceramics. 2nd ed.New York: John Wiley; 1976. p. 89.
15. Vichi A, Ferrari M, Davidson CL. Influence of ceramic and cement thickness on the masking of various types of opaque posts. J Prosthet Dent 2000;83:412-7.
16. Antonson SA, Anusavice KJ. Contrast ratio of veneering and core ceramics as a function of thickness. Int J Prosthodont 2001;14:316-20.
17. Douglas RD, Przybylska M. Predicting porcelain thickness required for dental shade matches. J Prosthet Dent 1999;82:143-9.
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.J Prosthet Dent 2003;90:563-70.
19. Barghi N, Lorenzana RE. Optimum thickness of opaque and body porcelain.J Prosthet Dent 1982;48:429-31.
20. Jorgenson MW, Goodkind RJ. Spectrophotometric study of five porcelain shades relative to the dimensions of color, porcelain thickness, and repeated firings. J Prosthet Dent 1979;42:96-105.
21. Zhang B, LI H. Research on application for color matching in textile dyeing based on numerical analysis. Proceedings of the international conference on computer science and software engineering, Wuhan, Hubei, China 2008;Pp:357-360.
22. Agahian F. A new matching strategy: trial of the principal component coordinates. CRA 2008;33:10-18.
23. Anusavice KJ. Phillips' science of dental materials. Philadelphia: WB Saunders; 1996. p. 594-5.
24. Hofstede TM, Ercoli C, Graser GN, Tallents RH, Moss ME, Zero DT. Influence of metal surface finishing on porcelain porosity and beam failure loads at the metal-ceramic interface. J Prosthet Dent; 2000;84:309-317.
25. 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.
26. Lund PS, Aquilino SA, Dixon DL. Evaluation of the color and appearance of a new textured opaque porcelain. Int J Prosthodont 1991;4:548-54.